The Secretary
Senate Standing Committee on Rural and Regional Affairs and Transport
Parliament House
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Parliament of Australia Senate Inquiry into Water Management in the Coorong and Lower Lakes

11 September 2008
Maria Riedl

The ecological health and condition of the Coorong and Lower Lakes continues to decline and this is due to the reduction of freshwater flows. The quality and quantity of habitats for waterfowl in the Coorong have been greatly reduced in recent years and continue to deteriorate. River Murray flows are inadequate to keep the mouth open. All migratory waders are in low abundance in the summer 2006/07.[1]

It is fairly obvious that the impacts on the Coorong and the Lower Lakes as well as other Icon sites along the River Murray are a result of; firstly the over-allocation of water, secondly the drought, and thirdly, a step change in the climate as a result of climate change. The inaction of Governments on all levels has resulted in the devastation that we see happening now in all the rivers of the Murray-Darling Basin. Since the signing of the 1994 CoAG National Water Reform Agreement it is fairly obvious that both State and Commonwealth governments have acknowledged there was a problem. The media release by the National Water Commission says that States have not done enough and that they must do more about ecological sustainability and adhere to what they have signed up to many years ago and again in March and then July. There is no excuse what-so-ever about the state of the Murray-Darling Basin. Absolutely none. It is of no use to blame the drought and climate change as these issues were known and it was known and publicly acknowledged in legislation that something had to be done. There has only been tinkling at the sides as over allocation is still unaddressed.

The Goulburn and the Murrumbidgee both tributaries of the Murray River are deemed to be the worst of 23 rivers in the Murray-Darling Basin. The Intergovernmental Agreement is simply not working, the arrangements are not adequate and the various governments that are signatory to the Agreement are simply not adhering to what they signed on to do. It is a terrible state of affairs when State governments are prepared to act inconsistently with their own legislative obligations as well as National Obligations and even International Obligations.

[1] Murray Darling Basin Commission, The Living Murray Icon Site Condition Report, October 2007.

This is a short history of the main actions establishing The Living Murray (TLM):

- April 2002-the Murray-Darling Basin Ministerial Council agrees to invest $150M in environmental works and measures and to investigate water recovery
- November 2003- The MDBMC agree to the First Step decision to invest $500 million to recover up to 500 GL of water for TLM for management in conjunction with the environmental works and measures
- June 2004- First Ministers of the MDBBMC signed the *Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray-Darling Basin* (the Intergovernmental Agreement) providing a framework for investment
- April 2005- Intergovernmental Agreement operational through The Living Murray Business Plan, and included a requirement for the Independent Audit Group ('IAG') to audit progress in the implementation of The Living Murray. The Business Plan was updated in May 2007
- June 2006- The Australian Government invested a further $500m through MDBC for additional water recovery (a notional $200m) and further funding of the Environmental Works and Measures program (approx $100m)

The focus of The Living Murray is to recover water and implement works to achieve specific environmental outcomes for six Icon Sites along the River Murray. The six Icon Sites are:

- Barmah-Millewa Forest;
- Gunbower Koondrook-Pericoota;
- Hattah Lakes;
- Chowilla Floodplains (including Lindsay-Wallpolla);
- Murray Mouth, Coorong and Lower Lakes; and
- River Murray Channel

As of 30 June 2007, no water has been recovered against the target of 500GL. The volume listed on the Eligible Measures Register is 273.45GL.[2]

It has to be acknowledged that there is an interaction between groundwater and surface water that streams, tributaries, wetlands, aquifers, rivers and floodplains are all connected.

Recognition of the need for a more integrated and coordinated national approach to water management led to the development of the National Water Initiative (NWI). Agreed in 2004, the NWI represents a shared commitment by the Australian Government and state and territory governments to achieve a nationally compatible market, regulatory and planning based system of managing water resources.
In particular, the NWI provides a framework to address and deliver the more difficult COAG water reform commitments, and focuses on areas in which greater compatibility across jurisdictions in the approaches adopted to water management would enhance outcomes.

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[2] Independent Audit Group, Audit of The Living Murray Implementation 2006/07, May 2008.

There are opportunities to accelerate the implementation of the NWI and improve water management more generally through further measures under the National Plan for Water and other collaborative efforts between different levels of government.[3]

The CoAG agreement on water is an acknowledgment that the system is over allocated and this allocation has yet to be addressed.

[3] National Water Commission, Update of Progress in Water Reform, 15 February 2008.

However, there is still room for improvement in identifying, quantifying and incorporating environmental outcomes in water plans; and integrating surface and groundwater management. The slow delivery of water plans is a potential threat to achieving NWI outcomes on a state-wide and national scale.
Almost all states have made statutory provision for environmental and public benefit outcomes within water plans to protect water sources and their dependent ecosystems. While policies, plans or management frameworks to address over-allocation or stress have largely been put in place, specific results have been less evident and possible over-allocation remains a major concern, particularly in the Murray-Darling Basin. Climate change is anticipated to exacerbate this problem in many areas, highlighting the importance of a more effective assessment of risks to water availability into water planning across the country. The CSIRO Sustainable Yield Project represents the benchmark of a robust, basin-wide estimate of the future availability of water resources, taking into account climate change and other risk. The results of this project, together with other information, will provide a much better basis for informing the development of new sustainable diversion limits for the surface and groundwater systems of the Murray-Darling Basin. However, New South Wales has advised that the roll out of water sharing plans in unregulated systems and in groundwater systems in inland New South Wales has been slowed awaiting the results of the project.[4]

The following is what is happening next year and in all likelihood the Coorong and Lake Alexandrina and the Lower Lakes will be listed on the Montreux Record and they will be removed from the Ramsar list.

World Wetlands Day 2009. It's not too early to begin thinking about it. **"Upstream – Downstream"**. **Wetlands connect us all**. Our suggested theme for this year is river basins and their management. We all live in a river basin (or drainage basin, catchment, watershed, etc.), and most of the people reading this are well aware of the challenges of managing it – and particularly the challenge of making sure that the basin planners think of wetlands and not just water in their planning.

We hope that WWD this year, 2 February 2009 or thereabouts, will be an opportunity for people to look around at their own wetland and its interconnections with the environment around it – how the wetland benefits the surroundings and, of course, how activities throughout the river basin may affect their wetland. **Read more here about what the Secretariat is planning to make available.** [07/08/08] español

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[4] Ibid 4.

The Ramsar Convention on Wetlands

10th Meeting of the Conference of the Contracting Parties

français español

RAMSAR CHANGWON 2008

What is the COP?

"Healthy Wetlands, Healthy People"
10th Meeting of the Conference of the Contracting Parties
to the Convention on Wetlands (Ramsar, Iran, 1971)
Changwon, Republic of Korea, 28 October - 4 November 2008

Pre-COP Information

General and pre-registration information	PDF
Side events request -- request form in Word, PDF	PDF
Exhibition space request -- form in Word, PDF	PDF
Excursions (2nd November) information	PDF
Pre-/Post COP Excursion programmes; early morning wetland visits during COP (external link)	
Accommodation information	PDF
Accommodation application guidelines	PDF
Travel from Seoul to Changwon	PDF
Visa information	PDF
Exhibition of children’s pictures	PDF

Pre-registration for COP10

General and information documents

Draft Resolutions

National Reports received (PDF)

The deadline for submitting National Reports was 31 March 2008.

Ramsar pre-COP Regional Meetings

Meeting	Dates	Venue
IV Panamerican Ramsar Regional Meeting	18-21 September 2007	Mérida, Venezuela
5th Pan-African Regional Meeting in preparation for COP10	26-30 November 2007	Yaoundé, Cameroon
Asian Regional Preparatory Meeting for COP10	14-18 January 2008	Bangkok, Thailand
Caribbean Regional Meeting on the implementation of the Convention	8-10 April 2008	Havana, Cuba
4th Oceania Regional Meeting for the Ramsar Convention	10-11 April 2008	Apia, Samoa
6th European Regional Meeting	3-7 May 2008	Stockholm, Sweden

RAMSAR CHANGWON 2008

For further information about the Ramsar Convention on Wetlands, please contact the **Ramsar Convention Secretariat**, Rue Mauverney 28, CH-1196 Gland, Switzerland (tel +41 22 999 0170 , fax +41 22 999 0169, e-mail ramsar@ramsar.org). Posted 15 October 2007, updated 8 July 2008, Dwight Peck, Ramsar.

The Ramsar Convention and the Montreux Record

Wetlands on the List of Wetlands of International Importance (the List) under *The Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971*, commonly known as the

Ramsar Convention,85 are selected on the basis of their "international significance in terms of ecology, botany, zoology, limnology or hydrology".86 Once a wetland is included on the List by a contracting party, the State is obliged under the terms of the Convention to, among other matters, "Formulate and implement their planning so as to promote the conservation of wetlands included in the List".

The *Ramsar Convention* provides for the contracting parties to adopt recommendations to promote the functions of the Convention and for them to take such recommendations into account in managing wetlands.87 The Conference of the Parties to the *Ramsar Convention* has created a public register to draw attention to sites where an adverse change in ecological character has occurred, is occurring or is likely to occur, to indicate that the site is in need of priority conservation attention. The register is known as the *Montreux Record*.88

The Commonwealth is able to request that the Ramsar Secretariat include a Ramsar listed site in need of priority conservation attention on the *Montreux Record*. It is also open to anyone to raise the issue with the Ramsar Secretariat, which will in turn bring it to the attention of the Contracting Party. Including a site on the *Montreux Record* (and subsequently removing a site) is always a matter for the contracting party.

There are at present 57 sites listed on the *Montreux Record* including sites in both the United Kingdom and the United States.
No Australian Ramsar sites have been listed to date.[5]

The Following I pulled out of an article written by John Scanlon and the reason I inserted it here is that you already know what needs to be done, to do Inquiry after Inquiry and study after study so on so forth does NOT get the job done!!!!! Here is a man who has stated ALL of what you are asking for in 2006, that is two years ago, before our rivers, wetlands, tributaries, floodplains had degenerated to the terrible terrible state that they are in,

It is no good asking us over and over again what we want because when we suggest, when we try to guide you, it becomes a POLITICAL football. (and I must add here I hate football!) this is not how it should be, this is not what will fix the problem.

You will only fix the problem if you address it with conviction, with a will to ensure what you have said you will do you do. It is no longer acceptable, as if it ever was for governments to play around with our water, with our environment and put the blame on the drought, on climate change.

Wrong!

Climate Change and the drought are not the ones responsible for this complete and utter mess, it is you the governments, both State and Federal, why; because you play politics, you take your eyes of the ball and the ball is lost. You have lost the ball, not us, you adn it is time that someone, anyone took responsibility and moved on to address the issues.

It is totally unfair to blame farmers and people that live along our rivers for the state we are in. We don't make the laws and rules, you do. You have just ignored them while forcing us into a corner. Forcing the environment into a corner it is struggling to escape from.

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[5] Scanlon, John, A Hundred years of negotiating with no end in sight: Where is the Murray-Dar;ing Basin Initiative leading us? 23 EPLJ 399 (2006).

Please read the following as it clearly states what has been agreed to and what can be done and what has NOT been done.

I say shame on the governments (politicians too), shame on you. (not you personally!)

It is time for the States to give up control of water because they have totally destroyed the Murray-Darling Basin. There needs to be Commonwealth powers "to obtain and deliver water" to the environment. There needs to be punitive measures brought to bear upon States that do not comply with the National Water Initiative and the Ramsar Convention, the Cap, those matters listed in the EPBC Act 1999.

Why should the Federal government be the one who pays for the States mistakes? Why should Victoria in particular be allowed to build the Sugarloaf pipeline (that is before Mr Garrett right at this moment) when it is yet another extraction from a Heritage Listed River? The savings have not been done, there is only 79% in Eildon, the Goulbusn is a tributary to the River Murray, They are planning to extract 75GL (there is a stage 3 of 150GL) and take it to Melbourne so they can flush their toilets with water from the Heritage Listed Goulburn River! How ridiculous is this?

They must not receive a single penny of Commonwealth money as they are planning on borrowing water already on the Developmental Register for the Living Murray Initiative at a time which will ensure the death of the Coorong and Lower Lakes. Unbelievable and unacceptable.

This is yet ANOTHER extraction for gods sake! This is "business-as-usual" and this is the reason why the Goulburn will die, the River Murray will die, the Coorong will die and other Ramsar listed wetlands will die...

This has to STOP, these types of rushed assessments that did not refer downstream effects in a time of over allocated rivers, longest drought ever, accelerating climate change are totally unacceptable and are in contravention of the NWI, and many many other agreements both State, Federal and International.

This is why I am just so angry. Here you are; yet again another Inquiry (I have done so many submissions in the last 2 months, I am struggling to keep up) and it too will go into a drawer and gather dust while the Victorian government merrily without due and rigorous and transparent assessment builds a pipeline that will take up to 150GL from the worst of 23 rivers in the Murray-Darling Basin so it can go back to no restrictions because the Melburnians they say are tired of them (they have used more water this year than last year!!!!!!) see page 17 of 'OUR Water Our Future the Next Stage June 2007', a Victorian government document that says they want Melbourne to go back to what it "has historically received" before= no restrictions.

Please read this:

Entering the market under The Living Murray First Step

Based upon current estimates from the Independent Audit Group, 275 GL of water will have been recovered within the five-year target period. Jurisdictions have focused their initial effort on maximising the amount of water that may be recovered through infrastructure improvement projects, in particular in the Australian Capital Territory, New South Wales and Victoria.[73]

It is apparent that the target of 500 GL of “new water” will not be achieved through infrastructure improvement projects alone and it will be necessary to purchase water from willing sellers if the target is to be achieved. The Commonwealth Parliamentary Secretary with responsibility for water, Malcolm Turnbull MP, emphasised that, “[w]e are committed to ensuring that we meet the target of restoring 500 GL to the river by 2009 … the rate of progress … is simply not good enough.”[74]

The purchase of water on the market – and the use of other market-based measures – has already been approved by the Ministerial Council through the *Living Murray Intergovernmental Agreement*,[75] is entirely consistent with the *National Water Initiative* and is fully supported by the Productivity Commission.

In order to meet the 2009 deadline, the fastest market-based measure to recover water is to purchase existing water entitlements from willing sellers through a tender process or direct purchase. There are no technical or legal impediments preventing the purchase of water from willing sellers under the laws of any jurisdiction to achieve the target of 500 GL. The timing of when to enter the market is a political rather than a technical decision and it is political considerations that have delayed entry into the market.[76]

Assessing market-based options under the *Living Murray Intergovernmental Agreement*

In December 2005 the Ministerial Council directed the Commission to report back to them in April 2006 on the use of market options, including purchasing entity options. A report prepared for the Commission[77] concludes that:

- The cost of purchasing water entitlements would be cost effective subject to the payment of any exit fees” or price effects on water entitlement markets arising from the scale of purchases.
- The purchase of 200 GL would represent some 2.3% of the long term diversion Cap for the potential Living Murray water recovery districts in the Southern Basin.
- Entitlement purchases for use under The Living Murray First Step could be progressed within the *National Water Initiative* 4% annual threshold limit on the level of entitlements to be traded out of irrigation areas.
- To progress water recoveries through market measures, there are a number of existing bodies, public and private, which can or do purchase water entitlements.
- The development of robust water registers and compatible institutional and regulatory arrangements by 2007, as already agreed under the *National Water Initiative*, will be important in enabling the use of market measures within the timeframe for water recovery for the First Step.

Some positive first steps to enter the market were made at the 40th Ministerial Council meeting in May 2006 through the package of measures put forward by The Hon Karlene Maywald MP, Minister for the River Murray in South Australia. These included the purchase of water from willing sellers and an indication from New South Wales of its preparedness to enter the market to meet its indicative an indication from New South Wales of its preparedness to enter the market to meet its indicative

[73] It is possible that Victoria will reach its jurisdictional indicative water recovery target through infrastructure improvements, but this is not the case in other jurisdictions.
[74] Commonwealth Parliamentary Secretary with responsibility for water. See Anderson L, “Grants Plan to Raise River Murray Flows”, *The Advertiser* (Adelaide, 28 April 2006)
[75] See cl 23(ii) of the *Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray Darling Basin 2004*.
[76] The purchase of water through the *Living Murray Intergovernmental Agreement* in a particular jurisdiction requires the approval of that jurisdiction under cl 43 of the *Living Murray Intergovernmental Agreement* and cl 63 of the Business Plan.
[77] See BDA Group, *Issues and Options in Applying Market Based Measures in The Living Murray First Step* (March 2006). The Ministerial Council has agreed to publicly release this report.

targets – with New South Wales having taken a lead in the "purchase of water from willing sellers in an open market place for environmental flows" through its "Riverbank Fund".[78] Malcolm Turnbull MP also detailed the Commonwealth's intention to purchase water from willing sellers by inviting tenders to sell water but on the condition that "the water offered for sale for the environment is water that can be delivered not later than 2009 and, most importantly, is water that has become available by reason of water efficiency measures".[79]

PUTTING INTO PLACE AN ENVIRONMENTAL FLOW REGIME THAT WILL ENSURE A HEALTHY SYSTEM WHILE MAINTAINING PRODUCTIVITY.

The Ministerial Council has received consistent advice from the world's best river ecologists that additional flow in the River Murray is the key to restoring it to good health. **The Scientific Reference Panel advised that at the whole-of-river scale, an additional 1,500 GL per year option alone would deliver, at best, a moderate improvement in the health of the River – assuming it was combined with improved structural and operational management.**[80] These conclusions were based on the conditions that prevailed in 2003, including any surplus or unregulated flows.

The Hon John Hill MP, then Minister for the River Murray in South Australia, in a paper delivered to the Ministerial Council in 2002 described the advice as follows:

The Murray-Darling Basin Ministerial Council received advice last April from the very best river ecology scientists in the world that, at the very least, an additional average annual flow in the Lower Murray of 1630 GL per annum would provide a moderate likelihood of a healthy working river system. I don't believe that we can contemplate a figure lower than this if we are serious about the health of the River Murray.[81]

The First Step has since been agreed through the *Living Murray Intergovernmental Agreement*, which seeks to return up to 500 GL of "new water" to the River for environmental flows by 2009 through a collective investment of $500 million; the Commonwealth has now invested significant additional funds to ensure there is no financial impediment to implementation. The First Step is just that, an essential and significant first step along the path of returning the River Murray to good health. It is intertwined with the finalisation of the Living Murray Environmental Works and Measures Program[82] to achieve the best possible environmental outcomes from the use of recovered water and existing flows,[83] including the management of surplus or unregulated flows.

It is essential that 500 GL of "new water" is recovered by mid 2009, which environmental managers will be able to make best use of through the infrastructure being developed under the Living Murray Environmental Works and Measures Program. If the "new water" is recovered and managed in accordance with the First Step, some excellent environmental outcomes can be expected, especially if surplus or unregulated flows are effectively managed (this is addressed below).

Access to permanently recovered water will allow environmental managers to trade water on the temporary market at times when not all of the water is needed for environmental purposes and to build up resources to purchase temporary water in years where they wish to manage a larger flow. **The second step of The Living Murray can open up opportunities to pursue other more novel market-based measures such as leasing water and purchasing options.84 These different market-based options should not be pursued as a part of the First Step, which should continue to focus on permanently recovering 500 GL of "new water".**

The Commonwealth has exercised strong national leadership, including making a substantial unilateral investment in the First Step to get it back on track. It is open to the Commonwealth to further support the implementation of The Living Murray First Step by enhancing its use of existing laws and related conventions.

78 See Debus B, *$105 million Fund to Rejuvenate Inland Rivers and Wetlands*, (Media Release, 30 November 2005). This funding package is not part of The Living Murray.
79 The tender has since been released. For initial announcement see Turnbull M, *Malcolm Turnbull announces new measures to recover water for the River Murray* 28 April 2006 available at http://www.malcolmturnbull.com.au/news/article.aspx?ID=423 (viewed 26 September 2006).
80 See Cooperative Research Centre for Freshwater Ecology, *Scientific Reference Panel, Ecological Assessment of Environmental Flow Reference Points for the River Murray System* (October 2003).
81 Per the Hon John Hill, *Environmental Flows in the River Murray*, Ministerial Council Meeting 32 (Adelaide November 2002).
82 Based upon Murray Darling Basin Commission budget projections in March 2006, the Environmental Works and Measures Program target completion year of 2011 would have been extended by almost 10 years to 2020. The Commonwealth injection of $500 million has put the programme back on track.
83 Through cll 108 – 110 of the Business Plan.

FEDERAL GOVERNMENT

THE LIVING MURRAY (TLM)– THE FIRST 500 GL

In August 2003 a 'First Step' decision was made by the southern Murray Darling Basin jurisdictions (the NSW, Vic, SA, ACT & Federal governments) to address water over-allocation. It committed $500 million over five years for the recovery of 500GL of water for environmental flows (E-water) to achieve specific environmental outcomes. Six significant ecological assets (SEA's) along the River Murray were identified as being in the most urgent need of immediate help. These are Barmah-Millewa Forest, Gunbower and Koondrook-Perricoota Forests, Hatta Lakes, Chowilla Floodplain, the Murray Mouth, Coorong and Lower Lakes, and the River Murray Channel. The Living Murray (TLM) Initiative has been called "the First Step" by governments because it is the initial program to return water flows back to the river and is recognised as not being the entire solution to the problem.

The "Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray-Darling Basin" (TLM Initiative) was signed on 25th June 2004 and committed the jurisdictions to the recovery of 500GL of E-water by the end of 2008-09 financial year. The financial commitment required by the jurisdictions during the same time frame is Victoria $115m, NSW $115m, SA $65m, ACT $5m and the Commonwealth $200m.

HOW CAN WATER BE RECOVERED?

Water can be recovered by either reducing waste in the system and improving the efficiency of the use of extracted water and returning the saved water to the river or by purchasing water allocations from irrigators. Purchase is on a voluntary basis from willing sellers. Compulsory acquisition is not currently an option. Purchasing water allocations is the most cost effective and quickest way to recover water but there are negative social and economic consequences associated with the resulting reduction in irrigation and agricultural production. These consequences will be felt the most by the rural communities that depend on the irrigation water extracted from the Murray Darling system.

HOW IS WATER BEING RECOVERED UNDER TLM INITIATIVE?

All water recovery proposals approved up to April 2006 under TLM initiative are for water to be recovered by improving extraction system efficiencies through infrastructure projects, or by transferring water from irrigation in good years (we have had very few of these). The infrastructure projects are measures for improving water delivery systems to reduce leakage and evaporation. These proposals are:

- Victoria Goulburn-Murray water recovery package – 145GL of water at a cost of $93million.
- Victoria Lake Mokoan water recovery package - 24GL of water at a cost of $13.7 million.
- NSW water recovery package A – 9GL of water at a cost of $8.9 million.
- NSW water recovery package B – 62GL of water at a cost of $63.25 million.

This is a total of 240GL at a cost of $179 million.

Media release

Victoria
The Place To Be

FROM THE MINISTER FOR THE ENVIRONMENT, MINISTER FOR

WATER

DATE: Wednesday, January 18, 2006

$93M WATER RECOVERY PACKAGE KICKS-OFF LIVING MURRAY

JOINT MEDIA RELEASE

The first water recovery project under the Living Murray Initiative — the plan to breathe new life into one of Australia's greatest rivers — will return 145 gigalitres a year to the environment.

The Australian Ministers for Agriculture, Fisheries and Forestry, Peter McGauran, and Environment and Heritage, Ian Campbell, and the Victorian Environment and Water Minister, John Thwaites, said the $93 million package would not only benefit some of the river's premier sites, but also Victoria's Goulburn, Loddon and Campaspe rivers.

Mr McGauran, Chairman of the Murray-Darling Basin Ministerial Council, said The Living Murray was a joint, $500 million initiative of the Australian, Victorian, NSW, South Australian and ACT governments.

Mr Thwaites said he was delighted that the first Living Murray project to be funded by the Commonwealth was in Victoria.

"Victoria is well advanced in achieving its commitment of 214 gigalitres to the Living Murray Initiative," Mr Thwaites said.

The Australian Government will contribute $37.2 million to the project and the Victorian Government at between $21.4 million and $43.7 million, depending on whether NSW and SA, which have expressed interest in the project, decide to contribute.

Mr Campbell said the project has the potential to benefit some of the river's most iconic sites.

"They include: the Hattah Lakes; the Barmah-Millewa Forest; the Chowilla Floodplain (including Lindsay-Wallpolla); the Gunbower-Koondrook Perricoota Forest; the Lower Lakes, Coorong and Murray Mouth; and the River Murray Channel."

Mr McGauran said that, as well as contributing to the Living Murray iconic sites, the Goulburn Murray Recovery Project would provide important environmental benefits to Victoria, particularly to the Goulburn, Loddon and Campaspe Rivers.

"The project will recover water from most of the regulated water supply systems operated by Goulburn-Murray Water," he said.

……………../2

"It will deliver lasting benefits to local communities in the Basin by improving infrastructure and ensuring a more flexible and certain water supply."

Mr Thwaites said the project would benefit the environment, farmers and regional communities.

"The Goulburn Murray Water Recovery Project has two main components," Minister McGauran said.

"The first involves regulatory reform to create tradeable and improved lower-reliability water entitlements with a healthy 20 per cent — equivalent to an average annual supply of 120 gigalitres — to be allocated to the environment. This entitlement will become available in 2007.

"That's a significant step towards achieving the Living Murray's target of recovering up to 500 gigalitres a year by June 2009."

Mr McGauran said the second part — worth 25 gigalitres — involved boosting the efficiency and sustainability of irrigation infrastructure, including reconfiguring the distribution systems.

The Ministers said they looked forward to their governments working together on future water recovery projects under the Living Murray Initiative.

The following are related matters because whatever happens upstream affects downstream and in this instance the effects will be magnified by the longest drought that we know of, in over 117 years, and the step change of climate change. To say that the following actions will not matter is a falsehood perpetrated by governments that have agendas that they are unwilling to share with the people.

The management of the Coorong and the Lower Lakes is without doubt a huge challenge but the Inquiry must look at the fact that removing water upstream, over 75GL, possibly 150GL will have an impact. The water has not been saved and the north has no options, unlike Melbourne. What is the point of trying to save the Coorong and the Lower Lakes if Melbourne at the other end is allowed to extract water that belongs to the environment and for how many years will this water be required or is it going to rain and flood? Does the Victorian government know something we don't, you don't that it can proceed with this? What about their 2 year long researched VEAC Red Gum Study, doesn't it state that River Red Gums that are hundreds of year old are dying because of lack of flooding and inundation? Shouldn't ring alarm bells for them? No, they have pushed this 2 ½ year study under yet another study and are intent on building a pipeline that takes even more water from them, not the reverse. Shameful and unacceptable. Melbourne has other options.

Victoria

And the Living Murray Initiative below from the website.

Goulburn Murray Water Recovery Package
The two measures within this proposal are the creation of a new medium reliability entitlement, and the implementation of plans to reconfigure distribution systems.

Medium reliability entitlement
Victoria will create a new separate tradeable medium reliability water entitlement with legal status to replace 'sales water', which has previously been made available through administrative decision. This will provide greater certainty for irrigators when making investment decisions. Twenty percent of this new entitlement will be allocated to the environment as a water recovery measure, resulting in an estimated increase in water available to the environment of 120GL, approximately two thirds of which will originate from the Goulburn and Loddon valleys. Much of this water will be available to the environment in wetter years when most environmental opportunities occur. The cost of implementing this measure includes offsets negotiated with stakeholders, such as upgrades of headworks.

High reliability water
Victoria will develop plans for reconfiguration of irrigation distribution systems. The implementation of the reconfiguration plans will result in a significant reduction of distribution system losses, and will recover 25GL of high reliability water for an estimated cost of $50m.

Lake Mokoan Water Recovery Package
This proposal is part of the larger $60m Lake Mokoan Project, the remainder of which is proposed to be funded by Water for Rivers (the trading name for the Joint Government Enterprise Limited) to provide up to 20GL for Snowy River environmental flows, and the joint Victorian and South Australian River Murray Environmental Flows Fund.

Since construction, Lake Mokoan has had ongoing water quality (blue-green algae) problems and annual evaporative losses of more than 50GL.

The Lake Mokoan Project consists of a number of infrastructure measures, including:
• decommissioning of Lake Mokoan as a storage
• provision of an alternative water supply for affected users and pipelining of some small domestic and stock and irrigation districts
• raising a headworks storage (Lake Nillahcootie) to provide greater operational flexibility.

The Lake Mokoan project will result in increased unregulated flows to the River Murray and a more natural flow regime, with increased winter and spring flows, and reduced summer and autumn flows. The project will also produce some local environmental benefits, including the rehabilitation and revegetation of wetland areas such as Winton Swamp.

Printed September 02, 2008 01:10am AEST

Our watermark of dishonour

Bill Phillips | *September 02, 2008*

AUSTRALIA can expect international condemnation at the upcoming global conference of the Ramsar Convention on Wetlands for allowing the Coorong and Lakes regions to die.

Representatives of the 156 government signatories to what is otherwise known as the Ramsar Convention (after the city in Iran where it was first signed in 1971) will gather in Changwon, South Korea, from October 28 to review how each country has been applying the oldest of the international environment agreements.

Before this, each government submits a national report card on its performance, and it remains to be seen how transparent and honest Australia will be in relation to the Coorong and Lakes "wetland of international importance".

Unless there is a miracle and it rains heavily between now and summer, October 28 may be the date used on the headstone of the Coorong and Lakes as it is laid to rest as a significant wetland.

The only other hope rests with the governments responsible for the Murray-Darling Basin.

Despite what came out of the federal cabinet meeting in Adelaide last month in relation to water, ramping up acquisitions, I suspect it is still too little, too late.

In Changwon, the Australian delegation can expect to be challenged over why this situation has arisen, why no emergency response has been activated, why Australia has not used its Environment Protection and Biodiversity Conservation Act to protect this site - even though Ramsar wetlands were one reason it was enacted - why Australia has failed to use its external affairs power (as in the case of protecting the Franklin River) to secure the water needed to save the site and why Australia has failed to place this site on the convention's Montreux Record of threatened sites.

Unlike the International Whaling Commission, where we could take the moral high ground, one suspects Australia will be in the cross-hairs this time.

Don't expect to see Climate Change and Water Minister Penny Wong or Environment Minister Peter Garrett attending this international photo opportunity.

Another question Australia will be expected to answer is whether the Coorong and Lakes will be delisted as a Ramsar wetland and replaced with another site that retains qualities comparable to how the Coorong and Lakes used to be, assuming there is one.

In the nearly 40-year history of the Ramsar Convention, this will give us a very special black mark for being the first country to delist a site of this size due to mismanagement.

If the predictions are correct and by October 28 the lakes have turned into an acid bath, with the Coorong becoming more saline than the Dead Sea, the site will be unrecoverable. We will have contravened our fundamental Ramsar obligation, namely to keep wetlands of international importance in the condition they were (or better) at the time they gained international status. That was November 1, 1985.

Perhaps ironically, the anniversary of this occasion will fall during the Ramsar conference in South Korea. I wonder whether the Australian delegation will host a birthday party or a wake?

Bill Phillips is a former deputy secretary-general of the Ramsar convention on wetlands.

This is about the pipeline from north of the divide to carry water from the Heritage listed Goulburn River to Sugarloaf for Melbourne. Operational by 2010 if they are allowed to proceed and the decision is due on 15 September 2008 from the Commonwealth Minister.

The Foodbowl Modernisation Steering Committee recommendations are below:

3.5 THE ENVIRONMENTAL WATER SHARE

1. Water savings should be shared equally between irrigators, Melbourne Water and the Environment, including volume reliability and timing of when savings become available. The environment will also receive half of any savings above and beyond the 225 GL.
2. The primary objective for the use of the environment's share of the savings should be for the improvement of Victorian Tributaries.

Page 16

3. The environment share of the savings should be managed to optimize multiple benefits to Victorian rivers and help achieve the Victorian Government's contributions to the Snowy and Murray Rivers.
4. The environment's share of the Food Bowl Modernisation Project savings be granted as an Environmental Entitlement to be held by the Minister for Environment.
5. Catchment Management Authorities should develop a plan for the best deployment of the environmental water, consulting with all stakeholders with the plan to be approved by the Ministers for the Environment and Water.
6. Catchment Management Authorities should also manage the delivery of water within the Victorian Tributaries, monitor environmental outcomes, and integrate environmental flows with river and wetland management programs.
7. Where existing environmental and irrigation allocations flow together through the system, the defined environmental requirement must be deducted first before the savings are then calculated on the basis of the balance of the water in the system. The defined environmental requirement is the volume currently required to meet defined environmental obligations (such as the Environmental Protection and Biodiversity Conservation Act and the Flora and Fauna Guarantee Act – e.g. North Lake – Woorinen).

8. **The environmental impacts of providing 75 GL to Melbourne in 2010/11 need to be assessed. Where such proposals have environmental impacts, offset measures need to be provided.**
9. Carryover and / or borrow and payback rules such as those in place for the Murray Wetlands be developed for the environment's share in consultation and agreement with irrigators and the environment.
10. Headwork charges be applied to this Environmental Entitlement and delivery charges applied where appropriate.

This is a clear statement tying the two projects together: the Foodbowl Modernisation Project and the Sugarloaf Pipeline Project

> Given the financial and structural interdependency of the Food Bowl Modernisation Project and the Sugarloaf Pipeline Project, the State Owned Entity and where appropriate Goulburn Murray Water, will enter into talks with Melbourne Water to establish an effective interface between the organizations to ensure complimentary timelines, ensure consistent community liaison processes and resolve any issues or points of difference.

5.5 Australian Government

5.5.1 2005/06 Activities

In April 2006 the Australian Government signed an Investment Agreement with Victoria to invest $37.2 million in the Goulburn-Murray Water Recovery Package.

The $37.2 million represented 40% of the $93 million cost of the package.

The Australian Government has made the first payment of $2.484 million (see Table 9) to the Goulburn-Murray Water Recovery Package as per the Investment Agreement.[6]

Table 21: 2005/06 Expenditure on Victorian Water Recovery Proposals	**Victorian Proposal**	**Total Budget (The Living Murray component)**	**Investor 2005/06 Expenditure**
Goulburn-Murray Water Recovery Package		$93m	$4.72m
Lake Mokoan Water Recovery Package		$13.7m	$0

See page 27 and 28 audit

I would like to conclude by stating that yet again it appears that the governments are rushing at decisions when they have known about the peril and dire straits

[6] Independent Audit Group, Audit of The Living Murray Implementation 2006/07, May 2008 p26.

that our river systems and associated wetlands, floodplains, tributaries, streams, aquifers, groundwater are in. I am attaching my reconsideration request, the third one I have sent the Commonwealth because it says it all.

It is a history of government inaction and refusal to follow the rules-only when it suits them politically and financially and blow the environment and blow rural Australia.

My next concern is the many many desal plants ringing the continents of the world spewing back salt into our oceans and killing them too. This I predict will be the next disaster. What happened with the idea that we should live within our means, and here I am not talking about financial means but resources and environmental means. What are we leaving the next generation?

What a selfish bunch of humans we are!

We need to get a grip and finally decide what we value above all else. If it is money and luxuries and ourselves then there is absolutely no point with trying to save the Coorong and Lower Lakes. This Inquiry will prove one thing, it will prove what our governments value above all else. Humans have the capability of moving, rivers and wetlands do not, and these support creatures and plant communities that they are dependent upon.

I ask that you save the Coorong and Lower Lakes not by a barrage and letting the sea-water in but in a responsible manner that ensures that those matters we have entrusted our governments to protect are protected. That they are not thrown our with the bath water at the first (and this instance last) instance. I value my environment, I value our rivers (I live on the banks of the Murray) and I ask that the government acts immediately and the pain of the dying Coorong and Lower Lakes is shared by all of us and in this I ask that you include the Victorian government and their unacceptable proposal of a 1750m pipeline taking water when it should be putting it back in!!!

Thank you and I will be submitting to the second half of the Inquiry on around 15 October 2008 as Peter has said I could.

Regards and thank you for this opportunity and I ask that you listen and then act.

PS It is just starting to rain a little. But that does not mean we stop, because what must be done must be done.

Maria I E Riedl

Ms Cathy Skippington
Assistant Secretary
Environment Assessment Branch
Approvals and Wildlife Division
Department of the Environment, Water, Heritage and the Arts
GPO Box 787
CANBERRA ACT 2601

epbc.referrals@environment.gov.au

Hard copy to Ms Cathy Skippington with all the information.
Email copies sent to Drew McLean, Mark Hall, Dr Jane Campbell, Minister Garret and Minister Wong

10 September 2008

I would like to request a new reconsideration of the referral decision under the EPBC Act 1999 Section 78 Regarding Sugarloaf Pipeline Project-EPBC 2008/3960.

Any action that reduces the surface flow of the River Murray or its tributaries, for example when a prescribed volume is exceeded, could be investigated as a new matter of national significance under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth), thereby requiring the consideration of the Commonwealth Environment Minister before the action proceeds. The precise description of such a trigger would require further thought and analysis. The Environmental Defender's Office of New South Wales has considered a possible water extraction trigger. For information see http://www.edo.org.au/ edonsw/site/default.php (viewed 26 September 2006). Section 100 of the *Constitution* provides that the Commonwealth shall not "by any law or regulation of trade or commerce, abridge the right of a State or the residents therein to the reasonable use of the waters of rivers for conservation or irrigation", a provision that has never been fully tested. The Commonwealth has used many heads of power to legislate on environmental issues, including legislating for the domestic implementation of international treaties under its "external affairs" power. Powers can also be referred to the Commonwealth by the States under Section 51(xxxvii) of the Australian Constitution. Scanlon (2006) 23 EPJL 386

Under Section 334 of the EPBC Act 1999 it states most clearly what the Commonwealth's responsibilities are:

(1) This section applies in relation to a wetland that is a declared Ramsar wetland.
(2) The Commonwealth and each Commonwealth agency must take all reasonable steps to ensure it exercises its powers and performs its functions in relation to the wetland in a way that is not inconsistent with;
   (a) The Ramsar Convention; and
   (b) The Australian Ramsar management principles; and

(c) If the wetland is included in the List of Wetlands of International Importance kept under the Ramsar Convention and a plan for managing the property has been prepared as described in section 333-that plan.

I have included substantial new information and a continuing substantial change in circumstances which I have highlighted in the material that I have collected and are attached to this request. I consider 'new' information to be information that was not put before the Minister when he made his original decision and I consider this information to be relevant because of the 'new' circumstances- ongoing drought, accelerating climate change, still unaddressed overallocations and the fact that there is no water, the Alpine bushfires have ensured that the runoff will be negligible, and the fact that Eildon is only 21.7% full or should I say 79.3% empty. Last summer it got down to 13% full or 87% empty.

I have also mailed a hard copy of other information that is relevant to this request (it was mailed 9 September 2008 in an Express Bag). It is clear that the original referral did not have enough information to inform the Minister, because the Commonwealth has had to request more information and this is still coming in and will till sometime next year. The referral did not include Ramsar wetlands and Migratory species and 18 and 18A downstream of the extraction. This omission must be addressed. I have attempted to show you, by again mailing all this information, that I am certain none of this was before the decision-maker and therefore he or she could not make an informed decision.

May I recommend a book to read: '*Water Policy in Australia- The Impact of Change and Uncertainty*' Edited by Lin Crase. It is very informative and sheds light on the situation of water and its importance in Australia with many references to the Murray-Darling Basin and its rivers and the peril they now find themselves in. Our governments and we the people who have elected them have allowed our rivers to get into the state that they are in. It is now up to us to stop this degradation and further losses. The EPBC Act is there to ensure that these types of projects; such as the Sugarloaf pipeline, are properly referred and assessed to ensure that 'business-as-usual' is no longer tolerated. This whole proposal has been flawed from the beginning with the Victorian government and Melbourne Water assuming that it was a given action with automatic approval.

This cannot be the case, as the damage is irreversible. An extraction from a Heritage River is not allowed. The Victorian government and Melbourne Water have decided that it is not an extraction because it will use "new saved water" and we have proven that this is not the case, unequivocally. The water is not there, the quantities are not there, they may never be there.

To say that 75GL "borrowed" from the Living Murray Initiative and "bought" from the Goulburn's Water Quality Reserve is not going to have an impact upon the River Murray and its Ramsar wetlands and migratory species and threatened species and communities is making an assumption based on what; on Melbourne Water and the Victorian government's assertion? It is also unclear how many years this will happen as we along the rivers are on zero allocations. The EPBC Act has clear requirements, on clear matters to be protected from actions that are likely to have significant impact. The precautionary Principal and ESD must be considered and these have been conveniently limited to the alignment of the pipeline. Since circumstances have measurably worsened in the Murray-Darling Basin and the rivers in the Basin, with massive fires in the Alps in 2006 which resulted in a change to flows into the tributaries, with the deepening of climate change, the continuation of the drought, the still unaddressed overallocations, **and this project cannot proceed without the most rigorous of assessments**.

Melbourne Water has failed to provide enough evidence and complete assurance that the "new water" to be saved will be available in the second year of this proposed pipe's operation. They have given false and misleading information to the Minister and failed to conduct a rigorous EES because they just wanted to push this project through as quickly as possible, before all these events that I send information on, would catch up with them and prevent the construction and extraction.

I have no doubt that they intended to start construction before it was made evident, that the water savings are simply not there. They cannot be there because irrigators are on zero allocations along the entire length of the northern rivers, this means that there will be no water or very little in the channels to be called "new water savings". All of the rivers as you can see from the newest information from Goulburn-Murray Water are on zero allocations with very little chance of improvement if any this year. One can only come to the conclusion that the proponent would be quite prepared to put the Murray-Darling Ramsar wetlands and the Migratory species and listed species and communities in peril by "borrowing" water committed to the Murray River and the Goulburn River or "buying" the Goulburn River's water quality reserve. There is a problem here as both Coliban Water and Central Highlands water have been able to buy some of this water and will do so again this season and with all probability next season as well.

It is clear that the National Water Commission states that the States are not doing enough in delivering what they have signed for under the National Water Initiative and that they are going to ensure that States comply.

Victoria, by not referring everything that will be impacted by this extractions without having done the savings first and full scientific investigations is without doubt misleading the Commonwealth and the National Water Commission by proposing an extraction from a river that is deemed as the worst of 23 in the already stressed Murray-Darling Basin and putting in jeopardy without any scientific justification the River Murray and all the Nationally Significant wetlands and migratory species.

The following is an law journal article that describes the history of the Murray-Darling Basin and the efforts of the Commonwealth and the States joining forces in ensuring its "good health and maintaining productivity." Pages 394-404 are vital to read as they clearly state that the Commonwealth is playing a major leading role (with the co operation and agreement of the States) in ensuring that the National Water Initiative and the Living Murray Initiative under the Ministerial Council and the National Water Commission *"put in place an environmental flow regime that will ensure a healthy system while maintaining productivity."* John Scanlon.

I have highlighted the areas that you must read, because it is clear to me that this pipeline referral has failed to ensure that these goals and aspirations that are reflected in law, in agreements that have been conveniently ignored by the Victorian Government and Melbourne Water.

This must not be allowed. It is clear there will/must be effects upon Ramsar listed wetlands and other matters to be protected by the Minister under the EPBC Act 1999 downstream of the extraction of water that has NOT been saved.

We can no longer accept "business-as-usual" actions, especially from governments and government owned water authorities.

A hundred years of negotiations with no end in sight: Where is the Murray Darling Basin Initiative leading us?

John Scanlon*

There have been many worthwhile developments over the past century in how the shared water resources of the Murray Darling Basin are managed. This stands as testament to the ability of governments and people with a vested interest in the Murray Darling to peacefully negotiate in a pragmatic and cooperative manner, even though, with the benefit of hindsight, some things might have been done differently. Today regulators are confronting many new water resource management challenges, resulting in federal and State governments agreeing to a bold new water reform agenda through the Intergovernmental Agreement on a National Water Initiative 2004. Fortunately, there is also a significant knowledge base, which now provides the foresight to better understand the consequences of both current and future actions. The inescapable conclusion from the knowledge available is that changes are required to the Murray Darling Basin Agreement and how it is administered if the system is to be restored to good health and maintain productivity.

PRAGMATIC ECOSYSTEM APPROACH: MURRAY DARLING BASIN INITIATIVE

In the late 1890s, a fierce debate raged over how the proposed Australian Constitution should address the sharing of the waters of the River Murray between the colonies of New South Wales, Victoria and South Australia – a debate that threatened to derail the process of Federation itself.1

The upstream colonies of New South Wales and Victoria had claimed the sovereign right to divert the whole of the water in their tributaries and the River Murray, with some slight concession to South Australia in the form of compensation water. Not surprisingly, during the pre-Federation convention debates, the downstream colony of South Australia argued that the Commonwealth be given the power to manage the waters of the River Murray; this was fiercely resisted by New South Wales and Victoria. A last minute compromise was negotiated between the colonies which cleared the path for the finalisation of the *Constitution* and the creation of Australia as a nation state.

The history of the creation of the Commonwealth and the constitutional sharing of powers between the States and the Commonwealth has had a significant influence on the measures that havebeen taken over the past 100 years to manage the shared resources of the Murray Darling Basin. The century has seen ongoing negotiation between all parties, which has resulted in a cooperative,

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* LLB, LLM (Environmental). Commissioner, Murray Darling Basin Commission and Vice Chair, IUCN Commission on Environmental Law. This article is based upon papers prepared for the Stockholm International Water Institute World Water Week *Beyond the river – sharing benefits and responsibilities* (Stockholm, August 2006); and the Environment Institute of Australia and New

Zealand Conference *Environmental Practice* (Adelaide, September 2006). The author gratefully acknowledges the assistance provided by Paul Harvey, Phil Cole, Adam West, Department of Water, Land and Biodiversity Conservation (South Australia); Professor Mike Young, University of Adelaide; and Ilona Millar, Environmental Defender's Office (New South Wales). All the opinions expressed in this article are those of the author.

1 See generally, Report of the Commissioners, *Report of the Interstate Royal Commission on the River Murray* (Sands and McDougall Ltd, 1902); River Murray Commission, *A Short History of the River Murray Works* (Eaton, 1945); Crabb P, *Murray Darling Basin Resources* (MDBC, 1997); Fullerton T, *Watershed* (ABC Books, 2001); Connell D (Ed), *Unchartered Waters* (MDBC, 2002); Blomquist W, Haisman B, Dinar A, Bhat A, "Institutional and Policy Analysis of River Basin Management" (2005) *World Bank Policy Research Working Paper* 3527; Connell D, *Water and Politics in the Murray Darling Basin* (Federation Press, forthcoming publication).

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pragmatic, and increasingly ecosystem-based approach2 being adopted by governments and the community to managing the shared resources of the Basin. The collective efforts of the Commonwealth, New South Wales, Victoria, South Australia, Queensland, and the Australian Capital Territory, together with the community, are known as the Murray Darling Basin Initiative (the Initiative). The Initiative is an interjurisdictional compact that provides an institutionalised means for dealing with matters of common interest.

CONFRONTING THE CHALLENGES OF A STRESSED SYSTEM: MAJOR ISSUES IN THE MURRAY DARLING BASIN

The Australian Aboriginals were the first to discover the bountiful resources of the Basin more than 40,000 years ago.3 The Basin and its floodplains shaped, and are still part of, the belief system and daily lives of the indigenous inhabitants of the area. The Basin has also shaped important elements of modern Australian history, and as the nation's first great transport network, it fostered the development of towns and agricultural industry.4

The Basin spans five State and Territory jurisdictions, is over one million sq km in area (covering 14% of Australia), is home to two million people and is Australia's most productive region for irrigated agriculture (70% of the national total occurs within the Basin). The Basin produces at least 40% of Australia's agricultural output and the city of Adelaide, which lies outside the Basin and has a population of over one million, relies on the River Murray for up to 90% of its water supply in drought years.

Today the Basin enriches Australia by an estimated $23 billion per year. This does not include the economic value of the City of Adelaide and the Iron Triangle in South Australia,5 which rely upon 1% of the Basin's water and have an economic value of over $16 billion per year.6 Agricultural produce now exceeds $10 billion (recent figures say $13.6 billion), mining $3 billion, tourism and leisure around $6.5 billion, hydro-electricity generation $0.3 billion and commercial fishing and other industries $2.5 billion.7

But economic gain has taken its toll on the environment, resulting in significant ecosystem degradation throughout much of the Basin, which is threatening both ongoing productivity and environmental health. The key issue is that too much water is being extracted from the Basin. The impact is most severe in the lower third of the 2,530 km-long River Murray. The challenges confronting the governments and the Basin community include irrigation-induced and dryland salinity, the overallocation of water, a decline in water quality and ecological health, and the underpricing and inefficient use of water, all of which are being addressed in one way or another.

Dealing with these challenges comes at a price. Who pays (and when and how) has involved a series of separate but related negotiations based upon constitutional roles and responsibilities, political and social imperatives, a shared knowledge base and intensive interaction with the Basin community. Within this context governments have negotiated extensive and detailed market-based measures to share the cost of ecosystem degradation in order to enhance the productivity of the Basin and restore its ecological health; these are seen as being inter-twined.

GOVERNANCE OF THE INITIATIVE – STILL EVOLVING TO MEET NEW CHALLENGES

In its broadest sense the Initiative involves two separate but related issues:

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2 While the Initiative institutionalised a basin management approach in 1987, the water sharing rules are still based on the *River Murray Waters Agreement 1914*.
3 See Crabb, n 1, p 258.
4 See *The Living Murray Discussion Paper* (MDBC, 2002) p 13. Full text available online at http://www.thelivingmurray.mdbc.gov.au (viewed 25 September 2006).
5 Both lie within the State of South Australia but outside the Basin.
6 See Blackmore D, "Protecting the Future", in Connell D (ed), *Unchartered Waters* (MDBC, 2002) p.7
7 See Crabb, n 1.

• the sharing and distribution of the waters of the River Murray between New South Wales, Victoria and South Australia in accordance with the *Murray Darling Basin Agreement 1992* (the Agreement); and
• the development of policies and programs to promote the integrated catchment management of the Basin.

The Agreement requires the Murray Darling Basin Commission (the Commission) to examine the possible effects that the exercising of its powers or functions, and the implementation of works or measures is having on the water, land, and other environmental resources of the Basin. In doing so it may need to give directions that will improve water management and environmental objectives consistent with the overall framework established for the distribution of waters.8

The Commission does not own any infrastructure or any land;9 they are owned by the contracting governments, normally through the constructing authorities.10 The constructing authorities build, own, and operate the joint works and measures that have either been included in, or subsequently agreed upon under the Agreement, for and on behalf of the Commission.11 The Murray Darling Basin Ministerial Council (the Ministerial Council) or the Commission authorise the joint works and measures12 but are not responsible for their implementation, which is carried out by a nominated contracting government.13

The institutional arrangements for the Initiative, which are set out in the Agreement, are:

The Ministerial Council

The Ministerial Council was established in 1985 as the peak policy-making body under the Agreement and it is responsible for considering and determining major policy issues of common interest.
The Ministerial Council consists of up to three ministers from each State and the Commonwealth and one from the Australian Capital Territory (recently admitted as a full member). Members are drawn from ministers who have "prime responsibility for matters relating to water, land and environment".14 The Commonwealth chairs the Ministerial Council, traditionally through the minister responsible for agriculture.15

The Initiative requires high-level political engagement and the establishment of the Ministerial Council in 1985 represented a significant step forward in managing the Basin as it provided a regular forum for this to occur. The Ministerial Council has been described as "almost, but not quite, a natural resources parliament for the Basin".16

The Commission

The origins of the Commission can be traced back to 1917. Until 1985, the Commission was the peak body under the various agreements. Since then it has answered to the Ministerial Council. The Commission is responsible for administering the Agreement and providing advice to the Ministerial Council.

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8 See cl 47 of the Agreement.
9 Nor does the Commission own the water resource or issue licences for its use; rather it has responsibility for controlling the bulk distribution of water in accordance with the Agreement.
10 See definition of Contracting Government and Constructing Authority in cl 2 of the Agreement. See also *Murray Darling Basin Commission Annual Report 2004-2005* (MDBC, 2005) p 34.
11 The constructing authorities are responsible for the actual release of water from the various storages as directed by the Commission and each jurisdiction is ultimately responsible for the delivery of water to users.
12 And the Commission subsequently declares them to be "effective" and monitors their ongoing operation.
13 This may become important in the context of the application of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).
14 See cl 8(3) of the Agreement.
15 The current chair is the Federal Minister for Agriculture, Fisheries and Forestry.
16 Blackmore D, *Water, Salinity and the Politics of Mutual Obligation* (2001) Alfred Deakin Lecture. Full speech available at http://www2b.abc.net.au/rn/deakin/disc/lforum/default.htm (viewed 26 September 2006).

The current Commission was established under the 1992 Agreement and it requires each government to appoint two commissioners who between them represent "water, land and environmental resource management".17 Two deputy commissioners are also appointed by each government. An independent president, appointed by unanimous vote of the Ministerial Council, chairs the Commission.18

Traditionally, State commissioners have been the heads of relevant State government departments, and Commonwealth commissioners have been secretary or deputy secretary of the relevant Commonwealth departments.19 The first departure from this convention was through the author's appointment as an independent20 commissioner in January 2005.21

The Community Advisory Committee

The Ministerial Council established the Community Advisory Committee (the CAC) in 1986.22 It is responsible for providing advice directly to the Ministerial Council on matters referred to it by the Ministerial Council and the Commission, and for providing advice on the views of the Basin's communities. Members also actively participate in Commission working groups and committees.
The CAC comprises an independent chair and 28 members, 21 of whom are chosen on a catchment or regional basis. Of the remaining seven members, six are drawn from four peak non-government groups and there is an appointee to provide an individual Aboriginal perspective.
The CAC has at times been an active, independent, and powerful community voice providing an alternative source of advice to the Ministerial Council.23

The Office of the Commission

The Office of the Commission (the Office) is not specifically recognised by the Agreement, but the Commission has the power to employ staff, which it does through its Canberra based secretariat. This office of over 100 highly skilled staff has been a key driving force of the Initiative and has played a vital role in helping the Initiative get through some difficult challenges. The Office holds a wide array of delegated authority and provides support to the Ministerial Council, the Commission and the CAC.

The work of the Office is separated into River Murray Water, an internal ring fenced business unit to manage the sharing and distribution of water in accordance with the Agreement,24 and Natural Resource Management. Since 2001, an environmental manager has been appointed to the Office to closely monitor the environmental aspects of water options for the River Murray and its tributaries, and to provide the Commission with advice on how arrangements could be better coordinated.

SOME REAL PROGRESS – THE EVOLUTION OF AGREED WORKS AND MEASURES

The finalisation of the *River Murray Waters Agreement 1914* was a major achievement coming at the tail end of decades of negotiations, as was the agreement to construct and jointly fund the built

17 See cl 20(2) of the Agreement.
18 The current president is the Rt Hon Ian Sinclair AC.
19 Current Commonwealth commissioners are secretary-level appointments reflecting the Commonwealth Government's increasing interest in the Initiative.
20 For instance, not employed as a public servant by any government.
21 See http://www.mdbc.gov.au/about/murraydarling_basin_commission/the_commissioners (viewed 26 September 2006). Prior to this appointment no non public servant had been appointed to the Commission, other than the heads of corporate bodies such as Goulburn-Murray Water and SA Water. This has been as a result of tradition not because it was a requirement of the Agreement.
22 The CAC is now recognised in the Agreement. See cl 14(1)(a).
23 Given the changes to the operating environment of the Initiative, it is time to revisit the composition and role of the CAC, particularly given the emergence of statutory catchment management authorities throughout the Basin. See "Walking the talk – some equally real challenges" below.
24 Established by the Ministerial Council in response to the Council of Australian Governments' Water Related Reforms (1994).

infrastructure which is now found throughout the River Murray system. This extensive system of storages, locks, weirs and barrages has secured the ability to provide water for irrigation, urban, industrial, recreational and navigational purposes under all conditions.25

The most significant contemporary measures taken under the Agreement have been by the Ministerial Council, which was first established in 1985. Recent achievements of the Ministerial Council have both enhanced productivity and improved the health of the system. They include:

1988-2001 Salinity and Drainage Strategy (the Strategy)

From 1975-1985 salinity levels when measured at Morgan in South Australia exceeded the Australian water quality guideline of 800 EC units 42% of the time. As a result of the implementation of the Strategy, including groundwater management schemes costing over $50 million, salinity levels were reduced to the point where in 1999 they exceeded 800 EC units 8% of the time, with average salinity being 520 EC units. In 2004-2005 average salinity at Morgan was 395 EC units26 but this figure is generally attributed to drought conditions reducing the level of salt entering the River from the floodplains.27

The Strategy provided a framework for joint action by the New South Wales, Victorian, South Australian and Commonwealth governments to deal with water logging and land salinisation in certain upstream irrigation districts of the River Murray and river salinity in the lower part of the River. Under the Strategy no State was, or is currently, allowed to undertake any action that would have an adverse impact on the salinity of the River, unless it had previously earned "salinity credits" by investing in salinity mitigation works. The Commission maintains an externally audited register of salinity debits and credits.28

The basic concepts that underpinned the Strategy29 were that:
• there was to be a salinity target of less than 800 EC units, 95% of the time30 at Morgan in South Australia, (a point near offtakes for water for urban use by Adelaide31 and Whyalla);

• salt interception schemes would be constructed by the Commission (through constructing authorities), which were to reduce salinity at Morgan by 80 EC units;
• New South Wales and Victoria would each earn salinity credits equivalent to 15/80 of each EC credit from investing in salt interception32 which would be used to cover the salinity impacts of constructing drains to protect irrigation areas; and
• after all of the States had used their credits, the salinity at Morgan would be reduced by 50 EC units.

As a result of a concern from irrigators in the mid section of the River – who were downstream from drains but upstream from salt interception schemes – credits and debits were based upon the cost

25 See Crabb, n 1, p 283, Pt VI of the *Construction Operation and Maintenance of Works* and Sch A of the Agreement. Water is also used to generate hydroelectricity at the Dartmouth Dam, Hume Dam and the Yarrawonga Weir.
26 See *The Salinity Audit of the Murray Darling Basin* (MDBC, 1999) pp 11-13 and *Basin Salinity Management Strategy – 2004-2005 Annual Implementation Report*, (2006) MDBC. Both reports available online at http://www.mdbc.gov.au (26 September 2006).
27 Among various other reasons (including the source of the water). See *Murray Darling Basin Commission Annual Report 2004-2005* (MDBC, 2005) p 70.
28 See *Murray Darling Basin Commission Annual Report 1998-1999* (MDBC, 1999) p 31.
29 Personal communication, Phil Cole, Department of Water, Land and Biodiversity Conservation (South Australia), 13 July 2006 with reference to draft *Register Adjustment* paper (July 2006) MDBC.
30 Noting that modelling and simulation against a benchmark period is used to test the target rather than real time management. The target was based upon Australian guidelines for drinking water quality and on the risks to irrigated horticulture. Personal Communication, Phil Cole, n 29.
31 The capital city of South Australia with a population of over 1 million. Located outside of the Basin, the city obtains 40% of its water from the River Murray in average years and up to 90% in drought years.
32 South Australia waived its right to such credits. Personal communication, Phil Cole, n 29.

of salinity to water users rather than the average EC at Morgan.33 In this way the impact on mid river irrigators was considered as a part of the assessment of proposals.

The credit and debit system provided a consistent currency through which investments in salt interception were assessed, trade-offs made and Basin-wide accountability achieved – a system that has carried over to the revised salinity strategy.

The Strategy was arguably the first time that the participating States, with the support of the Commonwealth,34 agreed to tackle a major environmental problem through a common effort across jurisdictional borders, while sharing the costs of ecosystem degradation. The Strategy, which has since been revised and replaced by the Basin Salinity Management Strategy 2001-2015 (see below), paved the way for further interstate cooperation in promoting the sustainable use of land, water and environmental resources in the Basin.

1995: Cap on water diversions (the Cap)

This is the most significant decision ever made by the Ministerial Council, in which all jurisdictions voluntarily agreed to cap their own surface water diversions from the Basin.35 An interim cap on diversions was introduced in 1995 and made permanent in 1997.

The Cap limits the amount of surface water that may be diverted from the Basin's rivers. In regulated rivers diversions are limited to what would have been diverted under 1993-1994 levels of development. In unregulated rivers the Cap may be expressed as an end-of-valley flow regime. The Cap has been applied in this way, with small variations, in New South Wales, Victoria and South Australia, which, when combined, account for 94% of the Basin's diverted water. Queensland and the Australian Capital Territory take a total of 6%; their Cap and the way it is determined has not yet been finalised.

The Ministerial Council implemented the Cap as the first step towards striking an appropriate balance between the economic and social benefits obtained from the development of the Basin's water resources, and the environmental uses of water in the Basin's rivers.36 The Cap was not set to reflect the sustainable level of extraction. While it limits diversions, this limit is based upon prior use not sustainable yield.

The implementation of the Cap is subject to an annual audit by the Commission's Independent Audit Group37 and where it is exceeded by an agreed percentage a Special Audit38 is triggered. The audit report is provided to the Ministerial Council annually and if a State is found to have exceeded its Cap in any of its valleys, it is given the opportunity to explain why this has occurred and what action it plans to take to re-align water use to bring it within the Cap.

1997: Pilot program for permanent interstate trade

The ability to trade water both within and between jurisdictions has allowed water to move to more valuable uses and has meant that the Cap on diversions has not been a cap on development.39

33 Costs to urban and rural users were calculated, urban costs (1988 estimates) making up 97% of the total salinity costs. A recent review has adjusted the cost functions, with agricultural costs now 24% of the total salinity costs and 96% of the costs calculated to occur within South Australia. Personal communication, Phil Cole, n 29, with reference to *Register Adjustment* paper (MDBC, July 2006).
34 The Commonwealth contributed 50% of the cost of salinity mitigation investigations and 25% of capital construction costs.
35 Queensland has agreed to a cap on diversions but is awaiting the finalisation of its water resources plans before it agrees on the level of diversions.
36 See Murray Darling Basin Ministerial Council, *The Living Murray Discussion Paper*, (MDBC, 2002) p 17.
37 The Independent Audit Group (IAG) was established in 1996 to set-up the Cap and it now reviews its implementation. The IAG is independent in that its members are not part of any partner government.
38 The IAG conducts a Special Audit of any Cap valley in which diversions have exceeded Cap targets by 20% of the average annual cumulative diversion.
39 See Land & Water Australia, *Property: Rights and Responsibilities – Current Australian Thinking*, (Land and Water Australia, 2002); Dyson M and Scanlon J, *Trading in Water Entitlements in the Murray Darling Basin – Realizing the Potential for* Where is the Murray Darling Basin Initiative leading us?

The pilot program for permanent interstate trade built on longstanding permanent and temporary trade in water within jurisdictions. It allowed, and set the rules for, cross jurisdictional trade in high security water in a defined part of the Southern Basin in order to maximise its commercial use by allowing the market to determine where water would achieve the best return. Trade was subject to the assessment of environmental and social issues, and physical constraints. It did not affect agreed water sharing rules between jurisdictions. Adjustments to volumes were made to take trading into account, which may also affect future contributions to the recurrent costs of the overall Initiative as they are based upon the service received by each jurisdiction.

The pilot program was successful, with 22.9 GL of high security water permanently traded between New South Wales, Victoria and South Australia from 1998-2003. This volume is however a small proportion of the overall volume of temporary water, or annual water allocations, traded across the Basin which accounts for 800 to 900 GL of water per annum.40 Temporary trade in water allocations across State borders was not subject to the pilot scheme.

At its 40th meeting in May 2006, the Ministerial Council agreed to adopt a new schedule on interstate water trade expanding the ability to permanently trade water within a wider area of the Southern

Basin. The same rationale that underpinned the pilot program underpins this expanded trading regime.

The new Schedule sets a framework for two different trading methods, “exchange rate trade” (as was adopted under the pilot trading regime) and “tagged trade”.41 The new Schedule, and the extensive protocols adopted (or to be adopted) under it, seeks to facilitate expanded trade through addressing a range of contentious issues including: the nature of entitlements to be traded; the setting of access and exit fees; the need for environmental assessment; addressing the impact of trade on the Cap; environmental flows; salinity; the parties’ financial contributions; and the capacity of the River to deliver water.42 The new Schedule, unlike the pilot program, applies to both temporary and permanent trade in water.

The pilot program and the expanded program are funded through each participating jurisdiction and through the Commission’s River Murray Water operational budget, which is jointly funded by the jurisdictions sharing the waters of the River Murray on the basis of the level of services received.43

2001 Basin Salinity Management Strategy

This cooperative and jointly funded strategy44 was developed to maintain river salinity at an agreed level, to control salt loads in all tributaries, and to control land degradation, while allowing productive activity to expand where appropriate. The Strategy builds upon earlier agreements to collectively address irrigation induced salinity and now covers both irrigation induced and dryland salinity.

Environmental Benefits, IUCN ELP Newsletter, (Issue 1 2002), p 14 available at http://www.iucn.org/themes/law (viewed 26 September 2006); *Understanding Water Rights and Water Allocation*, 1st NARBO Thematic Workshop on Water Rights and Water Allocation, (Hanoi, 2005).

40 Personal communication, Adam West, Department of Water, Land and Biodiversity Conservation (South Australia), 21 July 2006 with reference to *Evaluation of the Interstate Water Trade Program*, (2005) Tim Cummins and Associates. See also Australia, Draft Report of the Productivity Commission, *Rural Water Use and the Environment: the Role of Market Mechanisms* (June 2006), p 198.

41 As defined in Sch E, cl 3. Generally speaking, exchange rate trade cancels the entitlement in the State of origin and creates an equivalent entitlement in the State of destination, tagged trading leaves the entitlement in the State of origin but allows annual allocations to be used in the State of destination.

42 The trading method adopted for permanent trade, and the entitlements and allocations able to be traded and across which trading zones, will further develop over time.

43 The River Murray operations and maintenance budget is currently shared in the following proportions: New SouthWales 38%, Victoria 35% and South Australia 27%.

44 Replacing the 1988 Salinity and Drainage Strategy.

The Strategy was adopted by the Ministerial Council in 2001 to revise and replace the 1988 Salinity and Drainage Strategy. It is given effect through a schedule to the Agreement45 that sets new agreed “baseline dates”, time-based salinity “baseline conditions”46 and quantitative Basin-wide and river valley salinity targets. The Strategy retains the Basin-wide target of less than 800 EC units 95% of the time at Morgan and incorporates former salinity and drainage works. The main changes from the 1988 Strategy are the inclusion of salinity impacts and salinity targets in tributaries, including Queensland, and the creation of a new program for salt interception investment.

This new program of joint works and measures sets a salinity reduction target of 61 EC units by2007 47 – to be measured at Morgan. It allocates salinity credits to each of the three investing States, New South Wales, Victoria and South Australia, equivalent to 10/61 of each salinity credit achieved through investing in salt interception – thereby allowing an equivalent salinity debit to enable drainage disposal or increasingly, the development of new irrigation areas. The remaining 31 EC units are allocated against the anticipated “delayed salinity impacts”48 in tributaries required by 2007.

In addition to the Basin-wide target, the 2001 Strategy sets out a process for proposing, reviewing and adopting "end of valley targets" for tributaries,49 and a process for each State to develop agreed programs of actions in catchments, such as reforestation, aimed at reducing dryland salinity impacts in order to achieve the "end of valley targets".50 Programs are delivered through catchment management authorities linked to Commonwealth led funding programs such as the National Action Plan for Salinity and Water Quality and the Natural Heritage Trust.

The States of New South Wales, Victoria and South Australia are responsible for all actions that have a significant effect on salinity51 taken after their baseline date of 1 January 1988, and the State of Queensland is responsible for actions taken since 1 January 2001. Dealing with other salinity impacts is a shared responsibility. An annual audit of the performance of each State jurisdiction and of the Commission is carried out by the Independent Audit Group for Salinity which is appointed by the Commission.52

The salinity register established under the 1988 Strategy has been revised to include Registers A and B which, generally speaking, distinguish between actions that have a significant effect on salinity and those actions that relate to "delayed salinity impacts".53 Each jurisdiction acquires salinity credits and debits based on the actions they take after their "baseline date" in both irrigation areas and tributaries that affect salinity levels. They are required to remain in credit overall. Credits are achieved by investing in measures to reduce salinity, with debits being assigned to actions that increase salinity and to predicted "delayed salinity impacts" as determined every seven years.

As with its predecessor, the overall result of this Strategy has allowed productive areas to expand while achieving significant reductions in river salinity.

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45 Sch C – Basin Salinity Management.
46 Defined in Sch C, cl 2 and elaborated in cl 5.
47 It also estimated credits of 10 EC units to be achieved by 2007 through State based activities such as targeted reforestation and improved management of remnant vegetation. See Murray Darling Basin Commission, *Report of the Independent Audit Group 2004-2005* (MDBC, 2006) p 10.
48 Defined in Sch C, cl 2.
49 Targets are proposed by State governments, reviewed by the Commission and adopted by the Ministerial Council. For general information on the process see Murray Darling Basin Commission, *Basin Salinity Management Strategy Operational Protocols*, (Version 2.0 – March 2005).
50 Defined in Sch C, cl 2 and elaborated in cl 8.
51 Defined in Sch C, cl 18 as a change in average daily salinity at Morgan which the Commission estimates will be at least 0.1 EC units within 100 years after the estimate is made.
52 See Sch C, cl 34.
53 Register A transfers all debits and credits from the previous register and records debits and credits for actions taken under the 2001 Strategy as assessed against the revised baseline conditions, excluding actions taken to offset "delayed salinity impacts".
Register B records "delayed salinity impacts", being salinity impacts resulting from actions taken before the baseline dates, and records credits for actions in catchments taken to meet end of valley targets after 1 January 2000.

Where is the Murray Darling Basin Initiative leading us?
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2004: The Living Murray First Step

This is a cooperative and jointly funded initiative to return up to 500 GL of permanent "new water" to the River Murray as an environmental flow with an initial focus to improve the health of six agreed significant ecological assets, or icon sites, and to invest in a range of capital works and measures to make the best use of recovered water.

This initiative followed an extensive process of scientific analysis and community consultation.54

It was concluded outside of the Agreement through the *Living Murray Intergovernmental Agreement*55 and is known as the Living Murray First Step (the First Step), a separate intergovernmental agreement between the Commonwealth, New South Wales, Victorian, South Australian and Australian Capital Territory governments. Its implementation is overseen by the Ministerial Council and is externally audited by the Commission's Independent Audit Group.56

Each State jurisdiction is set investment and water recovery targets based upon its share of consumptive water use, the indicative targets for water recovery being 269 GL from New South Wales, 214 GL from Victoria, 35 GL from South Australia and 2 GL from the Australian Capital Territory. Each State is responsible for developing water recovery plans for icon sites within their jurisdictions, there are six icon sites overall. The Commission is responsible for the Basin-wide environmental watering plan.

The Commonwealth is the major financial contributor to the First Step, committing 40% of the $500 million, followed by New South Wales and Victoria at 23% each, South Australia at 13% and the Australian Capital Territory at 1%. The total investment is set against annual investment targets spread over the five years of the First Step. **The Commonwealth has since invested a further $500 million in the First Step (and other related works and measures under the Initiative) to ensure there are no financial impediments to its success.**

The works and measures, known as the Living Murray Environmental Works and Measures Program, involve an additional investment of $150 million over eight years (to 2011). It is separately funded through the capital and operational budget of the Commission, with the budget now being supplemented by the additional Commonwealth funds referred to above. Improvements in the health of the River will result from the combined impact of the additional flows and the improved structural and operational management.

It is recognised that the **additional flow is a first step towards recovering the health of the River Murray and that more water will be needed over time to achieve this objective.** The First Step is, however, a major achievement in its own right, which now has a combined budget of over $1 billion.

The five issues addressed above are major achievements of the Ministerial Council that are aimed at collectively providing greater investment security, addressing environmental degradation and allowing the market to influence where water is to be used. They have been jointly funded by the jurisdictions participating in the particular program or measure, with the share of funding being separately negotiated for each of them. **The Commonwealth has exercised national leadership by using its financial power to help support and drive these programs and measures, in particular the First Step where its investment now amounts to over $700 million.**

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54 For a general discussion of the process of determining the environmental flow regime for the River Murray see Scanlon J, "From Taking to Capping to Returning: the Story of Returning Environmental Flows to the in the Murray Darling Basin in Australia", *Report of the Stockholm International Water Institute Seminar* (Stockholm, 2002) p 77.
55 *Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray Darling Basin 2004* and the Business Plan developed under the *Intergovernmental Agreement* and adopted by the Ministerial Council.
56 See cl 78 of the *Living Murray Intergovernmental Agreement* and cl 158 of the Business Plan. Scanlon

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***I'm not happy with the progress of the Murray-Darling … I don't think there is a lot of State co operation there. I tend to sympathise with those from South Australia who say that … I think we've got to put a bit of a bomb under the process*.57**

While there have been many significant achievements over the past century, which stand as testament to the strength of the Federation of Australia and our ability to peacefully negotiate the sharing of natural resources in a pragmatic and cooperative manner, the situation is changing significantly for many reasons.

All Australian governments have agreed to a bold new water reform agenda under the *National Water Initiative*.58 The Initiative now operates in an environment where:

• new secure water rights have been created;
• newly created water markets are maturing;
• full cost-recovery for water services is being implemented;59
• the environment is now seen as a legitimate user of water;
• skills-based catchment management authorities play an increasingly significant role in natural resources management;60
• available water resources are becoming scarcer;
• significant new investment is being channelled through the Commission; and
• community values have changed and expectations increased.

Collectively, these changes require us to find new and more effective ways of managing our shared resources. **As will be seen below, our biggest challenge revolves around the effective implementation of the policy agenda that has already been agreed to at the highest levels of government.**

In response to these changes the Initiative is going through a period of review. Evolutionary change is required to the way in which the shared resources of the Basin are managed. Some of the more significant changes required are outlined below.

Avoiding cold feet and actually letting emerging water markets work

The *Living Murray Intergovernmental Agreement* committed jurisdictions to invest $500 million to recover up to 500 GL of "new water" for the environment over a period of five years. The target period of five years will expire in mid 2009.61

In June 2005 the Productivity Commission62 advised that governments should start buying water from willing sellers in order to achieve the First Step water recovery target. This advice is consistent with the independent advice tendered to the 40th meeting of the Ministerial Council in May 2006 in reports from the Independent Audit Group, private consultants63 and the Murray-Darling Basin Commission.

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57 Australian Prime Minister, Hon John Howard MP, as reported in Tingle L, "PM Backs Nuclear Solution", *Australian*
Financial Review (24 February 2006) p 78.
58 *Intergovernmental Agreement on a National Water Initiative 2004*.
59 Among other things, calling into question the manner in which the costs for water services are determined by monopoly service providers. See for example New South Wales Farmers Association, *Water Reforms off the Rails*, (Media Release, 12 July 2006).

60 There are now 56 regions across Australia through which Natural Heritage Trust and National Action Plan for Salinity and Water Quality funds are invested. See http://www.nrm.gov.au/index.html (26 September 2006).
61 As at 15 March 2006, the date of Meeting 87 of the Commission, none of the $500 million had been invested in water recovery and no water has been recovered.
62 Draft Report of the Productivity Commission, n 40.
63 The Ministerial Council resolved to publicly release these reports, which will be available online at http://www.mdbc.gov.au.

The Chair of the Ministerial Council and Commonwealth Minister for Agriculture, Peter McGauran, has been reported as responding to the Productivity Commission draft report (referred to above), saying that "it would hurt farmers".64

The Wentworth Group of Concerned Scientists responded to this suggestion in an opinion piece65 as follows: "[W]e are being told that, if you buy water from irrigators, you'll send the rural economy into recession. What nonsense."

The water reforms that have been made through the 1994 Council of Australian Government (CoAG) water-related reforms and the *National Water Initiative* of 2004 have revolutionised water resources management in Australia. One of the outcomes of the reform process is that the situation has changed from being one where water entitlements were short term, often annual, licenses, which did not vest the holder with any property right or long term security of water access entitlement, to the creation permanent, tradable, property rights.

Generally speaking, licenses across Australia were tied to the land and legally (as opposed to politically) able to be revoked by administrative decision without the payment of compensation to the holder, subject to the rules of natural justice being adhered to.

As the *National Water Initiative* states, the objective of the parties in implementing the agreement is to: "provide greater certainty for investment and the environment, and underpin the capacity of Australia's water management regimes to deal with change responsively and fairly".

Part of the deal was to facilitate the establishment of water markets and provide opportunities for trading, subject to interim threshold limits set within the Agreement.66 Over time, this would allow the market to determine the best use for water, including for the environment.67

While the practice of paying a premium for appropriate infrastructure improvements to generate water savings should continue to be considered, this needs to occur in a sensible, balanced and economically sound manner. This manner is anticipated by the *National Water Initiative*68 and The *Living Murray Intergovernmental Agreement* and Business Plan69 which requires measures to be assessed for their cost effectiveness.70

The Wentworth Group appears to take a rather extreme view in support of the market. The Productivity Commission's draft report recognises that in some infrastructure projects source water may have other benefits71 and The *Living Murray Intergovernmental Agreement* and Business Plan supports a range of possible eligible measures for water recovery.72

The views of the Wentworth Group do serve to remind us of the importance of utilising the market mechanisms that have been established throughout the past decade of reforms. Their recent opinion piece concludes by saying that

Commonwealth funds should not be used to subsidise uneconomic projects … Instead of running grants schemes that aren't delivering water, buy it from willing sellers and let them use the money to invest in water efficiency.

64 See Breusch J, "McGauran Hoses Down Water Alert", *Australian Financial Review* (16 June 2006), p 3.
65 See Cosier P "Let Market Set the Water Mark", *Australian Financial Review* (20 June 2006) p 63.
66 See cls 58 – 63 of the *National Water Initiative*.
67 Under the *National Water Initiative* the threshold limits are to be reviewed in 2009 with a view to "full and open trade by 2014 at the latest". See cl 60.
68 See cl 79 of the National Water Initiative.
69 Adopted by the Ministerial Council at Meeting 36 of the Ministerial Council, November 2004.
70 See for example cl 32 of the *Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray Darling Basin 2004*.
71 See Draft Report of the Productivity Commission, n 40, p 121.
72 See cl 23 of the *Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray Darling Basin 2004*.

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Entering the market under The Living Murray First Step

Based upon current estimates from the Independent Audit Group, 275 GL of water will have been recovered within the five-year target period. Jurisdictions have focused their initial effort on maximising the amount of water that may be recovered through infrastructure improvement projects, in particular in the Australian Capital Territory, New South Wales and Victoria.73

It is apparent that the target of 500 GL of "new water" will not be achieved through infrastructure improvement projects alone and it will be necessary to purchase water from willing sellers if the target is to be achieved. The Commonwealth Parliamentary Secretary with responsibility for water, Malcolm Turnbull MP, emphasised that, "[w]e are committed to ensuring that we meet the target of restoring 500 GL to the river by 2009 … the rate of progress … is simply not good enough."74

The purchase of water on the market – and the use of other market-based measures – has already been approved by the Ministerial Council through the *Living Murray Intergovernmental Agreement*,75 is entirely consistent with the *National Water Initiative* and is fully supported by the Productivity Commission.

In order to meet the 2009 deadline, the fastest market-based measure to recover water is to purchase existing water entitlements from willing sellers through a tender process or direct purchase. There are no technical or legal impediments preventing the purchase of water from willing sellers under the laws of any jurisdiction to achieve the target of 500 GL. The timing of when to enter the market is a political rather than a technical decision and it is political considerations that have delayed entry into the market.76

Assessing market-based options under the *Living Murray Intergovernmental Agreement*

In December 2005 the Ministerial Council directed the Commission to report back to them in April 2006 on the use of market options, including purchasing entity options. A report prepared for the Commission77 concludes that:

• The cost of purchasing water entitlements would be cost effective subject to the payment of any "exit fees" or price effects on water entitlement markets arising from the scale of purchases.
• The purchase of 200 GL would represent some 2.3% of the long term diversion Cap for the potential Living Murray water recovery districts in the Southern Basin.
• Entitlement purchases for use under The Living Murray First Step could be progressed within the *National Water Initiative* 4% annual threshold limit on the level of entitlements to be traded out of irrigation areas.

• To progress water recoveries through market measures, there are a number of existing bodies, public and private, which can or do purchase water entitlements.
• The development of robust water registers and compatible institutional and regulatory arrangements by 2007, as already agreed under the *National Water Initiative*, will be important in enabling the use of market measures within the timeframe for water recovery for the First Step.

Some positive first steps to enter the market were made at the 40th Ministerial Council meeting in May 2006 through the package of measures put forward by The Hon Karlene Maywald MP, Minister for the River Murray in South Australia. These included the purchase of water from willing sellers and an indication from New South Wales of its preparedness to enter the market to meet its indicative 73 It is possible that Victoria will reach its jurisdictional indicative water recovery target through infrastructure improvements, but this is not the case in other jurisdictions.

74 Commonwealth Parliamentary Secretary with responsibility for water. See Anderson L, "Grants Plan to Raise River Murray Flows", *The Advertiser* (Adelaide, 28 April 2006)
75 See cl 23(ii) of the *Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray Darling Basin 2004*.
76 The purchase of water through the *Living Murray Intergovernmental Agreement* in a particular jurisdiction requires the approval of that jurisdiction under cl 43 of the *Living Murray Intergovernmental Agreement* and cl 63 of the Business Plan.
77 See BDA Group, *Issues and Options in Applying Market Based Measures in The Living Murray First Step* (March 2006). The Ministerial Council has agreed to publicly release this report.

targets – with New South Wales having taken a lead in the "purchase of water from willing sellers in an open market place for environmental flows" through its "Riverbank Fund".78 Malcolm Turnbull MP also detailed the Commonwealth's intention to purchase water from willing sellers by inviting tenders to sell water but on the condition that "the water offered for sale for the environment is water that can be delivered not later than 2009

PUTTING INTO PLACE AN ENVIRONMENTAL FLOW REGIME THAT WILL ENSURE A HEALTHY SYSTEM WHILE MAINTAINING PRODUCTIVITY.

The Ministerial Council has received consistent advice from the world's best river ecologists that additional flow in the River Murray is the key to restoring it to good health. **The Scientific Reference Panel advised that at the whole-of-river scale, an additional 1,500 GL per year option alone would deliver, at best, a moderate improvement in the health of the River – assuming it was combined with improved structural and operational management.80 These conclusions were based on the conditions that prevailed in 2003, including any surplus or unregulated flows.**

The Hon John Hill MP, then Minister for the River Murray in South Australia, in a paper delivered to the Ministerial Council in 2002 described the advice as follows:

The Murray-Darling Basin Ministerial Council received advice last April from the very best river ecology scientists in the world that, at the very least, an additional average annual flow in the Lower Murray of 1630 GL per annum would provide a moderate likelihood of a healthy working river system. I don't believe that we can contemplate a figure lower than this if we are serious about the health of the River Murray.81

The First Step has since been agreed through the *Living Murray Intergovernmental Agreement*, which seeks to return up to 500 GL of "new water" to the River for environmental flows by 2009 through a collective investment of $500 million; the Commonwealth has now invested significant additional funds to ensure there is no financial impediment to implementation.

The First Step is just that, an essential and significant first step along the path of returning the River Murray to good health. It is intertwined with the finalisation of the Living Murray Environmental Works and Measures Program82 to achieve the best possible environmental outcomes from the use of recovered water and existing flows,83 including the management of surplus or unregulated flows.
It is essential that 500 GL of "new water" is recovered by mid 2009, which environmental managers will be able to make best use of through the infrastructure being developed under the Living Murray Environmental Works and Measures Program. If the "new water" is recovered and managed in accordance with the First Step, some excellent environmental outcomes can be expected, especially if surplus or unregulated flows are effectively managed (this is addressed below).

Access to permanently recovered water will allow environmental managers to trade water on the temporary market at times when not all of the water is needed for environmental purposes and to build

78 See Debus B, *$105 million Fund to Rejuvenate Inland Rivers and Wetlands*, (Media Release, 30 November 2005). This funding package is not part of The Living Murray.
79 The tender has since been released. For initial announcement see Turnbull M, *Malcolm Turnbull recover water for the River Murray* 28 April 2006 available at http://www.malcolmturnbull.com.au/news/article.aspx?ID=423 (viewed 26 September 2006).
80 See Cooperative Research Centre for Freshwater Ecology, *Scientific Reference Panel, Ecological Assessment of Environmental Flow Reference Points for the River Murray System* (October 2003).
81 Per the Hon John Hill, *Environmental Flows in the River Murray*, Ministerial Council Meeting 32 (Adelaide November 2002).
82 Based upon Murray Darling Basin Commission budget projections in March 2006, the Environmental Works and Measures Program target completion year of 2011 would have been extended by almost 10 years to 2020. The Commonwealth injection of $500 million has put the programme back on track.
83 Through cll 108 – 110 of the Business Plan.

up resources to purchase temporary water in years where they wish to manage a larger flow. The second step of The Living Murray can open up opportunities to pursue other more novel market based measures such as leasing water and purchasing options.84 These different market-based options should not be pursued as a part of the First Step, which should continue to focus on permanently recovering 500 GL of "new water".

The Commonwealth has exercised strong national leadership, including making a substantial unilateral investment in the First Step to get it back on

track. It is open to the Commonwealth to further support the implementation of The Living Murray First Step by enhancing its use of existing laws and related conventions.

The Ramsar Convention and the Montreux Record

Wetlands on the List of Wetlands of International Importance (the List) under *The Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971*, commonly known as the *Ramsar Convention*,85 are selected on the basis of their "international significance in terms of ecology, botany, zoology, limnology or hydrology".86 Once a wetland is included on the List by a contracting party, the State is obliged under the terms of the Convention to, among other matters, "Formulate and implement their planning so as to promote the conservation of wetlands included in the List".

The *Ramsar Convention* provides for the contracting parties to adopt recommendations to promote the functions of the Convention and for them to take such recommendations into account in managing wetlands.87 The Conference of the Parties to the *Ramsar Convention* has created a public register to draw attention to sites where an adverse change in ecological character has occurred, is occurring or is likely to occur, to indicate that the site is in need of priority conservation attention. The register is known as the *Montreux Record*.88

The Commonwealth is able to request that the Ramsar Secretariat include a Ramsar listed site in need of priority conservation attention on the *Montreux Record*. It is also open to anyone to raise the issue with the Ramsar Secretariat, which will in turn bring it to the attention of the Contracting Party. Including a site on the *Montreux Record* (and subsequently removing a site) is always a matter for the contracting party.89

The Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (the EPBC Act) is essentially divided into two parts. The first part deals with the assessment and approval of actions that have, will have, or will be likely to have a significant impact on "matters of national environmental significance". The second part deals with the listing and management processes associated with biodiversity conservation and heritage.90

84 The various market based options are addressed in BDA Group, *Issues and Options in Applying Market Based Measures in The Living Murray First Step* (March 2006); Draft Report of the Productivity Commission, n 40; and the submission presented to the Productivity Commission by the Australian Conservation Foundation (July 2006) available at http://www.pc.gov.au/study/waterstudy/subs/sublist.html (viewed 26 September 2006).
85 Placing a wetland on the List of Wetlands of International Importance under the *Ramsar Convention* is a decision for each Contracting Party to the Convention. Australia was one of the first parties to join the Convention in 1975.
86 Today there are 1,590 wetlands included on the List by the Conventions 150 contracting parties, 64 of which are included in Australia with 11 being in the Murray Darling Basin. See http://www.ramsar.org and http://www.deh.gov.au (viewed 26 September 2006).
87 Conferences of the Parties have included recommendations on many issues, including "environmental flows".
88 Full text of resolution available at http://www.ramsar.org/key_montreux_record.htm (viewed 26 September 2006).
89 There are at present 57 sites listed on the *Montreux Record* including sites in both the United Kingdom and the United States. No Australian Ramsar sites have been listed to date.
90 The *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) lists seven matters of national environmental significance, national heritage places having been added since the passage of the Act in 1999. The Act seeks to give effect to

Under the EPBC Act no "action" can be undertaken that will have "a significant impact on the ecological character" of a Ramsar wetland91 without the prior approval of the Commonwealth Environment Minister.92 The Commonwealth and its agencies are also obliged to take all reasonable steps to "ensure it exercises its powers and performs its functions in relation to a wetland in a way that is not inconsistent with … the *Ramsar Convention*".93

The Coorong and Lower Lakes: The Ramsar Convention and the EPBC Act

In 1985 the Coorong and Lakes Alexandrina and Albert Wetland located at the mouth of the River Murray in South Australia (the Coorong and Lower Lakes) were recognised as a wetland of international importance and included on the List.

Colin Thiele, in his book *Storm Boy*, vividly describes the wild beauty of the Coorong:

His home was the long, long snout of sandhill and scrub that curves away south eastwards from the Murray mouth. A wild strip it is, windswept and tussocky, with the flat shallow water of the South Australian Coorong on one side and the endless slam of the Southern Ocean on the other … They call it the Ninety Mile beach. From thousands of miles round the cold, wet underbelly of the world the waves come sweeping in towards the shore and pitch down in a terrible ruin of white water and spray. All day and all night they tumble and thunder.94

In 1981 the River Murray mouth closed, "*the only occasion since non-indigenous settlement*" and in 2003-2004 "*only dredging enabled it to stay open*".95 Low flows and their effects at the end of the system are not a new phenomenon. What is new is the frequency at which low flow events occur, with the median flow now 27% of what it was under natural conditions and low flows occurring 66% of the time under regulated conditions compared with 7% of the time under natural conditions.96

The Coorong and Lower Lakes is one of the six significant ecological assets under The Living Murray First Step. Recent reports have described a significant decline in the ecological health of the Coorong and Lower Lakes which is largely attributable to a lack of sufficient water flowing through the lower reaches of the River Murray.97

The state of health of the mouth of the River Murray and the Coorong and Lower Lakes is the most obvious and emotionally evocative indication of the success or failure in managing the shared Australia's international environmental obligations under a range of international conventions and to deal with the management of Commonwealth places, including heritage places. More information on the Act is available from its home page at http://www.deh.gov.au/epbc/index.html (viewed 26 September 2006).

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91 See *Environmental Protection and Biodiversity Conservation Act 1999* (Cth), s 16.

92 **Any action that reduces the surface flow of the River Murray or its tributaries, for example when a prescribed volume is exceeded, could be investigated as a new matter of national significance under the *Environmental***

***Protection and Biodiversity Conservation Act 1999* (Cth), thereby requiring the consideration of the Commonwealth Environment Minister before the action proceeds. The precise description of such a trigger would require further thought and analysis. The Environmental Defender's Office of New South Wales has considered a possible water extraction trigger. For information see http://www.edo.org.au/ edonsw/site/default.php (viewed 26 September 2006). Section 100 of the *Constitution* provides that the Commonwealth shall not "by any law or regulation of trade or commerce, abridge the right of a State or the residents therein to the reasonable use of the waters of rivers for conservation or irrigation", a provision that has never been fully tested. The Commonwealth has used many heads of power to legislate on environmental issues, including legislating for the domestic implementation of international treaties under its "external affairs" power. Powers can also be referred to the Commonwealth by the States under Section 51(xxxvii) of the Australian Constitution.**

93 See *Environmental Protection and Biodiversity Conservation Act 1999* (Cth), s 334.

94 Thiele C, *Storm Boy* (Rigby, Adelaide1963) in Muirhead P, "The Changing face of the River Murray" *ABC News Online* (undated) available at http://www.abc.net.au/news/features/ocean/adelaide.htm (viewed 26 September 2006).

95 Murray Darling Basin Commission, *The Lower Lakes, Coorong and Murray Mouth Asset Environmental Management Plan for 2005/2006* (2005) p 39.

96 See Walker D, *The Behaviour and Future of the River Murray Mouth* (Centre for Applied Modeling in Water Engineering, University of Adelaide, 2002) p 3, available online at http://www.thelivingmurray.mdbc.gov.au/reports/archived_reports (viewed 26 September 2006).

97 See eg South Australia, Department for Environment and Heritage, *Ecological Character of the Coorong, Lakes Alexandrina and Albert Wetland of International Importance – working draft for public consultation*, (October 2005).

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resources of the Basin.98 Minister Maywald from South Australia has long advocated that: "*if we can get it right at the end of the system the rest will follow*".99 All of the reports currently available warrant consideration about the inclusion of the Coorong and Lower Lakes on the *Montreux Record* under the *Ramsar Convention*. Placing the Coorong and Lower Lakes on the *Montreux Record* will provide very public recognition of the plight of the area and reinforce the Commonwealth's commitment to fulfilling its responsibilities under the *Ramsar Convention*, other relevant conventions,100 and the EPBC Act.

SERIOUSLY ADDRESSING THE SIX RISKS TO SHARED WATER RESOURCES AND MANAGING UNREGULATED FLOWS FOR THE BENEFIT OF THE WHOLE BASIN

The CSIRO has identified six risks to the shared resources of the Basin,101 appropriately described by some as "flow reducing activities" given that the impacts of most of them have been felt within the Basin for over a decade and have already eroded surface flows since the introduction of the Cap.102 The six risks could reduce surface water flows by anywhere between 2,500 GL and 5,500 GL over the next 20 years.103 The six risks are:

- climate change;
- changes in stream flow due to afforestation (large scale planting);
- groundwater extraction;104
- irrigation water management;
- farm dams; and
- bushfires.

Two of these risks are beyond the direct control of the parties: climate change and bushfires. A third risk, irrigation water management, refers to reduced return flows as a result of greater irrigation efficiencies. This should have been addressed at the time water entitlements were created by granting net rather than gross entitlements.105

There are three risks that are within the direct regulatory control of the parties yet there remains ongoing reluctance to promptly deal with them. They are afforestation, groundwater extraction and farm dams, the potential impact of which has been known for a decade or more. The estimates included in the CSIRO reports predict that these three risks could reduce surface water supply by 1,075 GL to 4,100 GL in the next 20 years – afforestation between 550 to 700 GL, farm dams between 250 to 3,000 GL and groundwater between 275 to 550 GL.

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98 Dredging has been underway at the Mouth of the River since October 2002, at a total cost of $15 million to June 2005. See Murray Darling Basin Commission, *Murray Darling Basin Commission Annual Report 2004-2005*, (2005) p 32. The total cost of dredging operations from October 2002 to June 2006 is $22.006 million. The cost of dredging has been shared equally by the Commonwealth, New South Wales, Victoria and South Australia. Personal communication, Geoff Haberfield Office of the Commission 26 July 2006.
99 Per the Hon Karlene Maywald MP, Personal Communication (July 2006, emphasis added).
100 **Australia has also entered into separate treaties with China in 1988 (CAMBA) and Japan in 1981 (JAMBA) for the protection of migratory birds that migrate between their respective countries (which were negotiated under the framework of the *Convention on Migratory Species 1979*, to which Australia is a party). Migratory birds protected under these treaties migrate to the Coorong and Lower Lakes.**
101 See Murray Darling Basin Commission, *CSIRO, The Shared Water Resources of the Murray Darling Basin*, (February 2006); and Murray Darling Basin Commisison, *CSIRO, Risks to the Shared Water Resources of the Murray Darling Basin*, (February 2006), both available online at http://www.mdbc.gov.au/news/MC_communique/mc40-reports (viewed June 2006). 102 Professor Mike Young, Personal Communication (17 July 2006). Professor Young also notes that the impacts of "*flow reducing activities*" need to be assessed as from the date of the Cap.
103 And in 50 years by between 4,500 gigalitres and 9,000 gigalitres.
104 An impact that is not accounted for is the reduction in flows caused by salt interception schemes. Young, n 102.
105 See Draft Report of the Productivity Commission, n 40, p 25; and for a detailed discussion see Young M and McColl J, *Robust Reform: Implementing Robust Institutional Arrangements to Achieve Efficient Water Use in Australia*, (CSIRO Land and Water, 2003).

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This volume needs to be considered in the context of the following figures taken from the CSIRO reports:

• average general run off within the Basin is 24,000 GL;
• total diversions in the Basin are about 11,000 GL per year, about 95% of which is used for irrigation;
• discharge at the mouth of the River Murray is 3,000 GL;
• The Living Murray First Step seeks to recover 500 GL of "new water" for environmental flows.

The CSIRO reports reveal a serious challenge to river health and productivity. Although the Murray Darling Basin Commission is spending $1 billion to secure and manage an additional 500 GL of water for environmental flows, the parties to the Agreement are allowing the continuance of a situation where the three risks that are within the control of the jurisdictions are projected to decrease flows over the next 20 years by between two and eight times this volume. This is occurring in the context of the best science indicating that an additional 1,500 GL per year is required to deliver a moderate improvement in the health of the River.

New compensable rights to water resources cannot continue to be created in light of this knowledge. Creating new rights now will severely impact upon the resource security of existing water users and impose an additional cost on taxpayers in the future as newly created water rights are purchased to provide for environmental flows.106

The Productivity Commission has called for groundwater to be included within the Cap.107 There is no need for a moratorium on taking water or prohibiting the establishment of new areas for afforestation. **What is needed is for each proposal,** with reasonable exceptions for some small farm dams, **to be assessed in terms of its impact on the surface water flows of the River Murray**. If it will have an impact, the proposal can still proceed but only if a surface water allocation is first obtained from within the Cap. It is open to jurisdictions to do this under their own laws without extending the Cap.

The response from some respected colleagues is that if they cannot access groundwater they will have nowhere to go for additional water. First, they do have somewhere to go, they can access water from within the Cap. Secondly, it is well established that there is a limit to the available resource, something South Australia recognised in 1969 when it put into place a self-imposed cap on diversions from the River.

This is a critical matter for the parties to address. The Ministerial Council and the Commission are responding to the six risks by undertaking further studies and analysis and at its 40th meeting in May 2006, the Ministerial Council agreed that the issue should become a standing item for all future meetings of the Council until strategies are in place to deal with the risks.108 All of this is good, but in light of the available knowledge and the regime that has been put into place through the CoAG water related reforms and the *National Water Initiative*, decision-makers must act now to stop creating new water rights that could impact the surface water resources of the Basin unless sourced within the Cap. All of this can be achieved in the context of the States' existing legislative regimes, with the possible exception of some farm dams which may require legislative (as opposed to regulatory) change.109

Unregulated or surplus flows

The Independent Audit Group after reviewing the progress of the First Step has stated that the potential impact of altered unregulated or surplus flows (unregulated flows) management (including

106 The Murray Darling Basin Commission cannot assume continuing budget surpluses to spend on recovering water.
107 See Draft Report of the Productivity Commission, n 40, p 11.
108 See Ministerial Council Communique available online at http://www.mdbc.gov.au/news/MC_communique/mc40-reports (viewed July 2006).
109 See Dyson M, *Risks to Shared Water Resources, Overview of Statutory Frameworks*, (Murray Darling Basin Commission, 2005). Also see n 92, above, regarding a possible role for the Commonwealth under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth).

for local environmental benefits) "on the achievement of the overall objectives of The Living Murray First Step is the most significant risk it identified in its audit".110

The Independent Audit Group also noted that the decisions made through The Living Murray First Step were premised upon a general baseline that assumed the 2003 distribution of unregulated flows in the River Murray System. This baseline information includes the reports provided by the Scientific Reference Panel on the volume of water required to be recovered in order to restore the River to good health.

Median unregulated flows in the Lower Murray below Wentworth in New South Wales under the conditions that prevailed in 2003 was 4,500 GL. Any significant reduction in this flow will change the general baseline assumed by the Scientific Reference Panel, which was the scientific basis upon which The Living Murray First Step was developed.

The volume of water recovered through the First Step is small compared to the volume of water available through unregulated flows and it does not match the amount of available water that can be lost to the system through the six risks to shared water resources, estimated at being between 2,500 GL and 5,500 GL per year by 2023.

A failure to adequately address the issue of unregulated flows will seriously undermine the objectives of the First Step, especially when considered in conjunction with the six risks to shared resources. The Ministerial Council recognised the significance of unregulated flows by incorporating the following provisions into the Business Plan:

• requiring the Commission to propose options for achieving improved environmental outcomes for the River Murray through the management of unregulated flows by June 2005 and to provide a report to the Ministerial Council in October 2005;111
• requiring the Living Murray Environmental Watering Plan to include rules for the management of unregulated and/or surplus flows;112
• requiring a Basin-wide account to be developed to enable monitoring and reporting on the volume and spatial distribution of unregulated flows in the Murray Darling Basin over time; and113
• requiring jurisdictions, while retaining responsibility for unregulated flows, to comply with cl 46 of the Agreement at any time when the assignment of water resources to tributary ecological assets is being considered in order to assess the relative merits of the various options.114

Minister Maywald from South Australia took the matter further in a statement delivered to the 40th Ministerial Council in May 2006115 and secured resolutions that the Council:

Recognises that the management of all environmental flows for the River Murray, including unregulated flows, requires a "One River" approach. In this respect, the appropriate vehicle is an agreed Living Murray Watering Plan, as amended from time to time …

Directs the Murray-Darling Basin Commission to include in its report advice on how unregulated flows within the Murray-Darling Basin might be clearly defined, quantified, managed, monitored and reported on in The Living Murray Initiative.

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110 See *Review of The Living Murray Implementation* presented to the Ministerial Council at Meeting 40 (May 2006) p 26.
111 An options paper or report has not yet been prepared by the Commission.
112 Rules have not yet been prepared.
113 A Basin-wide account has not yet been prepared.
114 No proposals have been submitted to the Commission under cl 46 of the *Murray Darling Basin Agreement*.
115 *Unregulated Flows – An Immediate Threat*, Murray-Darling Basin Ministerial Council Meeting No 40, May 2006.

Minimising the need to recover additional new water

Jurisdictions are finding it challenging to recover the 500 GL of water as is required by the First Step.

Additional volumes of "new water" will need to be recovered under subsequent steps of The Living Murray Initiative in order to restore the River to good health. How such water is recovered remains open.116

The Commission, and each jurisdiction, wishes to minimise the amount of additional "new water" that is recovered from consumptive users, including irrigators, following the success of the First Step in restoring the River to good health. The only future option available to the Ministerial Council to achieve this objective through better flows – other than recovering additional "new water" from consumptive users – is to better manage unregulated flows.117 This needs to be done correctly.

The optimal management of unregulated flows to achieve specific environmental outcomes for the six significant ecological assets and other local assets may reduce the additional volume of "new water" that will need to be recovered to restore the River to good health after the implementation of the First Step.

If unregulated flows are not collectively managed for the health of the overall river system, its health will continue to decline and pressure to recover significant additional volumes of "new water" from consumptive users will only increase.

CREATING MODERN AND EFFECTIVE GOVERNANCE AND COMPLIANCE ARRANGEMENTS.

The importance of "good governance" for sustainable development118 and of effective water governance has been universally recognised.119 Governance arrangements are not static; they evolve over time to adapt to changing circumstances.

The governance of the Commission has evolved over the years. In 1987 it was expanded from one commissioner per jurisdiction to two commissioners. Its role was also revised to include advising the new peak body under the Agreement, the Ministerial Council. The time has arrived for the further reform of the Commission120 in order to:

- provide the Ministerial Council with a more independent source of advice;
- give it the capacity to more effectively implement decisions of the Ministerial Council;
- more clearly define its roles and responsibilities; and
- be more open, transparent and accountable to governments and the community for its actions.

In 2001 the South Australian Parliament released a report supported by all political parties that recognised the need to reform the Commission.121 More recently the Commonwealth, as a

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116 Which could be through the use of an array of other market based measures including leasing water and purchasing options.
117 Addressing the six risks to shared water resources does not provide additional water.
118 The World Summit on Sustainable Development, (Johannesburg, South Africa, 26 August-4 September 2002), *Johannesburg Plan of Implementation* stated that "good governance within each country and at the international level is essential for sustainable development".
119 And numerous initiatives have been launched to promote water governance such as the joint initiative of the United Nations Development Programme and Stockholm International Water Institute through the Water Governance Facility available at http://www.watergovernance.org (viewed 26 September 2006), and the Global Water Partnership available at http://www.gwpforum.org/servlet/PSP (viewed 26 September 2006).
120 Having viewed the Initiative from many different perspectives, including as a Chief of Staff to a member of the Ministerial Council, Commissioner, Chief Executive of a government agency responsible for, inter alia, water resources management, and now independent Commissioner.
121 South Australia, House of Assembly Select Committee on the River Murray (3 May 2000 and 13 March2001),availableonlineathttp://www.parliament.sa.gov.au/committees/committee.asp?doCmd=show&intID=11 (viewed 26 September 2006). Committee Chair, the Hon David Wotton, is now the Chair of the South Australian Murray Darling Basin Natural Resources Management Board and Committee Member, the Hon Karlene Maywald MP, is now South Australia's Minister for the River Murray.

precondition to investing an additional $500 million in The Living Murray First Step, has required the parties to the Agreement to “undertake a review of the governance and financing of the Murray Darling Basin Commission”.122

Views expressed in evidence before a Select Committee of the South Australian Parliament, the downstream State, in 2000 on the need to reform the Commission (see below) remain equally valid today.123

Heads of government agencies work very closely with Ministers, and while not political in a party political sense, are appropriately close to the politics of government. They are contracted to carry out the government’s policy agenda,124 yet the expectations of the government of the day and obligations to the Basin under the Agreement may not always coincide. This stands in contrast to the intended role of commissioners under the Agreement which is to act in the best interests of the Basin without regard to political borders; this obligation is not expressly stated.125

The Commission has been inclined to shadow the political debate, to reflect jurisdictional positions **and to exercise excessive caution in the nature of the advice it provides to the Ministerial Council. Advice from a body of this nature should be frank and fearless and the politics of the Basin should be left for the elected members to debate, namely the Ministers who comprise the Ministerial Council, not the Commission.**126

Since the author returned to the Commission in 2006, it has become equally apparent that a level of independence is also required in the implementation of measures under the Agreement**. Under current arrangements the heads of State agencies responsible for the implementation of many measures, and related federally funded programmes sit on the Commission, which is also often responsible for overseeing, reviewing or advising the Ministerial Council on the implementation of the very same initiatives.**

It is time to have a more independent Commission, one that is skills-based127 with members obliged to act in the best interests of the Commission and able to dedicate sufficient time to the task at hand. However, to be effective, the Commission also requires good links to State and Commonwealth agencies that possess significant knowledge and expertise and remain critical to the success of the Initiative.

The challenge in reforming the Commission is to achieve an appropriate level of independence while retaining strong links to these agencies. This can be achieved through the appointment of a commissioner by each party from within government as an ex officio non-voting member, which is further discussed below, the continued involvement of agency staff on committees of the Commission and through the ongoing role of the network of departmental liaison officers.

122 See Agenda Item 5A Ministerial Council Meeting 40 – May 2006. See also Turnbull M, *Commonwealth Injects $500 Million, New Urgency Into Water Recovery For Murray Darling Basin*, (Media Release, 19 May 2006), available online at

http://www.malcolmturnbull.com.au/news/default.asp?action=article&ID=441 (viewed 26 September 2006).
123 See transcript of Scanlon J in, South Australia, House of Assembly Select Committee on the River Murray, *Hansard* (3 May 2000 and 13 March 2001), available at http://www.parliament.sa.gov.au/committees/committee.asp?doCmd=show&intID=11 (viewed June 2006). See also Scanlon J "The Need to Reform the Murray Darling Basin Commission" (2001) 18 EPLJ 230.
124 Department heads today are typically placed on three to five year contracts and subject to one to three months notice of removal without cause, and contracts of employment require the promotion of the government's policy agenda. **By way of example, the author's own contract with the then Premier of South Australia as head of department said that he was to "*faithfully serve the SA Government and at all times use his best endeavours to promote the interests of the SA Government*". There was nothing unusual or inappropriate about this, and the government of the day quite reasonably expects its Chief Executives to give effect to its policies.**
125 This role would be clearer if the Commission was treated as body corporate. For a discussion of this issue see Clark SD, "Divided Power, Co-operative Solutions", in Connell D (ed), *Unchartered Waters*, (MDBC 2002) p 15.
126 The Commission has achieved a lot over the years, and there have been many excellent and committed Commissioners. This is no criticism of individual Commissioners or their personal commitment to the Basin.
127 Membership should be drawn from appropriate disciplines including finance, business management, science and technology, law, engineering, conservation and management of natural resources, and government.

A selection process for independent members of the Commission that closely followed the process used at Commonwealth level for appointments to research and development cooperation boards was recommended in evidence before the Select Committee.128 This process should be adapted and applied to the appointment of a skills-based Commission. It would involve the chair of the Ministerial Council appointing a selection panel following consultation with all members of the Ministerial Council, an open process of inviting expressions of interest in being appointed to the Commission, and the Panel making nominations to the Chair based upon established selection criteria.
The Minister's discretion to reject nominations would be constrained, but if exercised would require the process to be repeated. The evidence presented to the Select Committee included the following:

So your Murray Darling Basin Commission would be comprised of a president, six skills based individuals, the chair of the Community Advisory Committee (CAC), the chief executive of the office, and a government officer from each of the participating States. However, the only voting members of the commission would be the president and the six skills based officers appointed following that selection process. That would ensure that the ministerial council does have access to a skills based commission, but it would also ensure that the commission retains its linkages through to government agencies of all participating jurisdictions and also retains linkages with the CAC and the office.

The Select Committee's recommendations closely followed this evidence, with the Committee's findings including Recommendation 4, which states that:129

The Murray-Darling Basin Ministerial Council give consideration to the composition of the Murray-Darling Basin Commission with the aim of changing it to an independent, expert (skills-based) Commission. The Commission must contain skills in ecology and natural resource management, irrigation technology, engineering, finance and business administration, resource economics, law, regional development and public administration.

• *The structure of the new Commission be:*
– *an independent President*

– six Commissioners who between them have extensive experience and/or qualifications in the disciplines of ecology and natural resource management, irrigation technology, engineering, finance and business administration, resource economics, law and regional development
– a senior bureaucrat from each of the Murray-Darling Basin Initiative partners
– Chair, Community Advisory Committee (non-voting member)
– Chief Executive Officer, Office of the Murray-Darling Basin Commission (non-voting member).
• The model used to appoint Directors to Research and Development Corporations under the Commonwealth's Primary Industries and Energy Research and Development Act, 1989 be applied to the appointment of Commissioners, with responsibility for the selection process delegated to the Chair, Murray-Darling Basin Ministerial Council.
• The appointment process, where possible, seek to obtain a reasonable geographic spread of Commissioners from across the various Basin states.

In addition to this recommendation130 it needs to be clearly set out in the Agreement and implementing legislation that commissioners are to act in the best interests of the Commission. This could be achieved by establishing the Commission as a statutory board to direct, govern, guide, monitor, oversee, and supervise the work of the Office. The role and function of the Office would also need to be recognised in the Agreement, along with requirements for the more open and transparent transaction of the Commission's business.

Moving ahead with Independent Commissioners

Learned writers such as Professors Clark and Cullen have expressed a variety of views on reform of the Ministerial Council and the Commission.

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128 See transcript of Scanlon J, n 123.
129 South Australia, Select Committee on the Murray River, *Final Report – 2001* (South Australia, 2001) p 6, available at: http://www.parliament.sa.gov.au/committees/documents/MurrayRiver_49_4/public_documents/Repors/SCRiverMurayFinal.pdf (viewed 26 September 2006).
130 The author suggests government members are appointed as ex officio, non-voting members.

Of particular note are the opinions expressed by Professor Sandford D Clark131 in an article written in 2002.132 Professor Clark expressed the view that:

The present principle of unanimity should … be abolished in favour of decisions by a majority of ministers or commissioners voting on any issue. Further, legislation in each jurisdiction should require that any person appointed as a Commissioner or Deputy Commissioner must have such skills, experience and background relevant to the business of the Commission as will allow that person to understand and participate effectively in making decisions upon issues determined by the Commission.133

The notion of appointing commissioners on the basis of their skills was also supported by Professor Peter Cullen through a recommendation made to the Government of South Australia as an Adelaide Thinker in Residence in 2004.134 Professor Cullen recommended that:

Recommendation 7

South Australia should appoint one of its Murray Darling Basin Commissioners to speak from a whole of government perspective. The second Commissioner position should be used as an opportunity to appoint an expert in a relevant area.

The South Australian Government took the lead under the Agreement when it implemented this recommendation in January 2006 with the appointment of the author as Australia's first independent commissioner, with terms of reference that included providing:

Strategic advice … on improving communication and collaboration between government agencies, academia and industry …maximising Commonwealth involvement and commitment to the MDBC135 and the development of appropriate policy; an independent assessment of issues raised at the MDBC; leadership and knowledge at the MDBC.

Minister Maywald also encouraged other governments to follow South Australia's lead. To date no other independent commissioners have been appointed.

Utilising majority voting – a first for the Commission

While most of the decisions required to administer the Agreement need the unanimous vote of all commissioners present and constituting a quorum,136 the Commission can provide advice to the Ministerial Council by majority vote.137 In the case of a majority vote, the President and each commissioner may tender separate advice to the Ministerial Council.

This option was exercised for the first time under the Agreement in March 2006 – with advice on The Living Murray First Step provided to the Ministerial Council by both a majority of commissioners and the present author's minority report. At the heart of the issue was the nature of the advice to be provided to the Ministerial Council on the progress being made in the implementation of the First Step.

The minority report provided unequivocal advice to the Ministerial Council that the First Step was not going to be implemented within the agreed timeframes for a variety of reasons, including a significant underinvestment by participating jurisdictions138 and reluctance to purchase water from willing sellers.139

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131 A long time legal adviser to the Commission.
132 An early contribution being his submission to the River Murray Select Committee and Working Party in March 1975 titled *Possible Changes in River Murray Administration* available from the Office of the Commission.
133 Clark SD, "Divided Power, Co-operative Solutions?", in Connell D (ed), *Unchartered Waters*, (MDBC 2002).
134 See report of Cullen P, *Water Challenges for South Australia in the 21st Century*, (South Australia, 2004).
135 Murray Darling Basin Commission.
136 See cl 32 of the *Murray Darling Basin Agreement*.
137 See cl 17 of the *Murray Darling Basin Agreement*.
138 The Commonwealth Government came to the financial rescue of The Living Murray by unilaterally agreeing to invest a further $500 million thereby ensuring there was no financial impediment to implementation.
139 See Agenda Item 9.3, Ministerial Council Meeting 40 – May 2006 referenced by Minister Maywald in Agenda Item 9.4.

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Majority Voting – removing the veto from the Ministerial Council

The Ministerial Council takes all of its decisions by the unanimous vote of all Ministers present and constituting a quorum.140 This has, on occasion, led to a situation where one jurisdiction has refused to yield and effectively vetoed progress on reform.141 There are many examples, the European Council of Ministers is one, of political bodies adopting voting requiring a qualified majority, or super majority, rather than a unanimous decision or simple majority vote.

A move to majority voting by the Ministerial Council should be promoted but the majority should require five of the six participating governments thereby ensuring strong support for a measure but preventing a veto. The extension of qualified majority voting to all decisions of the Commission should be incorporated into the Agreement to facilitate its administration.

FULLY IMPLEMENTING MAJOR INITIATIVES OF THE MINISTERIAL COUNCIL, IN PARTICULAR THE CAP ON WATER DIVERSIONS, BASIN SALINITY MANAGEMENT STRATEGY, LIVING MURRAY FIRST STEP AND INTERSTATE TRADE

These initiatives represent major achievements of the Ministerial Council, but a closer analysis of the independent audits and the facts reveals that implementation is still falling short of expected targets. For example, the Cap targets have still not been established in all jurisdictions ten years after it was agreed to cap diversions,142 the Registers required under the Basin Salinity Management Strategy have not been created in accordance with the Operational Protocols and cannot be used with confidence,143 water has not yet been recovered under The Living Murray First Step, decisions on unregulated flows have not yet moved forward,144 and the implementation of the expansion of interstate trade is not yet completed.

It is not the purpose of this article to run through the implementation challenges in detail, rather it is to highlight the importance of ensuring that focus is maintained on implementation and not being unduly distracted by the next emerging policy initiative.

Effective "on ground" implementation is the true test of policy success. Implementation does not happen by itself. It requires people with the necessary skills to deliver "on ground" results and an ongoing process of building capacity.

Implementation of the Murray Darling Basin Initiative is essentially a matter for State agencies and the Commission, with success inextricably linked to having the capacity to deliver on Australia's broad and ambitious reform agenda at a time when State agency, and until recently Commission, budgets have been shrinking. Many of the measures and programs developed through the Initiative are highly complex and demand significant professional expertise and experience. Successful implementation will require sustained levels of investment at agency and Commission levels.

ACHIEVING COMPLIANCE WITH THE NATIONAL WATER INITIATIVE.

For the first time, all Australian governments have committed to a national blueprint for water reform …The National Water Initiative is the agreed blueprint for the reform of water management throughout Australia.145

The *National Water Initiative* has set an ambitious water reform agenda that makes good use of market-based measures to address our water resources challenges. As with other bold policy initiatives

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140 See cl 12(3) of the *Murray Darling Basin Agreement*.
141 See generally Clark, n 133.
142 See Murray Darling Basin Commission, *Review of Cap Implementation 2004/5, Report of the Independent Audit Group* (MDBC, 2006).
143 See Murray Darling Basin Commission, *Report of the Independent Audit Group for Salinity 2004 2005* (MDBC, 2006) p 6.
144 See Agenda Items 9.3 and 9.4 Ministerial Council Meeting 40 – May 2006.
145 Transcript of the Prime Minister, the Hon John Howard MP, *Address to the Committee for Economic Development of Australia* and *Securing Australia's Water Future July 2006 Update*, (CEDA Conference, Sydney, 17 July 2006).

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implementation is the key, and in this case implementation essentially rests with the States. Unlike the 1994 CoAG Water Related Reforms,146 compliance with the *National Water Initiative* is not tied to competition payments, nor does it include any legislative compliance options.
If the *National Water Initiative* is to be implemented within agreed timeframes then, at a minimum, compliance will need to be directly linked to funding. This will be important for the recovery of the health and ongoing productivity of the River Murray.

The *National Water Initiative* requires the Murray Darling Basin parties to review the Agreement to ensure it is consistent with the *Initiative*.147 Steps have been taken to carry out this review, which includes determining the Agreement's consistency with the requirements of the *Initiative* in relation to integrated water resources management, adaptive management and managing the shared risks to water resources referred to above. In this context the Initiative's water sharing rules148 and the way in which they are administered is of particular significance. Unlike many other aspects of the Agreement, the water sharing rules have changed little since the time of the *River Murray Waters Agreement of 1914*. Today they are inconsistent with both the *National Water Initiative* and the *Living Murray Intergovernmental Agreement*, in particular with regard to recognising the "environmental and other public benefit outcomes sought for water systems".149

The Commonwealth, as a pre condition to investing an additional $500 million in The Living Murray Initiative, has required a wide-ranging review of the Agreement.150 This review will address the governance and financing of the Commission, Basin water sharing and natural resource management arrangements generally, including the case for creating a new legal entity to hold and operate water entitlements acquired by the Commission.

The requirement of reviews gives parties the opportunity to address each of the challenges referred to above. It also provides the opportunity for the Commonwealth to consider whether to start tying funding to the *National Water Initiative* and its ongoing investment in the Initiative to achieving necessary reform. Whether the parties seize the opportunity presented by these reviews remains to be seen.

A NEVER ENDING STORY: CREATING THE FRAMEWORK FOR ONGOING NEGOTIATIONS

The negotiation process is a little over a century old and will continue in perpetuity as governments and the community adapt to changing economic, social and environmental conditions by utilising innovative tools to enhance productivity and to improve the ecological health of the Basin.
High tension over sharing the resources of the River Murray, and later the Basin, can be traced back to the 1880s. This was the time when irrigation schemes first started to emerge in one of the upstream colonies causing alarm to the downstream colony that had invested heavily in navigation to promote trade and communications.

Many royal commissions and government and community-based conferences have been held both prior to and since the creation of the Commonwealth of Australia in 1901 and strongly-held

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146 The National Competition Policy was an agreement between the Commonwealth and State and Territory governments to progress a nationally coordinated approach to microeconomic reform in return for a series of national competition tranche payments, based upon the effective implementation of the reform agenda. The reform agenda included so called "related" reforms, including the strategic framework for the reform of the Australian water industry, adopted by all Australian governments in 1994. Through including the "related reforms", the National Competition Policy entrenched the following issues on the national agenda: identifying and managing assets; efficient pricing; trade in water rights; environment flows; and community involvement. More specifically, this strategic framework included provisions relating to urban and rural pricing, separating water allocations or entitlements from land title, institutional reform, water trading, third party access to infrastructure, environment flows and community consultation.
147 See cl 14 of the National Water Initiative.
148 See Pt X – *Distribution of Waters of the Agreement*.
149 See eg cll 78 – 79 of the National Water Initiative.
150 See Agenda Item 5a: Australian Government Funding Package paragraph 5(h), Ministerial Council Meeting 40 – May 2006.

Where is the Murray Darling Basin Initiative leading us? (2006) 23 EPLJ 386 409 ©

negotiating positions have been defended with great vigour. However, a sense of shared ownership and responsibility has prevailed as the parties have strived to work with the Basin community to find pragmatic and cooperative solutions to the economic, social, and increasingly environmental challenges that confront the Basin, its governments and its community.

The legislative framework was created in 1915 and has been changing ever since. In 1987 it was adapted to cover the entire Murray Darling Basin and to incorporate all jurisdictions and the community into the process. The Murray Darling Basin Initiative's solid legislative framework and its willingness to review and adapt this framework over time has provided a sound and robust negotiating environment within which to operate and confront new challenges as they emerge.

Over the past century the governments and communities of the Murray Darling Basin have done some truly great things within the Basin along with some things that, with hindsight, might have been done differently. The parties now have a significant knowledge base which allows a better understanding of the consequences of both current and future actions.

The latest version of the Agreement has been in place since 1992 and was revised in 1996. As has been described above, the Commission and Ministerial Council have now entered an era where they are confronting new and significant challenges. The inescapable conclusion from all the knowledge available is that changes are required to the Agreement and the way it is administered if the parties are going to successfully implement the measures deemed necessary by all governments to restore the system to good health and to maintain productivity.

If the necessary changes are made, society will be heading in the right direction to pass on a healthy and productive Basin to the next generation of Australians. If not, a steady decline in the health and productivity of the system is assured. Responsibility for the direction taken is shared by all of us.

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The following is the National Water Commissions position on what States are signatory too and it intends to make sure that States know and adhere to their responsibilities.

NATIONAL WATER COMMISSION— POSITION STATEMENT 28 APRIL 2008
Water Planning in Australia:

National Water Commission position
Water planning in Australia
Effective water planning is fundamental to the National Water Initiative (NWI) because it provides certainty about the terms of access for consumptive and environmental water users within an evidence-based, participatory and transparent process. Water planning is central to dealing with the challenges of stressed water systems and to determining how we share valuable water resources between competing uses.
Water planning processes have not always been of the necessary high standard and the roll out of completed water plans has been too slow.
The quality and extent of science and data underpinning water plans remains a critical concern and socio-economic information can be inadequate. There is an urgent need to better manage the connectivity between surface and groundwater resources and to more effectively factor in the impacts of climate change. Water plans also need to incorporate the effects of significant interception activities, such as farm dams and forestry, on future water availability. Returning stressed water systems to sustainable levels of extraction is not convincingly tackled in many water plans, and transparent decision making is lacking in some instances.

Planning commitments under the National Water Initiative

When they signed the NWI, all governments around Australia agreed to follow a nationally consistent approach to water planning. The NWI provides clear direction for water planning by:

> 'Recognising that settling the trade-offs between competing outcomes for water systems will involve judgements informed by best available science, socio-economic analysis and community input, statutory water plans will be prepared for surface water and groundwater management units in which entitlements are issued (paragraph 36).'

NATIONAL WATER COMMISSION— POSITION STATEMENT 28 APRIL 2008 2

Progress on water planning

In its 2007 Biennial Assessment and its 2008 update report to the Council of Australian Governments on progress in water reform, the Commission found whilst NWI parties have made good progress in implementing agreed water planning processes, the roll out of completed water plans has been slow. Delays have occurred due to the need for adequate consultation, insufficient time to source the required science, and resource constraints. No jurisdiction can yet claim to have a fully effective water planning system.

Future water planning priorities

The National Water Commission continues to regard NWI-consistent water planning as the best way to reconcile competing demands for water and tackle overallocation or overuse of water resources. A set of priority actions has been identified to assist governments in meeting their commitments under the National Water Initiative and to build community confidence in water planning processes. Future water planning should:

Achieve a shared understanding of sustainable levels of water extraction so that over-allocation is both rectified and avoided in the future.

Improve our knowledge of groundwater-surface water connectivity, with significantly connected systems to be managed as one integrated resource.

Factor in the impacts of climate change and the effects of interception activities (e.g. farm dams, forestry) on future inflows and recharge.

Ensure that environmental outcomes are clearly specified, decisions are based on best available information, and environmental managers have adequate resources.

Increase inputs from socio-economic analyses and incorporate consultation to improve the quality of decisions and build community confidence in the fairness of outcomes.

Give higher priority to ensuring that the values and interests of indigenous people are considered.

Be better integrated with regional natural resource management planning and urban water supply planning.

Provide adequate resources to develop and implement water plans, and evaluate their outcomes.

Improve monitoring and compliance of water use.

The National Water Commission is supporting efforts to improve water planning efforts through targeted investments in projects. The Commission has also published a Waterlines paper: *Water Planning Processes and Lessons Learned* to highlight lessons learned by individual States and Territories in the interests of sharing these experiences more widely to advance water planning in Australia.

This is the National Water Commission's summary of what their responsibility is in ensuring that the NWI achieves its goal of achieving 'sustainable use of water'.

Executive summary

Purpose

Water planning is a key aspect of the 2004 Intergovernmental Agreement on a National Water Initiative (NWI), and one of the most important tools for achieving sustainable use of water. Water planning requires consideration of best available science and water use values to develop measurable objectives to manage water resource systems equitably and sustainably. The type of water planning with which the NWI and this report is concerned is water allocation/ water sharing planning. At its core is planning for the extraction of water (both quantity and timing) from rivers and aquifers for irrigation, towns and cities, rural stock and domestic and other purposes. It also includes the management of infrastructure such as dams and weirs used to store and manipulate flows to supply water for extraction.

While in its broader sense water planning can apply to a range of matters such as flood risk, water quality, urban and rural water delivery systems etc, these are not the focus of water planning under the NWI, though they are linked to it and are sometimes addressed in the same planning process.

State and territory water planning authorities have invested many millions of dollars into water planning during the past 10 years. Approaches have varied dramatically from jurisdiction to jurisdiction, and indeed between regions within jurisdictions. The process has evolved with experience. With its relatively recent introduction, water planning approaches have, of necessity, been experimental in nature. The resulting effectiveness of those plans has varied, and plans have generally not been objectively evaluated.

It is clear that there are lessons being learned by individual states and territories that would benefit water planning in other jurisdictions if the experiences were shared. The opportunity exists for a major step forward in sharing knowledge through the building of a national knowledge bank that draws together the accumulated experience of the last 10 years and makes that knowledge available to all.

This report is an analysis of current practice and lessons learned in water planning. It is drawn from 11 case studies of water plans across Australia, examining the processes used to develop the plans and the content of the plans themselves. The case studies were selected to be representative of the different approaches taken around Australia and to cover a range of different issues. The report is a broad sample of significant processes, approaches, scope and content. It is intended to initiate sharing of experiences between water planners in different jurisdictions. It is also intended to be a catalyst for further research and for development of improved approaches and for improvement in water-planning practices nationally.

Case studies Case studies were selected to provide a representation of the main approaches to water planning in Australian jurisdictions. The 11 case studies were: • Water Sharing Plan for Gwydir Regulated River Source, New South Wales (NSW) • Water Sharing Plan for the Lower Gwydir Groundwater Source, NSW • Lower North Coast Water Sharing Plan, NSW • Central Region Sustain Sustainable Water Strategy, Victoria • Water Resources (Burnett Basin) Plan and groundwater amendment, the Regional Operations Plan and amendments, Queensland • Water Resources (Condamine-Balonne) Plan and regional operations plans, Queensland • Padthaway Water Allocation Plan, South Australia • Katherine/Tindall Limestone Aquifer Water Allocation Plan, Northern Territory viii NATIONAL WATER COMMISSION — WATERLINES • Lakes Sorell and Crescent Water Management Plan, Tasmania

• River Clyde Water Management Plan, Tasmania

• Ord River Water Management Plan, Western Australia.

It can be seen that the labelling of water plans varies across the country, as does the scope and scale of the plans. Some of the plans are now several years old and jurisdictions have moved on in the way they prepare plans. Nonetheless the lessons to be learnt from these are still valid.

Method

6. *Building in adaptability* – this step identifies how implementation and outcomes will be monitored and what should happen if things do not work as expected (for example, implementation failure, wrong assumptions, ineffective strategies, improved data, or situational change). Arising from this is a monitoring strategy and triggers for adaptation or change.

4. consultation and *community engagement*, including Indigenous communities (clauses 52, 95)

5. *settling the trade-offs* between competing outcomes for water systems, using best available science, social and economic analysis, and community input, and to address impacts on affected entitlement holders and communities (clauses 36, 97).

The 11 case studies were investigated and analysed using a framework that combines two perspectives: (1) steps in the strategic planning process, and (2) the five major NWI themes related to water planning. Considering that water allocation planning is, in fact, a specific kind of strategic planning, the following generic steps can be considered to apply to the development of a water allocation plan: 1. *Planning initiation* – this involves making the decision to undertake planning, establishing the planning processes, and organising the human resources required to drive the process. 2. *Situational analysis* – this step looks at the current status of resources, environmental and other public benefits, uses, and socio-economic factors as well as future threats, risks and opportunities. 3. *Setting directions* – given the situational analysis, this step is where broad decisions are made on which way to go, including the objectives and outcomes that are being sought. It encompasses such things as vision statements, which are typically very broad, and outcomes or objectives, which can be more specific. 4. *Identifying and assessing strategies* – this is usually achieved through a process of identifying and assessing options (benefits, impacts, mitigation measures). 5. *Strategy selection* – this involves comparing trade-offs (including socio-economic and equity factors) and deciding on a preferred approach. Arising from this are strategies, activities and measurable targets and actions. 7. *Plan approval* – for water planning, this is the final Ministerial endorsement that incorporates the outcomes of the process into a statutory framework. The five major NWI themes that relate to water planning are: 1. defining and describing *environmental and other public benefit outcomes*, and putting in place management arrangements to achieve those outcomes (clause 37) 2. defining *resource security outcomes* and water allocation and trading rules, and adjusting overallocated or overused systems (clauses 37, 43) 3. putting in place mechanisms for *risk management and adaptability* to improved information and knowledge, including monitoring and reporting (clause 40)

NATIONAL WATER COMMISSION — WATERLINES ix

The case studies were investigated in relation to the NWI themes and the general water planning analysis. The themes were then combined using the water planning steps as a framework. All the detail in the case studies is not contained in the analysis, for example specific comments made by agencies and stakeholders. We encourage readers to explore these insightful observations.

Main lessons learned

For each area of the analysis, the report contains an extensive discussion of a range of issues and a list of what we consider to be noteworthy practices and areas for development. Considering these, we have identified a number of key learnings that are set out below.

Recognising there are a variety of approaches to water planning

The approaches to 'water planning' vary significantly from jurisdiction to jurisdiction. As such, our analysis of case study plans is not comparing apples with apples. The various plans are a function of state legislation, policy and practice that has been developing since well before the advent of the NWI. This affects the overall purposes of the various plans, which range from dealing with water sharing only, to water sharing and use, to total water cycle management (in the case of the Victorian sustainable water strategies). It also affects the geographical scope of the plans.

In general, the broader the plan in terms of either geographic or thematic scope, the less specific it is about practical management rules, and the less clarity there is about factors affecting individual water entitlement holders' resource security, and about specific environmental management rules. Conversely, the more specific plans are, the less they consider wider trade-offs and broader supply and natural resource management (NRM) issues (including other catchment impacts on river health). Most commonly, there is a trend towards detailed plans sitting in a context of broad strategic plans or statewide 'default' policies and rules. Attempts to compare plans in different jurisdictions must recognise these differences.

Integrating water allocation planning with catchment/natural resource management and water supply planning

In nearly all of the case studies, we observed that the jurisdictions are still working to come to grips with the integration of water allocation planning with regional NRM planning (in some jurisdictions called catchment planning) and urban water supply planning. Mostly, urban water supply and NRM planning are run separately to water allocation planning. Linkages between these processes and water allocation planning appeared to be somewhat tenuous and *ad hoc*, although most statutes in theory require water plans to be consistent with NRM plans. It would be fair to say, however, that regional NRM plans themselves are in an early stage of development in most states, and in some instances, the water plans precede these. It is also apparent that in many of the case study plans, urban water supply was a very minor aspect of water sharing.

Regional NRM strategies or catchment action plans can provide the catchment context for water planning. They bring with them broader NRM assessments of land use, rivers, aquifers and dependent ecosystems. These are increasingly using repeatable and objective methods, which include environmental, social and economic value and risk assessments. These are critical to effective planning to ensure that investment and trade-offs are properly prioritised to deliver the best results. Integrating processes would also bring benefits in coordinating community engagement.

Inclusion of urban water supply planning into the same framework can ensure that river health and catchment priorities are properly considered in developing options for urban water supply.

The Victorian Central Region Sustainable Water Strategy (SWS) was the best example of integration we saw. The SWS is a regional strategic plan sitting over the top of river health and urban water supply planning. It identifies strategies that can meet multiple objectives relating to river health and water supply. It is essentially an integrated investment strategy that balances river health with economic and social outcomes and also links the management of water with catchment investment strategies driven by the NRM National Action Plan (NAP) and Natural Heritage Trust (NHT).

Commenting on the Central Region SWS, several interviewees noted the value of having urban and rural water authorities and catchment management authorities working together to come up with ways to achieve both environmental and water supply objectives. All the participants were forced to see beyond their immediate systems and areas of responsibility to the larger picture of water supply and river health. They worked together in the broader context to deliver an integrated outcome, across multiple water sources that considered options for both supply and demand.

One criticism levelled at the Victorian approach was that water entitlement planning (which is quarantined from this process as a matter of state policy) should be brought under this umbrella also. The SWS dealt with adjusting entitlements (where it was considered warranted) by planning for investments in such things as water efficiency savings, which could be traded off for water entitlement reductions. Provision for across the board changes to water entitlements to increase environmental water, which is a fundamental aspect of water allocation plans in the other states, is managed through a separate review process in Victoria at 15-year intervals.

In Queensland, a separate process is used for developing regional water security programs, which are intended to forecast and plan for regional water demands into the future. It was suggested that these should be subject to the same scrutiny as water resource plans and resource operations plans and integrated into the water planning process at the review stage if not possible earlier.

Integration provides greater opportunities for packaging strategies to achieve a better overall outcome. On the other hand rigid constraints on what strategies could or could not be included because of institutional rigidity frustrated many stakeholders and resulted in sub-optimal outcomes.

With the exception of Victoria, government funded measures to enable or support entitlement reductions were not considered 'up front' in water allocation planning processes, even though investments of this kind might be the most effective measures to improve river health. The New South Wales (NSW) plans were also limited by current infrastructure. Addition or modification of structures for environmental or resource security benefits was not considered.

Development of a better coordinated and integrated approach to bringing together river health and urban water supply planning with water allocation planning should be a high priority. The concept of an overarching strategic plan as deployed in Victoria and proposed in Western Australia has merit.

Achieving ecological sustainability

Generally, the case study plans aimed at maintaining current environmental values; that is, stopping further decline. Many aimed for a partial restoration of values (Victorian Central Region, Gwydir regulated river and Tasmanian plans). The most credible approaches to defining environmental sustainability undertaken in the case study plans involved an independent assessment of 'environmental requirements' (for example, the Queensland Burnett, Victorian Central Region, and Western Australian Ord plans). These requirements were subsequently traded off to some extent in the final decision-making processes but it was done transparently.

Many plans exposed these environmental target values to significant risks by allowing for other outcomes. Most were risks associated with delaying of action (for example, to allow phase-in of entitlement reductions or changed access rules, or time to do further investigations, or implement water saving measures), or with allowing additional development or extraction. For some, the risks were left to be managed by unspecified operational measures that were yet to be devised or are devised without public scrutiny. The principles of ecologically sustainable development should influence risk-management decision-making in relation to ecological assets. These principles include that: NATIONAL WATER COMMISSION — WATERLINES xi • the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations (intergenerational equity)

• conservation of biological diversity and ecological integrity should be a fundamental consideration

• if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (the precautionary principle).

Application of ecologically sustainable development in a framework of assessing risks would force risks to ecological assets to be weighted highly in the balancing process. Identification of a high risk of environmental degradation would mandate action to minimise the risk.

Several interviewees were of the view that the lack of certainty about ecosystem water requirements and risks as compared to the more pressing and obvious effects of reduced water for irrigation or towns resulted in greater ecological risks being taken. A disciplined approach would have triggered the precautionary principle and changed the strategies selected. It was observed that, in fact, people are far more able to adapt than ecosystems, but the thinking in water planning processes seemed to be the other way around. **People have a variety of options for water supply (for example, desalination, transporting water from other areas, moving to other areas, or reducing usage), whereas if a riverine ecosystem is not supplied with water adequately, the flora and fauna cannot get water from elsewhere and are thus more vulnerable. It was noted that recent research into resilience of riverine ecosystems has shown that there are points where ecosystems collapse and whole groups of species simply die out and do not recover. This does not seem to have been factored into considerations, probably because it has not yet been clearly translated into impact assessments.**

Connell1 argues that the reality of water planning in Australia has been that the debate has really been about how much water can be spared from current use rather than how much is needed for sustainability. Certainly this is what we observed in several of the case studies.

The principles of ecologically sustainable development have been agreed to by all governments. Development of guidelines for the practical and transparent application of these principles, particularly the precautionary principle, are needed in water planning. Adherence is impaired by lack of understanding by planners and policy makers of what ecologically sustainable development means and how it applies at the practical level of

water plan development. There is also a need for clearer and more easily understood ecological risk assessments that make it apparent where there is a real risk of 'severe or irreversible environmental damage'.

Forecasting future inflow patterns

In nearly all of the case studies**, future inflow patterns (including groundwater recharge rates) were assumed to be a continuation of past patterns**. The recent drought has brought to the fore the limitations of this assumption. It is evident that scientific assessments of possible climate change are only just beginning to be considered seriously in water planning as are the potential cumulative effects of plantation forestry, farm dams and other land use related matters.

In the South East region of South Australia, methods have been developed for assessing the impacts of plantation forestry on rainfall recharge of aquifers, and of the water extraction of trees from aquifers within reach of their roots. Based on this research, methods to incorporate plantation forestry into the water allocation system have been developed. The Victorian Central Region SWS included the only practical application of the latest information on projected climate change. It provides a useful case study in how this information can be used

[1] Connell, D 2007, *The sustainability of sustainable limits to extractions informing the NWI*, Land and Water Australia, Canberra, unpublished report. xii NATIONAL WATER COMMISSION — WATERLINES

to project possible future inflow patterns and in how the associated uncertainty can be handled.

Recent work done for Condamine-Balonne water planning has provided more accurate data about the storage potential of offstream storages built during the last 15 years. Future funding of extraction and flow monitoring using telemetry will improve knowledge about cumulative effects of overland flow harvesting.

Further development of approaches to incorporating the potential impacts of climate change and of various land use practices on future inflows and recharge into water planning is needed. Such approaches will need to assess and take account of the uncertainties involved.

Achieving distributional equity

A key and, in many cases, overriding factor in decision-making, which is rarely explicit, is perceived equity or fairness. In many statutes, the principle of equitable distribution of resources is contained in the objects, but implementing this has proved difficult. This is not surprising given the variety of perceptions of fairness held.

In the case of the Gwydir groundwater plan in NSW, a very difficult decision had been made to cut entitlements by a large amount. The affected licence holders had largely accepted the need to make the cut, and in 2004 a plan was approved (but not commenced), which provided for proportionally equal cuts in entitlements for all licence holders; however, there remained considerable unhappiness about the way the 'pain' was shared. Consequently, these licence holders continued to lobby for financial assistance from government, which eventually came from a joint state–Commonwealth fund. Additionally, a group of licence holders pushed for a change in the way the cuts were distributed between licence holders to take more account of the level of development of the entitlement. Eventually the Minister and Cabinet overturned the previous decision and required the alteration of all the major inland groundwater plans to reflect a different distribution of the cuts, which included a weighting for the level of development.

This illustrates how perceived equity in trade-offs can be critical to the success of a plan. Distribution was noted as one of four aspects of fairness in water planning by Howard[2]. Distributional fairness relates to the way the benefits or costs are shared. The case studies suggest that significant unaddressed concerns of a particular stakeholder group are likely to result in change to a plan because that group will continue to use all the political and legal processes of our society to have their concerns addressed. This is apparent in the Clyde Valley in Tasmania, where the water users are unhappy with the plan because they feel they have been unjustly treated. They have recently lodged an appeal against the plan in the courts and continue to lobby at all levels for change.

Similarly, downstream water users in NSW continue to lobby against bearing what they perceive are inordinate costs to themselves and the environment for upstream development in Queensland's Condamine-Balonne and their perception that water planning has not gone far enough to address it.

While equity and fairness in water sharing is an objective common to all jurisdictions, the methods for achieving it are not defined and seem to be left to the personal qualities of the planners, community feedback, and (in the end) to political processes at government level. We consider that further exploration of approaches to achieving distributional equity in water planning is of vital importance.

Distributional equity issues are best managed by firstly publicly acknowledging and assessing them. Measures to mitigate impacts can be identified and negotiated. Having access to a broad range of mitigation options (as in the integrated planning approach discussed earlier) is helpful. Having funding on the table from the start (as in the Central Region SWS in Victoria) where change is needed or economic impacts are likely provides for a more positive planning process and balances the discussion on trade-offs.

[2] Howard, J 2007, *Do stakeholder committees produce fair policy outcomes?* Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference. Charles Sturt University, Thurgoona, New South Wales May 2007 pp 157-162 NATIONAL WATER COMMISSION — WATERLINES xiii

Finally **having a process for making the final decision on cost/impact sharing which is perceived to be fair (as discussed below) is of critical importance.**

• the clear statements of government policy in relation to water planning such as in NSW, Victoria and Tasmania, which set out principles and 'ground rules' for planning from the start

• the ability for the community to make submissions and the public recognition and response to those submissions as, for example, in the Burnett Basin in Queensland and the Central Region in Victoria.

Nevertheless, we consider that there is yet a lot of room for improvement. Further exploration of alternative options for increasing the transparency and objectivity of trade-offs and final decision-making would be of particular value. Transparency in trade-offs would benefit from greater public involvement in assessment of options and use of decision-support systems. **Other options include a full public explanation of how the environmental and resource security objectives will be met by a plan;** the use of public reviews of draft plans by independent bodies prior to the final decision; the transfer of the final decision to independent tribunals; the tabling in parliament of the plan with the option of parliamentary review; and the availability of statutory appeal mechanisms. More open and objective plan making gives greater confidence in the plan and increases the likelihood of the plan being accepted by those affected.

The importance of having a clear policy framework in place prior to the commencement of water planning was stressed by many stakeholders interviewed. Victoria, Tasmania and NSW have the three most comprehensive documented policy frameworks within which water planning operates. These policies frame the objectives of water plans in a manner that is acceptable to the government (and presumably meets a broad public benefit test). The Gwydir case studies in NSW provided an example of clear and detailed policy frameworks and planning processes that came too late in the process. The lack of policy, and eventual injection late in the process, caused significant conflict, undermining what could have been a much more positive community process.

Improving community engagement Building community confidence in the planning process The viability of plans is built on community and stakeholder confidence and trust in the process. A number of practices were noted which contribute to this confidence, including: • the use of independent panels in Tasmania and in Victoria to publicly review draft plans and public submissions • the practice in South Australia and Queensland of pre-planning notification and information provision. These have the effect of clarifying at the start of the process what will and what will not be addressed, the status of current knowledge and how the community can engage in the process • the use of independent scientists to undertake technical studies in Queensland, Victoria and Western Australia • in many of the case studies, the use of expert peer review of models, scientific studies, and socio-economic assessments that formed the basis for options assessment and decision-making • the transparent acknowledgement of the nature of the final trade-offs adopted and the risks involved, such as in the Central Region SWS and the Lower North Coast and Clyde Valley plans • the ability in NSW to appeal an approved plan in the courts, provided the appeal is lodged within three months (not in the case of the Sugarloaf pipeline proposal)

In the case studies the commonly used methods for community engagement were stakeholder advisory committees, comprising of a range of stakeholders and invitation of public submissions on discussion papers and draft plans. Important factors in successful committee operation included: xiv NATIONAL WATER COMMISSION — WATERLINES **• having a full representation of relevant stakeholder interests • having clear up-front terms of reference so the 'rules of engagement' are known and understood • providing skilled independent facilitation by a chair or facilitator acceptable to the range of participants**

• providing the committee with adequate technical and administrative support

• having the committee members effectively engaging with their constituency, with information flowing in both directions.

On the other hand, committee members became cynical where agencies changed policies midstream, failed to establish policy ground rules from the start, or disregarded their 'local knowledge' and agreed recommendations and where committee members went outside the process to lobby for changes.

Committee members appreciated being involved in identifying options and interacting with technical specialists to test scenarios or groundtruth options, for example in the Gwydir regulated river and the Burnett and Condamine-Balonne water plans. In other cases, however, their views were sought on a solution derived within government.

While committees are a useful community engagement method, in some cases it appears that they have been used without particular forethought as to what is to be achieved and whether other approaches to engagement would be more effective. Committees are not a substitute for targeted interest group consultation or broader public engagement nor, according to both government and non-government stakeholders interviewed, should they assume the decision-making responsibilities of government. Community engagement needs to be designed for the purpose, context and stakeholder needs. Different purposes include building community capacity and understanding, identifying values and concerns, seeking local knowledge and groundtruthing data, helping to identify and assess options, resolving or reducing conflict, and building community trust and confidence in the plan. A wide range of tools can be used to achieve these ends, such as workshops, newsletters, focus groups, public submissions, public meetings, citizen juries, surveys and committees.

It is clear that there is a need for a more informed approach to community engagement, which considers what is to be achieved and determines the best approach to use in the particular circumstance. There would be value in having general principles and guidelines for effective community engagement. While it is possible to develop a menu of possible techniques to be used in different circumstances, these are already publicly accessible[3]. What is important is that staff gain confidence in choosing a variety of techniques where necessary and that there is a high level commitment in government to following through community engagement processes to create better decisions. **It is thus important to recognise the value of community engagement in legislation and provide minimal standards to ensure basic accountability and involvement. However, overly prescriptive and rigid requirements are not helpful in adapting to different circumstances and needs. States may wish to develop generic guidelines, standards or steps tailored to their own processes.**

We also consider it essential to conduct a stakeholder analysis and develop a consultation plan early in the planning process. A consultation plan developed in consultation with stakeholders and signed off at a Ministerial level clarifies commitment and expectations.

Independent and participatory evaluation of both processes and outcomes of community engagement would contribute to continuous improvement and demonstrate the value of community engagement.

Dealing with uncertainty and change

Nothing is more certain than change. If anything, the recent record drought has brought home the fact that looking at what has happened in the past is not enough when planning for the future. Nature is changing around us as is our understanding of it. Human society is also changing, not only in terms of population, distribution and demands, but also in terms of

[3] see, for example, <https://www3.secure.griffith.edu.au/03/toolbox/> NATIONAL WATER COMMISSION — WATERLINES xv

culture and values. **Sustainability – satisfying the needs of the present without compromising the ability of future generations to meet their needs – is not static. Current water plans, built on existing knowledge and values, will need to adapt or they will inevitably be discarded.**

All of the case study plans are built within a framework of reviews conducted every four to 10 years. For reviews to be successful, they need to be informed by appropriate monitoring and assessment programs that identify whether the plan has been successful in achieving its objectives. There should be a direct relationship between objectives, strategies, targets and outcomes. The programs should be attuned to the risks identified in the plans. Agency staff in several of the jurisdictions reported that they were actively improving their monitoring programs to refocus them more appropriately. To date, however, most monitoring programs have been not much more than the local part of ongoing state programs. The links to the regional NRM plans and monitoring frameworks were seen as an advantage. This is an area for continuing development.

In addition, there is a need to be able to adapt and respond to changes that happen at shorter timeframes. The plans themselves can incorporate adaptability. The extent to which this is appropriate depends on the level of uncertainty in the knowledge on which the plan is based, the risks involved and whether the structured ongoing review processes are adequate. Ideally this kind of adaptability is tied to monitoring of 'triggers' that are set for areas where both risk and uncertainty are high. The Central Region SWS provides an example of building adaptability into the plan itself. The SWS expressly provides for annual reviews of the water supply situation with the ability to advance or delay the implementation of strategies as needed. This approach allows for planning for a worst-case scenario with adaptive implementation in accordance with what actually transpires. This is in keeping with the nationwide approach for regional NRM planning. The NSW Lower North Coast macro plan includes provision for a mid-term revision of several of the water-sharing rules based on planned research which is intended to further clarify environmental needs. Several other plans include some internal trigger-response mechanisms. Queensland water resource plans are able to provide a timeframe and trigger for review ahead of the Scheduled 10 years. Its resource operations plans provide a flexible mechanism for defining detailed operating rules of the water resource plans. The NSW Lower Gwydir groundwater plan allows for local area management rules to be applied in response to changing groundwater levels or quality. There is still plenty of room to improve the identifications of risks, tailor monitoring programs around those risks and to build adaptive response mechanisms into plans.

There is tension between need for adaptability and desire for certainty. Water users in particular have pushed for certainty – wanting hard-wired rules for water sharing for long periods, so they can invest and operate businesses with greater confidence. Ironically, the highly rigid rules approach of the NSW plans, for example, while intended to give certainty, has in fact failed to do so in the face of the current drought (worse than the drought of record upon which the plans were developed). The inflexibility of the plans has meant that several of the first round water plans in NSW have been suspended almost from the time of their commencement. The plans intentionally relied on the emergency provisions of the *Water Management Act 2000* to deal with such unanticipated circumstances, but it appears in retrospect that this reliance was more than it should have been. The Tasmanian case study plans have likewise been overridden under the pressure of circumstance. In Queensland the preparation of critical water supply arrangements for water supply schemes to apply during times of water shortage is done separately to the water planning process and therefore is not subject to public scrutiny; yet extremes in climate variation should be taken into account as part of water planning processes. There seems little doubt that a fair degree of flexibility and adaptability is needed in water management, but this potentially undermines the goal of certainty. Consideration of a wide range of possible future scenarios as part of a public planning process assists in developing contingency plans that reduce surprise and help individuals make better decisions when dealing with uncertainty.

The NWI risk-sharing framework is one way of addressing this. In simple terms, it recognises that adaptation and change are bound to occur, but specifies how (in principle at least) the risk or cost of those changes should be shared. It needs to be acknowledged, however, that certainty comes at a cost. The Victorian government seems to have accepted this reality, as evidenced in the Central

Region SWS, which earmarks funding for investment in water savings or purchase of entitlements where alteration of entitlements is considered to be

xvi NATIONAL WATER COMMISSION — WATERLINES warranted. NSW has recognised the NWI risk sharing framework in its legislation and attaches compensation to changes to water allocation resulting from plan changes. There is, however, no explicit recognition of the funding that may be required to implement these provisions. There is some concern that changes necessary to achieve environmentally sustainable levels of extraction will not be made, or will be minimised, in the absence of any budgetary commitments.

As a general rule, the greater the risks and uncertainty, the more the need for transparency and adaptability. There needs to be more intensive monitoring of risks, more internalised triggers for change, shorter periods between reviews allowing for adaptability, greater caution in allocating water, and more contingency planning.

• the multiple criteria sustainability assessment used in the Central Region SWS. The sustainability assessment was most comprehensive in the matters covered (cost, effect on ecosystems, effect on greenhouse gas emissions, effect on social values, fairness, social acceptability) and was presented in a way that enabled rapid visual assessment

• the integration of water resource planning with the comprehensive value and risk assessments undertaken in NRM river health planning in the Victorian Central Region SWS.

• assessments done early in the planning process to profile community and industry characteristics, allowing them to act as a baseline

• an assessment of socio-economic impacts of options or scenarios.

The guidelines enunciate desired outcomes and quality standards for each step of the process. Development of methods for assessing *community* resilience to change in water access or availability (in addition to irrigation industry dependence on water availability) would improve the credibility of rapid assessment techniques and socio-economic assessments. Greater use of socio-economic assessments of the impacts of different scenarios and alternative strategies for achieving outcomes would contribute facts and objectivity into controversial decision-making, not only improving decisions, but alleviating stress and conflict. It would also highlight priority areas for mitigating or compensating for impacts.

We also consider that the continued development of multiple-criteria assessment tools is needed to bring together the myriad of factors needing to be considered. In addition to the **Improving risk and impact assessments** **A vital part of the planning process is assessing the water needs of rivers and transparently weighing up the benefits and risks of proposed strategies. We observed a variety of practices, including: • the use of time-series models of river systems or aquifers to simulate behaviour with different rules and demands • several robust approaches to assessing the flow needs of rivers, such as the Benchmarking Method used in the Burnett and the FLOWS method used in Victoria and in the Ord in Western Australia • the 'traffic light' environmental risk assessment diagrams used in Queensland's Burnett plans, which provided a clear visual indication of the environmental risk of different development scenarios •** the two-dimensional risk assessment used in the NSW Lower North Coast plan to rate the risk of extraction to instream values against community dependence on extraction. We see a clear and high-priority need for continued investment in development of methods for assessing ecological flow requirements and risks, including improving the understanding of the resilience of ecological assets. Recognising critical thresholds is an important element of risk assessment that is only beginning to be included into planning. Socio-economic assessments, where done, were highly variable in quality; or they were completely absent. The guidelines for socio-economic analysis produced by the NSW Department of Natural Resources are a useful resource. They clearly differentiate between:

NATIONAL WATER COMMISSION — WATERLINES xvii traditional environmental and economic impacts, these should address such things as procedural and distributional fairness, community wellbeing and effect on social values.

Several jurisdictions have put significant effort into including Indigenous values into the water planning process. The Indigenous Working Group for the Burnett plan and the processes used in the Ord in Western Australia and Daly in the Northern Territory for identifying Indigenous values are examples. However, knowing how to integrate the holistic Indigenous interpretation of landscape into water planning the way it is currently done, separate from other NRM planning, is a real challenge. This highlights one more reason for better links between regional NRM planning and water planning.

In some plans, such as the Burnett plan, Indigenous values were translated into protection of specific features such as waterholes. The NSW water sharing plans, though, provide both a broad and specific approach. They recognise that Native Title rights may increase during the term of the plan as a result of the granting of Native Title rights under the *Commonwealth Native Titles Act 1993* and that provision of water for the satisfaction of those rights should occur. They also provide for new Indigenous cultural access licences of up to 10 megalitres per year per application and, in some areas, commercial licences for Indigenous people.

Handling surface water - groundwater connectivity

Handling of the interaction between surface and groundwater in the case studies varied. In several, a cursory assessment concluded it was not significant. The South Australian Padthaway plan expressly identifies and takes account of returns of water from irrigation to the aquifer by deep penetration. The intention is to have special volumetric allowances for higher recharge irrigation methods (for example, flood irrigation) that would not be tradable and would only apply while that method of irrigation is being used.

Rather than attempting to numerically quantify the interaction, some of the plans make broad assumptions about connection and set up management arrangements accordingly. In the Northern Territory's Katherine/Tindall plan, it is logically assumed, that *all* dry season flows in the Katherine River are derived from groundwater, and the plan is built from this basis. In the NSW Lower North Coast plan, an analysis was done of the types of aquifers in the plan area and the level of connection with surface waters. In consideration of this, a decision was made to include the up-river alluvial aquifers into the same plan as the surface water, assuming a full connection. The result is that licences to extract water from these aquifers are in many respects treated the same way as surface water licences in the same area.

Further development of approaches to identifying and categorising surface water – groundwater linkages based on the level of connection is needed as are ways of addressing this in allocation planning.

Providing the needed human resources

Funding for and availability of appropriately skilled human resources for planning and associated tasks was an issue raised by interviewees in many of the case studies. In several of the case studies, agency staff were forced to short-cut processes and assessments because of funding constraints.

In Queensland, agency staff commented on the difficulty of retaining skilled people and on the need for greater recognition of the specialist skills needed. Concern was expressed about the demanding timelines and stress, which both affect staff turnover. Stakeholders in South Australia felt that the continual turnover of agency staff caused delays and inconsistencies in information and approach. They noted that it took a while, up to five years, for staff to gain the respect and trust of the community. In some cases, staff felt that lack of resources reflected on their ability to do a professional job. The availability of a pool of appropriately skilled people provided with adequate resources was identified in most of the case studies as a critical issue. Stakeholders in several areas were also critical of the government's under-funding of plan implementation. It was noted by interviewees that water plans actually create more work rather than reduce it. Plan implementation required an expansion of resourcing to address further information, investigation and monitoring issues raised in the process. It was observed by many interviewees that governments do not have a realistic understanding of the resources needed to develop and implement water plans.

A depth of experience and skill in the technical areas such as hydrology, hydrogeology and ecology is essential, and there is some concern that, in particular, the hydrology and hydrogeology skills and experience in Australia will not be sufficient to meet future demands.

While training courses exist for technical areas such as hydrology and ecology, there is also a need for training in water planning itself. Broadly, planners need to understand how to apply generic strategic planning principles and practices to water planning, while also understanding enough of the technical aspects to be able to pull them all together. Training should also encompass developing strategies and targets that can be measured; practical use of assessments of socio-economic impacts and how to integrate assessments; taking account of Indigenous, cultural and other public benefits such as recreation and fishing; and using decision-support systems interactively with the community and in an integrated way.

Practical skills training for water planners in community engagement is needed to build confidence and expertise in applying innovative ways of engaging the community and dealing with contentious issues. Topics might be: the range of methods of engagement, facilitation, dispute resolution techniques, use of local knowledge, and tools for use in trade-off analysis. There is, to our knowledge, no textbook on water planning.

There is, then, a broad need to face up to the human resourcing needs of water planning processes and to address both the skills and funding gaps.

Conclusion

Water planning is not yet a mainstream activity like town planning. While there are many courses relating to specific scientific and technical matters that are important for water planning, none exist for water planning itself. Water planners are largely technically trained people who have been thrown in at the deep end and who have learned by doing.

While water planning has aspects in common with other types of land use or natural resource planning, Australia's variable climate and streamflows make it a unique challenge. No other type of natural resource planning has to deal with a resource that fluxes from day to day and year to year, is often difficult to define in terms of its extent, incorporates rights to shares in a consumptive pool, is vital for ecological health, regional economies and communities, and it is a fundamental requirement for human life.

It is evident that water planning will not be a one-off process. The impact of climate change means that there is even less ability to predict and plan water resource use with certainty, so an adaptive approach to water resource management and planning is required. As the recent drought has brought home to many, water is vital for our environment, our economy and our very lives. Never before has the need for effective water planning been more starkly obvious. We have still to come to grips with what ecological sustainability means and how to achieve it in a fair and equitable way. There is little doubt that future revisions of current water plans will look very different to these initial plans.

This study has identified a range of noteworthy practices in the case studies – all worthy of emulation in other areas. It has also identified a number of areas for development through research and through changes in current approaches set out in legislation and policy. It is hoped that this study will provide a catalyst for further work and for the development of a discipline of water planning that leads to ongoing improvement in this most vital area for the nation's future.

NATIONAL WATER COMMISSION — WATERLINES xix

The Minister must inform himself of what the water quality reserve is utilised for, and how much of this water is there in Lake Eildon that would ensure that the water quality of the Goulburn is maintained? How much is allowed to be sold? How much is left? Who else is going to buy it and how much of it? These questions have not been addressed

much less referred. Because to keep "buying" this water would mean that an EES must be required that includes all likely impacts and this includes downstream. He needs to inform himself that Coliban and Central Highland Water have "bought" this water for two years in a row now. How much of it and how many years is this going to happen and is Melbourne going to do the same thing? How much of it will Melbourne "buy" and for how many years? The Victorian Government has this unshakeable idiot belief that it will rain and it will rain heavily and Eildon will fill up in less than a year. This is not the case. Check out the Eildon website on how long it takes for the dam to fill, 7 years.
I have included a copy of the Nathan Dam case because it is relevant and is becoming more relevant every day. Minister Wong and other Senators at Parliament yesterday stated that the hard decisions need to be made and to not do them will most certainly put the nail in the coffin for the Murray-Darling Basin. I have included Senator Nick Xenophon's 'Emergency Water (Murray-Darling Basin Rescue) Bill 2008' and the Explanatory Memorandum. I have highlighted areas that I feel would ensure that the States adhered to sustainable activities and protect the environment. See Section 17 on page 8 which would seek to stop any activity that would impede flow of water from the Murray-Darling Basin and this activity includes pipelines. It is obvious that the significant and continuing changes in circumstances are the worst in 115-117 years and as Dr Wendy Craik MDBC's chief executive stated "there is no relief in sight. I think we can say the drought is continuing to worsen." "This period of low water availability is worse than the previous two periods." And here she means the "federation drought" around 1901 and 1940s.

There is plenty of substantial new information and the circumstances are worsening every day. The fact is also that it will take over 7 years of healthy rainfall to fill Lake Eildon and this rain is just not coming. To pray for it and depend upon prayer instead of proper considerations and assessments and referrals is just not an option.

I ask yet again that the Minister requires an EES to assess the impacts and that the original referral should include Ramsar wetlands and Migratory species because these will be impacted. To take water without making sure that all impacts have been assessed is contrary to the EPBC Act and to what the Minister is required to do. I realise the Minister needs to make a decision but I do not believe that he can make an informed one because not all the information is before him. It is still coming in!

Articles that are of interest follow.

Empty promises?

Picture: John Krutop

Royce Millar

September 4, 2008

Garnaut: take the lead on emissions

The State Government has placed its faith in large engineering projects to secure Melbourne's water

future. But has good policy been trumped by politics?

SPRING 2006 was a turning point for water policy in Victoria. For years Labor had shunned big water

engineering projects - dams, desalination and the like - preferring instead to focus on demand-side measures

including water-saving ad campaigns, encouraging water-smart appliances, and incentives for rainwater tanks.

Through the early 2000s, scientists and economists were influencing an agenda long dominated by engineers.

Or, as Latrobe University water expert Lin Crase puts it: "This was one of those rare times in water history

when the enthusiasm of the engineer was tempered by the logic of the economist and the science of the

ecologist."

After a punishing decade of drought, culminating with record low rainfalls for winter and spring, then premier

Steve Bracks and his team confronted an unthinkable scenario: Melbourne running out of water.

The response, according to Government insiders and observers was something close to panic. The drought

seemed to be worsening and with climate change, it was possibly permanent. Maybe water-saving campaigns,

recycling and some rain harvesting on new estates would not be enough to ensure the city's water supplies?

In mid-2007 the Government, in a surprise new water plan, turned to big engineering-dominated answers; plants

and pipes that would delivered water fast, albeit at big financial and environmental costs: the energy-intensive,

$3.1 billion desalination plant at Wonthaggi and a $1 billion north-south pipeline to link Melbourne to the river

network north of the Great Divide.

Both projects have been hotly contested by coastal and farming communities concerned with the impacts on

the environment in Gippsland and rural economies to the north.

But what of the effects of these decisions for Melbourne's water future? It is a question that increasingly has

experts worried. Some are wondering whether the Brumby Government's enthusiasm for big-ticket solutions is

then sacrificing options that may well be more healthy for the state in the long term, including continued water

conservation and rain and stormwater harvesting and recycling.

Empty promises? | theage.com.au http://www.theage.com.au/environment/empty-promises-20080903-48v9....

1 of 3 4/09/2008 9:51 AM

Recent events have fuelled their concerns.

After 12 years of drought and a combination of water-saving campaigns and restrictions, Melburnians cut their

water use by 35% per head compared to the mid-1990s.

But this week Water Minister Tim Holding revealed that the citywide trend was upward again with more water

used this winter than in 2007 - about 13 million litres more a day, a small increase but an increase none the

less. The rise was attributed to population growth and fatigue with water-saving messages.

The news came the same week *The Age* revealed a behind-the-scenes row at the highest levels of

Government over the future of rainwater tankpolicy. Dubbed the "water tank wars" by one senior Government

figure, the water industry is watching the debate closely as an important indicator of the Government's policy

direction.

Under the current 5-star energy rating scheme, all new homes have to install either a rainwater tank, solar hot

water or third-pipe recycling. A concerted bid is under way high in the Government to relax this requirement,

especially the role of tanks.

"**With desalination plants and other water initiatives coming in, the rainwater tank has been singled out as**

something that may not be warranted in the future," one senior figure said .

The upward trend in water use and the anti-tank campaign have fuelled concern that Victoria is hitching itself to

a water future more in keeping with 19th-century rather than 21st-century thinking; that is, a centralised system

under which water is pumped from outside the city to consumers with little idea or interest in where it came

from, or where it will end up.

The Government insists that it remains committed to a range of water solutions including tanks, raingardens

and recycling as well as desal and pipelines. "We need a diverse range of solutions which is exactly what the

Brumby Government is doing," Holding said last week.

This view is shared by Melbourne Water managing director Rob Skinner who insists that "multiple options"

including tanks and recycling are necessary and supported.

Asked to paint a picture of the city's water sources in 2050, Skinner says: "Long term, we'll need to take the pressure off our drinking water supplies as they stand, through major water projects and initiatives like

increased use of recycled water and conservation measures like rainwater tanks. We'll also need sources that

are non-rainfall dependent, like the desalination plant to be completed by the end of 2011."

Skinner expects Melbourne to be "leading the world when it comes to water-sensitive urban design"; that is, a

city planned and developed with in-built water-saving and harvesting methods including a rain garden or

rainwater tank in most homes.

This view is largely supported in the Government's pre-desal document, *Central Regional Sustainable Water*

Strategy, which covers Melbourne. **It says the starting point should be conserving water, which has negligible**

environmental or social impacts.

To achieve this will take a concerted overall strategy - which does not currently exist - and years of concerted

policy work and investment in often commonsense but little explored water harvesting and recycling projects.

There are no official figures about the number of tanks, raingardens and the like currently in operation in

Melbourne. A confidential consultant's report to Government claims 237,000 tanks were sold between 2002

and 2007. A separate Government report from 2006 estimated that just 1 billion litres of water was harvested

by such means per year in Melbourne, a tiny fraction of the 400 to 500 billion litres a year used.

Still, as much rain runs off Melbourne as is consumed and to harness it could drastically reduce the need for

more mega-desal plants. So much so, says Monash University's Tim Fletcher, that half the city's water needs could be satisfied with a comprehensive water harvesting and recycling strategy.

But critics including the former director of the Water Studies Centre at Monash University, Professor Barry

Hart, say it is now clear the Government is more interested in making Melbourne "water secure" than "water

sensitive".

"Regrettably, since the mid 2000s governments have reverted to the frenzy of engineering fixes, panicked into

action by a perception that there will be an intolerable political backlash should stage 4 water restrictions ever

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2 of 3 4/09/2008 9:51 AM

be invoked."

Crase says the Government is wedded to politically driven, "iconic engineering works" whose economic and

environmental costs and benefits had not been properly assessed.

If it is true that projects such as desalination are diverting attention and resources from other alternatives, then

this may well present real problems for the future. For while the Wonthaggi desal plant is to be the biggest in

Australia it will not necessarily resolve Melbourne's water woes. This is especially given the estimates for the

city's population growth and parching impacts of climate change.

The Government believes Melbourne's population may balloon to 6 million by 2050. Based on current levels of

consumption, demand for water could rise as high as 650 to 700 billion litres a year.

Even with the desal plant and some recycled water, this growth in demand and declining rainfall and run-off into

catchments are likely to leave a shortfall come mid-century or before.

And the response?

Critics are concerned that if the Government withdraws support and investment for alternatives, pipelines and

desal plants will follow.

"The Government currently appears convinced that they have now solved Melbourne's domestic water situation

and appear reluctant to consider any of the more long-term solutions," Hart says.

"**This is a concern because if we don't start investigating and implementing some of the other more sustainable**

options (e.g. rainwater tanks properly plumbed into the house, storm water recycling, indirect potable water,

etc) Melbourne in 20-30 years' time will inevitably be left with another crisis situation and another technological

fix, perhaps another desal plant or two."

Others, including Melbourne University senior planning lecturer Anna Hurlimann doubts that more desal plants

will be built because their inadequacy as a real water option will be revealed soon after the Wonthaggi plant

commences operation.

"This will have happened in the period 2015-2020 after the political realisation that desalination is an

unsustainable approach to water management. Desal will be primarily too expensive to run, based not only on

initial costs, but also additional costs due to carbon taxes."

Hurlimann's predicts that by 2050 Melbourne will have moved to a more decentralised approach to water

management and that the city will indeed have become a water catchment with tanks recycling, sewer mining

and stormwater harvesting all part of daily lives built on massively reduced daily water consumption.

A popular theme among those wanting more focus on conserving and catching water is that the city itself should be transformed into a catchment. As well as boosting water supplies, goes the theory, the collection of

rain and stormwater results in less polluted run-off into the city's embattled rivers and creeks.

Not all are convinced however that all will be quite so rosy. The Australian Conservation Foundation's

sustainable cities campaigner, Kate Noble, says on current evidence Victoria's politicians are unlikely to make

the long-term commitment necessary to avoid a string of additional desal plants.

"In 2050, we will be in the odd situation (much like today) where we put huge amounts of public funding into

desalination plants so we can use drinking water to flush our toilets, water the lawn and cool our power stations,

while we watch stormwater equivalent to our annual metropolitan water use flow straight down the drain.

"We will have more empty dams in 2050 than we have now, because at some point one of the governments of

the day had the bright idea that another dam would save us from climate change."

Below is false and misleading information: It is Victorian Government propaganda in the media to mislead the people and the Commonwealth Government. Unacceptable falsehoods.

Herald Sun *(/heraldsun)*

MELBOURNE'S water supply will run out if restrictions and other conservation measures are the only tools to fight the drought, a confidential report discloses.

Victoria could also plunge below the trigger for stage four water restrictions before the $3.1 billion desalination plant goes online in 2011, a departmental analysis shows.

The report found that desalination is central to whether the state will be able to deal with the Big Dry if it continues indefinitely.

It argues that other big ticket infrastructure projects such as the $750 million north-south pipeline are crucial to protecting Melbourne's water supply, also warning that population growth is

another factor.

"Without supply from the augmentation projects, and in particular, supply from the desalination plant, storage levels will continue to fall to unsustainable levels if the extremely dry conditions

of recent years continue," the report says.

"Water restrictions and demand management initiatives alone will not guarantee enough water to meet the growing needs of Melbourne in this event."

The dire warning is made in the Department of Sustainability and Environment's analysis of Melbourne's water supply.

The study is expected to be used by Water Minister Tim Holding as an argument for building the controversial desalination plant.

Mr Holding today will be confronted by protesters in Wonthaggi, in South Gippsland, angry at Government plans to build the desalination plant on rugged coastline near the former coal

mining town.

The DSE report argues that the desalination plant, which will produce enough water to fill 150,000 Olympic swimming pools each year, may need to be cranked up further to create even

more water for Melbourne and some regional centres.

It warns that stream inflows have been parlous and there is no evidence to suggest that supply will return to long-term averages.

A poor winter and spring -- when most inflows occur -- would be of serious concern.

"It is therefore expected that any significant failure of winter/spring rainfall in the near future, such as a repeat of the extremely low level of inflows observed in 2006, would result in a further

decline in storage levels, most likely to well below 30 per cent of capacity," DSE found.

The report was modelled on storage capacity of 39.1 per cent at the start of the year, but dams have dropped to just 33.7 per cent compared with 38.6 per cent at the same time last year.

The report predicts that once the desalination plant comes online, the risk of storage levels falling below trigger points would be reduced.

It is unlikely the Government will back tougher water restrictions because of the impact this could have on jobs.

MINISTER SUSPENDS REEF COVE APPROVAL

Environment Minister, Peter Garrett has suspended approval of the Reef Cove Resort development at Queensland's False Cape and has ordered the developer to carry out an environmental audit of the site.

It is the first time a federal environment minister has suspended a project's approval or directed an environmental audit under the *Environment Protection and Biodiversity Conservation Act 1999*.

"Following a preliminary investigation by my department, I've decided to suspend approval of the False Cape project for a 12-month period because I am concerned about the threat of sediment run-off into the Great Barrier Reef World Heritage Area," Mr Garrett said.

"This suspension means there can be no construction at the site until I'm satisfied that the developer has completed the appropriate remediation work and can complete construction in a responsible manner and in full compliance with the approval conditions, without impacting on the marine environment.

"If I am not satisfied by the end of this suspension period that appropriate remediation measures have been implemented in accordance with the outcomes of the compliance audit I have the option under the EPBC Act of suspending the approval for a further period, or revoking it altogether.

"If revoked, any proposal for a new development at the site may need to undergo a new assessment process under the EPBC Act. This would be likely to require a new public assessment."

Mr Garrett said the directed environmental audit would provide important information that the Federal Department of the Environment, Water, Heritage and the Arts could include in its ongoing investigation.

"In the meantime, my department will continue to work with the Cairns Regional Council to address the immediate concerns at the site and to make the site stable before the coming wet season."

<<MR_False Cape suspension 040908.pdf>>

I ask that you read all the information I have sent you because it is most certainly relevant.
I insert here my submission to the Water Inquiry for Melbourne as I think it is also important to realise that Melbourne does have other options and that those along the river do not, and the environment and the most certainly can't move to another wetter place.

The Secretary
Environment and Natural Resources Committee
Parliament of Victoria
Parliament House
Melbourne 3002

Chair: The Hon. John Pandazopoulos MP

Submission to the Victorian Parliamentary Inquiry into Melbourne's Future Water Supply

August 29, 2008

By Maria I E Riedl

The Laws of Ecology
All things are interconnected. Everything goes somewhere. There is no such thing as a free lunch. Nature bats last.

-Ernest Callenbach[1]

Introduction

I am going to begin by citing information from people who are leaders in the field of water sustainability, as I cannot presume to have the knowledge and expertise they have accumulated over many years. This is what I believe the Victorian Government should be doing. They must be prepared to look at the global picture that is emerging and not just be parochial and fixated on a problem that is just not going to disappear just because they propose unacceptable short term measures such as the largest desalination in the entire world and a North-South pipeline that would be

[1] Maude Barlow, *Blue Covenant* (2007) 1.

nothing short of a disaster along the entire length and breadth of our rivers and underground water sources and wetlands and flood plains.

It is interesting that this Inquiry is started **after** the Victorian Government has made decisions on supplementing and assuring Melbourne's future water supplies. This is such an unacceptable and threatening exercise in the natural order of things, that many of us in Victoria, and in fact in South Australia and New South Wales, are prepared to protest and endeavor to prevent the inappropriate and ill-considered and less than rigorously assessed proposals that are being proposed

It is fairly obvious that this Inquiry should be done first not last.

The Background

The water set-up in Australia is wildly extravagant. For most towns and cities, water supply and discharge operates in a straight line. Water is extracted from rivers far away, is piped into the home, then piped out again to treatment plants, before most of it makes its way either into rivers again or the sea. This country has spent billions of dollars over the years, ensuring that all water delivered to the home is treated to a level of pure drinking water, yet we actually drink just 1 percent of it. Just one-hundredth of all pure water. Even more staggering, all of the water that goes to urban industry is pure drinking water as well, and while sectors such as the food industry might need such purity, the system seems most extravagant.[2]

The world is running out of water and every day more and more people are living without access to clean water. Corporations deliver drinking water and take away waste water; corporations put massive amounts of water in plastic bottles and sell it to us at exorbitant prices; corporations are building sophisticated new technologies to recycle our dirty water and sell it back to us; corporations extract and move water by huge pipelines from watersheds and aquifers to sell to big cities and industries; corporations buy, store and trade water on the open market like running shoes. Most importantly, corporations want governments to deregulate the water sector and allow the market to set water policy. Every day, they get closer to that goal.[3]

Imagine a world in twenty years in which no substantive progress has been made to provide basic water services in the Third World; or to create laws to protect source water and force industry and industrial agriculture to stop polluting water systems; or to curb the mass movement of water by pipeline, tanker and other diversions, which will have created huge swaths of desert.

[2] Ticky Fullerton, *Watershed* (2001) 42.
[3] Maude Barlow, *Blue Covenant* (2007) 2.

Desalination plants will ring the world's oceans, many of them run by nuclear power; corporate-controlled nanotechnology will clean up sewage water and sell it to private utilities, which will in turn sell it back to us at a huge profit; the rich will drink only bottled water found in the few remaining uncontaminated parts of the world, or sucked from the clouds by corporate-controlled machines, while the poor will die in increasing numbers from a lack of water. This is not science fiction. This is where the world is headed unless we change course- amoral and ecological imperative.[4]

The world is facing a water crisis due to pollution, climate change and surging population growth of such magnitude that close to two billion people now live in water stressed regions of the planet. The World Health Organization reports that contaminated water is implicated in 80 per cent of all sickness and disease worldwide. Every 8 seconds, a child dies from drinking dirty water.

Some wealthier countries are just beginning to understand the depth of their own crisis, having adopted a model of unlimited consumer growth based on industrial, trade and farming practices that are wasting precious and irreplaceable water resources. Australia, the driest continent on Earth, is facing a severe shortage of water to all major cities, as well as widespread drought in its rural countryside. Annual rainfall is declining, salinity and desertification are spreading rapidly; rivers are being drained at an unsustainable rate; and more than one-quarter of all surface water is management areas now exceed sustainable limits. Climate change is accelerating drought and causing freak storms and weather patterns just as the population is set to expand dramatically in the next twenty years. (Ironically, this is, in part, to take in the climate change refugees such as the inhabitants of the Solomon Islands, who will lose their lands to the rising seas.)[5]

As in Australia, anxious American politicians talk about "drought" as if this is a cyclical situation that will right itself.[6]

We were all taught certain fundamentals about the Earth's hydrologic cycle in grade school. There is a finite amount of available fresh water on the planet, we learned, and it makes its way through a cycle that ensures its safe return to us for our perpetual use. In the hydrologic cycle, water vapor condenses to form clouds. Winds move the clouds across the globe, spreading the water vapor. When the clouds cannot hold the moisture, they release it in the form of rain or snow, which either seeps into the ground to replenish groundwater or runs off into lakes, streams and rivers. (This is the water-less than one-half of 1 percent of all the water on Earth-available for human use that does not deplete the stock.) As these processes are

[4] Ibid.
[5] Ibid.
[6] Ibid.

happening, the power of the sun is causing evaporation, changing liquid water into vapor to renew the cycle. About four hundred billion litres of water are cycled through this process every year. In this scenario, the planet could never "run out" of water.

But this cycle, true for so many millennia, did not take into account modern human's collective capacity for destruction. In the last half-century, the human species has polluted surface water at an alarming and accelerating rate. The world may not be exactly be running out of water, but it is running out of clean water. Ninety percent of wastewater produced in the Third World is discharged, untreated, into local rivers, streams and coastal water. As well, humans are now using more than half of the accessible runoff water, leaving little for the ecosystems and other species.[7]

We are taking water from where it is accessible- in aquifers and other groundwater sources-and putting it where it gets used and lost, such as in mass irrigation of deserts, to make cars and computers, or to produce oil from tar sands and coal methane beds where it becomes polluted or actually lost to the hydrological cycle.[8]

Groundwater aquifers are being over-pumped almost everywhere in the world and are also being polluted with chemical runoff from industrial farming and mine tailings, as well as being invaded by saltwater from careless drilling practices. (In some cases, over-extraction of a river exposes an aquifer to danger.[9]

Australia

Aquifers are way over-pumped in Australia as well-groundwater extraction skyrocketed a whopping 90 percent in the 1990s- and is contaminated from the eighty thousand toxic dumpsites under Australia's major cities.[10]

Every day, the failure of our political leaders to address the global water crisis becomes more evident. Every day, the need for a comprehensive water crisis plan becomes more urgent. The world does not lack the knowledge about how to build a water-secure future; it lacks the political will.

But not only are our political leaders following the false promises of a quick technological fix, they are abdicating the real decision-making about the future of

[7] Ibid 6.
[8] Ibid 10.
[9] Ibid 11.
[10] Ibid 13.

the world's depleting water supplies to a group of private interests and transnational corporations that view the crisis as an opportunity to make money and gain power. The big players know where the water is, they simply follow the money.[11]

Any discussion about water has to be about sustainability, about the environment and about our values. In the end a discussion about water comes down to society and how we want to live. Our dams, our cities and our irrigation systems were all built in the wet decade. There were droughts, but we knew they would end. But the past is no longer a guide to the future.[12]

The environmental imperatives that kick-started water reforms in the 1990s, such as the 1000-kilometre long blue-green algal breakout in the Darling River, have largely been forgotten, but the stakes have never been higher. Australia is more vulnerable to the impact of temperature on our water supplies than any other country. Just 10 per cent of our rainfall, on average, ends up in our rivers, the lowest percentage in the world.

Don Blackmore, former chief executive of the Murray-Darling Basin, now chairs the Advisory Council of the CSIRO's Water for Healthy Country Flagship, among other commitments. He says only 2.4 per cent of the rain that falls in the Murray-Darling Basin ends up in a river. 'This is an arid basin,' he explains. 'What that tells you is that the landscape is going to be driven by temperature, not rainfall.'[13]

The Australian landscape is not just extremely ancient, it's also very fragile, with a network of complex interactions, or what Dr Ben Gawne, the director of the Murray-Darling Freshwater Research Centre, describes as cooperative and mutualistic relationships. One example is trees that rely on fungi to deliver nutrients. 'Because there are more of these complex interactions, you mess around with one bit and cascading effects appear all over the place that you can't really anticipate,' Gawne says.

Gawne believes the prolonged drought has amplified some of the impacts that we have had on the system. One major concern is the decline in health and the death of many red gums in the lower Murray: 'That has come about because not only are we going through a natural drought, but our flow regulation has imposed man-made drought on those trees and those systems. The duration and intensity of that drought for those trees is very severe and the trees are beginning to show it.' He says the drought could be a threshold for the system. If the trees are lost there could be changes to the microclimate and soils that inhibit recovery. 'Even under the best-

[11] Ibid 33.
[12] Asa Wahlquist, *Thirsty Country* (2008) 4.
[13] Ibid 5.

case scenario, recovery would take a long time because re gums take a long time to turn into those grand old trees. The really big ones that have the hollows and provide all the habitat for the animals are several hundred years old.'

Gawne is concerned that changes in climate and soil will make it more difficult for seeds to germinate and young trees to grow and recovery will take even longer. 'Some people are entertaining the idea that they may never recover at all, so you may be looking at a permanent landscape change,' he says.[14]

Professor Cullen, the former head of the Co-operative Research Centre for Freshwater Ecology, the 1999 Prime Minister's Environmentalist of the Year, and a member of the Wentworth Group, warns that switches can occur when we cross some threshold, perhaps in nutrient concentration or a flow regime, and aquatic ecosystem changes from one form to another. Australian aquatic ecosystems are well used to droughts and floods. But Cullen says this resilience can be pushed too far. An example is the way fish and other aquatic organisms survive drought, by living in the deeper waterholes that persist after a river stops flowing. When the river runs again, they re-colonize it. Destroy the waterhole and you destroy the system[15]

Australians are becoming resourceful and innovative in their attempts to live within the water constraints of this country. But those attempts are often frustrated by the bureaucracies that are accustomed to making fat profits out of water. Twenty years ago it was illegal to install a rainwater tank. Every kilolitre a householder collected from their roof represented a loss to the water authority. Big water will always seek big money-making solutions, like desalination plants. More rainfall falls on the average house and land than the household uses but because the solution is small-scale and local and won't earn income for Big Water it is not considered.

Professor Cullen argues that current institutional arrangements get in the way of things like water-sensitive urban design. He cites as an example the aquifer storage and water recovery, which has been a great success in Adelaide, was being stymied in Melbourne by local bureaucracy. Peter Cullen always reminded people that debate about water are really debates about the sort of society and the sort of environment we want to live in.[16]

[14] Ibid 7.
[15] Ibid.
[16] Ibid 11.

Melbourne

For 100 years Melbourne and its surrounds enjoyed relatively reliable rainfall. But in the mid-1990s that changed. Between 1997 and 2007 Melbourne went into an unprecedented and sustained drought. Inflows into Melbourne's dams fell 35 per cent below the pre-1997 average. Then came 2006, the driest year on record. Inflows into the already low dams were 30 per cent below the previous record dry year.

In 2007, the Victorian government's publication, 'Our Water, our future,' outlined three scenarios and said that 'Our water planning must enable us to deal with very low inflows. When it comes to water, being risk averse and prudent makes good sense.' The evidence was mounting that Melbourne had experienced a step-change in its rainfall due to climate change. In June 2007 the government of the Garden State announced a $4.9 billion water package that included a $3.1 billion desalination plant, piping water from the Goulburn River, a water grid and increasing recycling. Overall the projects would increase Victoria's total supply by 375 gigalitres a year.[17]

The Murray-Darling Basin

The rivers in the Basin are not just channels of running water they are flood-plain rivers and these flood plains contain 100, perhaps 1000, more species that the rivers that flow past them; myriad insects, mussels, yabbies and crayfish, 34 native fish species, native frogs, tortoises, water rats, platypus, tiny marsupials and 240 species of birds. When the river floods, it sweeps the massive production of the flood plain into its waters.

The Victorian tributaries on the Riverine plains-Ovens, Goulburn, Campaspe and Kiewa-contribute 37 per cent of the Murray River's flows. The Murraumbidgee 10 per cent and the Darling 17 per cent. Queensland provides 4 per cent of the Murray's flow.[18]

The river runs, but the flood plains drives it. Dry up the flood plain, or disconnect it from the river, and the river dies.[19]

Development in the Basin has raced ahead and the river was seen as a pipeline to deliver water, with no thought given to the health of the river and its flood plain until 1991 when a 1000 kilometre long, toxic blue-green algal bloom infested the Darling

[17] Ibid 105.
[18] Ibid 143.
[19] Ibid 144.

River. This was a physical indication that the system was in terrible trouble. This though there was a signing of the 1987 Murray-Darling Basin Agreement by the Commonwealth, New South Wales, Victoria and South Australia, which was to 'promote and co-ordinate effective planning and management for the equitable efficient and sustainable use of water, land and other environmental resources of the Murray-Darling Basin.'[20]

In his book, *Water Politics in the Murray-Darling Basin*, environmental historian, Dr Daniel Connell, write that for more than a century: 'Australian water management was controlled by public officials applying an administrative approach to the distribution of heavily-subsidised water. During most of this period it was governments and their officials who led the way in promoting increased water use.'[21]

Some facts: Under normal conditions, each year about 11 000 gigalitres evaporated or ran into terminal wetlands, and 12 850 gigalitres reached the sea. In the ten years to 2006, the average reaching the sea was 2700 gigalitres per year. The long-term average inflow into the Murray is 11 100 gigalitres and the average inflow into the Murray for the six years ending June 2007 was 4200 gigalitres.

An audit in 1995 of water use in the Murray-Darling Basin found that before development, the mouth of the Murray experienced severe drought-like flows five years in 100. Under 1994 diversions those low flows were 16 years in 100 and if development continued it would be 74 years in 100 and the 'river near the Murray Mouth would experience a severe drought in three out of four years.' The audit also stated that regulations had increased salinity in the Murray River and reduced flooding to wetlands and that wetlands were important to the environmental health of the river 'because they play a major role in absorbing and breaking down nutrients and are essential breeding areas and refuges for native flora and fauna.' It reported that the Victorian basin wetlands decreased by 70 per cent.[22]

An important report by the Cooperative Research Centre for Freshwater Ecology, February 2000 called 'Ecological Sustainability of Rivers' says: Historically, the environment used every drop of water from rivers within the Murray-Darling Basin. Once water is diverted from the river system there is an impact on the environment. The challenge for scientists is to identify, measure and understand the impact of current and future water diversions. The challenge for the community is to decide how much of an impact is acceptable.'[23]

[20] Ibid 149.
[21] Ibid 150.
[22] Ibid 155.
[23] Ibid 156.

Terms of Reference

The terms of reference for this Inquiry do not specifically ask us to address these issues but no inquiry into water issues can ignore the relationship and inter-dependency of surface water and groundwater and the systems that are dependent upon them. You must first gain a comprehension of what our governments have done to our resources, without making certain they understood these relationships. The complete collapse of the Murray-Darling Basin is a monument to State, Local and Federal government and their un-willingness to adhere to policies, Initiatives, COAG agreements and International agreement they are signatory to. To continue to ignore what decision-makers have been aware of for many decades is no longer acceptable. This Inquiry seems to be continuing along this 'business-as-usual' attitude that has caused our water crisis by only looking at Melbourne and supplementing its water supplies without regard to where and how water is inter-connected throughout all of the Victoria as well as to the rest of Australia. This Inquiry must look at the impacts that the actions they suggest will have upon further future water extractions in light of the rest of global community. You must no longer accept parochial actions that have had no regard for impacts elsewhere in the system.

Water must be regarded as a Human Right and this must be acknowledged and enshrined at all levels of government instead of continuing to allow a depleted and scare resource be regarded solely as a commodity that is allowed to be traded purely for private interests and huge profits.

This is the list you provided:

1. Further water savings that can be achieved by increased conservation and efficiency effort;

2. The collection of stormwater;

3. The re-use of treated waste water;

4. The use of groundwater;

5. Small locally based desalination plants;

6. Any other optional water resources which appears to the Committee to be appropriate.

Decided upon on 19 September 2007

The Merits

1.There is no doubt that rainwater tanks on every house and business in Melbourne would ensure that people would be able to save on their water bills by utilizing the water for drinking and for showering and washing. The water once it passed through the house can then be recycled and used on the gardens and lawns and trees outside the house. To me this seems to be a logical and effective option, as not only would it be cost efficient for people, but it would ensure that there would be less pressure on Melbourne's dwindling storages. People in rural Victoria, even in the drier areas have had tanks for years and they have never run out of drinking water and water to wash in. It seems to me that the big water corporations want to ensure that home owners are totally reliant on the water they provide at the increasing cost they provide it at!

For the government to state that this option would be too expensive and would not provide enough water to households seems to me to be a ridiculous self-interested assertion and makes it obvious that they are quite prepared to let companies build a desalination plant that is the biggest in the whole world (not to be outdone by Sydney of course) and a pipeline that will cost more that has been stated if it does go ahead (no guarantee of water in it of course) that would triple the amount that water would cost Melburnians is plain stupid and unacceptable. They should all be jumping up and down about this grab for money.

It is evident that the world is moving towards a corporate controlled freshwater cartel, with private companies, backed by governments and global institutions, making fundamental decisions about who has access to water and under what condition. For example who will own the water recycled by the water reuse corporations, just to give an example of this grab for money and control of water as a commodity.[24]

I am certain that the State Government will bring in laws that will force people with water tanks (like in Sydney) to pay their water corporation according to the roof area and according to other measurements they will conveniently come up with to make money. On one hand the government wants us to conserve water; on the other hand if we do then do they not lose revenue? Just a matter of time I believe! It is all about profits and huge corporations and governments making money. The fact is they have not invested the profits into upgrading infrastructures. The leaking pipes under Melbourne lose a massive amount of water and they dare talk about how much farmers lose.

[24] Maude Barlow, *Blue Covenant* (2007) 91.

2. Does it not seem logical that the State Government ensures that it is a priority that it re-uses treated wastewater. Does industry really need to use drinking water? Are there not other areas that would benefit for the re-use of this water rather than allowing it back into the Yarra and other Rivers where it eventually ends up acidifying the oceans?

3. The use of groundwater must take into consideration of what this groundwater does and how it is interconnected with the systems. Investigations must occur before action is approved. Perhaps investigate how Perth is using its groundwater resources as it relied upon before their desalination plant was built.

4. You mention small locally based desalination plants and the Victorian government has decided blow that we will have the biggest and place it as far from Melbourne as possible and make sure that the building of it does not have to be offset though it will release tons of greenhouse gases. It is also considering buying carbon offsets from interstate and this after clearly stating it would be reliant on green power. Mind you this is the government that announced a new coal fired power station as the Garnaut report on Climate Change was released. This does show that the government has good green credentials. I believe that this desalination plant should not go ahead with our money unless the government has signed up to the Equator Principal along with all the major banks. Desalination should be a last resort and in this case I believe, as do many others, that Melbourne has many options before it should consider this exorbitantly expensive, energy guzzling, toxic material producing option. The possibility that the a huge desalination plant would add to the acidification and dead cell zones in the ocean has not been thoroughly researched as yet and there is every indication that every time a government proceeds with a rush at a proposal of this magnitude with flimsy unacceptable Environmental Effects Statements the result is certain to be a disaster. Since I believe there are less harmful options I reject that a desalination plant must be part of this mix. It concerns me that this government is intent on the “business-as-usual” scenario and the “bigger is better” options, rather than the ecologically sustainable options!

5. Many people have suggested many other ways for Melbourne to be ecologically sustainable and I attach reports in my next email that will give a variety of options that might be considered.

I also attach my submission on the north-south pipeline proposal which I believe does not need consideration and in fact should be totally and firmly rejected as an option to be considered.

Some of the reasons I have found support for in the *Thirsty Country* by Asa Wahlquist 2008:

Those living along the Murray already know about living with reduced flow. The long-term inflow into the Murray River is 11 000GL a year, but inflows between July 2001 and June 2007 averaged about 4200GL a year. Irrigation licenses for about 4200GL have been issued on the Murray. Clearly there was not enough water to fill them. The combined inflows of the Goulburn, Murrumbidgee and Darling rivers (tributaries to the Murray) were just 15 per cent of their long-term average.

On Melbourne Cup Day in November 2006, John Howard called a Drought Summit with the premiers of the Basin states. David Dreverman, the manager of River Murray Water with the MDBC, outlined the severity of the drought. He told the meeting, "The probability of inflow was very low, and we said it was more typical of a one in a 1000 year event than one in 100 year event." The year ended with a record low inflow into the Murray of just 1211GL, only slightly more than 10 per cent of the average.

Rainfall started to return to normal in 2007, but inflows into the system, with its dry catchments and low ground water, continued to set low inflow records for the first six months of the year. The two years, 2006 and 2007, set the record for the lowest two-year inflow period for the Murray. MDBC Chief Executive, Wendy Craik, says flows were so low the water sharing rules had to be re-aligned early in 2007 'to make sure that we did actually get water to Adelaide and we did get water along the way to Victorian and New South Wales communities.'

What was most alarming was how perilously low the storages had fallen. The 2007-08 irrigation season opened with the storages holding just 1600GL, compared with 3500GL the previous year and a long-term average of 5500GL. 'It is outside the experience or record' said Craik.[25]

It is evident that the north-south pipeline option is not acceptable. Taking water from a dry catchment to a wetter catchment is not to be considered as an option.

As Professor Cullen stated: 'As water scarcity increases with climate change, there will be ongoing pressures for urban catchments to be more self-sufficient with water, and have less reliance on importing water from other catchements.'

We can no longer solely rely on big water utilities and state governments, which have failed to provide us with the water we want. Our water future will depend on the effort of individuals and households, on the community, and on our regions, as well as the state. Curbing our water use, installing households rainwater tanks, collecting storm water, treating waste water, using ground water, buying in water and using water from dams.

[25] Asa Wahlquist, *Thirsty Country* (2008)165-166

Please consider my submission. I have endeavored to establish that this is not just about Melbourne and its water because some of the proposed actions suggested by the Victorian Government will most certainly, without any doubt what-so-ever have unacceptable and enormous impacts upon the rest of the State. Water does not simply flow to Melbourne, it comes from somewhere and proposals such as the desal plant affects the people in Gippsland, the oceans of the globe, the north-south pipeline which affects the Rivers in the north as well as those that have not been assessed downstream all the way to the mouth of the Murray River.

The National Water Initiative to which Victoria is signatory to, the July 3, 2008 COAG agreement and the Living Murray Initiative all have as their basis that all water is interconnected, our water resources are over-allocated, the savings are simply not there, as even the Goldfield pipeline has to “borrow” “buy” water from Lake Eildon, water quality reserve for the second year in a row, and this water is water that is there to flush the Goulburn River if there is an algal bloom or a salinity issue! The rivers and wetlands are dying in the north from the mouth up and still the Victorian Government insists that all is hunky dory and they are still insisting on extracting water, 75GL and more under a Stage 3, for Melbourne with absolutely no concern about the fate of our rivers and our communities that do NOT have any other options, unlike Melbourne.

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The following sites might be of use to you.

- http://www.ourwater.vic.gov.au/allocation/water_allocation_framework

-http://www.ourwater.vic.gov.au/environment

-http://www.ourwater.vic.gov.au/programs/sws

SUBMISSION BY MARIA I E RIEDL TO THE

PROJECT ASSESSMENT REPORT

SUGARLOAF INTERCONNECTOR PIPELINE PROJECT

AND GOD SAID "ALL THE RIVERS SHALL RUN TO MELBOURNE."

DESIGNATED PROPONENT IS MELBOURNE WATER (GOD)

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MARCH 18, 2008 *

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1/This proposed project has triggered the EPBC Act, because it will have a significant impact upon matters protected by the Commonwealth, and as such needs approval from the Australian Government Ministers; Penny Wong, the Minister for Climate Change and Water and Peter Garret, the Minister for the Environment, Heritage and Arts.

This role under the previous government was held by one person, Malcolm Turnbull. Because matters of ecological sustainability and development have taken on such urgency, it has been the decision of this government to share this role. Being a water issue, as well as an environmental issue, I would ask that *both Ministers* have regard for this proposal. To limit the decision making to only one of the Ministers would be contestable because as it states in the EPBC Act 1999 Referral of proposed action statement; ***"Your referral will be the principal basis for the Minister for the Environment and Water Resources'…",*** since these two Ministers each have a part of that title I believe legally it would behoove them both to take this decision together.

2/A glaring error in the PIA, is found on page 12: *"A referral under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) was accepted on 15 January 2008. On 13 February 2008, the Minister's delegates determined that the proposal is a controlled action and therefore requires assessment and approval by the Australian Government Minister for the Environment, Heritage and Arts before it can proceed."* This is not correct, as it is clearly stated in the 'referral of proposed action', that it is the *"Minister for the Environment and Water Resources,"* which happens to be two separate Ministers. You cannot choose to exclude the Minister for Water Penny Wong just because it suits you.

As Penny Wong is dealing with water issue from the Murray-Darling Basin right at this exact moment in time, there is clearly scientific evidence that any action that impacts upon the Murray-Darling Basin will be significant and since this was not addressed in any way in its entirety, by the proponent, it is obvious that this entire PIA process is flawed, it does not seek to inform the Ministers. It intends to deliver the project no matter the damage to the environment and the rivers. As such, I ask that the proposal to construct a pumping station upon the Goulburn River and then laying pipes than are up to 1.7meters in diameter, from the Goulburn River to Sugarloaf Reserve must be completely abandoned, as the proponents have shown arrogance by refusing to action a comprehensive EES, and have shown utter contempt and demonstrated a ruthless evil action that is demonstrating a total inability to comprehend the significance of the impacts upon nationally threatened species and ecological communities and upon migratory species protected under international agreements. Ramsar wetlands of international significance, a river listed under the Heritage Rivers Act and the fact that the Goulburn River feeds the Murray River at Echuca, thus the impacts continue all the way to Adelaide on every Ramsar wetland, on every threatened community, on every aquatic species, on every threatened human community that is totally dependent upon the integrated river systems.

3/We know they are integrated because this is what has been written about in most of the literature you read about the catchments and rivers and has been thoroughly covered from every single angle that we can think of and we know that the EPBC Act, has its primary goal; ecological sustainable development (ESD). To ignore all this information and not provide it so that the Ministers can be fully and unequivocally informed on a comprehensive suite of ramifications and impacts that might occur, and in reading all of this information come to the realization that scientific evidence, the desire of humans to survive, their desire to assure that their environment survives, the desire to see that their children inherit a healthy environment that has been improved upon, using knowledge that is contained in part in the following literature, to name but a few, as I did not have enough time to list every single piece of literature. These are the ones that I own myself and have yet to read all of them, but on opening up any of them, there is the same underlying theme that all governments are required to act upon as it is stated in the ***Planning and Environment Act 1987 Act No.45/1987 Part 8-Panels s 161 General procedures for hearings:***

(1)In hearing submissions, a panel-

(a) Must act according to equity and good conscience without regards to technicalities or legal forms; and

(b) Is bound by the rules of natural justice; and

(c) Is not required to conduct the hearing in a formal manner. And

(d) Is not bound by the rules or practices as to evidence but may inform itself on any matter-

(i) In any way it thinks fit; and

(ii) Without notice to any person who has made a submission.

(2)A panel may require a planning authority or other body to produce any document relating to any matter being considered by the panel under this Act which it reasonably requires.

(3)A panel may prohibit or regulate cross-examination in any hearing.

(4)A panel may hear evidence and submissions from any person whom this Act requires to hear.

(5)Submissions and evidence may be given to the panel orally or in writing or partly orally and partly in writing.

*The following is found in **s166. Technical defects**.*

(2) A panel may adjourn the hearing of submissions and make an interim report to the planning authority if it thinks there had been a substantial defect, failure or irregularity in the preparation of a planning scheme or amendment or any failure to comply with Division 1, 2 or 3 of Part 3 in relation to the preparation of the planning scheme or amendment.

s168. Panel may take into account any relevant matter

A panel may take into account any matter it thinks is relevant in making its report or recommendations.

The following is the partial list of relevant literature:

- ***Watershed - Ticky Fullerton 2001***
- ***EPBC Act 1999***
- ***Managing Water for Australia the Social and Institutional Challenges-Karen Hussey and Stephen Dovers CSIRO 2007***
- ***Australia's Water Resources from Management to Use- John J Pilgram 2006***
- ***The Murray A River and its People-Paul Sinclair 2001***
- ***The Deepening Crisis South Australia:Murray-Darling Wetland Report Card-Australian Conservation Foundation***
- ***Unchartered Waters-Murray-Murray-Darling Water Commission-Daniel Connell-2002***
- ***Framework for State of Environment Reporting-Commissioner for Environmental Sustainability-Dr Ian McPhail 2003***
- ***National Principles for the Provision of Water for Ecosystems- Sustainable Land and Water Resouce Management Committee Subcommittee on Water Resources-1996***
- ***Response to the Environmental Audit of the Goulburn River-Lake Eildon to the Murray River-DSE 2005***
- ***Securing Our Water Future Together Victoria's Action Plan for a Secure Water Future-DSE 2004***
- ***Our Water Mark Australians making a Difference in Water Reform-The Victorian Women's Trust-2007***
- ***Planning and Environment Act No.45/1987 and No. 47 of 2007***
- ***Marine Conservation and Conservation ParkWatch-VNPA 2008***
- ***Sustainable Water Strategy Northern Region Discussion Paper-DSE 2008***
- ***Delivering for Victoria Annual Statement of Government Intentions-Hon Brumby MP -2008***
- ***Setting the Cap Report of the Independent Audit Group-Murray-Darling Ministerial Council-1996***
- ***Our Water Our Future The next Stage of the Government's Water Plan-DSE 2007***
- ***Water Act 2007 No. 137-Commonwealth 2007***
- ***Charter of Human Right and Responsibilities Act 2006 Act No. 43/2006***
- ***Flora and Fauna Guarantee Act 1988 Act No. 47-Victoria (incorporating amendments as at June 2000)***
- ***Water Act 1989 Act No. 80/1989-Victoria (reprinted incorporating amendments as at August 2006)***
- ***Update Bulletin Victoria-Water Act 1989 No.80 (latest reprint No. 8 dated August 2006***
- ***Catchment and Land Protection Act 1994 Act No. 52/1994-Victoria (reprinted incorporating amendments as at 31 October 2006)***
- ***National Parks Act 1975 No. 8702 of 1075-Victoria (reprinted incorporating amendments as at 14 February 2008***

- *Environment Protection Act 1970 No 8056 of 1970-Victoria (reprinted incorporating amendments as at 16 July 2007*
- *Environmental Impact Assessment in Australia theory and practice-Ian Thomas and Mandy Elliot 2005*
- *Water Law-D E Fisher 2000*
- *The Precautionary Principal in Practice Environmental Decision-Making and Scientific Uncertainty-Jacqueline Peel-2005*
- *Water Politics in the Murray-Darling Basin-Daniell Connell-2007*
- *Silent Flood Australia's Salinity Crisis-Michael Sexton-2003*
- *State Water Report 2005/06 A Statement of Victorian water resource-DSE Tim Holding 2005-2006*
- *Environmental Law in Australia-Gerry Bates 2006*
- *Environmental Protection and Legal Change-Tim Bonyhady1992*
- *Climate Law in Australia-Tim Bonyhady and Peter Christoff-2007*
- *Back from the Brink How Australia's landscape can be saved-Peter Andrews-2006*
- *The Economics of Climate Change The Stern Review-Nicholas Stern 2006*
- *Environment and Sustainability Policy Creation, Implementation, Evaluation-Stephen Dovers 2005*
- *Watching Brief Reflections on Human Right, Law and Justice-Julian Burnside2007*
- *Australian Environmental Law- D E Fisher 2003*
- *Environmental Principals and Policies an Interdisciplinary Approach-Sharon Beder 2006*
- *Environment and Politics-Timothy Doyle and Doug McEachern 1998*
- *Environmental Policy Australian Practice in the Context of Theory-Ian Thomas 2007*
- *Environmental Management Processes and Practices for Australia-Ian Thomas 2005*
- *The Natural Advantage of Nations Business Opportunities, Innovation and Governance in the 21st Century- Karlson 'Charlie' Hargroves and Michael H. Smith 2005*
- *Statutory Planning in Victoria-Des Eccles and Tannetie Bryant 2006*
- *Greenhouse Solutions with Sustainable Energy- Mark Diesendorf 2007*
- *An Environmental Handbook-Department of Water Resources Victoria 1989*
- *Our Environment Our Future Sustainability Action Statement 2006-DSE*
- *Assurance and Accountability Annual Report- Victorian Auditor-General 2006-07*
- *State of the Parks 2000 Park Profiles-Parks Victoria*
- *Climate Change Science-Australian Government Department of the Environment and Water Resources 2007*
- *Victoria's Native Vegetation Management A framework for Action-Victorian Department of Natural Resources and Environment 2002*
- *Native Vegetation Sustaining a living landscape-DSE 2006*
- *Local Government:Results of the 2006-07 Audits-Victorian Auditor-General's Report Feb 2008*
- *Melbourne Water Seawater Desalination Feasibility Study Executive Summary June 2007*
- *Draft Scoping Requirements Desalination Project Environmental Effects Statement-Department of Planning and Community Development Feb 2008*
- *Native Vegetation:planning permit applicant's kit-DSE 2007*
- *Gaurnaut Climate Change Review Interim Report to the Commonwealth, State and Territory Governments of Australia Feb 2008*
- *A Fairer Victoria Building on our Commitment-DSE 2007*
- *Victorian Greenhouse Strategy Action Plan Update 2005-DSE*

- ***Melbourne Water Sustainability Report 2005/06-Melbourne Water***
- ***Building one Victoria: Projects the are Growing and Strengthening the State-DSE 2005***
- ***Annual Report2006 Mallee Catchment Authority***

4/The PIA or Project Impact Assessment Report, (over 1000 pages) of which I read as much of as I could manage in the short space of time that we were all limited to has proven to be lacking in rigorous investigations (the proponent says that it is desk-top and modeling and a limited on the ground investigation), and scientific evidence. In light of this, and more importantly since it has been chosen by the Planning Minister as the assessment process by which the Commonwealth Ministers are required to be fully informed, so they can make a knowledgeable decision. There has been too many omissions inadequate rigor and a narrow scope to inform the Ministers, with the result that the decision she or he is to make is ill-informed as the full impacts have not been addressed or brought up by the proponent, in their rush to put this PIA together.

The Planning Minister has demonstrated a complete lack of understanding of the impacts that this project actually will have and has omitted to require due diligence in making sure that the Commonwealth Ministers are fully informed about the entire range of impacts of National Environmental Significance, not just the ones that are close by. (The Goulburn drains into the Murray, which drains into the sea at Adelaide) If there had been researched scientific and properly assessed evidence being provided, their decision could have been based on enough information which would have assured the Commonwealth that the decision would have prevented the loss of those '***Matters of National Environmental Significance'*** listed under the Commonwealth EPBC Act and which had taken into account ESD and the Precautionary Principal as they are required to do so.

5/The fact that information has been omitted from scrutiny, by clearly minimizing the impacts is evident, and as such it must be considered by the panel in advising the Ministers that there is not enough information to make an informed decision.

This decision must be an informed decision, and the PIA report must contain enough information, based on facts and scientific evidence because of the significant impacts on matters of *'National Environmental Significance*.'

6/It is evident to me and others that the Commonwealth EPBC Act sets out the procedure that the Commonwealth Ministers must follow when making a decision. The ***EPBC Act*** states:

s 75(2)"If, when the Minister makes a decision under subsection (1), it is relevant for the minister to consider the impacts of an action:

(a)The Minister must consider ***all*** *adverse impacts (if any) the action:*

(i) has or will have; or

(ii) is likely to have;

On the matter protected by each provision of Part 3; and

(b)Must not consider any beneficial impacts the action;

(i) has or will have; or

(ii) is likely to have;

On the matter protected by each provision of Part 3.

Further:

s76(1) If the Minister believes on reasonable grounds that the referral of a proposal to take an action does not include enough information for the Minister to decide:

(a) whether the action is a controlled action; or

(b) which provision of Part 3 (if any) are controlling provisions for the action;

The Minister may request the person proposing to take the action to provide specified information relevant to making a decision.

(3) If the Minister believes on reasonable grounds that the information given to the Minister in relation to the action is not enough to allow the Minister to make an informed decision on the approach to be used for assessment of the relevant impacts of the action, the Minister may request the person proposing to take the action to provide specified information relevant to making the decision.

(5) The Minister may make a request under subsection (3) even if the Minister has not yet made the decision under subsection 75(1) in relation to the action.

I would like to bring the following further EPBC Act section to your attention as they have relevance to the extent of the information that is needed for the Ministers to make decisions.

s82(1) If the Minister has decided under Division 2 of Part 7 that an action is a controlled action, the ***relevant impacts*** *of the action are the impacts that the action:*

(a) has or will have; or
(b) is likely to have;
on the matter protected by each provision of Part 3 that the Minister has decided under that Division is a controlling provision for the action.

Section 87(4) of the EPBC Act 1999 states that:

The Minister may decide on an assessment by an accredited process only if the Minister is satisfied that:

(a) the process is to be carried out under a law of the Commonwealth, a State or a self-governing Territory; and
(b) the process and the law meet the standards (if any) prescribed by the regulations; and
(c) the process will ensure that the relevant impacts of the action are adequately assessed; and
(d) he or she will receive a report of the outcome of the process that will provide enough information on the relevant impacts of the action to let him or her make an informed decision whether or not to approve under Part 9 (for the purposes of each controlling provision) the taking of the action.

7/The information provided by the proponent in this case uses words that create the question whether there has been a thorough and scientific and sufficiently believable investigative process that has proven that this action will not have significant impact on matters of National environmental significance and the environment that are protected by the EPBC Act specifically and including Part 3 matters:

- *World Heritage (sections 12 and 15A)*
- *National Heritage places (sections 15B and 15C)*
- *Wetlands of International importance (sections 16)*
- *Listed threatened species and communities (sections 18 and 18A)*
- *Protection from nuclear actions (sections 21 and 22A)*
- *Marine environment (sections 23 and 23A)*
- *Protection of the environment from actions involving Commonwealth land (sections 26 and 27A)*
- *Protection of the environment from Commonwealth actions (28)*

I list these words here:

- It is likely that
- May be affected
- May have minor impacts
- It is considered
- Little impact
- Potentially unstable
- Ongoing tectonic activity
- Mitigate risks
- Minimize impacts
- May occur
- Further investigation will be undertaken
- Attempts to avoid
- Can be managed adequately
- Potential presence of EPBC and FFG Act listed species
- Most social impacts are localized
- Direct and indirect consequences
- The project has the potential to affect
- Likely to be of limited duration
- Residual effects may need to be addressed
- Residents may be inconvenienced
- Ground vibration could be an issue
- Pump station noise will be controlled
- Ongoing vibration
- People with a focus on landscape values will be impacted
- Clearing of vegetation may create views
- Potentially relevant
- May also occur
- No assessment has been made
- Most terrestrial invertebrates have not been considered
- Additional fauna species may be recorded
- Landscape generally dry
- Approximately 4420 bat calls were recorded
- Opportunistic observations
- Random meandering technique

- Vehicle-based rapid assessment (2 days)
- Review of databases and other literature
- Predictive database
- Desktop assessment
- Likelihood of occurrence
- Possible in
- May provide habitat
- Still potential for these species to occur
- Predicted occurrence

I would like to ask, where is the proof that this project will not significantly impact upon matters protected by the State as well Commonwealth and International Legislation? I have to stop here as the list could go on and on. What it does prove is that the study has not been able to be thorough enough because of time constraints and this is of grave concern because if the proponent is relying on databases and literature and some inadequately rushed observation, they are omitting to recognize that with the drought and other disturbances, the danger is that species are closer to peril that they have assessed, and the impact of this project would thus be measurably more significant. Since the investigation has not been a thorough EES and all that this would entail; the information that is given, is just lists and suppositions without really efficiently upon relying scientific evidence.

8/Preston CJ *"described the role of environmental impact assessment and approval as a key means of achieving ESD, as follows (omitting some citation):*

Requiring prior environmental impact assessment and approval is a key means of achieving ecologically sustainable development.

<u>It facilitates achievement of the principal of integration of economic and environmental considerations in decision-making processes."</u> s 6 (2) of Protection of the Environment Administration Act adopted by s 5(1) of NWP Act. See also the Principle 4 of Rio Declaration on Environment and Development 1992 (Int). ***<u>If environmental considerations are to be an integral part of decision-making processes, it is necessary to assess the environmental impacts and risks associated with proposed activities. Environmental impact assessment is widely applied to predict impacts of proposed activities on the environment.</u>***

<u>Prior environmental impact assessment and approval are important components in a precautionary approach. The precautionary principal is intended to promote actions that avoid serious or irreversible damage in advance of scientific certainty of such damage. Environmental impact assessment can help implement the precautionary principal in a number of ways including:</u>

- ***Enabling an assessment of whether there are threats if damage to threatened species, populations or ecological communities;***
- ***Enabling an evaluation of the conclusiveness or certainty of scientific evidence in relation to threatened species, populations or ecological communities or the effect of proposed development on them;***
- ***Enabling informed decisions to be made to avoid or mitigate, wherever practicable, serious or irreversible damage to the threatened species, populations or ecological communities and their habitat; and***
- ***Shifting the burden of proof (evidentiary presumption) to persons responsible for potentially harmful activity to demonstrate that their actions will not cause environmental harm: Conservation Council of SA Inc v Development Assessment Commission (1999)…***

The requirement for prior environmental impact assessment and approval enables the present generation to meet its obligation of intergenerational equity by ensuring the health, diversity and productivity of the environment is maintained and enhanced for future generations."

All this says is that a thorough scientific investigation like an EES in this specific instance with all the additional information given by experts, would ensure that the principals of ESD, including the Precautionary Principal, are taken into consideration and adhered to as required by statute, which does say there must be due regard to the principals of ESD. This has not been done in this instance, as the Minister for Planning has said that it is unnecessary to do an EES because an EES was deemed unnecessary for the Wimmera-Mallee Pipeline! It is the Minister's right to make this decision but I insist that he has chosen the incorrect form of assessment, especially since it is required under law to provide "enough" information.

9/I insert a few photos here of the territory that the Wimmera-Mallee pipeline goes through, and you will see that it is totally and unequivocally and glaringly, a vastly different area to the one that this pipeline proposes to bulldoze and blast through without a thorough scientific investigation using the appropriate mechanism which is an EES at the very least!

A PIA is not only flimsy and insubstantial and unsubstantiated, but since it is crafted by the proponent themselves, in a very short period of time, without adequate expert scientific evidence, is bound to be biased and omit details they do not wish to be looked at. And I assert that there is sufficient evidence to support lack of duty of care by the Minister for Planning in allowing the inadequate PIA report to be the information on which the

Commonwealth must decide on whether this project proceeds on not. Not enough information is provided with the result that the Ministers cannot make an informed decision.

It follows that the Minister upon information given, I assume by the proponent, has to decide whether the 'relevant controlling provisions' of

'The project is likely to have a significant impact on:

- Listed threatened species and communities (sections 18 & 18A)

10/I insert the relevant sections (as separate scanned sheets) end of this submission with other additional information which I believe is relevant to an "informed" decision,

11/I would like to proceed by pointing out that the PIA Report's Terms of Reference **cannot exclude anything that would be taken as relevant** to the informative decision-making that the Ministers must adhere to. In order to do this, the Ministers must be given all relevant information, not just those that are convenient, to the point they ignore significant impacts not thought of, or not considered by the proponent to be significant and make a decision based on the limited scope and unsubstantiated and unscientifically proven assertions by the proponent.

12/The significant impacts which are exacerbated by the drought are well documented and are scientifically proven. The most obvious proof is Minister for Climate Change and Water Penny Wong is at this present time spending $50million dollars to buy back water for the Murray-Darling Basin. (This should be more than enough proof for the panel to call for a full EES immediately.) Why is the Commonwealth so concerned about the Murray-Darling Basin; because it is seriously degraded and the Murray River and tributaries are in peril, due firstly to over-allocation and mismanagement, and secondly the drought and thirdly global warming and this includes climate change.

The Murray River is fed by other rivers and one of the most vital is the Goulburn River, which runs into the Murray at Echuca, it then proceeds to run all the way to Adelaide. I would like to point out in no uncertain terms that the proponent in their rush and exuberance to supply the new projected 90,000 houses with water, have totally omitted to include this in any part of their PIA assessment.

13/In Gray v The Minister for Planning the project required environmental assessment, the "applicant sought, and the Court made, a declaration that the view of the Director-General of the Department of Planning that the environment assessment adequately addressed the Director-General's environmental assessment was null and void and without effect. Pain J accepted that greenhouse gas emissions from the burning of coal to be extracted from the new mine should have been considered in the proponent's environmental assessment because of their potential contribution to global warming. It was indicated that both the direct and indirect impacts of the project on the environment of New South Wales were relevant to the assessment process. Her honor held that environmental assessment had to take proper account of ESD principles and that the precautionary principle and the inter-generational equity principal had not been taken into account.

14/The ignoring of the direct and indirect impacts upon the entire connected river systems of the Goulburn, the Murray, the Murrumbidgee and all their tributaries is not possible as this would be an unforgivable oversight that would forever have impacts upon flows in the Murray River and other rivers that tie into this system. The Goulburn does not flow out to sea towards Melbourne it flows out to sea via the Murray River. Any CMA and MDBC, Minister Penny Wong and Any person living along these rivers can tell you this.

This unbelievable omission also brings into play the following pieces of legislation and policy and International Agreements which are there to prevent this type of ill-considered and single-minded action. By single-minded, I mean the incomprehensible proposal, to grab 75gl of water and pipe it to Melbourne (Sugarloaf Reservoir) whether the water savings can be proven or not, whether there is drought or not, whether there are environmental flows or not, whether river dwellers have water or not, whether irrigators along these river have water or not!

15/These are the following policies that Australia is a signatory to:

1/ Stockholm Declaration- Principal 1*-"Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations."* You are denying the people of Wonthaggi this right and in fact you are in breach of this Principal because their dignity and well-being is being diminished as well as the environment being destroyed for "*present and future generations"* which again brings to mind the Charter of Human Rights.

2/ the Rio Declaration-Principal 1- *"Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature."* Again this I would assume (and so should you) includes the people at Wonthaggi and all the other people who visit this area. They should not see the destruction of their environment by a project that could and should be placed closer, because it is possible as you have indicated in the scope and the GHD and Melbourne Water Feasibility Study.

3/the Bonn Convention on the Conservation of Migratory Species of Wild Animals 1979.

4/the Vienna Convention for the Protection of the Ozone Layer

5/the Montreal Protocol on Substances that Deplete the Ozone Layer

6/the United Nations Convention on Biological Diversity 1992

7/the United Nations Framework Convention on Climate Change 1992

8/the Kyoto Protocol 2008

9/the Noumea Convention for the Protection of the Natural Resources and Environment of the South Pacific Region 1986

10/the Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1874

11/the Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment 1986

16/This proposal without an EES to inform the Commonwealth of all impacts can be regarded as environmental terrorism. There are no guarantees that Melbourne Water will allow water for the environment to be used for it in times of what is perceived a drought, rather than a result of an entire suite of activities. It sounds so much better to justify this pipe blaming the shortages onto a drought. Our fear is that Melbourne has already cut environmental flows to the Yarra River, rather than go onto Level 4, as the rest of Victoria did! Instead they made up a new Level 3a and cut the environmental flows to the Yarra showing the rest of Victoria that this is what is allowed to be done and will probably legislated to be done in times of drought. Though it is a fact that Victoria is in this predicament, not only because of the drought, but also because of failure by the State to carry out its duty in upgrading the delivery of water infrastructure, initiating effective and fair water saving measures and installing infrastructure that would allow for reclaiming water, recycling water, rain water tanks, all projects that should have been done in the last 12 years of this government. To deny the environment its fair share of water because it can't speak up for itself as: irrigators, farmers, urban dwellers, rural users, industry and politicians can is terrible and there should be legislation enacted that prevents grabbing Environmental flow allocations as a first measure because of proven inaction and incompetence of governments and other water bodies.

This in itself demonstrates that the 75gl will not be 75gl in that pipe, (the pipe is large enough to take 200gls and the pumps 4x7,000 horsepower electricity driven not renewable energy driven), it will be 225gl and it will be stored for Melbourne, why, because Mr Brumby has boasted that Melbourne will be bigger than Sydney and he is opening up 90,000 housing lots, this during an over 12 year drought and at the same time extracting water from over the Great Divide out of a drier and different catchment and this and the other 150gl will have an impact of the Goulburn, on the Murray, on all the wetlands and Ramsar wetlands and other areas of National Significance along the entire length of the river systems.

17/This action is not an ecologically sustainable development and it most certainly is ignoring the Precautionary Principal both of which must be considered, under law. The other, additional, extractions have not been assessed in this PIA and these are: the 18 and 20GL respectively delivered to Bendigo and Ballarat and additional spurs, via the Goldfields Superpipe supplied from that might river, with lots and lots of new water in it (??), the Goulburn! Not only does this add another dimension that has been conveniently ignored by the proponent, but it adds to the very real impacts that will happen and that these impacts must be considered as relevant and taken into account by the Ministers making this decision. To not take all of this into account would mean that this process was flawed and that the decision by the Ministers was not base upon "enough" information to make an "informed" decision and this would trigger another sort of statutory response!

18/The empty Darling River, February 2008 just north of Wentworth NSW and the Darling receiving a flush from the Menindee Lakes. This is an example of what is happening to our rivers when upstream impacts of extractions are not considered important when considering the protection of the environment. The same thing, downstream impacts must also be

considered.

18/Below is a photo I took in Feb 2008 which shows the Murrumbidgee River, which also flows into the Murray, half empty at Hay and the open kilometres of inefficient channels and

watering that drains both rivers in certain areas. Again the infrastructure and upgrades are the responsibility of State governments and it is a statutory requirement that they are required to upkeep and improve infrastructure, without resorting to blackmail, and using

water from an already stressed river system to the detriment of the entire ecosystem. These are impacts that can and should be avoided and this is relevant because this river is also tied into the Murray, as is the Goulburn and if they are over-allocated already and the savings are not proven in a scientific manner before the pipeline is built then it's the end of our river systems and they become nothing more than insignificant irrigation channels solely for the use of irrigators and urban metropolitan dwellers and this is a lost that cannot be allowed as it results in a significant National loss. The evaporation from these channels would be immense as unlike a river they do not have River Red Gums and other species shading kilometres of open channels.

The sides of earthen channels also crumble in and the moisture seeps out the sides of these channels. Most definitely not efficient and ecologically unsustainable.

17/The open, evaporating earthen channel than run for kilometres and kilometres, 60 kilometres out of Hay, are shown on the previous page. This inefficient method of transferring water and over-allocation, are part of the reasons why our rivers are going to be impacted upon and until governments unite, as the Commonwealth is endeavouring to facilitate, to address this problem once and for all. It is **not** only the drought that is playing a part. Then, for the Victorian State Government to assume that it can merrily use the "*drought*" as a justifiable reason to grab water from the rivers that are already half empty without first making sure that the "*new water*" or so-called *"savings*" have been achieved makes one feel chilled to the marrow, at the cold-heartedness of such an ill-informed proposal.

18/I bring to mind the Nowingi Toxic Dump proposal that took us 4 years to win, because the government was so "*bloody-minded*" that it just assumed no one lived near Hattah therefore, no one would care. We, the people now have a Charter of Human Rights and Responsibilities and in this it does state and one of these rights is "*a right to a fair hearing."* This means that this "*requires public authorities to act in a way that is compatible with* *human rights"* this includes their decision-making. "*It also requires that all statutory provisions are interpreted in a way that is compatible to human rights."*

I ask therefore that the advisory committee allows the public "*the opportunity to present their submissions*" to you and that you allow us to *"cross examine evidence or bring expert witnesses."* The environmental grounds that would trigger this would be the fact that **there has been no scientific evidence that the taking of water from the Goulburn River will not affect the downstream aquatic ecology, species and communities, both human and biological.**

19/The water savings have not been achieved, and there is absolutely no verifiable scientific evidence that they can be achieved to the extent promised, because of; climate change, global warming, continued greenhouse gas emitting projects such as the desalination plant, the pumps that are proposed to run the pipes, because of the already endangered and declining state of our rivers and tributaries and wetlands, because of salinity issues which also have not been addressed as part of significant impacts, because of the over-allocation of our rivers-eg the new Goldfield Superpipe to Bendigo and Ballarat which is extracting 38gl from the Goulburn and this also has not been considered in the impact statement, To then assume that Melbourne can remove 75gl in 2010 and then every year after is a flagrant disregard of every environmental statutory, administrative Law and policy and International obligation that Australia has on its books!

20/In the book ***"Water Politics in the Murray-Darling Basin"*** which obviously ties into the Goulburn system, as it is a statement of fact that all water systems are interlinked in some way or another, and it states: *"Business-as usual poses a number of threats to regional economies. Despite the well-chronicled poor environmental state and continuing decline of the MDB river systems, many urban centres in the region are still pleasant places to live, attracting significant numbers of retired people. Further environmental deterioration is likely to reduce this attraction."*

Discussing the potential implications for the MDB should it fail to implement an effective Cap and other programs for environmental rehabilitation, John Marsden and Peter Jacob, the authors of the second companion report to the review, predicted that resource sustainability would become a major issue. Under those circumstances they thought that increased irrigation development would undermine the security of established producers and provide a disincentive to new entrants. Degradation of the riverine environment and water quality would proceed at an accelerating pace and there would be increasing tension between irrigation groups and surrounding regions as water supply security declined." I would like to point out the obvious that this is exactly what is happening as I write this submission!

"Water trading would become more aggressive and the incomes and viability of irrigated enterprises and communities across the MDB would be increasingly sensitive to seasonal and climatic variation. Ultimately, as end-of-valley flows continue to fall and the damage to riverine environment became stark, irrigation communities would become increasingly alienated from the wider society, a bleak prospect for all concerned."

The above statements I plucked at random from one of the many bits of literature and there are many many of these and they are being published at a rate unheard of before, because the terrible, devastating, no longer acceptable losses and impacts on our environments; of global warming, greenhouse gases, drought, over-allocations, over-use, inappropriate proposals, unacceptable impacts- proposing to further unsustainable development; all of which ignore the principals of ESD and the Precautionary Principal, which in themselves, could compliment and assist ecologically sustainable development.

If these principals were applied rigorously to every development, we would not be required to defend the environment against our own governments ill conceived proposals that are without question "knee-jerk" reactions because of previous inactions.

21/As you can see, this is the reason the Ministers must have ***all the information on all possible impacts*** as one system affects another, rivers in the north are all interconnected so it cannot be said there will be no impacts. These and other considerations that I will pursue are all used to "*inform"* the Ministers so that they can make an "*informed"* decision, not one with localized impacts only.

Downstream impacts on the Murray-Darling system, such as impacts upon the rivers downstream, the Ramsar wetlands the area of National Environmental Significance, are called into play with the EPBC Act, which makes it a responsibility to provide information that includes downstream impacts and it is obvious from the lack of these being addressed and taken into account. Mid to Lower Murray must be a part of this consideration, this is not speculative assertion as there is scientific evidence that these areas are threatened, that species of aquatic life could be impacted in a real manner.

22/This is a photo I took in Mildura on Thursday, March 12, 2008 and this is a dead vineyard, one of many many acres, because we had 0 allocations and they have crept up to 43 right at this moment. To say that extracting 75gl of new water, when it has not been proven, as the modernization has not happened and thus it is doubtful, as it has not been proven and there isn't scientific evidence that it can be achieved. Significant impacts are "*highly likely"* using some of the words the proponent uses continually!

Bulldozed dead citrus trees. There are acres of them around these areas and on both sides of the Murray River. Photo taken at Nangiloc- March 2008

Dead, not just dying, old growth forests of river red gums along the Murray River at Nangiloc-March 2008

The levels of the Murray River, stress the river red gums. March 2008 See VEAC report.

The state of the Murray, because of lack of flow has an increased incidence of blue-green algae, which is also an impact that will be exacerbated by this taking of water from an integrated Goulburn-Murray River system.

23/In a document called ***Securing Our Water Future Together, June 2004 page 4***, I found these statements:

"The Great Dividing Range geographically splits Victoria. North of the Divide, the majority of available water comes from river systems that flow into the Murray River.

As well as supporting Victoria's northern communities, this water is used to irrigate valuable farms and crops. South of the Divide, water is used for irrigation and by the large urban populations in cities and towns, particularly along the coastal fringe."

"A catchment approach

All Victorians get their water from one of 10 major catchment areas across the State.

These catchments are the geographic regions that collect rainfall and feed water to local creeks, lakes, rivers and reservoirs.

Each has its own Catchment Management Authority responsible for overall planning and waterway protection, while water authorities deliver services to towns and farms."

"The water from these catchments:

- ***Provide drinking water for all Victorians;***
- ***Supports high value, efficient agriculture and other industries***
- ***Generates recreation and tourism;***
- ***Is home to a diverse array of plant and aquatic life; and***
- ***Holds important cultural value for indigenous Victorians.***

These competing demands pose particular challenges for the environment and communities in each catchment."

"The Bracks Government's proposals have been developed after extensive consultation with communities and water experts in each catchment and provide an overall plan for all catchments to use water more efficiently.

Everyone is now able to play a part in securing Victoria's water future together."

25/This publication makes absolutely no mention of piping water from a catchment that is in peril to an area that has many options of augmenting their water supplies, rather than resorting to a "*knee-jerk*" reaction (such as re-cycling, asking industry for the water management plans, rain water tanks…) rather than creating a significant impact on the entire North of this state and along the entire length of interconnected rivers that are the lifeblood of people living along them. Is this not significant enough? There is enough scientific proof and many books written about the Murray-Darling Basin and all our water sources which are integral to each other, that suggest that this project will, more than likely (note, more) (note this triggers the ESD and Precautionary Principal) have an environmental impact and do irreversible harm, especially since the Commonwealth Government has signed up to the Kyoto Protocol and basically thus admitted that Global Warming, Greenhouse Gas emissions, are having an impact on not only our climate but the entire global climate. Why do you think we now have a Minister for Climate Change and Water and another for Minister for the Environment?

This is what happens in the Mallee without water. March 2008

*26/**The Environmental Protection Act 1970 No. 8056 of 1970***

Part 1-Introduction

***IJ** Principal of integrated environmental management*

If approaches to managing environment have potential impacts on another segment, the best practicable environmental outcome should be sought.

IK Principle of enforcement

Enforcement of environmental requirements should be undertaken for the purpose of-

(a) Better protecting the environment and its economic and social uses;
(b) Ensuring that no commercial advantage is obtained by any person who fails to comply with environmental requirements;
(c) Influencing the attitude and behaviour of persons whose actions may have adverse environmental impacts or who develop, invest in, purchase or use goods and services which may have adverse environmental impacts.

IL Principal of accountability

(1) The aspirations of the people of Victoria for environmental improvement.
(2) Members of the public should therefore be given-
(a) Access to reliable and relevant information in appropriate forms to facilitate a good understanding of environmental issues;
(b) Opportunities to participate in policy and program development.

2 Application of Act

(1) This Act binds the Crown in right of Victoria and, so far as the legislative power of the Parliament permits, the Crown in all its other capacities.

27/The above EPA Act also mentions that the Victorian Government must enforce environmental requirements ensuring *"that no commercial advantage is obtained by any person who fails to comply with environmental requirements."*

It is also a statutory requirement that the Melbourne Water, the proponent, and the State Government who is partner to this proposal, must be cognoscente of the fact that environmental requirements must be enforced for the purpose of *"influencing the attitude and behavior of persons whose actions may have adverse environmental impacts or who develop, invest in, purchase or use goods and services which may have adverse environmental impacts."* This makes it clear that any action that has environmental impacts has environmental requirements. In the second part, the proponent and the Victorian Government must be accountable under the ***"Principals of Accountability" which*** means that they must hold the ***"aspirations of the people of Victoria for environmental improvement"*** and be accountable to these aspirations and therefore must give us upon askance ***"access to reliable and relevant information in appropriate forms" so that we have a "good understanding of environmental issues."***

I assert that the Planning Minister, by authorizing a PIA instead of an EES has ignored this statutory requirement (one of many) and since the information presented to the public and the Commonwealth is scanty and does not present the full picture of possible impacts, both he and Melbourne Water are in breach of this Act and have made light of the *"aspiration of the people in Victoria*" by not providing the *"reliable and relevant* information" allowing us a "*good understanding of environmental issues*". We in the areas north of the Great Divide, have absolutely no true understanding of why this government would take water (new water?) (or a book keepers shifting of columns to make it appear like new water) 75gl then 18gl then 20gl to metropolitan areas out of the Goulburn River without scientifically accessing the impacts along the entire river system.

28/The environmental impacts on extracting water from the Goulburn 225gls would most certainly have impacts. The environmental flows are also going to be removed and stored so to say that only 75gl is going to be removed is not correct. Once removed, the environmental water under the ***Water Act 1989 Act No. 80/1989 48L Part 4-Allocation of Water***, be re-assigned as there appears to be statutory abilities that the Minister has where he can or could make a decision to re-assign an *"allocation of water under an environmental entitlement…*" , even though there has been assurances given that this would not happen, we just have to look to the fact that the Yarra environmental flows have been cut back so that Melbourne did not have to go to Level 4 August 2007 though this was triggered.

29/The fact that the Minister can cut an entitlement drastically to the environment, which has the same value as an irrigator's right, is of serious concern as this also has not been examined, not taken into account when assessing impacts. Especially since the Goulburn River is listed under the Heritage Rivers Act and under this Act I believe there must not be any extractions that have impacts upon the river and all that is in it and along it. Since this has not been thoroughly investigated and the results included in the PIA, I would put it to you that this is another omission that will leave the Ministers without information that they need to inform themselves enough to make an informed decision.

30/ ***Under this Water Act 1989 Act No. 80/198964GB (4)*** *"An authority must not make a determination under this section until the Authority has assessed the amount of water available in the system to be taken and the amount reserved for the environment."* I would assume this can be taken to mean that unless the saving that are promised are shown to be achieved each year are proven to be achieved, the "*Authority"* who I believe is the Minister, will not allow it to be taken. To assume and state that there are savings without scientific evidence of the amounts and where they came from, so it is transparent that there isn't any doubling up or counting twice or just taking back water from different sources and saying it is "*new water*" would demonstrate a lack of transparency.

31/The National Strategy for the Conservation of Australia's Biological Diversity has a stated aim which is: *"to bridge a gap between current activities and those measures necessary to ensure the effective identification, conservation and ecologically sustainable use of Australia's biological diversity"* ***"Several principles have been developed to support this aim; including: biological diversity is best conserved in-situ; all levels of government have clear responsibility; and co operation of conservation groups, resource users, indigenous peoples, and the community in general is critical to the conservation of biological diversity."***

To say that ***"biological diversity is best conserved in-situ"*** and that governments have clear responsibility I would assume means what it says. This proposal make slight of this and the proponent in their rush to push this through the approval stage are completely ignoring this. They are saying that the actions that they are seeking approval for are *"not likely*" to have any significant impact on that which has Nationally Significant, such as, listed threatened species and Communities. Not having done an EES to state this would be ill informed, as there isn't enough information from proper intensive studies which should have been triggered by the EPBC Act and many other Acts. This again should present a problem of "not enough information" for the Ministers to make an *"informed*" decision.

The following is -- Important!

32/The following paragraphs, which I have quoted in full, are from the ***Editorial Commentary Lawbook Co (2004) 21 EPLJ 325 by D E Fisher MA LLB PhD (Edinburgh) Professor of Law, Queensland University of Technology, Consultant , Phillips Fox Lawyers. -*** and I believe that this case in law is most relevant to this proposal specifically and the resulting decision by the Federal High Court must be taken into account by the panel, as information that is vital, and its urgent consideration might unhinge this development and stop a waste of anymore time and money (eg waste of resources, like the Nowingi Toxic Waste Dump proposal) and it is in the statutory powers of the panel under

I'd now like to bring up a landmark case that was brought before the Federal Court of Australia on 19 December 2003 called the ***Nathan Dam*** case, a case of the ***Minister of the Environment and Heritage v Queensland Conservation Council Inc.*** In this case "Kiefel J of the Federal Court of Australia decided in the Nathan Dam case that the Minister for the Environment and Heritage had erroneously interpreted and applied obligation in s 75(2) (a) of the Environmental Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) to consider all adverse impacts that a proposed action was likely to have on the values protected by the legislation.

*35/**On 30 July 2004 the Full Court of the Federal Court of Australia dismissed an appeal by the Minister.***

The Issue

Section 75(1) requires the Minister to decide whether the action in question is a controlled action and which provisions are controlling provisions for the action, Subsection (2)(a) requires the Minister to consider all adverse impacts the action has, will have or likely to have on the matter protected by the controlling provisions for the action when a decision is made under subs 1 and it is relevant for the Minister to consider the impacts of the action. The issue in the Nathan Dam case was whether the impacts of the action included not only the impacts of the construction and operation of the dam on the immediate and localized environment of the dam but also upon the downstream environment likely to be adversely impacted upon by the use of the water from the dam for irrigation purposes. Significantly, in his decision, the Minister acknowledged that "irrigation of land adjacent to river-beds has the potential to increase nutrient concentrations and other agricultural pollutants downstream of the dam". Notwithstanding the irrigation of the land by persons other than the proponents, using the water from the dam, are not impacts of the referred action, which is the construction and operation of the dam. It was this finding which provided an opportunity for a challenge to the validity of the way the Minister had interpreted and applied 2 75(2)(a) of the Act.

The arguments summarized

During the appeal proceedings, the Minister contended for an interpretation of the Act which limited the inquiry under s 75(2)(a) to the impacts of the construction and operation of the dam over which those proposing the action of construction and operation and control. On the other hand, it was argued for the respondent that the expression "impacts" was "wide enough to include consequences brought about indirectly through the actions of persons other than the primary or "original actor." In essence, therefore, was the inquiry under s 75(2)(a) restricted to impacts of the action for which the actor was responsible or capable of including impacts of the action for which others would be responsible?

A number of subsidiary arguments were put forward to support each of these propositions including the effect of similar legislation in other jurisdictions. Justice Kiefel herself had placed some weight upon how earlier Environment Protection (Impact of Proposals) Act 1974 (Cth) and environmental legislation in other Australian and overseas jurisdictions had been interpreted. However the Full Court preferred to interpret s 75(2) (a) of the EPBC Act in its own terms and without reference to other similar, but in some respects different, legislation. In other words, the approach taken by the Full Court was based entirely upon the ordinary meaning of the words in the legislation in question. The critical expression was impacts s75 (2)(a) but in accordance with the scheme of the Act as a whole. Indeed, their Honours specifically said it was unnecessary to consider other legislation in this case "where the ordinary English meaning of 'impacts' mandates an inquiry consistent with the objects of the EPBC Act."

Methodology for determining impacts

What does "impacts" mean? The Full Court avoided any paraphrase of the expression "all adverse impacts" in s 75(2) (a). Instead they referred specifically to the relevant meaning of the word "impact" in the Oxford English Dictionary. "In the relevant sense", it was concluded, means the "influence or effect of an action". According to Fowler, an "impact" is primarily "the striking of one thing against another, a collision and, by extension, its effect on the object struck". So "impact" for the purposes of 275(2)(a) of the Act is used in this more figurative but nevertheless literal sense. Having established that impact means influence or effect of an action, their Honours concluded:

We take s 75(2) to require the Minister to consider each way in which a proposed action will, or is likely to, adversely influence or effect (sic) the world heritage values of a declared World Heritage property or a listed migratory species.

The focus was thus upon the action and the influence or effect of the action. Whoever might be responsible for the action was almost, if not totally, irrelevant. Consistently, their Honours went on:

As a matter of ordinary usage that influence or effect may be direct or indirect. "Impact" in this sense is not confined to direct physical effects on the action of the matter protected by *the relevant provision of Pt 3 of Ch 2 of the EPBC Act. It includes effects which are sufficiently close to the action to allow it to be said, without straining the language, that they are, or would be, the consequences of the action on the protected matter.*

The instruction not to strain the language is important. It means that the impacts are relevant for the purposes of the Act are not unlimited. A point noted by Kiefel J when she excluded from consideration "those possible impacts which lie in the realms of speculation". According to this analysis, impacts are thus matters of fact and circumstance. The Full Court concluded accordingly that "it is a question of fact for the Environment Minister whether a particular adverse effect is an "impact" of a proposed action". The question thus was whether the Minister in this case had adopted the correct methodology of decision-making in reaching his conclusion that downstream impacts were irrelevant.

Application of this methodology

The response to this question necessitated a review of the reasons given by the Minister for the decision to exclude impacts of the action for which the actor was not responsible. An examination of the reasons led the Full Court to conclude that the Minister had decided that pollution downstream of the dam could not under any circumstances constitute an adverse impact of the proposed action which was the construction and operation of the dam. The Minister Reached this decision not a conclusion of fact based upon relevant information or evidence but rather as a statement of principle or policy unrelated to the facts and circumstances of the case.

Significantly, as already noted, there was information before the Minister that the use of water from the dam for irrigation purposes was likely to have effect on the world heritage values and the other values protected by the legislation. In some circumstances it would no doubt be difficult to draw the line between matters of fact and matters of principle or policy. Thus the Full Court avoided "an exhausted definition of 'adverse impacts" and in their view:

It is sufficient in this case to indicate that "all adverse impacts" includes each consequences which can reasonably be imputed as within the contemplation of the proponent of the action, whether those consequences are within the control of the proponent or not.

This is an objective test the Full Court has mandated. This is not whether the consequences are actually within the control of the proponent or not. Nor is it whether the proponent contemplates the consequences or not. Rather the test is the reasonable imputation of a consequence. Which impacts are relevant is a matter of law. But it is a matter of fact what the impacts are in any particular set of circumstances provided they are as a matter of law relevant.

The validity of the approach adopted by the Minister was examined against the background of the methodology of decision-making prescribed by the Full Court. Their conclusion was clear:

The inference from that material is inescapable that the use of water downstream from the dam, including its use for growing and ginning cotton, was within the contemplation of Sudaw as proponent of the action. Indeed, the Environment Minister did not suggest to the contrary. Rather, as already noted. He took the view that such "cumulative" or "potential" impacts of, or resulting from, downstream irrigation were incapable, as a matter of law, of constituting "impacts" of the referred action, which he confined to the construction and operation of the dam.

The decision of the Minister was thus erroneous as a matter of law and the construction of s 75(2)(a) of the Act adopted by Kiefel J was unexceptionable.

Conclusion

The reasons articulated by the Full Court were more limited than those of Kiefel J. The approach of the Full Court was essentially twofold. First, to ascribe to the word impacts its ordinary meaning and, second, to apply that meaning as a matter of fact to the circumstances of the case. For this purpose, an "impact" is an influence or an effect of an action. This may include the indirect consequences of a proposed action, for instance those consequences that are the result of actions other than those of the proponent of the action. It is the objectively identifiable impacts in this sense that are the subject of the clearly mandated duty in s 75(2)(a) of the Act.

Much of Kiefel J's reasoning had focused upon the values protected by the legislation. This was to some extent implicit in the approach adopted by the Full Court. Their Honours nevertheless made it clear that "the ordinary English meaning of 'impacts' mandates an enquiry consistent with the objects" of the Act. Indeed, the objects of the Act as set out in s 3(1) were stated in detail in the second paragraph of the reasons for judgment. These make it clear that the focus of the legislation is the protection of the environment and the conservation of biodiversity, notwithstanding that different values, such as economic and social consideration, are clearly relevant in other decision-making processes under the Act. Their Honours were influenced by the nature and function of the process prescribed by s 75. Thus:

The consideration required by s 75(2) is a "gateway" process which does not permit or prohibit a proposed action but merely determines whether it should be subject to one of the prescribed modes of assessment, and is one of the processes to which is made applicable the "precautionary principle" defined in s 391 of the EPBC Act.

36/this states:

(1) **Minister must take account of the precautionary principle in making a decision listed in the table subsection (3), to the extent he or she can do so consistently with the other provisions of this Act.**

(2) The ***precautionary principle*** is that lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage.

(3) The decisions are:

(4) Decisions in which precautionary principal must be considered

(5) **Item** 1 -**Section decision is made under** 75- **Nature of decision** whether an action is a controlled action

37/So, while the objects of the Act did not play as dominant a role in the reasons of the Full Court as in the reasons of Kiefel J, there seems little doubt that the objects of the Act as stated in the legislation constituted a set of substantive boundaries within which decisions are to be made and to the achievement of which decisions are directed. Thus the decision of the Full Court – just as the decision of Kiefel J – has *"ensured that the Minister was in the long run more likely than not able to achieve the objects of the Environment Protection and Biodiversity Conservation Act 1999."*

38/Taking the above case and placing Sugarloaf proposal into it we get this result:

1/The action proposed to be undertaken in this case (Sugarloaf Pipeline Project) is *"to construct and operate a water pipeline and associated infrastructure to transfer up to 75 gigalitres of water per year from the Goulburn River, near Yea, to the Sugarloaf Reservoir, Victoria."*

Section 75(1) requires the Minister to decide whether the action in question is a controlled action and which provisions are controlling provisions for the action.

2/Status of proposed action: The proposed action is a controlled action.

3/The relevant controlling provision is: The project is likely to have significant impact on: Listed threatened species and communities (sections 18 & 18A)

Subsection (2)(a) requires the Minister to consider all adverse impacts the action has, will have or is likely to have on the matter protected by controlling provisions for the action when a decision is made under subs 1 and it is relevant for the Minister to consider the impacts of the action.

39/The question to ask is: are the impacts of the action included not only in the impacts of the construction and operation of a water pipeline and associated infrastructure to transfer up to 75 gigalitres of water per year from the Goulburn River, near Yea, and only in the immediate and localized environment, but also upon the downstream environment likely to be adversely impacted upon by the extraction of 75gl of water. (Especially since another 18gl and 20gl are being extracted from the Goulburn for Bendigo and Ballarat and spurs).

40/As in the Nathan Dam case there are Matters of National Significance downstream and these are:

Ramsar listed Wetlands:

- Banrock Station Wetland Complex
- Barmah Forest
- Gunbower Forest
- Hattah-Kulkyne Lakes
- Kerang Wetlands
- Lake Albacutya
- NSW Central Murray State Forest

The Full Court in the Nathan Dam case decided that "*impacts"* means influence or effect of an action and therefore s75(2) of the EPBC Act requires the Minister to consider each way in which the proposed action will, or is likely to, adversely influence or effect, in that case a declared World Heritage property or a listed migratory species, as in this case it would be the Ramsar listed Wetlands and other listed threatened species both land, air and aquatic and communities along the Goulburn River from Yea to near Echuca and then the length of the Murray River. The extraction of 75gl which additional to the extractions of 18gl and 20gl and all the other extractions that occur as a result of irrigation and urban usage (and vary because of drought, over-allocations, larger farms, shifting of water between catchments and rivers, climate change to name a few) as well as environmental extractions must surely be considered, as it is all accumulative and the consequences of not considering this extraction would indicate that "*all adverse impacts*" includes each consequence which can reasonably be imputed as within the contemplation of the proponent of the action, whether those consequences are within the control of the proponent or not".

41/Another question to ask is what the likely adverse impacts are, both direct and indirect, of natural events, such as droughts and climate change and floods, and overuse of groundwater, lower volumes of surface water, losses of water from evaporation and leakage, and even rising salinity levels in our water ways and also salinities environmental impact which have not been considered as a substantial impact, the loss of old growth red gum forests along our rivers, logging in the catchments, algal blooms, fish kills, hot and cold water, low and high water, even forest fires, increases in populations both urban and rural create an increase in demand, which has also been omitted in this project consideration. What is the cumulative adverse impact upon the rivers when the red gums along it die, will the water table change, and will there be higher salinity levels and what will this do along the entire length of the rivers? What about the species and communities upon the river, in the river? Has this been included in the impact of taking the water out of the river? Then add the extraction of 75gl each and every year, as well as the storage of 150gl, which is the rest of the entire proposal. It is not clear whether this proposed action (the pipeline) is included with the three way split of the water, 75gl to irrigators, 75gl to the environment and 75gl to Melbourne or is it a separate proposal as the 150gl is not mentioned in the referral.

42/The Full Court's decision in the Nathan Dam case made it clear that the focus of the legislation is the protection of the environment and the conservation of biodiversity, notwithstanding that different values, such as economic and social considerations, are clearly relevant in other decision-making processes under the Act.

In the Sugarloaf Pipeline Project Environmental Implications of transferring water saving from the G0ulburn River February 2008 it states on pages 13and 14:

"A potential environmental impact of irrigation modernization is the reduction in "losses" of flows that may have provided some environmental benefit in the past. These reduces losses may have both local (within the irrigation system) and Murray and Goulburn River environmental impacts, related to less flow into drainage systems and associated wetlands, changes flow patterns in the river system and changes in water quality, including salinity. The component of these water savings assigned to the environment (75GL Stage 1) may, in part be available to mitigate the environmental impact of reduction in losses."

"The share of the savings for the environment and Melbourne will be held in Lake Eildon and released in a different pattern and in some years not fully released and carried over."

This proves my argument using the Nathan Dam case, it is admitted that there will be impacts but that is all. There has been no research on the extent of these impacts and where they would be, how far downstream, it is stated that Lake Eildon and the Goulburn and the Murray would be affected, but this does not appear in any impact statement and there is no scientific measure of what would be lost and what needed to be done, whether the EPBC Act should have been triggered for these areas as well and what measures, if any could be taken to avoid them. To state that there were environmental benefits in the past should have sent up a red flag as to what species and communities might be adversely impacted by this action. Why is it that the environmental water share has to alone hold the bag, what about each of the three holding the bag? It is an assumption that whatever the impacts are they won't be much. How can the proponent know this? Why did not the Minister see that this was required to be part of the assessment and would have been included in the EES? It is an impact, though it is away from the site the Minister has omitted to include it and thus I hold that he has ignored the downstream impacts.

To ignore downstream impacts must not be allowed, as the report states; *"If savings are not achieved from the modernization by this time 75gl can be augmented from savings already achieved from existing projects and 10gl from the water quality reserves."* These reserves are usually committed to the environment and to commit them in advance to Melbourne means that there is an intention to take water, no matter the cost downstream, to the environment, to rural towns along the river, to irrigators.

43/The following list tells the death of a major river system and to take even more water even though the savings have not been substantiated will have an *"impact"*.

1991 - 1000km of the Darling River is infested with blue-green algae, an early sign that the river is stressed.

1994 - COAG's Water Policy Reform document decrees that river health should be factored into water management.

1996 - Further removal of water from the Murray-Darling system is restricted through introduction of a cap set at 1993-94 levels. Surveillance of groundwater pumping is not increased.

1999 - An audit finds that Adelaide's water will be unacceptably salty by 2050.

2002-03 -Impacts of a severe drought begin to seriously hit farms, towns, businesses and communities in the Murray-Darling Basin. Dredging keeps the mouth of the Murray River open in South Australia. The governments of Australia, NSW, Victoria and South Australia commit $500 million to buy 500Gl from irrigators to increase environmental flows in the river system.

2004 -The National Water Commission articulates its aim to increase the productivity and efficiency of Australia's water use, including introducing full water trading between the states.

2005 -The survey of river red gums on parts of the Murray flood plain finds that 75% of the trees are stressed because of low flows due to the drought and because too much water is being removed for irrigation.

2006 - The Murray-Darling Basin experiences its worst on record. Water allocated for irrigation is halved. Surface water flowing into the basin's rivers drops to 550GL. In an *average year the figure is 11 200GL. The Murray-Darling Commission (MDBC) has not been able to purchase any water for environmental flow in the Murray.*

Hydrological analysis of aquifers in the MDB indicates that groundwater pumping in NSW, SA and Victoria increased after introduction of the cap on surface water removal.

2007 - A report on well-being of river red gums on the Murray River flood plains below the Euston in NSW indicates that most of the 200-year-old trees are either dead or dying. Prime Minister Howard intervenes and releases a national plan for water security.

44/The following relatively new ruling has also not been assessed as having an accumulative impact;

"From July1, 2007 each landholder's water entitlement will be separated from the land title (a process called 'unbundling'). In addition, for the first time in Australia it will be possible for anyone to permanently acquire a water entitlement (or entitlements) without owning any farmland. The water entitlement itself can now be held in perpetuity. It can be leased, used as collateral, and it can be bequeathed or permanently traded. Water entitlements will now also be registered."

"These arrangements bestow a new status upon water – making it a commodity that can be bought and sold in the marketplace."

45/Previously water was held for the *"common good".*

46/ The following is also an impact, because impacts occur when water is taken out of a district or catchment and traded into another. Because this is possible, Melbourne Water has absolutely no way of knowing how much water will actually be in the Goulburn in any given year. An example of something that has not been considered and therefore is likely to affect this entire proposal and have direct or indirect impact is: let's give an example: we are in a severe drought that continues till 2011, water is traded out into areas where the farmers or companies have enough money to buy water, the evaporation losses are greater because the summer is hotter and longer, because water is traded out of areas and stored let's say on a corporate farm, no-one else knows what is actually happening to the water, where water is traded over long distances the transmission losses are greater, irrigation channels become uneconomic, stranding water-infrastructure assets such as dams and diversion works, major channels so on so forth.

47/The list of impacts of yet another 75GL and 75Gl for the environment and 75GL for irrigators and 18GL for Bendigo and 20GL for Ballarat, and the rest of the allocations would all be out of the Goulburn River, but then we must also look at the scientific fact that the Goulburn River runs into the Murray River, then impacts and further extraction would most definitely cause significant environmental losses of species and communities and even the rivers themselves.

We no longer have the option of continuing along the business-as-usual path, ESD and the precautionary principal are part of the EPBC Act and it all must be considered as cumulative. It is not a fairytale; the dangers of irreversible damage are scientifically proven. It is written in every single book on environmental law, on biodiversity, on ecological sustainability and climate law.

48/The government's response to the Environmental Audit of the Goulburn River-Lake Eildon to the Murray River January 2006 has a forward to it by Mr John Thwaites and in this he makes a few statements that I feel are relevant for your consideration as it will provide information that the proponent has chosen not to provide. Considering the impacts that this water diversion will have it is vital that you understand what he says. I will only quote important parts of this Forward.

i. *The Victorian Government White Paper Our Water Our Future (2004) recognizes the importance of healthy rivers and commits to significantly improving the health of Victoria's rivers, floodplains and estuaries by 2010. This will ensure our rivers are capable of delivering a wide range of services to the community.*

ii. *The Government will create, and then enhance, the Environmental Water Reserve for the Goulburn River by establishing legislation and undertaking a number of water recovery projects. These include 120GL of lower reliability water for the River Murray and its tributaries, decommissioning Lake Mokoan to deliver 44GL to the Lower Goulburn River and improvements in irrigation infrastructure to provide 25GL of high reliability water for the River Murray and its tributaries.*

Some of the recommendations:

9-78 Revise the Bulk Entitlement (Eildon-Goulburn Weir) Conversion Order to ensure that the environmental obligations for managing the Environmental Water Reserves are clear, transparent and auditable.

2-14 Establish a SEPP (WoV) Attainment Program for the Goulburn River between Lake Eildon and the Murray River including the weir pool and Lake Nagambie.

Both these recommendations tie the Goulburn and the Murray Rivers to each other and make it certain that whatever impacts upon one will eventually impact upon the other. This is additional proof that there is a linkage.

49/ Melbourne Water, the proponent seems to be omitting the list of savings and where they would come from, all 225GL, because they have stated the savings will be shared three ways. They have also asserted that this is ***"new***" water savings. I beg to differ. And I also request that since taking this water without knowing where it will come from, will have an impact. You can't take water that isn't there or has been committed elsewhere.

- It is also stated that *" the Shepparton Modernization Project is listed to contribute 24GL to the 2010/11 Melbourne requirement. This water has already been earmarked as environment water for use in the Murray River."*

- *"Changing the responsibility of the losses from lateral channels to farmers does not create savings; it moves losses to someone else."*

- Again: *"If savings are not achieved from modernization by this time (2010-11), 75GL can be augmented from savings already achieved from existing projects and 10GL from water quality reserves."*

- It is interesting to note that the proponent quotes 2010 in some publications as the time frame when Melbourne will receive its 75GL and in others 2012 and yet in other 2010-2011. This demonstrates a complete lack of certainty and it is a presumption and the idea that they can take it no matter what should concern the panel as well as the Ministers.

50/ Nowhere does it state in the first *Our water Our Future (2004*) or even *Securing Our Water Future Together* that there will be a pipeline from the Goulburn River to Sugarloaf for Melbourne's usage. It is only in 2006-07-08 publications as a knee-jerk reaction to the prolonged drought, because the government had done nothing in Melbourne to drought proof it.

51/The following pages are about the Living Murray water Recovery program which also will be impacted upon by this proposal as environmental flows always seem to be taken in time of less water as a matter of course, unlike irrigators and urban dwellers entitlements which seem to have more weight!

WATER RECOVERY

Water recovery program aims to provide water to contribute to the achievement of ecological

objectives under The Living Murray. One of the key objectives of the Intergovernmental Agreement is a cost effective, permanent recovery of water to achieve the environmental outcomes of The Living Murray program's First Step decision. More than $500 million is being invested to recover 500GL of water for the environment.
There are a number of ways in which this water can be recovered, including:

- **Infrastructure improvements**
  Water can also be recovered by improving or installing new infrastructure to allow better measurement and control of flows, or reduce evaporation and seepage. Sometimes this process involves removing outdated or superseded infrastructure. These types of projects generally lead to efficiency gains.
- **On-farm Initiatives**
  Incentives can be offered, or programs facilitated to encourage land owners to improve the use of water on their properties.
- **Market-based measures**
  This involves the purchase of water from willing sellers. Often referred to as a "buy back" of water from users, these projects can be implemented quickly. There are currently several types of market-based measures being considered through The Living Murray.
- **Urban improvements**
  Water can be recovered from urban areas as well as rural areas through improved use of water. This can be achieved through demand management (reducing reliance on water), permanent water conservation measures, or water recycling projects.

The process of water recovery:
Although most proposals have come from Governments, water recovery projects can be proposed to The Living Murray by anyone at any time. Guidelines have been developed to assist those who would like to propose a new project, and are available for download through the Water Recovery Guidelines page. The guidelines include references to the original and Supplementary Inter Governmental Agreement, along with The Living Murray Business Plan. More information on these documents is available on the 'background' page of this site.
Once a water recovery project is shown to be feasible it may be listed on the Central Register of water recovery measures. This register is made up of three parts (Developmental, Eligible Measures, and Environmental Water). The process of water recovery, including the three parts of the register, is illustrated in the following graphic:

During this stage, water recovery projects are assessed to determine their suitability,	Once a measure has been assessed and entered onto the Developmental	Following the process of assessment and development, water recovery measures are	When implementation of a water recovery measure is complete, the project is

practicality and potential outcomes. Projects considered feasible progress to the Measure Development stage.	Register, it is further developed and refined before being implemented.	entered into the Eligible Measures Register and then approved for implementation.	entered into the Environmental Water Register, which holds a record of recovered water available for use in delivering ecological outcomes at The Living Murray Icon Sites.

Further information on water recovery:

- Water Recovery Progress Report
- Guidelines for Proposing a water recovery project
- Feasibility assessments of new water recovery projects
- Central register of water recovery measures
- Pilot Environmental Water Purchase project

Links to The Living Murray's Other Programs

- Water Recovery
- Water Application
- Environmental Works and Measures
- Communication and Community Consultation

Below a photo of the Murray River at Nangiloc half full! March, 2008.Terrible!

52/I have found another section in the book called *"Water Politics in the Murray-Darling Basin" by Daniel Connell-2007* that will be of interest to you, the panel as well as it might inform the Ministers.

"Another of these cautionary histories is that of the rich agricultural Goulburn-Broken region in northern Victoria in the MDB. Over the past 150 years it has been transformed by the clearing of perennial vegetation that has allowed much higher rates of recharge to groundwater. This has changed the hydrological cycle, which rises and falls with succeeding dry and wet climate periods. Under pre-development conditions the depth to groundwater table was 20 to 25 metres so variations were of no consequence for surface vegetation. The groundwater table now however is near surface vegetation. As a result, the buffer zone within which the water table can be allowed to oscillate without reducing productivity has become very narrow".

"The situation has been contained since then by a range of engineering interventions which includes an extensive system of pumps that remove more than a million litres of groundwater a year. Although much of this water is reused in the short term it is gradually becoming more saline over time as it picks up salt concentrated near the landscape surface. Concern about the potential impacts on the River Murray prevents saline water being pumped to streams so this groundwater pumping merely provides a means of managing the problem, not a long-term solution."

"For longer term sustainability and resource security these debates (environmental rehabilitation programs…) will need to take account of a much wider range of factors than has been the case in the past."

This again adds weight to my assertion that the *"**adverse impacts**"* have not been taken into account as the Minister has not had sufficient information to make a decision on what is to be referred via the EPBC Act. It has omitted to study the results of actions further than the actions of the proponent has stated as being impacted, in that they cannot control the impacts likely to occur in the groundwater table and in the matters under the EPBC act that must be taken into consideration. The word "***impact"*** must also take into account the dictionary definition as in the Nathan Dam case, where the Full Court ruled that the impacts that are downstream can also have bearing on a proposal upstream and that these impacts when assessing a proposal under the EPBC Act must be taken into consideration by the Minister. But it is a little difficult for him to make this decision if he hasn't got "***enough information"*** with which to inform herself or himself. He or she must not ignore information that demonstrates that all relevant impacts have not been considered.

In ***Our Environment Our Future 2006***, there are statements I would like to draw your attention to as they point to the direction this state was intending on heading:

P33 s 5.2 Heritage Rivers

We will introduce new legislation to stop new dams and extensions to existing man-made barriers on Victoria's 18 heritage rivers to protect 2000 kilometres of our most precious rivers and streams…this will give added protection to the limestone cliffs of the Glenelg and the river red gums of the Wimmera rivers, the floodplains of the Goulburn, Ovens and Yarra rivers…

s 5.4 Improving Victoria's rivers *We will continue to improve and protect the health of all rivers, riparian environments and estuaries with a 10-year blueprint for on-ground action to be completed by the end of 2006. This will identify priority river reaches for protection and restoration in each of our major catchments and will set 10-year river health targets to guide future Government's commitment to safeguarding our precious water resources for the future.*

S 5.5 New sustainable wetland strategy

We will develop a strategy to protect our threatened wetlands.

Victoria's wetlands are currently under significant pressures, particularly as a result of climate change. Our wetlands provide important habitat and water purification functions, Eleven Victorian wetlands are listed as wetlands of international importance under the Ramsar Convention, which obliges the conservation and wise use of wetlands. The Government will develop a strategy to establish best practice policy for natural resource management and planning of our wetlands, helping us to meet our international obligations under Ramsar and to provide an investment strategy to guide future funding opportunities.

Nowhere in this report which was written as late as 2006, is there any mention of a pipeline taking water from an area that this government has stated it wants to protect!

In ***Our Water Our Future the next stage of the Government's water plan June 2007***, we find the following statements:

- *Safeguards for northern Victoria concerning water savings destined for Melbourne*
- *In addition, the Government will consider setting up a purpose-built body to oversee the delivery of the project to modernize the Goulburn and Murray irrigation systems. This body will work with local communities and all levels of government to manage and complete the project.*
- *Another link being investigated is a Murray-Goulburn Interconnector to bypass the Barmah Choke on the Murray River.*
- *The Food Bowl modernization project will assist Victoria's agriculture and irrigation industries to expand their strong contribution to Victoria's economy and exports.*
- *The impacts of the Food Bowl project will be positive and far reaching, delivering the biggest water upgrade in the system's history.*

The government has concerns for northern Victoria and they do admit that there is a need for safeguards v the transfer of water to Melbourne. They know there will be impacts, but the say they are positive, but what about those impacts that are negative, where are they listed. Where is the "*purpose built body"* who is working with the community? Why would you harm the Barmah Choke? Why would there be a need to expand our irrigation industries when there is talk of 0 allocations next year? This is just too ridiculous!

The real purpose for the modernization is not to help the farmers and the environment it is this:

P 17 Securing Melbourne's water supplies

By introducing supply from more than one source, including rainfall independent sources such as projects provide security through diversity of supply.

The new supply projects and the Tarago reconnection underway will provide around 240GL per annum to Melbourne and surrounding regions' systems by the end of 2011, with additional recycling options potentially coming on line later. In total this would provide a conservative addition to Melbourne's water supply of 290GL annually. By 2010 annual supply to Melbourne's system will exceed annual water used in 2005/06. Supply will grow further after desalination comes on line in 2011, enabling rebuilding of storages.

This program of supply will enable Melbourne households to move off the current restrictions regime to the more secure level of service they have historically received. If the scenario based on the past three years is taken as a guide, the new supply will enable Melbourne to move to Stage 2 water restrictions by 2010 and progressively move back to low level or no restrictions by 2013. If inflows closer to the average of past 10 years are restored, Melbourne will move out of water restrictions earlier.

My observation:

I would like to bring the above statement to your attention because this is a the bare statement of why this government is willing to go to any extremes and destroy any environmentally significant species and communities and ignore the plight of the Murray River and all the species and communities along it and I would include the Barmah Choke and all other relevant impacted Ramsar wetlands that have been incorrectly excluded from the impact assessment done by the proponent.

The Minister for Planning Justin Madden has made a huge error of judgment in not informing the Commonwealth Ministers of ***"all adverse impacts***". The above statements are the reason for this; Melbourne is primed to go off restrictions because that is the "***more secure level of service they have historically received."*** They are not concerned about the environment, about the rivers, about any impacts that would harm national environmental matters of importance; they aren't concerned about rural Victorians in the North of the state who live and work and depend on these connected rivers, all the way to Adelaide.

All this proposal seeks to do is to make certain that Melbourne goes of restrictions as soon as the 75GL starts flowing, and of course I cynically assume that they will then take the environmental flows as well so they don't have to cut the flows to the Yarra as they have done! This whole proposal is unbelievable in its evilness and in the obvious way the PIA assessment which only assessed those things that might be able to not "*avoid*" but "*mitigate*"!!

In conclusion and trying not to restate all that I have said:

Some of the relevant objects of the EPBC Act are:

(1)

(a) To provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance; and
(b) To promote ecologically sustainable development through the conservation and ecological sustainable use of natural resources; and to promote the conservation of biodiversity; and
(c) To provide for the protection and conservation of heritage; and
(d) To promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples
(2)In order to achieve its objects, the Act:

(a) recognizes an appropriate role for the Commonwealth in relation to the environment by focusing Commonwealth involvement on matters of national environmental significance…

(e) enhances Australia's capacity to ensure the conservation of its biodiversity by including provisions to:

(i) Protect native species (and in particular prevent the extinction, and promote the recovery, of threatened species) and ensure the conservation of migratory species: and

(iii) protect ecosystems by means that include the establishment and management of reserves, the recognition and protection of ecological communities and the promotion of off-reserve conservation measures; and

(iv)Identify processes that threaten all levels of biodiversity and implement plans to address these processes; and

(e) Includes provisions to enhance the protection, conservation and presentation of world heritage properties and the conservation and wise use of Ramsar wetlands of international importance; and the involvement of community management planning.
Principles of ecological sustainable development

3A the following principals are the principals of ecologically sustainable development:

(a) Decision-making process should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
(b) If there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;

(c) The principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
(d) The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making;
(e) Improved valuation, pricing and incentive mechanisms should be promoted.

This is a clear indication that the people and the commonwealth government have a desire to protect and conserve and re-habilitate and enhance areas that "matter" so that they can be maintained and enjoyed by future generations as well as ours.

These principals are imbedded in all Australian statutes and must be followed.

Please consider the proposal and make the decision to recommend that it does not progress because the action of the proponent might in itself be harmful, but if not it might cause downstream harm that has not been assessed. By choosing the PIA as the form of assessment the Planning Minister has not followed proper duty of care and has abrogated his responsibility the Minister will not have enough information to make an informative decision.

I am so tired that I must stop here. I am physically tired as well as drained. 3 submissions in as many days are just not fair. I also add here that I did not receive the information on time. I had rung up and though it was mailed 'express/ it didn't get here for 6 days. The information was over 1000 pages, to read it sitting in front if the computer is too difficult and painful! I then ordered the hard copy and it arrived on Monday as our post office is not open on Saturday.

It is all too much to take in; the social impacts will resound for years if this proposal goes ahead. Another broken promise by this government. Isn't there a way that ministers and public authorities should act. Isn't there *'natural justice'*?

Mr Madden said" *'potential effects on biodiversity, landscape, waterways and other matters are not likely to be so complex or significant as to warrant detailed scoping or major new studies'* yet the Federal Minister has admitted 'it is likely to have significant impact on listed species and communities'.

Mr Madden had failed to protect and I sincerely hope that it is just so obvious that the wrong assessment was chosen that this project does not go ahead.

There is also the issue of "***Public Trust"*** to be considered and this concept basically says that air, waterways and forests, (natural resources) are held in trust by the present generation for future generations.

Regards and thank you for reading everything. This project is shameful.

Maria I E Riedl

PS I insert my submission on the Northern Water Strategy because I feel that all of this is tied together. Since the government also insists that it wants interconnectors and connectors and pumps and pipes so they can control the entire State's water systems I feel that it is not out of place. In fact it might add information where the PIA is lacking.

RENEWABLE ENERGY AT WAUBRA

ECOLOGICALLY SUSTAINABLE DEVELOPMENT FEB 2008

SUBMISSION BY MARIA I E RIEDL TO THE

SUSTAINABLE WATER STRATEGY

NORTHERN REGION DISCUSSION PAPER

MANAGING WATER SCARCITY

THE NEXT 50 YEARS

MARCH 17, 2008

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The following are pictures of the Darling, empty then filling up in February 2008. What have we done to our rivers? Are we responsible? Have we over allocated our rivers so that not a drop can be left in them to maintain their health? Does sustainable water mean that the population of our cities and irrigation areas can grow exponentially? Is there a method by

which we can decide when enough is enough? When do we at last realize that unsustainable development and increased populations in areas that have limited water supply is not ecologically sustainable? Do our government's have a responsibility to consider what we leave for our future generations, or are they only concerned about development at no matter the cost to our environment

because we human god?

My Background-

I have lived in the Mallee since 1981, and have come to love the flat, most times dry landscape, the staunchly surviving Mallee

flora and fauna species and the Murray and Darling Rivers which are the life blood of our area. I am at present studying through the ANU a Masters in Environmental Law because I have developed an interest in the environment and ecologically sustainable development. The important and vital issues of water, and water allocations and water sharing of this precious resource are timely as I believe addressing them right now is an urgent action. To secure water for all stake holders, of which the environment is the most important, is an action that must be thoroughly considered and dealt with because time is not on our side.

I was born in Australia in 1951, left to go to Vancouver Canada in 1961 and then to America where I did my high school in Denver and finished it in Cleveland, Ohio. I then did 2 years University at St. John College and then transferred to Cleveland State University in 1972 to finish my Bachelor of Science in Education (4year degree) in 1974.

I worked as a bank teller in Cleveland until I was interviewed for a job to work in Victoria, Australia staring at Drouin in Gippsland in April 1976. I taught primary grades 2, 4, 5 and music and art/craft until 1992. I have since had my own business, teaching art and making collectable mohair animals until 2005. I still make them and paint etc on order. I joined the toxic dump fight in 2004 and played an active part attending every day of the panel hearings, both here and in Melbourne. My interest in the environmental issues stems from my grandfather and father being forest engineers in Hungary. My father took us on camping holidays as a child in Canada and America so I have always been somehow tied into nature and its values.

My parents immigrated as refugees to Australia in 1950, they had 3 children, all born here. We then moved to Vancouver, Canada in 1961 on the PO Canberra's maiden voyage. Then moved to Montreal, Quebec and we stayed there 2 years till 1967. Then again moved to Denver, Colorado USA for 2 years. Our last move as a family was to Cleveland, Ohio USA. My parents have since died, dad in 1983 and mom in 1997. I have a surviving brother who lives in Atlanta, Georgia with his wife and two grown up children and a sister who lives in Willoughby, Ohio with her two yorkies. I moved back here, to Drouin, Gippsland in 1976 and to Mildura in early 1981.

I have been involved with the following groups:

Current: Palliative Care Volununteer

Current: Country Women's Association; Secretary

Irymple Inner Wheel; President

Current: Member of the Heritage Trust

Players: Gippsland-sets and actor

Hungarian Scouts in USA; member then leader for 9 years

Current: Member; EDO (Environmental Defender's Office)

Current: Member; VPNA (Victorian Parks Association)

Current: Member; Australian Geographic

Advisory Committee Member for Mildura Rural City Council Committee on the Mall

Current: Member; ATA (Alternative Technology Association)

Current: Owner of Business; The Riedl Bear Collection

Current: external student at ANU studying Masters in Environmental Law

Member: Girl Guides of America-post 1961

Member: Girl Guides of Australia-pre 1961

On the right, my sister in Cleveland, Ohio in August 2007 with Polly. Below I am in the middle and my sister is the one on the right again in August 2007.(the other is a friend.

My introductory comment:

1/In responding to this Strategy I would like to take the opportunity to vocalize my total sense of injustice, due to the fact that there are 3 water issues that have needed to be responded to within a week. All of them major issues, and all of them affecting me ,and though we asked for extensions on these issues, we received only one small extension and this before the Sugarloaf super pipeline PIA was mooted to be responded to. This unseemly rush is a demonstration that this government, which has had an unprecedented opportunity to shape the face of Victoria and secure our water future has failed abysmally because it is now proposing to make ill-informed and untested and unscientific decisions with disastrous consequences for the entire state of Victoria.

2/You have done very little in upgrading infrastructure at appropriate intervals, resulting in utterly degraded systems that are leaking, that lose masses of water through evaporation, you log catchments to their detriment (because you don't want trees to have the water) without any scientific certainty that this is the correct action. DSE proceeds to be the state body that puts development ahead of the environment at every turn, they not only log catchment areas but they burn and destroy whole systems that are intricately inter-woven by bull-dozing large areas in the name of fire-protection.

3/I have very little faith that this government, the Labor government, has any intention to honor its promises made time and time again, in the many many publications that I will sight later. The policies and strategies, the statutory obligations, the social and environmental expectations are being ignored so that Mr. Brumby can boast about Melbourne out growing Sydney in population, so he can open up 90,000 housing lots at a time when the entire world is under threat from global warming, due to greenhouse gases and climate change which is already impacting upon our catchments, in that they have less water due to less precipitation. The Brumby government has not attempted to deliver his governments promises that have been made in the last 12 years they have been in office and these can be found in the many publications that have been commissioned to inform themselves of what the direction for this state should be.

4/To again ask for more information and then obviously ignore it is just not fair and in fact I state that it infringes upon my ***Human Rights set out in the Charter for Human Rights and Responsibilities Act 2006*** in which it is stated (in law)Part 3 s38:

(1) Subject to this section, it is unlawful for a public authority to act in a way that is incompatible with a human right or, in making a decision, to fail to give proper consideration to a relevant human right.

In the Schedule s47 5:

5.2 (g) human rights-public officials should respect and promote the human rights set out in the Charter of Human Rights and Responsibilities by-

(i) making decisions and providing advice consistent with human rights; and

(ii) actively implementing, promoting and supporting human rights.

In s8:

(1) every person has the right to recognition as a person before the law

(2) Every person has the right to enjoy his or her human rights without discrimination

As you can read we have rights and they must be taken into account when making decisions about what happens to those matters that belong to the common people. Water and air and the environment is something that must not be privatized to the extent you remove it from the public domain.

Here is my list of literature that must be read and used to inform the policy makers about decisions that will affect our major right, which is a right to water.

- *Watershed - Ticky Fullerton 2001*
- *EPBC Act 1999*
- *Managing Water for Australia the Social and Institutional Challenges-Karen Hussey and Stephen Dovers CSIRO 2007*
- *Australia's Water Resources from Management to Use- John J Pilgram 2006*
- *The Murray A River and its People-Paul Sinclair 2001*
- *The Deepening Crisis South Australia:Murray-Darling Wetland Report Card-Australian Conservation Foundation*
- *Unchartered Waters-Murray-Murray-Darling Water Commission-Daniel Connell-2002*
- *Framework for State of Environment Reporting-Commissioner for Environmental Sustainability-Dr Ian McPhail 2003*
- *National Principles for the Provision of Water for Ecosystems- Sustainable Land and Water Resouce Management Committee Subcommittee on Water Resources-1996*
- *Response to the Environmental Audit of the Goulburn River-Lake Eildon to the Murray River-DSE 2005*
- *Securing Our Water Future Together Victoria's Action Plan for a Secure Water Future-DSE 2004*
- *Our Water Mark Australians making a Difference in Water Reform-The Victorian Women's Trust-2007*
- *Planning and Environment Act No.45/1987 and No. 47 of 2007*
- *Marine Conservation and Conservation ParkWatch-VNPA 2008*
- *Sustainable Water Strategy Northern Region Discussion Paper-DSE 2008*
- *Delivering for Victoria Annual Statement of Government Intentions-Hon Brumby MP -2008*
- *Setting the Cap Report of the Independent Audit Group-Murray-Darling Ministerial Council-1996*
- *Our Water Our Future The next Stage of the Government's Water Plan-DSE 2007*
- *Water Act 2007 No. 137-Commonwealth 2007*
- *Charter of Human Right and Responsibilities Act 2006 Act No. 43/2006*
- *Flora and Fauna Guarantee Act 1988 Act No. 47-Victoria (incorporating amendments as at June 2000)*
- *Water Act 1989 Act No. 80/1989-Victoria (reprinted incorporating amendments as at August 2006)*
- *Update Bulletin Victoria-Water Act 1989 No.80 (latest reprint No. 8 dated August 2006*
- *Catchment and Land Protection Act 1994 Act No. 52/1994-Victoria (reprinted incorporating amendments as at 31 October 2006)*
- *National Parks Act 1975 No. 8702 of 1075-Victoria (reprinted incorporating amendments as at 14 February 2008*
- *Environment Protection Act 1970 No 8056 of 1970-Victoria (reprinted incorporating amendments as at 16 July 2007*
- *Environmental Impact Assessment in Australia theory and practice-Ian Thomas and Mandy Elliot 2005*
- *Water Law-D E Fisher 2000*
- *The Precautionary Principal in Practice Environmental Decision-Making and Scientific Uncertainty-Jacqueline Peel-2005*
- *Water Politics in the Murray-Darling Basin-Daniell Connell-2007*
- *Silent Flood Australia's Salinity Crisis-Michael Sexton-2003*

- ***State Water Report 2005/06 A Statement of Victorian water resource-DSE Tim Holding 2005-2006***
- ***Environmental Law in Australia-Gerry Bates 2006***
- ***Environmental Protection and Legal Change-Tim Bonyhady1992***
- ***Climate Law in Australia-Tim Bonyhady and Peter Christoff-2007***
- ***Back from the Brink How Australia's landscape can be saved-Peter Andrews-2006***
- ***The Economics of Climate Change The Stern Review-Nicholas Stern 2006***
- ***Environment and Sustainability Policy Creation, Implementation, Evaluation-Stephen Dovers 2005***
- ***Watching Brief Reflections on Human Right, Law and Justice-Julian Burnside2007***
- ***Australian Environmental Law- D E Fisher 2003***
- ***Environmental Principals and Policies an Interdisciplinary Approach-Sharon Beder 2006***
- ***Environment and Politics-Timothy Doyle and Doug McEachern 1998***
- ***Environmental Policy Australian Practice in the Context of Theory-Ian Thomas 2007***
- ***Environmental Management Processes and Practices for Australia-Ian Thomas 2005***
- ***The Natural Advantage of Nations Business Opportunities, Innovation and Governance in the 21st Century- Karlson 'Charlie' Hargroves and Michael H. Smith 2005***
- ***Statutory Planning in Victoria-Des Eccles and Tannetie Bryant 2006***
- ***Greenhouse Solutions with Sustainable Energy- Mark Diesendorf 2007***
- ***An Environmental Handbook-Department of Water Resources Victoria 1989***
- ***Our Environment Our Future Sustainability Action Statement 2006-DSE***
- ***Assurance and Accountability Annual Report- Victorian Auditor-General 2006-07***
- ***State of the Parks 2000 Park Profiles-Parks Victoria***
- ***Climate Change Science-Australian Government Department of the Environment and Water Resources 2007***
- ***Victoria's Native Vegetation Management A framework for Action-Victorian Department of Natural Resources and Environment 2002***
- ***Native Vegetation Sustaining a living landscape-DSE 2006***
- ***Local Government:Results of the 2006-07 Audits-Victorian Auditor-General's Report Feb 2008***
- ***Melbourne Water Seawater Desalination Feasibility Study Executive Summary June 2007***
- ***Draft Scoping Requirements Desalination Project Environmental Effects Statement-Department of Planning and Community Development Feb 2008***
- ***Native Vegetation:planning permit applicant's kit-DSE 2007***
- ***Gaurnaut Climate Change Review Interim Report to the Commonwealth, State and Territory Governments of Australia Feb 2008***
- ***A Fairer Victoria Building on our Commitment-DSE 2007***
- ***Victorian Greenhouse Strategy Action Plan Update 2005-DSE***
- ***Melbourne Water Sustainability Report 2005/06-Melbourne Water***
- ***Building one Victoria: Projects the are Growing and Strengthening the State-DSE 2005***
- ***Annual Report2006 Mallee Catchment Authority***
- ***Murray-Darling Basin Commisssion Annual Report 2002-2003***
- ***Habitat Volume 36 Number 1: January 2008***
- ***Environment Planning Law in Victoria-Victorian Law Foundation EDO***

The above are photos around taken on and near the Murray River near Mildura. These are the impacts of human greed. March 2008

1/ What is my view on raising the 4% limit on the amount of water shares traded out of an area in an irrigation season? Should the review of the rule take place sooner than 2009?

My response to this is that the whole system of water trading has been handled in a manner that benefits industry and large businesses and urban areas. It does nothing to address the over-allocation of water, it does nothing to provide water security in fact it has done nothing more than allow water to be collected and bought by MIS schemes that use it in their tax minimizing schemes and hoard it to sell it to the higher bidder. It is regarded as a commodity not a resource that must be protected and shared equitably amongst the common people.

The cap has been shown to be ineffectual as it failed to take into account drought, the many sleeper water rights and the growth of irrigation. The strategies the government must employ are:

(a)information as to water use, environmental costs, sustainable river audits and assessment of environmental flows

(b)capping-no further extractions

(c) trading-assess the impacts now that trading has occurred

(d) claw-back- reduce over-all extraction

(e) seeking efficiencies-investment in infrastructure

The amount traded should not be raised it would devastate communities and strand infrastructure and make irrigation along the rivers questionably unsustainable. The result would be devastating. The review needs to take place but again it must be cautious as the results of climate change, global warming, over-allocation, even more extractions such as the Goldfield's Superpipe, the proposed Melbourne 75GL extractions plus of course the 150Gl to be stored in the Eildon and then shared between irrigators and the environment, and of course the state government inability and unwillingness to upgrade infrastructure without blackmail are not yet know.

Actually the literature list that I have provided should give you enough information because they are written by many different people and these people have high regard. A common theme runs through all these publications and this theme is that it is already too late. That any action to protect, save, re-habilitate, our northern rivers must be done yesterday.

To further suggest piping water here and there by flicking a switch in Melbourne is just unbelievable and should not be allowed to happen. Melbourne Water must not be allowed to take water to the south; it must not be allowed to enter the northern market. It must source water in more efficient and commonly acceptable ways because the rivers are nearly dead. Do your research and do not create an entire north that is disadvantaged in comparison to metropolitan Melbourne, Geelong, Bendigo and Ballarat. There does exist an area past these cities, and we do need water, our environment needs water, our irrigators, who produce the food that you eat must not be relegated to 2nd class Vicotorians!

2/It is incomprehensible to me what this government proposes to do in order to assure the growth of Melbourne. The rivers in the North are in dire straight, they are over-allocated, they are stressed environmentally but Mr Brumby and Mr Holding and Mr Madden, at the same time are proposing to create inter-connectors so that they can take even more water form a system in the north that is about to die a sudden death. As it is stated on p 18 *"Communities rely on healthy rivers and wetlands to provide reliable, high-quality water for households, farms and industry, maintain social and heritage values and provide recreational and tourism opportunities. The community derives considerable economic benefits from our rivers-and pays a considerable cost when their condition declines."*

3/If you actually read and digest what this says and the proposals that you are suggesting as knee-jerk reactions to the prolonged drought, as well as not addressing the over-allocations the devastation that will occur will be unprecedented. Mr Brumby made a statement I have not forgotten, as it is seared into my mind (the horror of it!) just after he picked up the baton which was tossed aside by Mr Bracks and Mr Thwaites, and this statement was; that there will not be additional flows to the rivers. The VEAC study is yet to be completed and with the full knowledge of this he is making a decision **before** he has sufficient information-information I would like to point out, requested to be provided to this government by a Minister!!

4/To say that the *"region now has highly integrated system of natural waterways and man-made channels, pipes, dams and weirs is fine but you must look further. This complex system has enabled a substantial increase in water use, evident from the 1970s through to the 1990s. This water underpins the Northern Region's current irrigation industry,"* and not include the fact that these rivers and underground waters, dams, and aquifers are all interconnected in a myriad of ways.

For Melbourne to get its hand on it by taking the saving of the government and private upgrade of infrastructure is simply wrong. The government has a responsibility to upgrade public infrastructure and it does not have the right to blackmail sections on the community in its desire to take something away. This is an action that will call up Human Rights issues and issues of Natural Justice and fairness and will see the government thrown out because of a lack of attention to rural Victorians in favor of metropolitan areas, this creates a division and this creates an isolated section of the community that will fester and rise up against this unfairness and arrogance.

5/ "*The condition of the region's natural assets can affect the community benefits, including economic, social and heritage, recreational and environmental values."* For a government to ignore the values placed upon water by a whole section of the community I am certain is a case in '*common law'*. Water is not just there for the wealthy, for the metropolitan areas benefit, for the political votes, it is there for the use by the common people and we in the north say that to take water to a low end market to allow Melbourne and metropolitan areas to grow obscenely is unacceptable.

I and others can see what this paper is trying to accomplish. This paper is a slow leak of water that will turn into a torrent, or should I use a waterfall as the image, all draining south so that Mr Brumby and Mr Madden can allow Melbourne to grow in an ecologically unsustainable manner. This action from Ministers should be called into a review or what their roles should be. I would have assumed there would be statues and policies and other papers that all say that the government and its Ministers must take into account the ESD or ecologically sustainable development principals as well as the precautionary principal.

6/The government must make a plan for the future that does not disadvantage the northern section of the state. This plan must ensure that water savings are re-allocated to the environment in the very first instance. This is a given as every piece of literature that I have provided for you points out the dire, terrible, unbelievably perilous state our rivers and all other natural water bodies are in right at this moment (as I write this!) this includes out Ramsar wetlands, our over-allocated aquifers, our whole river systems and all that relies upon it. I cannot stress this enough, but you can inform yourselves and make decisions that actually enhance, protect, and re-habilitate our natural water sources. This is a must, as to do nothing but continue along a business-as-usual manner is unacceptable. This includes the complete abandonment of the sugarloaf pipeline immediately and not proceeding to take water from the north to the south.

7/The options to be dealt with are:

- No water taken south north of the Great Divide
- No new allocations of water
- No more trading until the present issues of trading are properly and scientifically assessed
- No MIS schemes that encourage using water in schemes that are set up to minimize tax –the reason for the set up is wrong
- Sign up to the commonwealth scheme immediately so that water may be looked at across a whole continent
- Incremental proposed taking of water via a pipeline to sugarloaf solely for the benefit of Melbourne stop immediately as this is a broken election promise
- Upgrade all infrastructure in a regulated and timely manner ASAP
- Cover all channels
- Leave water in the rivers which are shaded by trees and prevent loss and keep salt levels down

- No chopping trees in catchment areas –this to stop immediately
- No bull-dozing around catchment areas as this has an effect
- Think about the entire trans-evaporation system when thinking about tress and catchments and rivers and trees
- Have respect for the northern rural dwellers and actually show this respect
- Apologize to the north for the unbelievable inaction on infrastructure upgrades in the last 12 years
- Upgrade without blackmailing areas in the north-anywhere for that matter
- Tell Tim Holding not to call us names as he has done. This is just an arrogant presumption on his part that he is in the right and we in the north are wrong
- Be fair and equitable when dealing with people in the planning stages of proposals and note that under planning law, you must listen to them
- I request Mr Brumby to stop treating us in the north with such contempt and arrogance, this is inappropriate behavior of a Premier and reflects back upon him
- Stop allowing and encouraging Melbourne to grow in such an ecologically unsustainable manner-put a cap on its population-especially since you are now trying to drain all our northern water courses to the south, over mountains and under and through stream via pipes, so you can turn on a tap and all of our water runs out down in Melbourne------come on be reasonable!!!!!!!!!!

I have run out of time as I now have to go and finish the submission on the ugly, evil Sugarloaf proposal. Shame on you all for putting rural Victorians last yet again. the amount of broken promises this government has made are more than those that arrogant Mr Kennet made. Mr Brumby is exactly the same as Mr Kennet, he does not give a d… about country Victorians, he just wants to known as the Premier who drained all of Victoria's river to Melbourne (and used the drought as an excuse!) and he even cut the train lines past Bendigo and Ballarat and allows them to further decay and thus prevent proper delivery of freight on rail lines instead acting like Kennet and allowing B-Doubles and road trains (trucks!!) to line up on all our rural roads! He also is failing like Mr Bracks to deliver the passenger train back that this government promised back (Mr Batchelor) by 2004. We haven't forgotten but Mr Brumby has and Ms Kosky too!! Shame on you all, you are treating us with contempt and I find that the pipeline is another example of this.

The future for the Northern Region should look as healthy and environmentally sustainable as possible. Our rivers should not be piped south, our infrastructure should be upgraded without blackmail-as we provide your food! ESD principals must be adhered to and not compromised.

Stop treating rural Victorians with contempt. If we are truly a part of Victoria then we must have respect, we are not here to be taken advantage of. Consider action such as a connector by-passing the Barmarah choke, consider that environmental water should have the same rights in law and should not be taken first every single time that this government feels there is a shortage. It must be of equal standing with irrigation water and urban water.

Regards,

Young boys at Lelma Station surviving the drought and waiting for the Darling to fill.

In Conclusion:

Last night (Wednesday 3-09-08) there was a program on SBS which took place in Spain and they have exactly the same problems, possibly worse and they are making the same decisions but it must be noted that they have made a decision not to take water out of their river but look at other more ecologically sustainable options. Minister Garrett did comment on Q & A saying that Melbourne need water, so does Adelaide, so does the Coorong and other Ramsar wetlands, so do the towns that live along these rivers. It is not up to the Minister to take into account Melbourne's water issues as Melbourne is still processing an Inquiry but it is required of him to make a decision on this reconsideration request. I ask that you look at ALL the information I and others have sent to you, and without prejudice; without looking at the Victorian Government's constant publicity, crying about how Melbourne is going to run out of water to justify this irresponsible project. It is unfair of the Victorian Government to force you to make a decision that will harm those matters of National Significance that you are to protect under the EPBC Act.

To say that there will be a minimal impact of extracting water during the irrigation season does not take into account that even that will have an impact.

Only a full EES and the addition of Ramsar wetlands and Migratory species to the referral which only included 18 and 18A along the alignment of the pipeline would ensure that the Minister had addressed his duty.

Thank you and I hope that the information has proved to be useful and helpful to you. As Minister Wong states, we have to make the "hard decisions" and these must be made because it is no longer acceptable to continue to ignore the EPBC Act, or just pick out parts that won't disallow a project. The damage to our environment and our rivers will be irreparable.

I would just like to add here that there is a Senate Inquiry into the "Operation of the Environmental Protection and Biodiversity Conservation Act 1999 and in this Inquiry it is noted by the Senate that "the continuing decline and extinction of a significant proportion of Australia's unique plants and animals, and the likelihood of that accelerating climate change will exacerbate challenges faced by Australian species." They talk about the "cumulative impacts of EPBC Act approvals on threatened species and ecological communities." Also with particular reference to "lessons learnt from the first 10 years of operation of the EPBC Act in relation to the protection of critical habitats of threatened species and ecological communities, and potential for measure to improve their recovery" so on, so forth. The EPBC Act needs a backbone and this can only happen if the Minister is prepared to make the "hard decisions" and make certain that proponents include all likely impacts and make certain that they are not creating cumulative impacts by breaking up actions so they get approval. This pipeline has to have something in it and I presume it would like to be water, but, where this water is coming from, must be included in the assessment for this project.

I have hope that the environment will be protected. I am just as passionate as Minister Garrett was about the environment before he became Minister for Environment. The information is there, he just has to have the will to use it and to make those "hard decisions". This proposal is on par with the Franklin Dam, the Nathan Dam cases. It is about a Minister and his duty to uphold the EPBC Act.

MEDIA RELEASE

The Hon Peter Garrett MP

Minister for the Environment, Heritage and the Arts

PG /131 4 September 2008

MINISTER SUSPENDS REEF COVE APPROVAL

Environment Minister, Peter Garrett has suspended approval of the Reef Cove Resort development at Queensland's False Cape and has ordered the developer to carry out an environmental audit of the site.

It is the first time a federal environment minister has suspended a project's approval or directed an environmental audit under the *Environment Protection and Biodiversity Conservation Act 1999*.

"Following a preliminary investigation by my department, I've decided to suspend approval of the False Cape project for a 12-month period because I am concerned about the threat of sediment run-off into the Great Barrier Reef World Heritage Area," Mr Garrett said.

"This suspension means there can be no construction at the site until I'm satisfied that the developer has completed the appropriate remediation work and can complete construction in a responsible manner and in full compliance with the approval conditions, without impacting on the marine environment.

"If I am not satisfied by the end of this suspension period that appropriate remediation measures have been implemented in accordance with the outcomes of the compliance audit I have the option under the EPBC Act of suspending the approval for a further period, or revoking it altogether.

"If revoked, any proposal for a new development at the site may need to undergo a new assessment process under the EPBC Act. This would be likely to require a new public assessment."

Mr Garrett said the directed environmental audit would provide important information that the Federal Department of the Environment, Water, Heritage and the Arts could include in its ongoing investigation.

"In the meantime, my department will continue to work with the Cairns Regional Council to address the immediate concerns at the site and to make the site stable before the coming wet season."

Media contact: Ben Pratt, 0419 968 734

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"In the meantime, my department will continue to work with the Cairns Regional Council to address the immediate concerns at the site and to make the site stable before the coming wet season."

The following is more information that there is a requirement for both State and Federal Governments to protect the resources of Rivers and wetlands under the National Water Initiative. This was also not in front of the Minister, because it is obvious that this too would ensure that all matters to be referred would and should have been referred. Since Victoria is a signatory to the National Water Initiative, they are required to protect these matters, and not ignore them in their rush without due investigation, not a flitting 3-5 months worth of cursive studies that are not yet complete. What is the rush? Is there a reason Melbourne Water is trying to drain the northern rivers?

If they build this pipe what rule change with regards the South's access to the northern rivers systems?

What about the other options they have and these rivers do not?

Is that not to be considered?

A baseline assessment of water resources for the National Water Initiative

Level 2 Assessment

River and Wetland Health Theme

Assessment of River and Wetland Health: A Framework for Comparative Assessment of

the Ecological Condition of Australian Rivers and Wetlands

Australian Water Resources 2005

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May 2007

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Raising National Water Standards Programme

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The River and Wetland Health theme of this report was made possible through interaction, support and input of many organisations and individuals. In particular, thanks are due to the jurisdictional reference group consisting of representatives of the Australian states and Australian Government agencies. These provided important input and feedback, often at short notice. Colin Chartres, Matt Kendall, Judy Hagan and Craig McVeigh of the National Water Commission were closely involved with all aspects of the project and had significant input throughout. Paul Wilson from the Victorian Department of Sustainability and Environment and Martin Read from the Tasmanian Department of Primary Industries and Water played a major role in supplying data and contributing to the project.
Authors: Richard H. Norris, Fiona Dyer, Peter Hairsine, Mark Kennard, Simon Linke, Linda Merrin, Arthur Read, Wayne Robinson, Chris Ryan, Scott Wilkinson, and David Williams. May 2007

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Contents

Executive summary

The National Framework for the Assessment of River and Wetland Health (FARWH) is being developed as part of the Australian Water Resources 2005 (AWR 2005) project being undertaken by the National Water Commission (the Commission) under the National Water Initiative (NWI).

The AWR 2005 Discovery Phase, undertaken in early 2006, examined the availability of data to undertake a national river health assessment based on the last national assessment under the *Australian Catchment, River and Estuary Assessment 2002* (NLWRA 2002). It was determined that, although there were significant gaps in available data in some areas of Australia, other areas of Australia had methods and techniques that had advanced beyond those of 2002. For this reason, the Commission is progressing the development of a national framework for river and wetland health assessment, with partner governments to enable the future application of a robust national assessment that uses existing work to the maximum extent possible.

The resulting framework, FARWH, is designed to provide the information needed to:

• establish 'environmental and other public benefit outcomes' (NWI paragraph 35)
• 'address currently over allocated and/or overused systems' (NWI paragraphs 41–45)
• support 'integrated management of environmental water' (NWI paragraphs 78–79).

FARWH has been developed through extensive consultation with partner state and territory governments. Other stakeholders, such as regional authorities that monitor natural resources, will also be increasingly involved to better incorporate all relevant monitoring regimes. A framework such as FARWH is seen as essential because it allows existing work to be used for reporting the aggregate impacts of resource use on rivers and wetlands at a national scale. In this way, long-term changes in condition can be identified, including changes resulting from water management regimes.

FARWH is closely linked to other major programs such as:

• Victorian Index of Stream Condition
• Victorian Index of Wetland Condition
• Tasmanian Conservation of Freshwater Ecosystem Values Framework
• Queensland Wetlands Program
• Natural Resource Management Ministerial Council, National Natural

Resource Management Monitoring and Evaluation Framework (NNRMM&EF)

The FARWH is based on a hierarchical model of river and wetland function, which addresses: environmental components to be represented by a national assessment, reporting scale, reference condition, discussion on selection of indices, methods for integrating and aggregating indices for assessment, sensitivity analysis, range standardisation, and managing missing data. The FARWH proposes that six key components are appropriate for the assessment of river and wetland health, all of which are considered to represent ecological integrity. These are:

• catchment disturbance
• hydrological change and spatial extent of wetland and temporal change
• water quality
• physical form
• fringing zone
• aquatic biota.

The FARWH describes how to develop and combine indices so that nationally comparable assessments of river and wetland health can be achieved. This is designed to enable states and territories to include data that are already being collected (for example, AUSRIVAS invertebrate data) and to compare these data between regions. In some cases, such as the Victorian Index of Stream Condition, little change is needed to incorporate specific datasets into the national framework.

The framework presents the components of the environment to be represented but does not prescribe which indices should be selected to represent them. It also describes how to create the indices so that their characteristics allow direct comparisons between jurisdictions without having to take the same measurements in each place. For example, an index score of 0.5 on a scale of 0–1 for biota in one place should mean the same as a 0.5 score in another place, even if different biotic groups have been used. The index would then represent the condition of the biota considered important for that state or territory. This is achieved by agreed range standardising, reference conditions, validation, and sensitivity analysis.

The framework also recommends that indices should be:

• relative to a reference (usually pre-European conditions)
• linear and range standardised to 0–1, in increments of 0.1
• divided into condition bands.

Consideration should also be given to:

• the weighting of indices when aggregating from the finest scale of measurement, which will usually be the reach or individual wetland, to represent the surface water management area (SWMA). This weighting would normally be by stream length, or the wetted area of individual wetlands

• methods of integration, which may follow expert rules (e.g.such as the CFEVF, Sustainable Rivers Audit). Where these are well thought out, inverse ranking should be used, as in the Victorian Index of Stream Condition. Euclidean distance is recommended where other methods have not been well developed
• sensitivity analysis to determine which indices contribute most to the evaluations
• the inevitably that there will be missing data at the finest scale of measurement. It is recommended that three of the six components should be present before an overall assessment can be reported
• at the scale of an individual surface water management area, at least five per cent of the recognised river reaches or wetlands should be represented.

The Assessment of River and Wetland Health: Potential Comparative Indices (companion document produced by the River and Wetland Health Theme, NWC 2007), describes indices that have been developed in a way that meets the requirements of the FARWH, largely during the first National Land and Water Resources Audit. Indices developed as part of the Victorian Index of Stream Condition and the Tasmanian Conservation of Freshwater Ecosystem Values Project also conforms to the FARWH. Any of these may be selected by various jurisdictions. They may also be selected to fill gaps in the environmental components that may not be covered in existing state or territory programmes. Although these indices are not prescribed, some of them such as the AUSRIVAS and hydrology indices (flow stress ranking) have already been accepted for use by several jurisdictions and may be used quite widely.

The Assessment of River and Wetland Health: Potential comparative indices, (NWC 2007) therefore provides a series of methods that can be used in the assessment of river and wetland health, including a new method that has been developed for the fringing (riparian) zone.

1 Introduction

1.1 Purpose

The National Framework for the Assessment of River and Wetland Health (FARWH) is being developed as part of the Australian Water Resources 2005 project being undertaken by the National Water Commission (the Commission) under the National Water Initiative (NWI).

Australian Water Resources 2005 (AWR 2005) reports under three headline parameters: Water Availability, Water Use, and River and Wetland Health. Philosophically, the term ‘river and wetland health’ is useful because it is readily interpreted by most people and evokes societal concern about human impacts on river and wetlands. The common goal of achieving healthy rivers and wetlands unites scientists, in particular ecologists, and others because the value of the scientific contributions is clear. A possible problem arises in the choice of relevant symptoms, or indicators, because no single indicator is likely to stand alone to reveal river and wetland health unequivocally (Boulton 1999): there is a wide variety that can be measured with varying accuracy and at a broad range of spatial scales. Thus, the FARWH is designed to provide a framework to guide assessment of river and wetland ‘health’.

The AWR 2005 Discovery Phase examined the availability of data relevant to undertaking a national river health assessment based on the last national assessment under the *Australian Catchment, River and Estuary Assessment 2002*. It was determined that, although there were significant gaps in available data in some areas of Australia, other areas of Australia had access to methods and techniques that had advanced beyond those of 2002. For this reason, the Commission is progressing a national framework for river and wetland health assessment. The resulting framework, FARWH, is designed to provide the information needed to:

• establish ‘environmental and other public benefit outcomes’ (NWI paragraph 35)
• ‘address currently over allocated and/or overused systems’ (NWI paragraphs 41–45)
• support ‘integrated management of environmental water’ (NWI paragraphs 78–79).

The FARWH is being developed through extensive consultation with partner state and territory governments. Other stakeholders, such as regional authorities that monitor natural resources, will also be increasingly involved to better incorporate all relevant monitoring regimes into an assessment of national river and wetland health.

A framework such as the FARWH is seen as essential because it allows existing state and territory work to be used for reporting the aggregate impacts of resource use on rivers and wetlands at a national scale. In this

way, long-term changes in condition can be identified, including changes resulting from water management regimes.

National natural resource management at broad scales requires information at matching broad scales. Such broad-scale information on river and wetland condition is required to assist managers to assess and develop policies, decide on investments, evaluate program and policy performance and direct resource management activities, particularly those of government. Thus, broad-scale assessment that focuses on the information needs of the Australian and state and territory governments are needed. Local government, rural industries, community groups, and various other government and nongovernment organisations will also benefit.

Water resource managers in Australia have recognised significant problems that are associated with an increasing demand for water, declining river and wetland health, and public pressure for changed management. For example, dryland salinity and soil and streambank erosion are problems that affect rivers and wetlands nation-wide. Both require management at broad scales. More positively, the Murray-Darling Basin Cap has limited diversions in recognition of the maintenance of environmental values as a legitimate use of water.

The formulation of policies to manage such problems generally does not require site-specific information but does need assessment at regional, state or national levels. Answers are needed to questions such as:

• ‘What is the extent and condition of our renewable natural resources?’
• ‘Where and what parts of the environment are changing?’
• ‘What is causing the observed environmental changes?’ (Olsen et al.
1999).

The problems inherent in answering these questions have been recognised in several countries, with the result that large-scale programmes have been implemented. There have been national surveys of lakes and rivers in Great Britain (Wright 1995, Raven et al. 1998), Sweden (Wiederholm and Johnson 1997), and the United States of America (Wadeable Streams Assessment. A Collaborative Survey o f the Nation’s Streams, US EPA 2006, <http://www.epa.gov/owow/streamsurvey/report.pdf >).All Australian states and territories have developed white papers, strategic plans, or policies on water that recognise shortages and the need for management, especially in relation to the environment and achieving sustainable water use. These policy documents lay out how water reform will be achieved and the objectives of the relevant state and territory water Acts. The June 2004 Intergovernmental Agreement on a National Water Initiative (NWI) http://www.coag.gov.au/meetings/250604/index.htm#water_initiative renewed these efforts by reaffirming commitment to the 1994 agreements and setting a new schedule of actions. All states and territories have now

signed up to the NWI. The specific NWI objectives that relate to environmental water provisions are:

• Objective (iii) – statutory provision for environmental and other public benefit outcomes, and improved environmental management practices
• Objective (iv) – complete the return of all currently overallocated or overused systems to environmentally sustainable levels of extraction.

Furthermore, paragraph 79 (f) of the NWI requires ‘management and institutional arrangements to ensure the achievement of environmental and public benefit outcomes including any special requirements needed for the environmental values and water management arrangements necessary to sustain high conservation value rivers, reaches and groundwater area’.

The aim of the FARWH is to develop an approach that can be used by all Australian states and territories to provide assessments of river and wetland health that is comparable nationally. It is intended to incorporate a range of river and wetland attributes that indicate key ecological processes. The attributes measured and method of reporting also will be designed to aid in interpretation of the causes of observed environmental degradation.

1.2 The philosophy

FARWH is based on the premise that ecological integrity is represented by all the major components of the environment that comprise an ecosystem. Damage to biota is usually the final point of environmental degradation and pollution. Thus, the aquatic biota are a fundamental indicator of disturbance to rivers and wetlands and their catchments, including groundwater. Aquatic biota should therefore be included in any assessment of river and wetland health. The biota are also components of, or critical to, the goods and services provided by rivers and wetlands that are valued by society.

The function of the FARWH is to bring together in an assessment a number of related elements of river and wetland condition. The approach that has been adopted has been informed by our understanding of the links between catchments, river and wetland habitats, and their aquatic biota. The conceptual model and components of the FARWH are summarised in Figures
1 and 2.

Figure 1: Conceptual model of scales of factors related to river and wetland condition.
This hierarchical model demonstrates catchment features such as longitudinal and lateral connectivity (dams and levees) and land use, which in turn have an effect on habitat features (riparian vegetation, snags, channel geomorphology), and these together affect the biotic components of the system (algae, aquatic vegetation, insects, fish, water birds). The model includes floodplain wetlands but groundwater will be more important for coastal plain and other wetlands and connectivity between rivers and their floodplains less so.

Figure 2: Generalised models of wetlands, their main features and their interactions with groundwater and surrounding catchments (source: Queensland wetlands project)
Elements other than the aquatic biota need to be included in a comprehensive FARWH for several reasons.

• other features of the environment have value in their own right
• the available or selected group of biological indicators may not be sensitive to all forms of river or wetland degradation
• there may be a time lag between environmental disturbance and observable biotic response
• monitoring only the biota may tell us that the biota are damaged, but not why. A comprehensive assessment that includes measurements of the key stressors will provide information about the probable causes of degradation, and therefore guide management decisions and actions
• Unless monitoring is continuous and includes all types of biota, certain types of disturbance may go undetected, or be detected only after severe impairment has occurred, because the chosen group of biological indicators are insensitive, or there is a time lag between environmental disturbance and biotic response.

The framework proposed here is based on a hierarchical model of river and wetland function (Figs 1 and 2) in which broad-scale catchment characteristics affect local hydrology (water regimes), hydraulics, habitat features, and water and soil quality. These influence the river and wetland biota, an ultimate indicator of river and wetland health. This model is a refinement of the model underpinning the assessments made in the Snowy Water Inquiry (Young et al. 1998) and similar models that have been adopted in other major state programmes such as:

• the Victorian Index of Stream Condition
<http://www.vicwaterdata.net/vicwaterdata/data_warehouse_content.asp x?option=5>
• the Victorian Index of Wetland Condition
<http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/3EA5B6AEFB53EE 3DCA25708B00145F44522C816829EBF3F7CA25700C00240E63>
• the Tasmanian Conservation of Freshwater Ecosystem Values Project
<http://www.dpiw.tas.gov.au/inter.nsf/WebPages/JMUY-5QF35H?open>

• the Queensland Wetlands Program
<http://www.epa.qld.gov.au/publications/p01948aa.pdf/Monitoring_wetland_extent_and_condition.pdf>.

At the broad scale, catchment character influences a river or wetland through large-scale controls on hydrology, sediment delivery, and chemistry (Allan and Johnson 1997, Johnson and Gage 1997, Mitsch and Gosselink 2000).

Therefore, if catchments are disturbed or in degraded ecological condition, then associated rivers and wetlands will also be unhealthy. Much of the degradation in Australia's rivers and wetlands results from land-use practices in surrounding catchments (Boulton and Brock 1999). Assessing catchment condition may therefore provide information about the ultimate causes of any observed biological impoverishment, and highlight potential impacts that have not yet caused biological degradation within rivers but that are likely to do so.

At the local scale, available habitat and the local physical, chemical and biological features that provide living space and resources determine the types and numbers of plants and animals that can potentially live at a site. The quantity and quality of available habitat affects the structure and composition of resident biological communities (Hynes 1968, Meffe and Sheldon 1988, Boulton and Brock 1999, Maddock 1999), and are thus critical elements of ecological condition. Habitat assessment provides information about the likely proximal causes of impoverished biological states, and may be used as a surrogate for biological condition (including biodiversity) where these latter data are unavailable. Aspects of habitat assessed in the FARWH include water quantity and quality, soils of wetlands, geomorphology, fringing zone vegetation structure, and the connectedness, longitudinal of rivers and lateral of rivers to their floodplain (including wetlands), and wetlands to their catchments and groundwater.

1.3 Role of the national framework

The FARWH is designed to use data from existing programmes such as:
• the Victorian Index of Stream Condition
<http://www.vicwaterdata.net/vicwaterdata/data_warehouse_content.aspx?option=5>
• the Victorian Index of Wetland Condition
<http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/3EA5B6AEFB53EE3DCA25708B00145F44522C816829EBF3F7CA25700C00240E63>
• the Tasmanian Conservation of Freshwater Ecosystem Values Project
<http://www.dpiw.tas.gov.au/inter.nsf/WebPages/JMUY-5QF35H?open>
• the Lake Eyre Basin Rivers assessment (Sheldon et al. 2005) and the Queensland Wetlands Program
<http://www.epa.qld.gov.au/publications/p01948aa.pdf/Monitoring_wetland_extent_and_condition.pdf>.

The FARWH is also designed to provide the basis for choosing and managing reporting measures from the Natural Resource Management Ministerial Council, National Natural Resource Management Monitoring and Evaluation Framework (NNRMM&EF) <http://www.nrm.gov.au/monitoring/>. The relationship between the two frameworks is shown in Figure 3 While the two are closely related in some ways, the NNRMM&EF is more targeted to assessing particular issues of relevance to the National Action Plan, rather than overall river and wetland health.

National Water Initiative NHT / NAP
Australia's Water Resources 2005 National Monitoring & Evaluation Framework
National River & Wetland
Health Assessment Framework 4. Inland Aquatic Ecosystem Integrity River Condition Wetland Condition Wetland Extent & Distribution Nationally Agreed Recommended Indicators 10 Matters for Target Catchment Disturbance Index Water Quality & Soils Index Aquatic Biota Index Physical Form Index Hydrological Disturbance Index Nationally Agreed Recommended Indicators Nationally Agreed Recommended Jurisdictional / Basin Programs Indicators (eg MDBC SRA, Vic ISC, Tas CVEF) Fringing Vegetation Index

Figure 3: Relationship between the Framework for the Assessment of River and Wetland Health and the Natural Resource Management Monitoring and Evaluation Framework (source Edgar et al. 2006)

A primary function of the FAWRH is to provide the approach for locally relevant, comprehensive assessments of river and wetland health that are comparable across jurisdictions. In this context, there is no need for the same measures to be made in each place, but the indices derived from the various measures must be directly comparable. For example, salinity could be an important water quality measure in one place, and nutrients could be important in another. The indices representing the various measures of water quality should be equivalent, so a score of 0.8/1.0 based on salinity is equivalent to the same score based on nutrients.

2 Methods

2.1 Environmental components to be represented

Catchment and habitat conditions are not the sole determinants of the richness and abundance of aquatic biota. Biological processes such as primary production, trophic relationships, competition, predation, immigration, emigration and recruitment also influence the composition and structure of running water communities. Some states and territories already have well-developed methods for assessing ecological processes that may be incorporated as biological measures. In many places, these ecological processes can be too complex and poorly understood to be explicitly included in an assessment method, but they should be considered for inclusion anyway. Interactions among chemical and physical process create conditions at a range of scales that strongly influence biological processes (Boulton and Brock 1999). For example, the level of photosynthetic activity is heavily influenced by light, temperature and nutrient regimes—aspects of habitat that could be covered in the assessments of nutrient and suspended sediment loads and riparian condition. Similarly, hydrology, connectedness, and riparian vegetation all affect carbon fluxes, and therefore trophic structure, in rivers. Thus, while ecological processes might not be measured directly, structural variables that affect, or are affected by, those processes would be assessed.

It is proposed that the following environmental components be assessed as part of the FARWH:

Catchment Disturbance Index incorporates the effects of land use, change in vegetation cover and infrastructure (for example, roads and railway lines) on the likely runoff of sediments, nutrients and other contaminants to rivers and wetlands. The index should incorporate the effects of large-scale, nonpoint source impacts.

Physical Form Index uses measures of sediment inputs, riparian vegetation structure and connectedness (dams, weirs, levee banks, groundwater abstraction) to assess the state of local habitat and its likely ability to support aquatic life.

Hydrological Disturbance Index recognises the importance to aquatic ecosystem function of the water regime, both surface flow and groundwater, depending on the ecosystem.

Water Quality and Soils Index considers the effects on biota of long-term changes in toxicant levels.

Fringing Zone Index represents structural and condition features of the streamside zone, or the zone surrounding a wetland. While this index could contain features relevant to the Physical Form and Aquatic Biota indices, the

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zone is seen as such an important focus of management that it requires its own category.

Aquatic Biota Index represents the response of biota to changes in the environment. This index can be based on extensive national sampling of invertebrates sensitive to disturbance. Other components of the biota (for example, fish, water plants, algae, and riparian vegetation condition) would give a fuller picture of the response of ecosystems to change.

2.2 Assessment and reporting framework and scale

Australia’s land area is just under 7.7 million square kilometres with a population of around 21 million people (about 2.5 people per square kilometre). The island continent has large regional variations in climate and, after Antarctica, is the driest continent on earth. Compared with most other continents, Australia has few lakes, and the country is heavily reliant on water from rivers for economic, agricultural, industrial and domestic activity.

Indeed, 95 per cent of the population lives within 10 kilometres of a river channel (Thoms et al. 2000), which is high compared to other countries.

River and wetland health assessments should be conducted at the scale of river reaches, or individual wetlands. Reaches should be specified within the region assessed (usually surface water management area). A method for reach specification that was used in the National Land and Water Resources Audit I (NLWRA I) is described below (section 2.4). The scale of the NLWRA I reaches can be changed depending on the resolution of the digital elevation models used and it is recognised that some states (such as Victoria) already have their own methods based on on-ground or other assessment methods.

Wetlands will be specified according to a minimum area when wet. Twooutstanding issues are the number of wetlands required to adequately represent a surface water management area and whether their assessment scores should be weighted by their relative size to provide . Numbers of wetlands to be sampled has been discussed in the Lake Eyre Basin Rivers Assessment <http://www.deh.gov.au/water/basins/lakeeyre/publications/assessment.html>. Both issues are being addressed in the National Indicators for Wetland Ecosystem Extent, Distribution and Condition project <*http://www.nrm.gov.au/monitoring/indicators/index.html*>*.*

Assessments at the reach scale may be reported at that scale to meet local needs but also can be aggregated to broader spatial scales to provide assessments for surface water management areas, an entire state or territory, and at the national level. It is intended that assessment for the NWI will be undertaken at the scale of a surface water management area. State-based assessment programmes that conform to FARWH (such as the Victorian

Index of Stream Condition, the Tasmanian Conservation of Freshwater Ecosystem Values Framework, and eventually the Murray-Darling Basin Sustainable Rivers Audit) could also be reported at scales that meet jurisdictional needs.

2.3 Surface water management areas

The river basins used for the framework will be the surface water management areas provided by each of the states and territories to the National Water Commission. In some cases, these are groups of small river basins. In New South Wales they have been divided into regulated and unregulated sections.

2.4 Reaches and wetlands

River basins are large areas with a considerable diversity of river and wetland condition, necessitating a finer basic unit for calculation of the framework indices. Wetlands will usually be discreet units of measurement and the number of individual wetlands assessed may constitute the sample size representing the surface water management area (see Sheldon et al. 2005).

Wetlands may need to be weighted by their area when aggregated to provide an assessment of a surface water management area.

River links, the stretches of river between tributary junctions, are an easily defined, fine-scale unit within a river network. There may be many thousands of river links (depending on the mapping resolution used) in any assessment area, making reporting and modelling cumbersome. For example, the

Tasmanian Conservation of Freshwater Ecosystem Values Framework has about 400,000 river links at a 25-metre resolution. Many of these links do not differ very much in their physical character. A large river is unlikely to changeits physical character in response to being joined by a small tributary stream. Consequently, river links may be aggregated into reaches of similar character to reduce unnecessary duplication of calculations and results. Geomorphologists have many ways of defining river reaches that often depend on intensive surveys (Rosgen 1996, Brierley et al. 1999). Intensive on-ground surveys are unlikely to be possible for reporting on all surface water management areas in a state or territory (or perhaps even one).

Consequently, an automated system based on geomorphological principles was developed in NLWRA I and is available for use in this assessment, although other approaches can be used if they are available. The headwaters of catchments contain many small stream sections that could numerically overwhelm all other sections of a surface water management area, and for which little information is available for broad-scale surveys. To avoid this problem, and to ensure that the reporting scale represents most of the surface water management area in the reporting area, a reach was defined in the NLWRA I as having a minimum contributing catchment area of 50 square kilometres (this could be changed depending on state and territory needs).

The physical character of a river is likely to change from one link to another as a result of major changes in catchment area that determine the flow and other fluxes such as sediments and nutrients. Changes in slope between links influence the velocity of flow and hence the shear stress and the stream power or sediment transport capacity, leading to changes in channel and bed morphology. Flow and material loads are also influenced by catchment areas, and hence the product of catchment area and slope (a simple surrogate

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measure for stream power) is often used by geomorphologists as a primary indicator of geomorphic form (Montgomery and Buffington 1997; Dietrich et al. 1993). Entry to, or exit from, reservoirs and lakes must also be considered, and it was ensured that river links and reaches were broken at these points.

The above principles were used to aggregate river links into reaches.

A branching network of river links joined by nodes was defined in the NLWRA I from the AUSLIG 9-second digital elevation model (DEM) of Australia. This data set is

available for the framework, however, finer scale DEMs are available in some places and there may be benefits in using them. An alternative method of defining river networks from mapped streams was dismissed in the NLWRA I because, in places, the position of the mapped streams does not coincide exactly with valleys in the DEM. The DEM is required to generate topographic attributes of catchment area and the slope of each river link, and errors in positioning produce many spurious results.
However, some states with extensive on-ground measurement programmes, such as Victoria, may have reaches defined by direct observation.

The NLWRA I used the ARCInfo flow accumulation algorithm to define the catchment area of all cells in the DEM. The river network was defined as beginning at a catchment area of 50 square kilometres. Short links, where the catchment area had reached less than 75 square kilometres by the downstream node, were removed. This data set is available for use but could also be modified using the same algorithm with finer resolution DEMs.

In the NLWRA I, links were further separated by nodes at the entry to and exit from reservoirs and lakes. The presence of lakes and reservoirs was derived from an AUSLIG waterbody database mapped from 1:2.5 million topographic maps. This database was found to unreliably distinguish natural lakes from waterbodies created or regulated by dams. A separate AUSLIG point coverage of flow control structures was obtained to define regulated waterbodies from natural lakes. Lakes were defined as those waterbodies that did not intersect an associated structure in the dam database.

Reservoirs were defined as water bodies that intersected structures of 10 metres height or greater. All river links downstream of reservoirs were defined as having regulated flow. Reaches used for the NLWRA I were formed by concatenating one or more network links and joined according to the following rules:

• all first order links (those with no tributary) were assigned as separate reaches
• for links downstream, the product of link slope and drainage area (a stream power surrogate) was compared to that of the two tributary links
• if one tributary link provided 90 per cent or more of the area of the link, then the tributary reach was continued downstream unless the area slope product differed by a factor of two or more. In that case a new reach was started
• if no tributary link dominated the area of the downstream link, then the tributary reach of closest area and slope product was continued

downstream. If the product of area and slope for the link differed by more than twofold from both tributaries a new reach was started
• new reaches were initiated at the entrance and exit from lakes and reservoirs.
Each reach has an internal contributing area (called a subcatchment area in this project). The subcatchment area is the catchment area added to the reach between its upper and lower limits (Fig. 4). The subcatchment area of first order streams is the entire catchment area of the river link.

Subcatchment areas for each reach were determined from the flow accumulation grid. The slope of the link was defined as the elevation difference between the upper and lower ends of the link divided by the length of the link.

The total catchment area of a river reach is the spatial extent of land that drains to the most downstream point of a reach. That means that the catchment of a reach has nested within it the catchments of all upstream reaches. The catchment area was determined by merging the subcatchment of the reach with all upstream sub-catchments (Fig. 4). A unique seven or eight digit identifier was given to each reach, composed of the three or four-digit Australian Water Resources Council basin identifier followed by an arbitrarily assigned four-digit code.

Figure 4: Relationships between reaches, subcatchments and catchments

As a check, DEM-derived river networks were compared with named streamlines recorded on the AUSLIG 1:250,000 topographic map series. A close match was found in all upland areas (areas with ridge and valley topography). If links did not coincide with a named stream they were excluded from the database. This process was necessary in the drier and flatter regions to remove DEM-generated flow accumulations that are not expressed on the ground as streams for reasons such as transmission losses, dispersion of flow, terminal lakes, or lack of flow through dune systems and depressions.

The Murray-Darling Basin stream network was also manually checked and edited against the 72 1:250,000 topographic map sheets that cover the basin. The lowland rivers of the Murray-Darling Basin were not well represented by the link network because of problems of anabranching streams, distributary channels, and flow through very flat areas that were not well represented by the DEM. Accurate representation of this type of system requires further development, and reaches identified in lowland parts of the Murray-Darling Basin used in the NLWRA I should be treated with caution.

The derivation of the river reach network in the NLWRA I was time consuming, and it has not been verified. To improve reporting, knowledge of the types of rivers in the area assessed would be useful and could be considered by each state and territory. There have been attempts to classify the rivers of specific regions within Australia but there has no attempt to do this at broader scales.

2.5 The reference condition approach

When conducting a financial audit it is not sufficient to know merely how much is in the till. Crucial to any audit is knowing how much is in the till in relation to how much should be there. Using a health analogy, a measurement of blood pressure by itself is insufficient to interpret the health of the patient. Information is also needed on what a healthy blood pressure would be and the patient’s measurement is compared with that reference.This referential approach has been adopted for the framework. That is, an assessment of river health relative to what the river or wetland would have been like if it had not been changed by human activities.

Assessments for each element of the framework are based on departures from reference conditions. Where ecological integrity is the criterion for health, reference conditions are usually defined as the presumed natural state of a site, determined by physically and chemically similar undisturbed sites. Typically it is impossible to find completely undisturbed sites with which to compare test sites, in which case minimally disturbed or best available sites are often used to define reference conditions (Wright et al. 1983, Simpson et al. 1996, Reynoldson et al. 1997). Reference conditions

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can also be set by professional judgement (Ladson et al. 1999), modelling of past conditions, historical records, or palaeoecological evidence (Thoms et al. 1999). Reference conditions for the FARWH have been set by a combination of minimally disturbed sites, historical data, modelling of past conditions, and professional judgement; the guiding principle is that reference conditions should be as close to natural (pre-European settlement or pre-1750) as possible.

The indices calculated in the framework all assess the condition of a river reach using a referential approach. The Aquatic Biota Index could use a modified reference approach, but the reference for some biotic indices may be straightforward. The approach is dictated by the way sites are compared statistically and the absence of unchanged reference sites in some parts of the country. For example, the reference for exotic plants and fish would be zero. Most of the other indices could use a simpler comparative approach and take as their reference point a completely unchanged condition. Both of these approaches are valid and can be used jointly to assess the overall condition of a river. Nevertheless, differences in the way reference condition is determined in relation to the different indices should be kept in mind when interpreting the condition of a reach or surface water management area.

2.6 Indices and index features

Initially, reaches and individual wetlands should be assessed, and the results should then be aggregated to generate assessments of surface water management areas. Directly measured data will not be available for every river reach, with the result that a variety of approaches could be adopted, including direct site measurements, remotely sensed data and modelled data that can be combined to provide assessments for all of the reaches in an area of interest.

Ideally, several biological measures would be included in the assessment as components of the Aquatic Biota Index (for example, fish, water plants andalgae). The most extensive dataset that will be available is that for aquatic invertebrates from the National River Health Program. Methods for fish have been developed by the Murray-Darling Basin Sustainable Rivers Audit andare being applied across the basin.

The extensive datasets compiled for the Wild Rivers Project—including land uses, infrastructure, levee banks, and dams—are also useful, and they are available from the NLWRA I. Data on sediment transport, nutrients and hydrology could be provided in some cases by process models that were used extensively in the NLWRA I. Water quality data are spatially sparse (see testing in Victoria and Tasmania below) when considered at the scale of reaches and surface water management areas and, apart from nutrients, are difficult to model for the extensive areas without them.

2.7 Integration of the framework components

2.7.1 Reach, wetland and basin scale aggregation and integration

In the FARWH the term 'aggregation' is used to denote assembling measures of the same index in different places into a measure at a larger spatial scale, for example, aggregating measures of the Aquatic Biota Index for a group of reaches, or a group of wetlands to provide a measure of the Aquatic Biota Index for a basin (for either the rivers, or the wetlands). The term 'integration' denotes assembling measures of different indices at a given scale to generate a combined assessment at the same scale, for example, reachscale indices of flow regulation, nutrient and suspended sediment loads integrated for a reach. These issues have been considered in more detail for reaches representing a river within a surface water management area than they have for individual wetlands that represent a surface water management area.

At the reach or wetland level, an assessment will usually be provided for each index and individually these provide most information. These indices can be integrated to produce an assessment for each reach, or each wetland. Similarly, an assessment will usually be required for each individual index at the scale of an entire surface water management area. In turn, these may be integrated to produce an overall assessment at the surface water management area. A summary of the decisions taken to integrate indices and sub-indices, and to aggregate from reach to basin scale can be found in

Table 1. Normally, the surface water management area assessments for wetlands and rivers would be separate because they represent the condition of different waterbody types, namely rivers or wetlands.

In calculating the assessment for a surface water management area, a decision is needed whether to aggregate the individual reach or individual wetland scores or to integrate the individual indices across the surface water management area. It is considered appropriate to produce the basin-scale assessment by integration rather than aggregation because of the nature of the two processes involved. Aggregation is more appropriate when crossing spatial scales, and integration is more appropriate for combining different indices. When aggregating indices up to the basin scale, different weighting approaches are likely to be chosen for different indices.

Table 1: **Summary of integration and aggregation procedures for different sub-indices and indices.**

Index – reach scale Integration approach and weighting Aggregation approach and weighting Index
Hydrological Disturbance Index As per Index of Stream Condition framework
Arithmetic average with double weighting to change in seasonal periodicity
Reach index aggregated to basin index by calculating length weighted average of all reach scores
Surface water management area (SWMA)
Hydrological Disturbance Index
Water Quality Index (e.g. nutrient and suspended sediment loads)
Worst measure in reach taken as nutrient and suspended sediment load assessment
Components unweighted
Reach index aggregated to basin index by calculating length weighted average of all reach scores
SWMA Nutrient and Suspended Sediment Load Index
Physical Form Index
Standardised Euclidean distance Components unweighted
Reach index aggregated to basin index by calculating length weighted average of all reach scores
SWMA physical index
Catchment Disturbance Index Impacts summed
Components unweighted calculating area weighted average of all reach scores
SWMA Catchment Disturbance Index
Aquatic BiotaIndex
Reach index aggregated to basin index by calculating area weighted average of all reach scores
SWMA Fringe Index ⇓ ⇓
Fringing Zone Index
Unweighted reach average
Reach index aggregated to basin index by calculating area weighted average of all reach scores
SWMA Fringe Index ⇓
Overall Index Above six indices integrated to give
FARWH for reach Standardised Euclidean distance Components unweighted or inverse weighted rankings
Above six indices integrated to make FARWH for
SWMA Standardised Euclidean
Distance Components unweighted or inverse weighted rankings

For example, reach length or wetland area weighting might be used for a Water Quality and Soils Index, and contributing catchment area weighting would be more appropriate for a Catchment Disturbance Index. If the reach or wetland-scale assessment scores were to be aggregated to the scale of an entire surface water management area, weighting would be limited to one weighting approach that may not be entirely suitable for all the indices. Where the weighting is different for some indices, then they SHOULD be weighted to the basin scale FIRST. Even more relevant, there are bound to be many reaches that do not have all indices available, hence reach- or wetland-scale integrations could be biased away from some indices and aggregation will enhance this bias. Regardless of the balance of the individual sub-indices, the basin scale (weighted) averages are unbiased. For example, an effect of aggregating all indices by reach then to surface water management area, or by index and then to surface water management area is shown in Table 2.

Table 2: Example of weighting by either reach or index for all reaches

Reach
Length of reach Index1 Index2 Index3 Index4
Reach standardised Euclidean distance
1 162 6 4 6 9 0.58
2 192 1 4 7 8 0.43
3 114 2 3 5 2 0.29
4 14 3 3 1 0.23

5 88 4 9 4 0.51
6 19 3 8 4 0.45
7 22 4 7 6 0.55
8 34 8 5 7 9 0.69
9 116 3 3 8 0.42
10 95 8 0 2 0.25
BASIN weighted average standardised Euclidean distance [1] 0.44 Weighted BASIN mean [2] 3.89 3.82 5.39 6.10 0.47

[1] Used in NLWRA1
[2] Recommended by FARWH

Furthermore, aggregation of each index to the basin scale allows flexibility in the effect of scale and basin-wide reporting for the component indices. For example, there could be indices that apply at different scales to FARWH reaches: certainly hydrology acts at different scales from macroinvertebrates.
Reporting at the basin level using independent aggregation makes more sense.
There might be a shortcoming to this approach where reporting is desired at individual reaches or wetlands, and they are represented by different subsets

of the full set of assessment components. For example, water quality could be missing from one and hydrology from another. Where initial reporting is desired at the individual reach or wetland, methods may need to be employed that allow this.

The inverse ranking system used by the Index of Stream Condition in Victoria is applied at the reach scale and then integrated measures are aggregated to broader scales.

2.7.2 Methods to integrate indices

Indices can be integrated at the reach, wetland or basin level in different ways to produce an assessment of river and wetland condition (Table 3). The standardised Euclidean distance approach provides a measure of how different a reach is from the reference condition using information from the measures comprising an index or sub-index. It has an advantage over a mean value in that it can be used to represent the location of reaches in the n-dimensional space defined by the measures. An example of the calculation of an index using the standardised Euclidean distance is given below where I = index score, and A, B, C and D are the sub-indices that comprise the index. The denominator is the square root of the number of indices, in this case 4).

$$I = 1 - \frac{\sqrt{(1-A)^2 + (1-B)^2 + (1-C)^2 + (1-D)^2}}{\sqrt{4}}$$

A second type of integration approach is to take the worst of the component sub-indices. This follows the precautionary principle and is useful for water quality indices such as nutrient and suspended sediment loads. For instance, if a reach had very low total phosphorus and total nitrogen measures, but the suspended solids load was enormous, then the condition of the reach should be assessed as poor as a result of the suspended solids condition. Similarly, a toxicant that exceeds lethal limits should be the one that drives the overall assessment, regardless of the levels of other water quality measures.

A third type of integration approach that is used is to sum the impacts of the sub-indices. This approach was used for the Catchment Disturbance Index in the NLWRA I, for which three sub-indices each contributed very similar types of impact though from different activities. The sum returns a value that is dependent in magnitude on the number of component indices, and so it should be avoided or standardised where possible. The average of the component indices is simple and is recommended in some situations where equal weighting is intuitive.

In an adaptation of the precautionary principle, the Index of Stream Condition uses an inverse ranking method that gives more weight to lower scores. For example, if five indices are used and they are all on a standard scale, they are ranked in order of lowest to highest score. The first ranked index (the lowest score) is multiplied by five, then the next ranked score is multiplied by four, and so on. All weighted scores are then summed and divided by 15 (that is, 5 + 4 + 3 + 2 + 1). The same principle can be used for any number of

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indices but the denominator (the sum of the ranks) varies accordingly. This method tends to moderate the effect that one large value may have on a simple arithmetic mean or sum.

The Tasmanian Conservation of Freshwater Ecosystem Values Framework and the Murray-Darling Basin Sustainable Rivers Audit employ expert rules to integrate the subcomponents and components. These are weightings determined by expert knowledge about the environmental importance of components (see http://www.mdbc.gov.au/__data/page/64/summary_macroinvert_theme.pdf).

For example, the rules developed for the Sustainable Rivers Audit macroinvertebrate index give highest importance to biodiversity—richness (SR-MIr) followed by presence of pollution sensitive taxa (SIGNAL or SRMIs)— and least importance to the presence of expected taxa (AUSRIVAS OE or SR-MIoe). The AUSRIVAS OE was allowed to affect only the overall macroinvertebrate index where the score was low. This was because of the lack of confidence in higher scores due to the lack of suitable reference sites.

Table 3: **Integration techniques recommended for use in the framework**

Note: other methods may be appropriate but the underlying philosophy and their effects on the final index should be made explicit

Integration technique Rationale Proposed use Standardised Euclidean distance

The measures comprising an index are different but complementary ways of estimating the overall status
Integrating the flow regulation sub-indices
Integrating the Physical Form sub-indices
Integrating the indices into the overall score
The worst of a group of measures is taken as the overall measure
Used where the overall measure is best estimated by the lowest common denominator, not an average type measure
Integrating the water quality sub-indices
The impacts of the measures in the group are added to arrive at an overall measure
Used where measures are estimates of the same type of impact, though derived from different origins. As a consequence, the impacts should be added
Integrating the Catchment Disturbance sub-indices where individually they may have similar effects
Expert rules based on knowledge of the relative importance of possible combinations of components
Used where the scientific understanding of components can be applied to enhance the overall score and aid interpretation
May be especially important of biological measures that can be affected by scale, or any features with varying level of confidence

Not all indices will be available for all reaches or wetlands. In such instances it is possible to calculate the standardised Euclidean distance, the precautionary principle method (using, or weighting to the lowest scores) and the sum of the component indices just from those that are available.

However, the number of missing values may influence the integration and aggregation chosen for broader scales of reporting (Table 2).

2.8 Analysis of common factors determining river condition

An overview of categories of major river management issues, and their scale of impact can be provided by statistical analysis of the suite of indices, rather than individual indices, since actual condition is usually determined by several factors. Groups of reaches or wetlands with common issues can be identified systematically using a multivariate statistical approach. The NLWRA I calculated the Euclidean distance between each pair of reaches, based on the environmental measures for each reach. Reaches were then grouped using Ward's Clustering method (SAS Institute 2000), which is an efficient method for large data sets. The groups formed in this way may be particularly useful for avoiding the information loss that is inherent in integration, providing additional information on the spatial distribution of combinations of issues.

2.9 Sensitivity analysis

2.9.1 Method

The overall assessment will change because of changes in selected indices, their sub-indices, and the methods used for integration and aggregation. Interpretation of the scores to some extent will be dependent on understanding the sensitivity of the overall assessment to changes in the sub-components. Two methods of sensitivity assessment used in the NLWRA I were found to yield similar results and the computationally simpler one was recommended. This recommended method is analogous to the 'jackknife', a commonly used statistical technique whereby one sub-index at a time is removed from the dataset, and the mean absolute change in overall assessment is then calculated (Norris et al. 2001).

This analysis should be performed in two ways:

• on reaches or individual wetlands with complete data sets of all selected indices and sub-indices
• on all reaches or wetlands in the reporting region where many will have one or more indices missing.

Sensitivity in this second dataset mirrors the effect on the overall assessment for a jurisdiction, because it depends not only on impact gradients and integration techniques, but also on data availability. Consequently, subindices with data in many reaches have more effect on the overall assessment than sub-indices with fewer data points. An example of the components of sensitivity testing from the NLWRA I follows.

2.9.2 Sensitivity and underlying reasons in the NLWRA I

The main reasons for the differences in influence between the sub-indices in the NLWRA I were identified as:

• the method of aggregation of the indices representing each environmental component
• the range and distribution of the scores

• the number of observations (in case of the national data).

In the ideal sensitivity analysis testing in the NLWRA I for reaches having all indices (Figure 5), five factors played an equally important role: land use, the three habitat sub-indices, and total phosphorus. The three habitat components each had a wide range of sub-index values, and ranked roughly equally because they were aggregated to the habitat index by the standardised Euclidean distance method. Although the range of total phosphorus values was not wide, the sub-index ranked highly because of the integration approach used for the nutrient and suspended sediment load index. The nutrient and suspended sediment load sub-index was determined by taking the value of the lowest component; in most reaches this was total phosphorus. The land use sub-index was ranked more highly than the infrastructure sub-index because of the smaller range of values of the latter sub-index.

The Hydrological Disturbance Index consisted of four components, none of which had a major influence on the NLWRA I Assessment of River Condition (environment) (ARC_E) score because they were not as variable as other subindices, and each sub-index contributed only 25 per cent to the Hydrological Disturbance Index.

Change in ARC

0.00
0.02
0.04
0.06
0.08
0.10
Infrastructure
LCC
Landuse
Mean Annual Flow
Flow Duration
Seasonal Amplitude
Seasonal Period
Connectivity
Bedload
Riparian Vegetation
Suspended Sediments
Total Phosphorus
Total Nitrogen
CDI Hydrology Habitat Water
Quality

Figure 5: **Influence of each sub-index on the ARC$_E$ using only reaches for which there was a complete dataset.**

The sensitivity analysis using all reaches assessed in the NLWRA I, including those with missing data (Figure 6), showed that the contribution of the subindices to the national assessment differed slightly from the ideal situation.

The strong influence of the three habitat components remained, but the influence of the total phosphorus sub-index was slightly greater. This results from the near complete dataset for the nutrient measures based on modelled data compared to some other indices. The effects of land use and infrastructure in the Catchment Disturbance Index are now identical in this example, because the integration rules required both to be present to calculate the Catchment Disturbance Index. With few hydrological data available, the hydrological disturbance sub-indices had relatively little influence on the ARC$_E$ at the national level.

Figure 1.6 **Influence of each sub-index on the ARC$_E$ using data from all reaches**
Change in ARC E
0.00
0.02
0.04
0.06
Infrastructure
LCC
Landuse
Mean Annual Flow
Flow Duration
Seasonal Amplitude
Seasonal Period

Connectivity
Bedload
Riparian Vegetation
Suspended Sediments
Total Phosphorus
Total Nitrogen
CDI Hydrology Habitat Water
Quality

2.10 Range standardisation and bands of condition

2.10.1 Range standardisation

It is proposed that assessments of river and wetland health be range standardised to 0–1 with increments of 0.1 for each of the indices representing the major environmental components (biota, catchment disturbance, hydrological disturbance, physical form, fringing zone and water quality). This is necessary so that assessments from different jurisdictions are immediately comparable. Range standardisation also renders the scores dimensionless, thus accounting for different types of measurements that will inevitably be required for various indices selected both within and among jurisdictions.

A score of 1 corresponds to the best attainable or pristine condition, and a score of 0 to a totally degraded condition. Each of the indices should be examined to ensure that it is theoretically possible to arrive at index values ranging from 0 to 1. Each of the index values should also be examined to ensure that the reach conditions that produce values of 0, 0.5 and 1 could be appropriately described as totally degraded, halfway between degraded and pristine, and pristine (as the scores imply). This evaluation can be based on professional judgment because the composition of each index of a number of sub-indices means that different combinations of sub-index scores could produce the same index score. It is unlikely to be possible to develop a more objective link between index scores and the described condition.

2.10.2 Bands of condition

Prior extensive consultation with states and territories in the National River Health Program (NRHP) and the NLWRA I has confirmed the desire for the assessments to be divided into bands of condition as an aid to mapping and interpretation. It is proposed that the range of scores be divided into five bands to produce five categories. Values of 0–0.2 are accorded a condition of severely modified, 0.2–0.4 substantially modified, 0.4–0.6 moderately modified, 0.6–0.8 slightly modified, and 0.8–1.0 largely unmodified. The categories in the NLWRA I ARC_B (Aquatic Biota Index) had different labels and used slightly different cutoff points, depending on the distribution of the values for the AUSRIVAS reference sites on which it was based.

The derivation of the ARC
B bands is described in more detail in the proposed possible Aquatc Biota Index section of the potential comparative indicesdocument (NWC 2007).

The purpose of this section is to provide further interpretation of the framework categories: largely unmodified, slightly modified, moderately unmodified, substantially modified and severely unmodified.

Largely unmodified condition: 0.8–1

Rivers and wetlands that are largely unmodified considered to be in pristine, or near pristine condition should have some or all of the following:

• catchment land uses that minimally disturb the river, such as conservation, some types of forestry, low levels of grazing or cropping

• at most, limited changes to the hydrological regime

• at most, limited changes to the physical form (for example, fringing vegetation structure reasonably intact, no dams or levees and very little sediment deposition)

• loads of suspended sediment, total nitrogen and total phosphorus close to natural

• stream plants and animals should be in similar numbers and of similar types to those at unimpacted reference sites.

A healthy Murray River wetland with a mosaic of wetland plants that provide diverse habitat for a range of species (Source: Andrew Tatnall for CRC for Freshwater Ecology) A Healthy Murray River wetland with a mosaic of plants that dries out during summer (fore ground: Moira Grass, Milfoil, Primrose; background: Giant Rush, Phragmites, Red Gum (Source: Andrew Tatnall for CRC forFreshwater Ecology)

Slightly modified condition: 0.6–0.8

Rivers and wetlands that are slightly moderately modified and considered to be in good condition should have some or all of the following:

• a catchment dominated by land uses that have little effect on waterbodies such as state forest or protected recreation areas

• some minor changes to the hydrological regime as a result of diversion or abstraction

• some minor changes to the physical form; for example, fringing vegetation reduced to 60–80 per cent of original coverage, diversions or abstraction upstream but not in the reach, and some little or no sediment deposition

• water quality close to natural but with occasional minor short-term events possible

• plants and animals with noticeable slight loss in variety and numbers or condition. Few, if any, exotic species present.

Mostly native well vegetated riparian zone, some encroachment into the channel (Source: Institute of Applied Ecology, University of Canberra) Good flow, natural channel, some clearing for a picnic area (Source:

Institute of Applied Ecology, University of Canberra) Wetland with slightly modified riparian vegetation but still with a variety of aquatic plants (Source: Institute of Applied Ecology, University of Canberra)

Protected catchment but with low flows modified by a road crossing

(Source: Institute of Applied Ecology, University of Canberra)

Moderately modified condition: 0.4–0.6

Rivers and wetlands that are moderately modified and considered to be in fair condition should have some or all of the following:

• a catchment dominated by land uses that disturb the river to some extent, such as dryland cropping and grazing

• some changes to the hydrological regime as a result of impoundments or abstraction

• some changes to the habitat, for example, fringing vegetation reduced to 40–60 per cent of original coverage, dams upstream but not in the reach, and some sediment deposition

• loads of suspended sediment, total nitrogen and total phosphorus above natural

• plants and animals with substantial loss of condition, variety and numbers. For AUSRIVAS, 20–50 per cent of the expected animals have been lost.

Little catchment disturbance, riparian zone intact but extensive sediment deposition (Source: Institute of Applied Ecology, University of Canberra) Some loss of riparian vegetation, some catchment disturbance from cropping, and some sediment deposition (Source: Institute of Applied Ecology, University of Canberra) Extensive change to riparian vegetation, reduced flow as a result Riparian vegetation intact, minimal disturbance to the surrounding

of abstraction (Source: Institute of Applied Ecology, University of Canberra) catchment, mine upstream causing impaired water quality (Source: Institute of Applied Ecology, University of Canberra)

Substantially Modified Condition: 0.2–0.4

Rivers and wetlands that are substantially modified and considered to be in poor condition may have some or all of the following:

• catchment land uses with moderate to severe disturbance such as intensive cropping and irrigated land uses

• moderate to severe changes to the hydrological regime as a result of impoundments, diversions or abstractions

• moderate to severe changes to the physical form, including loss of 50–75 per cent of riparian vegetation, connectivity affected by nearby dams or levees, and substantial sediment deposition

• poor water quality, possibly with moderate to high loads of suspended sediment, total nitrogen and total phosphorus

• plants and animals that show substantial change possibly with obvious invasion of exotic species (for example, fringing plants, aquatic plants and fish such as carp). For AUSRIVAS, 50–80 per cent of the expected animals have been lost.

Very little riparian vegetation, catchment heavily disturbed by cropping and grazing, some sedimentation (Source: Institute for Applied Ecology, University of Canberra) Reduced riparian vegetation, catchment disturbed by cropping, altered hydrological regime (Source: Institute of Applied Ecology, University of Canberra)

Horse Park Wetland, ACT. A wetland of national significance. A bird breeding site that has been grazed for decades and is subject to urban encroachment (Source: Institute of Applied Ecology, University of Canberra) Substantial loss of riparian vegetation, catchment disturbed by grazing, high levels of sedimentation (Source: Institute of Applied Ecology, University of Canberra)

Severely Modified Condition: 0–0.2

Rivers and wetlands that have been severely modified and considered to be in very poor condition may have some or all of the following:

• catchment land uses that cause significant disturbance to rivers and wetlands such as intensive agriculture or urbanisation

• significant changes to the hydrological regime, for example, large reductions in flow, extended wetting or drying of wetlands, and changes in the seasonality of flow and inundation events

• extensive changes to the physical form, including loss of riparian vegetation, loss of connectivity, and extensive sediment deposition

• poor water quality possibly including high loads of suspended sediment, total nitrogen and total phosphorus

• major invasion of weeds and other exotic organisms, little regeneration of riparian species, and likely dominance of a few taxa. For AUSRIVAS,

80–100 percent of the expected animals have been lost (this is possible with some toxic effluents such as mine wastes).

Total loss of riparian vegetation, catchment impacts from clearing and grazing, dam immediately downstream, poor water quality(Source: Institute of Applied Ecology, University of Canberra) Major loss of riparian vegetation, intensive cropping in catchment, hydrological regime altered by abstractions (Source: Institute of Applied Ecology, University of Canberra) Extensive changes to hydrological regime as a result of multiple dams upstream (Source: Institute of Applied Ecology, University of Canberra) Mine waste polluted creek, deposition of ferric hydroxide and high trace metals, poor water quality (Source: Institute of Applied Ecology, University of Canberra)

2.11 Missing data

2.11.1 Overall Index at various scales

It is inevitable that many reaches and wetlands will have missing data for several possible reasons. It is necessary that protocols for dealing with missing data are determined at the outset. There are six components, each of which is represented by an index. At least three of these indices must be present before an overall assessment can be reported. There could be a marked effect on the final score where this is done at the reach or individual wetland scale before aggregating to the surface water management area. Many reaches within a surface water management area will have different

indices missing but there will still be enough to provide an overall assessment. Therefore, although this may be acceptable, it means that the overall score for a surface water management area could include errors introduced because of variability in the component indices that have been incorporated for individual reaches or wetlands.

The Victorian Index of Stream Condition also suggests handling missing data on a *pro rata* basis at the reach scale (http://www.vicwaterdata.net/vicwaterdata/isc2004/download/doc/2ISC%20 FACTSHEET%20DR03.pdf). Where indices for individual reaches or wetlands are aggregated first, and then integrated at the scale of a surface water management area, each component should be represented by a minimum number of reaches or wetlands. This should be five per cent of the recognised reaches or wetlands (minimum wetted area) in the surface water management area. Thus, the sample size will be proportional to the number in the surface water management area.
The following examples were developed during the NLWRA I for each of the major environmental components represented. The approaches described here could form the basis for rules that can be adopted in FARWH.

2.11.2 Hydrological Disturbance Index

The Hydrological Disturbance Index of the NLWRA I consists of four subindices, similar to the 'flow stress ranking' used in the Victorian Index of Stream Condition and proposed for the Tasmanian Conservation of Freshwater Ecosystem Values Framework and the Murray-Darling Basin Sustainable Rivers Audit. For reaches that had adequate hydrology data, all four measures could be calculated and then used to calculate the Hydrological Disturbance Index. However, the majority of reaches in the area assessed did not have hydrological data, and protocols had to be developed for managing those places. In some cases, such as remote areas with little or no development, the assumption could be made that there was no hydrological change, thus providing a score of 1. A similar approach may be adopted in many areas for wetlands, depending on the nature and scale of development.

2.11.3 Nutrient and suspended sediment load index (Water Quality and Soils Index)

At the reach scale, the nutrient and suspended sediment load index consists of three sub-indices: the suspended solids sub-index, total nitrogen subindex, and total phosphorus sub-index. These sub-indices were derived from modelled data and so reaches had either a full set of nutrient and suspended sediment load results, or none if the models could not be run. The relative completeness of the data is a major advantage of modelled data over measured data. Salinity data were not used to calculate the water quality reach-scale water quality index. The reach-scale nutrient and suspended sediment load index was aggregated to give a basin-scale (surface water management area)

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assessment if the data in the basin were from reaches whose total catchment area represented at least 50 per cent of the basin. If less than 50 per cent of the basin was represented by data, the basin was not assessed.

2.11.4 Habitat index (Physical Form Index)

The habitat index of the NLWRA I (Physical Form Index in this framework) consists of three sub-indices: bedload condition, riparian vegetation, and connectivity. There were a number of reaches for which either the bedload condition or riparian sub-indices were missing. The connectedness subindex was calculated for all reaches. These three measures were integrated using the standardised Euclidean distance. In theory, the loss of one or more components does not introduce a bias with this integration approach, although it does result in a loss of information. That is, if all three measures were identical, the loss of one would not affect the resulting Physical Form Index. As a result, a decision was taken to require a minimum of two measures for calculation of the

Physical Form Index.

The reach-scale Physical Form Index was aggregated to give a basin-scale assessment if the data in the basin were from reaches for which the total catchment area represented at least 50 per cent of the basin. If the reaches with data represented less than 50 per cent of the basin area, the basin was not assessed.

2.11.5 Catchment Disturbance Index

The Catchment Disturbance Index used in the NLWRA I consists of three sub-indices: land use, land cover change, and infrastructure. Most reaches had sufficient data to determine the land use and infrastructure sub-indices. Data required to calculate the land cover change sub-index were missing for a number of reaches. These sub-indices were integrated to generate the Catchment Disturbance Index by summing their impacts. Loss of any measure will result in a positive bias to the score; however, for most reaches the land cover change subindex was close to one and varied little. Given this situation, it was decided that the Catchment Disturbance Index required a minimum of the land use and infrastructure sub-indices to be calculated.

The reach-scale Catchment Disturbance Index was aggregated to give a basin-scale (surface water management area) assessment if the data in the basin were from reaches whose total catchment area represented at least 50 per cent of the basin. If the reaches with data represented less than 50 per cent of the basin area, the basin was not assessed.

2.11.6 Aquatic Biota Index

The AUSRIVAS data from the National River Health Program represents a large data set of many thousands of sites. Some states have continued to sample I substantially since the NLWRA I. With large datasets such as this, which are

based on individual site measurements, there is an opportunity to model the gaps where strong relationships can be established. This approach was adopted in the NLWRA I, and rules were set for when a model was deemed of sufficient quality to accept the outputs.

Thus, the function of the ANNA models used in the NLWRA I (Linke et al. 2005) was to enable prediction of the biotic condition of a reach that had not been sampled (Norris et al. 2001). The AUSRIVAS modelling approach uses two measures for each site: a list of taxa predicted to occur if the site is in good condition (E value), and the taxa observed to occur at the site (O value). Together these two values give the O/E score.

For reaches that had not been sampled, there was a need to predict the taxa expected at the site if it were in good condition (E value), and to also predict taxa that occurred at the site under current conditions (modelled observed value MO). Together these values provide the MO/E score, a measure of condition and a surrogate for the AUSRIVAS O/E score. The ANNA modelling approach was judged more suitable for the needs of the NLWRA than the AUSRIVAS modelling approach because, while it produces similar outputs, it avoids the classification step and is computationally more efficient.

2.11.7 Integrating the four environmental indices into an NLWRA I ARC_E at the reach level

The nutrient and suspended sediment load sub-index and Catchment Disturbance Index could be calculated for most reaches given the rules above. The Physical Form Index was missing for several reaches, and the Hydrological Disturbance Index was not assessed for many reaches. These four measures were integrated into the ARC_E using the standardisedEuclidean distance approach. A decision was needed on whether to require the full complement of four indices to calculate the ARC_E, or whether this requirement could be relaxed to base the ARC_E on a subset of the four indices. As outlined above, this index is relatively unbiased by the loss of measures, put all four indices are important. This has already been argued in relation to the conceptual understanding of the processes determining river condition.

he decision taken was to require a minimum of three indices to calculate the ARC_E. While not a satisfactory situation, this approach is preferable to calculating the ARC_E for that small subset of the reaches for which a complete dataset was available. A comprehensive monitoring programme by states and territories would enable more rigorous data standards to be set than those described here. This should be possible in Tasmania, Victoria and the Murray-Darling Basin.

2.11.8 Validation of indices

With the measures selected by jurisdictions within this framework, it is important to show that they accurately represent the true river or wetland condition. This requires independent, accurate information on the state of river or wetland condition against which the data can be compared.

For components of the sub-indices used in the NLWRA I, and the ARC$_B$ based on AUSRIVAS, there are various additional data that can be used for this purpose. The detailed validation of these components used in the NLWRA is dealt with in the following methods sections for the different indices. A useful approach is to compare the selected indices to datasets that have similar measures at a similar spatial scale. This is one of the objectives of the testing of this framework but that should also remain an important step for individual states and territories.

Several states and territories have conducted river condition assessments; usually they differ from the NLWRA I in the spatial scale at which the assessment is conducted, and in the measures used. The river condition assessment with which the Assessment of River Condition 2000 has the greatest similarity in terms of measures and spatial scale is the Victorian Index of Stream Condition. The Index of Stream Condition has been completed for the entire state, has measures most similar to those in the

Assessment of River Condition 2000, and has detailed documentation of the methods used. Index of Stream Condition data were used to validatecomponents of the ARC used in the NLWRA I.

3 References

Allan, JD and Johnson, LB 1997, 'Catchment-scale analysis of aquaticecosystems', *Freshwater Biology,* **37**:107–111.

Boulton, AJ 1999, 'An overview of river health assessment: philosophies, practice, problems and prognosis', *Freshwater Biology,* **41**:469–479.

Boulton, AJ and Brock, MA 1999, *Australian Freshwater Ecology Processes and Management*. Gleneagles Publishing, Glen Osmond, SA.

Brierley, G.J., Cohen, T., Fryirs, K. and Brooks, A. 1999. Post-European changes to the fluvial geomorphology of Bega catchment, Australia: implications for river ecology. *Freshwater Biology* **41**, 839-848.

Dietrich, WE, Wilson, CJ, Montgomery, DR and McKeen, J 1993, 'Analysis of erosion thresholds, channel networks and landscape morphology using a digital terrain model', *Journal of Geology,* **101**:259–278.

Edgar, B, Conrick, D and Innes, A 2006, 'Matter for target. Inland aquatic ecosystem integrity – wetlands', Department of the Environment and Heritage,

Wetlands and Waterbirds Taskforce and the Queensland Department of Natural Resources and Water.

Hynes, HBN 1968, 'Further studies on the invertebrate fauna of a Welsh mountain stream', *Archives Hydrobiologia,* **65**:360–379.

Johnson, LB and Gage, SH 1997, 'Landscape approaches to the analysis of aquatic ecosystems', *Freshwater Biology*, **37**:113–132.

Ladson, AR, White, LJ, Doolan, JA, Finlayson, BL, Hart, BT, Lake, PS and Tilleard, JW 1999, 'Development and testing of an index of stream condition for waterway management in Australia', *Freshwater Biology,* **41**:453–468.

Linke, S, Norris, RH, Faith, DP and Stockwell, D 2005, 'ANNA, A new prediction method for bioassessment', *Freshwater Biology*, **50**:147-158.

Maddock, I 1999, 'The importance of physical habitat assessment for evaluating river health', *Freshwater Biology,* **41**:373–392.

Meffe, GK and Sheldon, AL 1988, 'The influence of habitat structure on fish assemblage composition in southeastern blackwater streams', *American Midland Naturalist,* **120**:225–240.

Mitsch, W.J. and Gosselink, J.G. 2000, *Wetlands*, Third Edition. (John Wiley and Sons, USA). ISBN 047129232X

Montogmery, DR and Buffington, JM 1997, 'Channel-reach morphology in mountain drainage basins', *Geological Society of America Bulletin,* **109**:596– 611.

NLWRA (National Land and Water Resources Audit). 2002. Australian Catchment, River and Estuary Assessment. Volumes 1 and 2. National land and Water Resources Audit. (Land and Water Australia, Canberra.), ISBN 0
642 37125 3

Norris, RH, Prosser, I, Young, B, Liston, P, Bauer, N, Davies, N, Dyer, F,
Linke, S and Thoms, M 2001, *The assessment of river condition. An audit of the ecological condition of Australian rivers*. Report to the National Land and
Water Resources Audit, Canberra, 288pp.

NWC 2007, Assessment of River and Wetland Health: Potential comparative indices, National Water Commission, Canberra.

Olsen, AR, Sedransk, J, Edward, D, Gotway, CA, Ligget, W, Rathbun, S,
Reckhow, KH, and Young, LJ. 1999, 'Statistical issues for monitoring ecological and natural resources in the United States', *Environmental Monitoring and Assessment,* **54**:1–45.

Raven, PJ, Holmes, NTH, Dawson, FH, Fox, PJA, Everard, M, Fozzard, IR and Rouen, KL 1998, *River habitat quality: the physical character of rivers and streams in the U.K. and Isle of Man*, River Habitat Survey Report No. 2,
Environment Agency, Bristol, England, 86 pp.

Reynoldson, TB. 1997, 'The reference condition: A comparison of multimetric and multivariate approaches to assess water-quality impairment using benthic macroinvertebrates', *Journal of the North American Benthological
Society,* **16:**833–852.

Reynoldson, TB, Norris, RH, Resh, VH, Day, KE, and Rosenberg, DM 1997,
'The reference condition: A comparison of multimetric and multivariate approaches to assess water-quality impairment using benthic macrionvertebrates', *Journal of the North American Benthological Society,*
16:833–852.

Rosgen, D 1996, *Applied River Morphology*, Wildland Hydrology, Lakewood, Colorado.
SAS Institute 2000, *SAS Online Documentation, Version 8*, S.A.S. Institute, Cary, North Carolina, USA.
Sheldon, F, McKenzie-Smith, F and Brunner, P. 2005. *Methodology for Assessing the Health of Lake Eyre Basin Rivers*, Final Report to Land and Water Australia, Canberra.
Simpson, JC, Norris, R, Barmuta, L, and Blackman, P 1996, *Australian River Assessment System. National River Health Program, Predictive Model Manual*, Cooperative Research Centre for Freshwater Ecology, University of Canberra, Belconnen, Canberra.
Thoms, MC, Ogden, RW and Reid, RA 1999, 'Establishing the condition of lowland floodplain rivers: a palaeo-ecological approach', *Freshwater Biology,* **41:**407–424.
Thoms, MC, Foster, JM and Gawne, B 2000, 'Floodplain sedimentation in a dryland river: the River Murray, Australia', *International Association of Hydrological Sciences* **263:**227–236.
US EPA (United States Environmental Protection Agency) 2006. Wadeable Streams Assessment. A Collaborative Survey of the Nation's Streams. (United States Environmental Protection Agency Office of Water, Washington, DC 20460) EPA 841-B-06-002.
http://www.epa.gov/OWOW/streamsurvey/WSA_Assessment_Dec2006.pdf
Wiederholm, T and Johnson, K 1997, 'Monitoring and assessment of lakes and macroinvertebrate fauna in flowing waters', *Australian Journal of Ecology,* **20**:181–197.
Wright, JF, Furse, MT and Armitage, PD 1993, 'RIVPACS – a technique for evaluating the biological quality of rivers in the UK', *European Water Pollution Control,* **3**:15–25.
Young, W.J., Chessman, B., Erskine, W., Jakeman, A., Raadik, T., Tilleard, J., Varley, I., Wimbush, D. and Verhoeven, J. (1988) Environmental assessment method for the rivers in the area of interest of the Snowy Water Inquiry. In: Anon. (1988) Resource Materials – Appendix to the Final Report of the Snowy Water Inquiry, 44pp.
(http://www.snowywaterinquiry.org.au/documents/appendix/appendix.htm).

The following is new information I received today at 5:30pm 9 September 2008 and it is clear from this that not only does Adelaide have ecologically sustainable options for ensuring water but Melbourne does too and this has most definitely NOT been assessed in a rigorous and transparent manner. It is therefore totally unacceptable that the Victorian Government be allowed to proceed to build a pipeline that has irreversible and unassessed impacts upon those matters that the Commonwealth Minister is required to protect. The Victorian Government has demonstrated that it has absolutely NO environmental credentials because it is prepared to extract water from the Heritage listed Goulburn River, the worst out of 23 rivers in the entire Murray-Darling Basin. The have shown that they are prepared to mislead the people of Victoria and indeed the Commonwealth so that they get their way.

I would like to ask that the Minister take note of the fact that this government is still to this day prepared to publicly state that Melbourne is running out of water and this is why they need the pipeline (and the desal plant), both energy guzzling, expensive and ecologically devastating proposals. They are in the paper and on Television every day making sure that the Commonwealth believes that this is true. It is not. Melbourne's supplies are better than they make out, it is the size and quantity of the dams and reserves and the percentage that these are filled. The fact that Melburnians use MORE water this year at the same time is a reflection they are complacent and they are wanting to get back to zero restrictions as their government has promised them they would by 2010-11, see page 17 of Our Water Our Future the Next Stage June 2007. The articles I have mailed you make this clear as well.

The fact is also that both the pipeline and the desal plant are projects that use enormous amounts of energy at enormous costs. This has not been made clear to Melbournians! Their water bills are: water they use is $9 and the rest of the $155 bill is Melbourne Water's charges. Unbelievable! They are also charging for rain water and anyone that has a rainwater tank, again unbelievable.

Isn't water meant to be a resource not a commodity?

I request that the Minister immediately require **a full EES to be conducted in an appropriate time-frame; not rushed, and that the new referral include Ramsar Wetlands and Migratory Species and 18 and 18A along the entire river systems**!! Extracting 75GL and up to 150GL(as per Stage 3) from the worst river in the Murray-Darling Basin has to have an effect downstream on matter protected under the EPBC Act 1999.

The Victorian Government by not including this in the original referral has blatantly tried to mislead the Commonwealth Government and this cannot be regarded as acceptable. They have ignored the Precautionary Principal and totally ignored ESD in the process and this also is unacceptable.
The following is a proposal for South Australia and I believe that Victoria is remiss in not doing an audit of Melbourne's options BEFORE spending millions on trying to force this pipeline through. It is environmental vandalism of the highest order.

Name calling by the Premier and Mr Holding shows that they have guilty consciences and that this proposal as is the desal plant; are NOT in the best interest of our community and indeed our Nation.

Please read everything. I am not trying to hold you up, I am trying to show you that this pipeline proposal is a disaster and it will spell the death of the Goulburn and the Murray River system. I though all systems in the Murray-Darling Basin were meant to be regarded as interlinked. All surface and underground water, if they are not then what is the NWI about?

Kind regards

Maria I E Riedl

Assisting organisations move towards sustainability.

with Richard Clark & Associates

Report on Sustainable Water Options for Adelaide

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Executive Summary

The purpose of this report is to review water options for Adelaide under current and future scenarios of population growth and climate change and to recommend more sustainable strategies to cost-effectively meet Adelaide's water requirements, while achieving the best possible associated environmental and social outcomes.

Adelaide's water supplies are at immediate risk with historically low flows in the River Murray and this will be a long term problem as climate change accelerates. Under expectations of continued population growth and climate change the traditional approach to water management of importing water to Adelaide in continually larger amounts from ever increasing distances, or by ever increasingly costly methods, while continuing to discharge stormwater and treated effluent to downstream rivers, estuaries or the sea is obviously an inherently unsustainable direction.
Adelaide has a combination of hydrological characteristics which sets it apart from all the other capital cities in Australia. First, the plains areas of Adelaide are underlain by a series of quaternary and tertiary age aquifers, with the latter virtually free from past pollution. The total storage capacity of water in these aquifers is not accurately known but is many times the total storage capacity of the reservoirs in the Mt Lofty Ranges. This opens up the potential for Aquifer Storage and Recovery. Second, despite Adelaide and its hinterland receiving the lowest rainfall of all the
Australian capital cities, because it has most of its urban areas built over unstable flood deposition fans and ancient flood plains it has a very high risk of severe damages in large flood events. While our focus during the early years of the twenty-first century has been much engaged with drought, if a storm similar to that which occurred over North Adelaide in February 1925 were to occur again under our present development situation, it is reasonable to suggest that lives could be lost and property damage would be extensive.

Defining sustainability for urban water systems is a critical first step in comparing water supply options. Since water supply is essentially associated with water diversions, storages and quality modifications, the effects of water supply operations cannot be divorced from their impacts on other aspects of water management. The authors have developed a definition of sustainability as related to urban water management and have compared the currently considered urban water supply options for Adelaide against performance criteria related to this definition. Principles to be adopted for attaining sustainable water systems and the need for a transition strategy to make the necessary changes are also outlined.

Ta ranking of the options are inevitably subjective. However, if the definition of sustainability is accepted in some form as presented, the authors believe it will be difficult to dramatically change the relative ranking of the options. Also provided in Table A are order of magnitude estimates of the quantities of supplies that could be made available via these options in the near future.

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Table A. Analysis and ranking of water options along with order-of-magnitude estimates of preferred, feasible supply sources. Category Assessment Score (out of 50) Gigalitres (GL)
Demand management
Highly cost effective with excellent environmental and social benefits.
41 64
Stormwater harvesting
As above, but particularly compatible with reduction in flood damages and urban amenity. Has future growth potential
41 60
Existing catchments
Existing catchments are a proven and reliable option.
35 82
Wastewater reuse
Offers great potential for large scale future cost effective supplies with high environmental benefits, but problems to be overcome for immediate re-use in urban areas.
32 15
Rainwater tanks
While popular with the community relatively expensive and difficult to manage.
28 6
Groundwater use
Groundwater extraction without recharge is inherently unsustainable, but offers scope for immediate emergency supplies.
26 0
Desalination
Useful measure of last resort but expensive and energy intensive therefore not an immediate priority.
22 0
River Murray
The River Murray is failing and should not be relied on as a long term supply.
19 0
Increased storage/Mount Bold expansion
Storage relying on River Murray inflow andsubject to climate change impacts is not recommended.
9 0
Total
Based on conservative estimates exceeds current water use. **227**
Current water use
216 Table A shows that demand management, stormwater harvesting, existing catchments, wastewater reuse and rainwater tanks can supply all of Adelaide's water requirements with excellent environmental, social and financial outcomes. The volumes of stormwater and wastewater will grow as the city develops and thus have significant future potential. Adoption of these options will lead to reduced costs and much greater benefits in the long term. Continued extraction of water from the River Murray, desalination and/or increasing reservoir storage do not fit with the sustainable directions outlined.

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Climate change is now widely accepted as a reality, along with planned future growth for Adelaide. Water planning is in crisis through past fragmentation and low levels of resourcing. While sustainability is widely touted, it has received very little analysis. The authors are convinced that sust
.
It is recommended that the following actions be undertaken in parallel as a matter of the greatest urgency:
 Establish a comprehensive long term demand management program with a residential target of 140 litres/person/day and a commercial/industrial target of 20% improvement in water use efficiency. As part of this, change the pricing structure for water by increasing the volumetric costs and reducing other charges to provide more incentive for users to

reduce their demand to meet the overall target levels.
 Undertake an assessment of the capacity of the aquifers beneath Adelaide to support temporary groundwater 'mining', with treatment as necessary, as an emergency water supply, and commence determination of the limits of the aquifers for storing and recovering bulk water harvested from treated stormwater and wastewaters. Research means for exploring and raising the limits, as warranted.
 Commence implementation of a major metropolitan-wide stormwater harvesting program in partnership with local governments and SA Water.
 Identify and pursue strategies for making the total flow of treated wastewater acceptable for urban or peri-urban water supplies in a manner that directly or indirectly reduces the demand by the urban users on non-sustainable water sources by an amount equal to the total of the wastewater flow.
 Provide a single State government department with responsibility for multi-purpose, participatory, total water cycle planning, within the context of the State Water Plan. The
Plan to cover the whole gamut of natural and engineered water systems. The department to beresponsible for the immediate Water Security investigations.
 Broaden the present Water Security investigations to better define the costs and benefits of the long-term water options for Adelaide using total water cycle principles and judged on sustainability criteria as laid out in this report, but with a greater level of resourcing including:
o consultation with Local Government and others who have successfully initiated and developed the more sustainable options to date; and
o a program of information and consultation with the broader community on the implications, benefits and costs of the options as they emerge and progress.
 Put on hold funding proposed for desalination and reservoir storage and redirect to more sustainable options once the above assessments have confirmed the preferred options as feasible.
 Protect and improve existing catchments.
 Prescribe quaternary aquifers to prevent excessive extraction (this will be a specific issue as other sources of water become more scarce).

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Contents

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1. Introduction

Traditionally, as water demands have continued to grow, supplies have been imported to Adelaide in continually larger amounts and from ever increasing distances – first from the Mt Lofty catchments and then from the River Murray. At the same time, the volumes of stormwater runoff and sewage effluent, generated as a direct consequence of the growth of Adelaide, have been discharged in ever increasing quantities to downstream rivers, estuaries or the sea.

While the systems that have been established have brought about great benefits in public health, prosperity and convenience, the upstream environments from which the water is diverted, and the downstream environments which receive the unused and polluted waste flows, have all suffered.
The flood risks within the urban areas have also escalated to a dangerous level, while the extensive concreting and undergrounding of the urban drainage networks have reduced amenity and significantly reduced habitat for biodiversity.

Now Adelaide's water supplies are at immediate risk with historically low flows in the River Murray and this will be a long term problem as climate change accelerates. Under expectations of continued population growth and climate change the traditional approach to water management can only lead to increased environmental and social damages and rapidly rising costs for water supply and discharge. It is obviously an inherently unsustainable direction.

The purpose of this report is to review water options for Adelaide under current and future scenarios of population growth and climate change and to recommend more sustainable strategies to cost-effectively meet Adelaide's water requirements, while achieving the best possible associated environmental and social outcomes. It should be noted from the outset that reviewing water options for Adelaide covers a far broader scope than water supply only. In fact it can be argued that the development of water supply systems without paying due attention to the bigger picture has brought us to this point where we obviously have to make changes. This report sets out to define sustainability for urban water systems as a critical first step in comparing water supply options.

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2. Defining sustainability for urban water systems

Target 3.9 of the State Strategic Plan is 'Sustainable water supply: South Australia's water resources are managed within sustainable limits by 2018'. However, despite a careful search the authors have not been able to find a definition of water sustainability that is used by the State
Government in relation to its urban water planning, nor any ranking of options for urban water systems to address the present and emerging water management problems.

The closest that the Government has come to this exercise recently is embodied in the 'Water Proofing Adelaide' (WPA) project. However, while the report discussed aspects related to its id entified alternative sources, there was no ranking of them to support the choice of a preferred supply mix.
Defining sustainability for urban water systems is a critical first step in comparing water supplyoptions. Since water supply is essentially associated with water diversions, storages and quality modifications, the effects of water supply operations cannot be divorced from their impacts on other aspects of urban and regional water management such as flooding, pollution, biodiversity conservation and amenity. Energy and greenhouse impacts of water supply must also be quantified and managed, particularly where the options for increasing water availability are energy intensive.

A holistic definition of sustainability in relation to urban water management is therefore required. It must cover all these aspects of water management and must therefore include the other major urban water systems of drainage and sewerage, as well as water supply. Table 1 provides a definition of sustainability as related to urban water management developed by the authors against which urban water options may be judged.

Table 1. Definition of and criteria for assessing sustainability of urban water systems Category Assessment criteria

Reliability of services

Reliable water supply and other water services for household and industry into the foreseeable future including access to sufficient clean water for recreation, amenity and aesthetics and freedom from interruption by accident or malice.

Affordability Affordable water supply for household and industry into the foreseeable future.

Current availability

Adelaide is facing a water crisis. The speed at which proposed supply options can be brought on line is of critical importance at present.

Human health Healthy water supply and disposal for people including the supply of water that is fit for purpose including potable and non-potable water and the removal of stormwater and wastewater from living areas to avoid disease and inconvenience

Protection from flood damage

Minimal damage to persons and property from floods (or sea storms) up to a nominal recurrence interval of one in 100 years, but also building in the ability to survive more infrequent, but 'catastrophic', storm events occurring (say) once in 500 years.

Upstream and in-stream environmental protection

Upstream (of Adelaide) and in-stream (in Adelaide) environmental protection including the promotion of biodiversity and quality habitat through:

 minimising diversion of water from supporting environments and
maintaining environmental flows in our river systems
 minimising land impacts on native vegetation

Downstream environmental protection

Avoidance of downstream (of Adelaide) environmental impacts from the discharge of excessively polluted water (including nutrients and sediments) to land, river systems and/or coastal marine habitats.

Greenhouse

Emissions Reduce greenhouse emissions of Adelaide's water supply compared with 1990 levels in line with South Australia's Strategic Plan and Tackling Climate

Change Strategy by dealing with emissions from construction and operation of water supply and treatment infrastructure (mainly associated with energy use).

Sustainable Focus

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The key to achieving sustainability for urban water systems will lie in the design of a system of water infrastructures and operations that can best satisfy these criteria.

Once criteria have been established setting targets can be addressed. Even without formally addressing definitions and criteria it is noted that several agencies have already set targets that are implicitly related to definitions and criteria for sustainability. Among these are:

1) The Australian Coastal Waters Study provides specific targets as follows:

 The total load of nitrogen discharged to the marine environment should be reduced to around 600 tonnes (representing a 75% reduction from the 2003 value of 2400 tonnes).

 A 50% load reduction in particulate matter (from 2003 levels) would be sufficient to maintain adequate light levels above seagrass beds for most of the time.

2) The Adelaide and Mount Lofty Ranges NRM Plan provides twenty year Regional Targets of 75% stormwater use and 100% of wastewater reuse.

3) The State Strategic Plan includes Target T3.1 'Lose no species: lose no known native species as a result of human impacts'.

The Stormwater Management Authority has been established with responsibility for coordinating the assessments of flood risk and drawing up plans to reduce the level of incipient flood damages in Adelaide.

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3. Water related characteristics unique to Adelaide

One of the main barriers to progress in water reform is the tendency of authorities to seek 'one size fits all' solutions to our many water problems. Thus the same solutions tend to be slavishly copied from area to area across the whole of Australia with little regard to the local conditions, i.e. the industry acts globally without thinking locally first.

Adelaide has several hydrological characteristics which, when taken together, set it apart from all the other capital cities in Australia. Some of these characteristics, and their implications, are central to the investigation of sustainability and the layout of sustainable urban water systems at least cost.
Unfortunately, since sustainability itself has not been previously defined in relation to urban water systems, it is not surprising that these features have not been adequately recognised, investigated and incorporated into a coherent water policy across the full water management spectrum. Two major characteristics are the:

- topography of Adelaide in relation to its flood potential; and
- existence of major underlying aquifer systems suitable for bulk storage of water captured for future supplies in drier years.

The first will cause problems for the sustainability of Adelaide unless it is addressed. The second is a potentially major advantage in addressing the sustainability of water supplies.

3.1 Flooding

Australia is widely recognised as a land of droughts and floods. With respect to the former,
Adelaide and its hinterland share the lowest rainfall of all the Australian capital cities. However, it is less well recognised that, at the other end of the water spectrum, Adelaide has most of its urban areas built over unstable alluvial flood sedimentary fans, terraces and flood-out areas and is thus at a high risk of severe damages in large flood events.

The present system of stormwater drainage can deal relatively successfully with minor and even medium flood events. However, above this threshold, flood water will spill out of the perched channels and travel by pathways that are very difficult to predict. In a major flood, overflows will originate in the eastern suburbs. Fast travelling water will spill down roads and through gardens creating debris dams which will cause major erosion and damages. The water will slow, deepen and pool as it enters the western suburbs.

Taken in conjunction with the present drought crisis, the above information points to the conclusion that the past water management and development regimes have delivered Adelaide a position where it cannot claim to be sustainable in respect of foreseeable risks in either flood or drought conditions.
Moreover, as the city and its population expand and the potential for intensified floods and droughts associated with climate change emerge, these inherent problems will only worsen. While our focus during the early years of the twenty-first century has been much engaged with drought, if a storm in 3 hours), it is reasonable to suggest that, following the subsequent development of the western suburbs and continued encroachment of development onto flood plains, many lives could be lost and property damage would be extensive.

3.2 Aquifer systems

The plains areas of Adelaide are underlain by a series of quaternary and tertiary age aquifers. In general, the upper quaternary aquifers are shallow, individually limited in extent and often saline. However in places, mainly where these aquifers are recharged from surface flows, good but limited supplies of water can be extracted with salinities within potable standards. Of greater potential, however are the two deeper, thicker and more homogeneous tertiary aquifers, which are presently used for larger irrigation and industrial supplies.

Sustainable Focus
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In the past, a sustainable level of extraction from the tertiary aquifers has been limited by the slow rate of their natural recharge. The aquifers are separated from direct vertical recharge from rainfall and surface flows by thick layers of overlying clay. The main path for recharge is horizontal, via

relatively low salinity surface flows entering via the extensive fault lines at the foot of the hills face areas. Because of the slow rate of horizontal recharge over the long distances from the recharge areas to the areas where supplies are taken, local over extraction has taken place and large areas of reduced pressure now exist.

Over the past 15 years recharge has been shown to be feasible by drilling into the aquifers and recharging with surface water. This dramatically short-circuits the longer and slower natural recharge process and greatly enhances the possibility of using the aquifers for storage of larger volumes of lower salinity water.
The total storage of water in these aquifers is not accurately known but is generally estimated by h of the reservoirs in the Mt Lofty Ranges. However, since most of the water in storage in the aquifers is only of marginal quality and could not be removed without causing major subsidence problems, it is the potential to progressively exchange increased volumes of the marginal quality stored water with artificially introduced and easily recoverable fresh water that is of greater interest.
This is further discussed in the next sections.

4. Adelaide and regional water balance

4.1 Present water balance

Table 2 shows the present sources of water used for water supply to Adelaide in comparison to the unused outflows, as given in the 2005 Water Proofing Adelaide (WPA) report. The inflows cover the present levels of water demand.

Table 2. Current Water Balance for Adelaide

INFLOWS to the Supply System	**Average Year (GL)**	**Dry year (GL)**
River Murray	80	171[1]
Adelaide Hills	121	30
Groundwater	9	9
Rainwater tanks	1	1
Stormwater reuse and recycled wastewater	5	5
Total	**216**	**216**
OUTFLOWS		
Stormwater (including hills face runoff)	160[2]	50
Treated effluent from coastal wastewater treatment plants	70[3]	70
Total	**230**	**120**

Notes
1. Pumping from the Murray is higher in dry years to offset reduced inflows from the Adelaide Hills
2. Appears high. 115 GL more likely. Dry year appears correct at 50 ML
3. Appears low. Should equate to about 40-50% of supply

The tabling of the water balance in this way gives a broad indication of the general supply and demand situation but does not address many of the more detailed problems, particularly those associated with water quality and the amount of storage required to overcome flow variability. The table does however indicate that the existing and potentially available sources of water in an average year, represented by the addition of both the inflows and outflows, at 446 GL/annum, are well in excess of the existing level of the average year demand of 216 GL/a. In fact the outflows alone are higher than the required inflows in an average year. Average water quantities, per se, therefore do not appear to be a major problem at present in relation to average levels of demand, although the challenges of securing adequate drought storage, reducing flows due to climate change and increasing demand due to population growth must obviously all be addressed. The future water balances under climate change and population growth are addressed below.

Despite the above, Adelaide's water supplies are at immediate risk due to low flows in the River Murray combined with over-allocation of upstream flows. Other serious underlying problems are the rising salinity of the River Murray and the potential for algal blooms[1] within South Australia. These emerging problems have been widely recognised over the past two decades during which time very little planning has been undertaken to secure alternative, additional sources of water for Adelaide. In view of the above, emergency measures may now have to be taken to access supplies from alternative sources that can be brought on line quickly. It would obviously be advantageous if these sources were those that will go on to be developed further into the future.

4.2 Future water balance

The information in Table 2 assumes present day average levels of demand and outflow. However, this information is insufficient for future planning under expectations for population growth to two million persons (State Strategic Plan Target 1.22), and climate change with an expectation of

[1] CSIRO, Oct 2003,"Is the River Murray Water Quality Deteriorating? A Salinity Perspective".
MDBC, Dec 2007, "River Murray System Drought Update No 11"

reduced rainfall, higher temperatures leading to higher evaporation rates and more extreme weather patterns.

The WaterCress water systems planning model, used by the Department of Water Land and Biodiversity Conservation and local governments for their water resource assessments and water systems designs, has been used to simulate the Adelaide and regional water flows and to assess the feasibility of supplying demands from different combinations of source waters (Clark, 2003).

These results have been reworked to investigate the way in which the Adelaide water balance will change under scenarios of population growth, urban development and climate change. The rate of change of all these factors is highly uncertain. The following assumptions have been made for illustrative purposes when the population reaches two million in about 2030-2050.
Ongoing urban expansion and consolidation is assumed, including smaller gardens requiring irrigation. A 13% reduction in rainfall is assumed which results in a 30% reduction in runoff from the Mt Lofty and hills face catchments. Because of their higher runoff efficiency, the runoff per unit area of the urban catchments only reduces by 17%, however, since the urban catchments, under a doubling of the population, are assumed to increase in area by at least 1.5 times, the total stormwater runoff actually increases. Wastewater has the largest increase since it is less influenced by climate change and rises in direct proportion to the population growth.

Table 3 uses figures given in Table 2 above and shows that under the assumption that only 70% of all wastewater and stormwater flows could be harvested, then, even under the assumed level of climate change and a population growth to two million, the total harvestable flow would remain greater than the demand, without either the River Murray or desalination as supplies. Whilst estimates only, the figures illustrate the increasing and significantly large proportions of the total future water budget that stormwater and treated effluent (in particular) could provide.

Table 3. Water balance for 2 million population and 13% reduction in rainfall

Water Demand	**Now GL/a**	**2050 GL/a**
Potable water for internal purposes (discharged to wastewater treatment plants)	100	200
Potable or non-potable water for external purposes and lost by evapotranspiration	102	154
Total	**202[1]**	**354**
Estimated Potential Harvestable Water		
Mt Lofty Ranges flow to the Adelaide reservoirs	121	85
70% of stormwater runoff (current total runoff assumed at 115 ML/a)[2]	80	100

85% of internal supplies returned as wastewater (suitable for nondrinking purposes)
85 170

Total 286 355
Notes
1. Reduced from 216 GL shown in Table 1 by exclusion of present 'non-mains' supplies
2. 70% capture achieved by present stormwater schemes in Adelaide. Conservative estimate of runoff assumed

We believe the figures in Table 3 are conservative. They are estimates based on the amounts that are being presently captured and supplied. These can be expected to increase as experience and technologies progress. They confirm that even without desalination or the River Murray, the local flows are sufficient to supply present demands and could potentially remain sufficient into a future involving a doubling of Adelaide's population and an expectation of reduced rainfall caused by climate change.

The amount of storage required to carry the flows through drought conditions is addressed in subsequent sections.

Sustainable Focus
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5. Assessment of options

A range of water supply options are assessed against the criteria listed in section 2. Each option is given a score from 0-5 based on its merits, apart from affordability which is scored out of 15 to reflect the importance of an affordable water supply. Figure 2 shows the allocation of scores against each sustainability criterion.

Figure 2. Sustainability criteria weighting

The criteria have been loosely grouped according to the three pillars of sustainability as follows:
- The blue criteria reflect social sustainability considerations (30%)
- The red criteria reflect economic sustainability considerations (40%)
- The green criteria reflect social sustainability considerations (30%)

Obviously many of the criteria reflect more than one sustainability pillar so this only provides a rough guide. The sum of the scores gives the total for the option analysed. The higher the score the better the supply option.

The 1994 EWS report "Future Water Supplies: 21 Options for the 21st Century"[2] contained a list of 21 possible options for future water supplies in SA. Included were options such as pipelines from the Ord River, diversions of rivers inland, icebergs, etc. These options were all shown to have major disadvantages and many would rank very poorly against the sustainability criteria defined here-in. The current set of water supply options considered here-in include those which were rated
[2] EWS (SA Water) Library Ref 94/4

Sustainable Focus
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most highly in the EWS report and/or are still widely recognised as legitimate options under present conditions. Options assessed are:
1. River Murray
2. Existing catchments
3. Rainwater tanks
4. Stormwater harvesting, wastewater reuse and groundwater extraction.
5. Demand management
6. Desalination and interconnector
7. Increased reservoir storage

Stormwater, wastewater and groundwater are considered in the same section since they are all located within the Adelaide area itself and have close synergies in the manner in which they may be developed.

The scoring and ranking of the options are inevitably subjective and should only be regarded as an initial screening. It is hoped that the process draws attention to the definition of sustainability, the inter-action that different water supply options have with the sustainability criteria and illustrates the fundamental importance of the decisions that must be made with respect to our future water supplies on the future development directions of Adelaide itself.

5.1 River Murray

The River Murray provides 80 GL or 37% of Adelaide's water in an average year and 180 GL or 79% in drought years[3]. In fact 91% of the total water delivered state-wide in 2006/07 (245 GL) was supplied from the Murray.[4]

It is now well documented that the River is failing, suffering from over-extraction and reduced rainfall. Although urban water use only comprises a very small part of the total diversions from the

River Murray and further supply rights could be purchased, further diversions will be to the detriment of other users and will be seen to be socially undesirable where alternative options for Adelaide could be pursued that would not be detrimental to others.

Pumping from the River Murray is an energy, and therefore greenhouse, intensive process. In 2005/06 SA Water supplied 234 GL with only 48.7% sourced from the River Murray. The associated electricity consumption for all water supply activities was approximately 280 GWh, an overall energy intensity of 1.2 kWh/kL. However, in the dry year of 2006/07 SA Water supplied 245 GL[5] with 91% supply from the River Murray. The electricity consumption was approximately 530 GWh, an overall energy intensity of 2.2 kWh/kL. If the energy intensity is reduced 30% to include only major pumping and water treatment and increased by 5% to lift the proportion of supply from the Murray to 100%, the energy intensity of supplying potable water from the Murray is estimated at 1.6 kWh/kL.

Table 4 provides an assessment of the River Murray as an urban water option.

3 Waterproofing Adelaide
4 SA Water Annual Report 2007 http://www.sawater.com.au/NR/rdonlyres/FFAE4759-C70E-4322-B6ED-00E74F92EA60/0/SAWater_AR_Parliament_2007.pdf
5 SA Water Annual Report 2007 http://www.sawater.com.au/NR/rdonlyres/FFAE4759-C70E-4322-B6ED-00E74F92EA60/0/SAWater_AR_Parliament_2007.pdf

Sustainable Focus
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Table 4. Assessment of River Murray

Category	Assessment criteria	Score
Reliability of services (5)	**Flows in the River Murray are steadily decreasing and becoming more saline and there is a widespread acceptance of the need to wean Adelaide off this source of water which is increasingly unreliable.**	0
Affordability (15)	At present pumping from the River Murray is affordable. As competition for water in the Murray and energy costs increase affordability will reduce. WPA cost estimate $1.1-$1.3/kL.	9
Current availability (5)	At present water from the River Murray is easily accessible.	4

Human health
(5)
Water from the River Murray requires extensive treatment prior to potable use. Upstream inputs to the River Murray include sewage, pesticides and fertilisers. Supplies presently meet potable standards.
4
Protection from flood damage (5)
Supply from the River Murray does nothing to reduce flood risk for
Adelaide. 0
Upstream and in-stream environmental protection
(5)
Supply from the River Murray results in diversion of water from supporting environments and reduces environmental flows in the river system
0
Downstream environmental protection (5)
Supply from the River Murray does nothing to reduce downstream environmental impacts for Adelaide. 0
Greenhouse emissions (5)
Greenhouse emissions from pumping water over such long distances are relatively high. Estimated energy intensity of 1.6 kWh/kL.
2
Overall (50) 19

5.2 Existing catchments

The total runoff from the Onkaparinga, Torrens, South and Little Para catchments into the Mt Lofty Range reservoirs is about 180 GL/a of which 15 GL/a is lost by evaporation, 10 GL/a is diverted by farm dams and 34 GL/a spills. Thus 121 GL/a or 56% of Adelaide's reticulated supplies are provided from these sources. This drops to only 30 GL or 14% in drought years[6].

The total storage capacity of the Adelaide reservoirs is 222 GL. Further capture of the 34 GL/a presently spilled would require about 3 to 6 units of storage for each unit of spill saved. Moreover, evaporation losses and salinity rapidly increase as the storage sizes increase so that achieving an average long term supply equal to the long term average inflow is an impossibility using surface storages.

Further diversions could be sourced from catchments further north and south, but these sources are also expected to reduce by 30% under predicted climate change scenarios and diversions would create environmental damages. An alternative is to release Mt Lofty Ranges water from the reservoirs for storage in the Adelaide aquifers. This has been proposed by CSIRO and appears an attractive alternative to additional

[6] Table 1, Water Proofing Adelaide

surface storages[7]. However, the limits to aquifer storage need to be assessed. Storage in the fractured rock aquifers within the Mt Lofty Ranges should also be investigated. Environmental flow requirements must still be met.
Table 5 provides an assessment of existing catchments as an urban water option.
Table 5. Assessment of existing catchments
Category Assessment criteria Score
Reliability of services (5)
Flows vary significantly from year to year. Expected reduction of 32% under climate change impacts with higher variation from year to year.
If flows can be stored (eg in aquifers), relatively high reliability.
4
Affordability
(15)
Very affordable.
12
Current
availability (5)

At present water from the existing catchments is easily accessible.
4
Human health
(5)
Water from the catchments requires treatment prior to potable use
but is of a relatively high standard.
4
Protection from flood damage (5)
Supply from the existing catchments already provides an important service in flood mitigation by reducing flows from the Adelaide Hills through the suburbs in storm events.
3
Upstream and in-stream environmental protection (5)
Supply from existing catchments results in diversion of water from local supporting environments. Land impacts on biodiversity have occurred in the past.
2
Downstream environmental protection (5)
Storage and supply from the existing catchments already reduces stormwater discharges to the natural environment. Does not reduce sewage flows to the gulf.
2
Greenhouse emissions (5)
Greenhouse emissions from pumping water from existing catchments are relatively low. Assume emission intensity of 0.4 to 0.6 kWh/kL for conventional water treatment[8].
4

Overall (50) 35

5.3 Rainwater tanks

Adelaide has more rainwater tanks per capita than any other Australian capital city and there is community interest in rainwater capture and reuse. Roof runoff is generally of potable quality with little treatment however the captured rainwater is relatively expensive (due to the cost of system installation) and maintenance requirements are not always managed well at the household level.
The total amount of roof runoff generated in Adelaide is estimated to be about half of the total stormwater runoff (say presently about 50 GL/a). This is the highest quality water available from any of the sources. It also runs off with minimum losses in all rainfalls and therefore has a high reliability. However, because of roof designs and tank capacity limitations, only part of this water could be easily harvested by individual houses.

7 Verbal Peter Dillon, CSIRO
8 http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

Sustainable Focus
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Rainwater tanks and water recycling appear to have greater immediate application in industrial situations where economies of scale exist. On-site storage capacity in the form of tanks can be used to reduce peak flows in mains water supply. The benefit of tanks for mitigation of peak flow rates in water supply and the additional benefit of reduction in stormwater flooding have not been adequately investigated.
Table 6 provides an assessment of rainwater tanks as an urban water option.

Table 6. Assessment of rainwater tanks
Category Assessment criteria Score
Reliability of services (5)
Reliability will vary with year to year variations in rainfall, household use and level of maintenance of systems.
3
Affordability
(15)
Very expensive. WPA cost estimate $5.6/kL. NWC cost estimate $3- $11 depending on connected roof area.[9]
3

Current availability (5)
Rainwater tanks can be relatively quickly installed and plumbed in.
3
Human health
(5)
Rainwater from roofs is considered as potable by the Department of Health but maintenance requirements should not be underestimated.
3
Protection from flood damage (5)
Rainwater tanks plumbed into indoor uses will provide some flood mitigation benefits. 3
Upstream and in-stream environmental protection (5)
No negative impacts on the upstream environment.
5
Downstream environmental protection (5)
Some benefits in the reduction of stormwater discharges.
4
Greenhouse emissions (5)
While greenhouse emissions are associated with tank manufacture this is offset by relatively low energy use from direct indoor reuse.
4

Overall (50) 28
Improvements in rainwater tanks are seen to be a major growth area in conjunction with the development of more sustainable homes (both existing and new). The development of on-site systems, including solar energy, composting toilets, greywater recycling and rainwater (and other water) storage devices should be encouraged by research, regulations and incentives. Until costs can be reduced and maintenance standards improved, rainwater tanks and greywater recycling are seen to only have a small role in Adelaide's water supply mix. The greatest contribution may initially come from the industrial sector. By 2050, this situation may have changed as on-site technologies continue to develop.

5.4 Stormwater harvesting, wastewater reuse and groundwater extraction.

Stormwater harvesting, wastewater reuse and groundwater extraction are addressed together, but in separate sub-sections, since they all have interlinkages with aquifer storage and recovery.

[9] The cost-effectiveness of rainwater tanks in urban Australia, Marsden Jacob Associates for the National Water Commission

Based on WPA information present levels of combined stormwater harvesting and wastewater reuse is about 5 GL/a and groundwater consumption is 9 GL/a. The present total stormwater and wastewater flow is given by WPA as 230 GL/a. These sources are generated in almost direct proportion to the growth in population and development; hence they have an intrinsic sustainability in respect to their future availability as potential water supply sources.

Since the aquifers are spatially distributed over a wide area of central and western Adelaide and recharge and recovery of stormwater and wastewater can only be established in sufficiently large volume rates by spatially distributing the bores across the extent of the aquifers, the development of these sources will be necessarily best accomplished via decentralised systems. This raises particular issues in relation to land planning and building designs which are addressed in section 7.

As noted above, the total capacity of the tertiary aquifers is uncertain but may be of the order of 100 times the capacity of the Mt Lofty reservoirs. Clark (AWA 2003) addressed the amount of storage required in surface and aquifer storages under various strategies in which stormwater and wastewater were used to augment Mt Lofty catchment runoff in order to replace reliance on River Murray water. Assumptions were made based on the experience gained by the demonstration projects at Mawson Lakes and elsewhere. Clark assumed that because of limitations on open space for wetlands to capture stormwater, only 70% of the stormwater could be harvested, however 95% of wastewater could be recycled. Stormwater and wastewater would be stored by a network of distributed bores in the upper and lower tertiary aquifers. Clark's modelling showed that only 50 to 250 GL of aquifer storage would have to be accessed in order to reliably supply present day demands throughout a 100 year period receiving the past record of historical rainfalls under various combinations of sources and supplies in which:

- Mt Lofty catchment water was mainly retained as the primary source for 'in-house' potable demands
- treated wastewater was used as the primary source for non-potable demands including toilet flushing and all garden and open space irrigation within the City, and
- stormwater was used in conjunction with the above, or as a fill-in for either or both sources if/when they failed.

The large range of 50 to 250 GL of aquifer storage arose because of the different matching that could be made between the different combinations of the supply sources and the demands, with each having markedly different seasonal patterns, i.e. Mt Lofty runoff is markedly winter oriented; stormwater is similar but also has a larger summer component; in-house demands and wastewater flows are essentially seasonally constant, while irrigation demands are markedly summer oriented.
The use of rural catchment and stormwater runoff for supplying irrigation therefore requires large storage volumes. The use of treated wastewater for toilet flushing and constant industrial purposes requires virtually no storage at all.

In general, because of the lesser variability and greater reliability of stormwater and the constant supply of treated wastewater flows, the amount of aquifer storage required to provide a reliable supply over 100 years for a typical urban area when using a combination of these sources (assuming they could be satisfactorily treated to acceptable standards), was found to be of the order of 5 to 8 times less than the surface reservoir storage required when the supply was sourced from Mt Lofty rural catchments.

Clark found that the space required for wetlands to capture 70% of the stormwater flow at any location would constitute about 5% of the upstream urban catchment area. Since 12.5% of new development areas is commonly assigned as open space, the wetlands could be sited within these areas. However such open areas may not be suitably located, or may not exist where development has been intensive. To date open spaces where wetlands could exist in already developed areas have been located in parks, golf courses, airports and re-development zones.

In areas where development has left few open spaces, wetlands could be replaced by the adoption of permeable paving, underground 'buffer' tanks and rainwater tanks. Alternatively, the water quality and treatment aspects of wetlands could be foregone in favour of small-footprint rapid sand filtration plants. In the extreme, high risk flood-prone buildings could be removed to make way for

linear parks which could contain mini-wetlands, as well as creating walking and bicycling tracks and enhanced public amenity and biodiversity.

Clark (AWA 2005) also showed that the largest peak flood flow rates in urban areas of Adelaide will continue to occur in summer rather than winter. Flood detention dams situated in urban areas (as are increasingly being required under urban consolidation trends) are generally required to be larger than would be required for stormwater harvesting. Since stormwater harvesting will occur mainly in winter, when the full capacity of the dams are not required for flood mitigation, the dams can be used for both flood mitigation and harvesting at no additional cost.

Overall Clark's modelling showed that approximately 900 bores would be required for aquifer injection, storage and recovery under the supply strategy that entailed access to 60 GL of aquifer storage.

The feasibility of storing large quantities of water in the aquifers beneath Adelaide is the key to the use of stormwater and wastewater as new sources of low cost water supplies that will bring with them all the other benefits of sustainability, as defined. Recent trials by CSIRO have shown that aquifers can be used for water treatment and transmission in addition to storage. Water of potable standard was extracted from an aquifer at Parafield which had been previously recharged by stormwater, which had only been treated before injection by passing through a wetland. The recovered water exceeded drinking water standards and was bottled as drinking water for publicity purposes[10]. The ability to recharge in one location, and recover in another, offers the potential for water trading between rechargers and users without the need for linking pipelines.

If however, the usable capacity of aquifer storage and recovery is found to have lower limits than has been generally informally identified by hydrogeologists (about 60-80 GL), the option exists to pump stormwater (possibly after pre-treatment) to the nearest existing reservoirs, after which it can be treated to potable standards in the existing treatment plants. This may be a short term solution while the broader planning aspects of a more decentralised system involving spatially distributed wetlands and ASR bores is sorted out.

5.4.1 Stormwater harvesting

The total amount of stormwater generated is far in excess of the flows on the Adelaide plains before urban development took place. The quality of the flows varies from very good (eg roof runoff) to poor (eg runoff from arterial roads). The negative impacts of stormwater on coastal environments are well documented.

Poor quality runoff is best treated at or near its point of generation. Where possible, this can be done using wetlands, which then enhance biodiversity and urban environments and can assist in flood mitigation. The cleaned water is then suitable for supply. It is in sufficient quantities to be used for augmentation of potable supplies after storage in underlying aquifers and will grow in volume along with the expansion of the city. Its volume is less affected by climate change than supply from dams on rural catchments.
The location of capture and treatment storages can be made compatible with a program for reducing flood damages.

Estimates of harvestable stormwater vary significantly, including:

- WPA assessment of 15 GL.
- Todd Hodgkin 50 GL[11].
- The Cities of Salisbury, Playford and Tea Tree Gully are in the process of completing projects to extract 20 GL by themselves[12]. Most of the harvesting schemes are being designed for a 70% capture efficiency.
- The South Australian Liberals proposed 89 GL of stormwater capture and reuse[13].

10 CSIRO publication
11 Aquifer Storage Capacities of the Adelaide Region Report DWLBC 2004/47
12 City of Salisbury press release 21/7/2005
13 South Australian Liberals website http://www.martin2010.com.au/Pages/Article.aspx?ID=389

Sustainable Focus
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The Adelaide and Mount Lofty Ranges NRM Plan provides a twenty year Regional Target of 75% stormwater harvesting and use.

Over the past 15 years stormwater has gone from being generally regarded as a nuisance to being a potential resource. The State Government is working with local governments on stormwater harvesting and reuse through its Stormwater Management Authority. The Government is contributing some funding to the Authority for projects incorporating floodplain mapping, preparation of stormwater management plans and priority stormwater infrastructure works[14].

Most advances in stormwater management have been left up to individual local Councils, developers and research organisations. Although considerable success has been achieved, progress has necessarily been ad hoc and almost completely uncoordinated in respect to any State policies, plans or strategies.

In view of the potential of stormwater, much more needs to be done, the question of responsibility for planning needs to be addressed and the whole process needs to be accelerated by an order of magnitude.

Table 7 provides an assessment of stormwater harvesting as an urban water option.
Table 7. Assessment of stormwater harvesting
Category Assessment criteria Score
Reliability of services (5)
Flows vary from year to year but less than flows from catchments.
With flows stored through ASR relatively high reliability.
4
Affordability
(15)
Relatively inexpensive. WPA cost estimate $0.1-$1.5/kL.
12 Current availability (5)
Will take some time to fully identify preferred configurations and construct. Groundwater may be used in the meantime.
3
Human health
(5)
Relatively easy to treat to potable standards if required.
4
Protection from flood damage (5)
Significant flood mitigation benefits subject to sufficient detention capacity. 4
Upstream and in-stream environmental protection (5)
No negative impacts on the upstream environment.
5
Downstream environmental protection (5)
Very significant benefits in the reduction of stormwater discharges.
5
Greenhouse emissions (5)
Relatively low greenhouse emission option. Assume 0.7-1.2 kWh/kL for brackish reverse osmosis[15].
4

Overall (50) 41
[14] http://www.ministers.sa.gov.au/news.php?id=3228
Sustainable Focus
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5.4.2 Wastewater reuse
Wastewater is excess to all previous flow regimes. It constitutes a present large pollution source.
The level of mandatory cleansing to make it acceptable for discharge to the environment makes it suitable for irrigation, toilet flushing and other industrial purposes at little or no additional treatment cost. However, under the existing system layout, where the sewage treatment plants are sited on the coast, the cost of reticulating the treated water back for re-use is a potentially large cost.

To date wastewater reuse has focussed on peri-urban irrigation. The proximity between the northern and southern wastewater treatment plants and the irrigation areas reduces the reticulation cost. Some of this use replaces past unsustainable extractions of groundwater, however additional allocation to new irrigation ventures requires a closer examination of the relative long term costs and benefits of re-use by first users or use by the range of possible new users.

The flow of wastewater is essentially constant. It therefore has virtually zero need for storage if used for supplying constant demands (eg toilet flushing and certain industrial uses). This is a large advantage which greatly reduces its cost as an alternative water source.
Sections of the public have shown a strong aversion to acceptance of even highly treated wastewater for drinking and washing, even when health standards are met or surpassed. Several hierarchies of preferences for the use of treated wastewater have been obtained. These generally indicate wide acceptance for garden irrigation with growing un-acceptance for more 'personal' uses. It is less well

known that several towns along the Murray River and in the Mt Lofty Ranges discharge their treated effluent into the creeks and rivers that inflow to the water supply reservoirs, although on a minor scale overall, and that this practice of recycling effluent through river flows is an accepted practice on a much wider scale in most water supply systems in Europe.

The Australian Coastal Waters Study provides specific targets for wastewater as follows:
 The total load of nitrogen discharged to the marine environment should be reduced to around 600 tonnes (representing a 75% reduction from the 2003 value of 2400 tonnes). A 50% load reduction in particulate matter (from 2003 levels) would be sufficient to maintain adequate light levels above seagrass beds for most of the time.

The Adelaide and Mount Lofty Ranges NRM Plan provides a twenty year Regional Target of 100% of wastewater reuse.

The Government has announced that it will spend about $426 million over four years on upgrades and expansion of wastewater treatment plants and water recycling infrastructure to meet the increasing demand of the State's growing population. About $80 million will be spent in 2008/09.
The upgrades will increase the percentage of wastewater reused in South Australia from 29% to 45%. This includes the Glenelg Waste Water Treatment Plant to Adelaide Parklands project which will be a first instance of bringing recycled water into Adelaide's CBD. These schemes have not, however, been framed within a long term integrated plan for managing Adelaide's water systems.
Table 8 provides an assessment of wastewater reuse as an urban water option.
15 http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

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Table 8. Assessment of wastewater reuse
Category Assessment criteria Score
Reliability of services (5)
Consistent flows from year to year and proven re-use technologies provide a high level of reliability.
4
Affordability
(15)
Relatively inexpensive, but depends on treatment required. WPA cost estimate $1.0-$1.75/kL.
9
Current availability (5)
To develop and construct additional wastewater reuse schemes will take some time.
2
Human health
(5)
Not an issue for non-potable purposes. Cross-connection with potable supplies possible, but low risk even then. Can be treated to potable standard, but very low level of present public acceptance.
3
Protection from flood damage (5)
No significant flood mitigation benefits.
0
Upstream and in-stream environmental protection (5)
No negative impacts on the upstream environment. Can assist upstream environments if used to replace upstream sourced supplies.
4
Downstream environmental protection (5)
Very significant benefits in the reduction of effluent discharges.
5
Greenhouse emissions (5)
Low greenhouse emission option. 0.8-1.0 kWh/kL for wastewater reclamation[16].
4

Overall (50) 31

5.4.3 Groundwater extraction (without artificial recharge)

As a general principle long-term groundwater extraction rates should not exceed the long-term aquifer recharge rates. While recharge rates rise to partly compensate for rises in extraction rates, continued high extraction rates raise the risk of drawing high saline water into the existing usable aquifer zones. While the lower tertiary aquifers are now under prescription, thus limiting the total extraction from them, unconstrained extraction from the upper quaternary aquifers will continue unregulated.

An average of 18 GL/a rising to 24 GL/a was withdrawn over the decade 1990-2000 via about 1,200 private irrigation bores over the Northern Adelaide plains. A similar rate of withdrawal had been in existence for many years previously and is still continuing despite estimates that these rates are many times in excess of the natural recharge rates. Since the aquifers extend over at least double this area, the withdrawal of emergency supplies of about the same order would appear to be feasible.
Groundwater can be brought on-line quickly as an emergency supply. In areas with buildings or flood prone land extraction of groundwater needs to be carefully managed to avoid the possibility of subsidence if Hindmarsh Clay is dewatered or pressures are excessively reduced.

16 http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

Sustainable Focus
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Table 9 provides an assessment of groundwater extraction without managed aquifer recharge as an urban water option.

Table 9. Assessment of groundwater
Category Assessment criteria Score
Reliability of services (5)
The large volume available ensures high reliability over the short term, but recharge is required over the longer term to sustain higher supply rates.
2
Affordability
(15)
Relatively inexpensive. Can be accessed close to demand. Will require treatment. Estimate $0.75-$1.00/kL.
12 Current
availability (5)
Can be brought on line very rapidly as 'emergency' source.
Groundwater has been a traditional source of emergency supplies with last use in Adelaide during the drought of 1954.
5
Human health
(5)
Relatively easy to treat to potable standards if required. Some shallow groundwater sources chemically contaminated.
3
Protection from flood damage (5)
No significant flood mitigation benefits unless used in conjunction with stormwater harvesting and ASR. 0
Upstream and in-stream environmental protection (5)
Unsustainable for additional supply without artificial recharge. Rates of natural recharge are poorly nown. No particular benefit to upstream environments
0
Downstream environmental protection (5)
Unsustainable supply without recharge. No particular benefit to downstream environments 0
Greenhouse emissions (5)
Low greenhouse emission option. 0.7-1.2 kWh/kL for brackish reverse osmosis[17].
4

Overall (50) 26

5.5 Demand management

There is a widespread tendency to focus on the sources of water supply during drought. However, there is the opportunity to reduce the amount of water we use in the first place. This is not a trivial matter. In South East Queensland, per capita mains water consumption reduced from 300 litres per day in 2005 to 129 litres per day in 2007 – a reduction of 57%18. This followed the introduction of a comprehensive demand management program Target 140, a campaign to achieve a regional average water use target of 140 litres per person per day.

The Target 140 program included[19]:

- The Residential Excessive Water Users Compliance Program under which households which use above a specified allocation without a legitimate reason are exposed to penalties.
- Water restrictions.
- Requirements for industry to implement Water Efficiency Management Plans.

17 http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

18 Queensland Water Commission http://www.qwc.qld.gov.au/tiki-read_article.php?articleId=260

19 Queensland Water Commission http://www.qwc.qld.gov.au/Demand+management

- Requirements for new houses to substitute 70,000 litres per annum from rainwater or local recycling and to incorporate water efficient fixtures.
- A comprehensive water rebate scheme.
- Pressure and leakage reduction programs. Brisbane City Council has saved 20 megalitres (ML) of water per day under such a program.[20]

The Target 140 program has recently been slightly softened to Target 170 to reflect the reduced scarcity of water at this time.

In 2006/07 average residential consumption per household in the metropolitan Adelaide area was 246 kL for an estimated population supplied of 1,095,000[21]. Based on an average household size of 2.4 persons[22] this gives a daily per capita water consumption of 280 litres. If a program similar to Target 140 is introduced this has the potential to reduce Adelaide's residential water consumption by 50%. Sustainable Focus has taken into account the different climate and in particular rainfall amount and distribution in making this recommendation.

Average daily per capita consumption including commercial, industrial and residential use was 388 litres in 2006/07[23] By deduction, commercial and industrial water consumption is approximately 108 litres per person per day. A twenty percent reduction in industrial and commercial water consumption could be expected through a targeted water efficiency program based on the practical experience of Sustainable Focus.

Overall, the potential saving from a strong demand management program (supported with pricing reform – refer below) targeting residential and commercial/industrial users would therefore be in the order of 160 litres per capita per day, equivalent to 64 GL per annum.

The South Australian State Government has a rebate package to encourage the harvesting of rainwater and to reduce water use in the home. Rebates are available for water efficient showerheads, toilets, washing machines and garden products, home water audits and installation of rainwater tanks[24]. This program is a beginning. A much more comprehensive approach is needed. This should include making the program as simple and non-bureaucratic as possible and including additional measures. An example of an additional measure is reducing mains pressure at each household or the neighbourhood level to less than 500 kPa. Above this pressure most water efficient

fixtures are not guaranteed to function and water wastage is inherent. Obviously fire and other systems require higher pressures but 500kPa is more than sufficient for all household needs.
Pricing is an essential component of managing demand. In South Australia the two-tier structure for residential customers for 2007/08 includes:

 $0.50/kL for water use from 0-125 kL.
 $1.16/kL for water use above 125 kL.
The new three tier structure for 2008/9 is:
 $0.71/kL for water use from 0-120 kL.
 $1.38/kL for water use from 120-520 kL.
 $1.65/kL for water use above 520 kL.[25]

Costing water in the vicinity of $1 per tonne provides little incentive to reduce consumption. While the new tariffs are higher, the increases are most heavily weighted towards the lowest water users (42% increase below ~ 125kL compared with 19% increase above 125kL). This effectively

20 Brisbane City Council http://www.brisbane.qld.gov.au/BCC:BASE::pc=PC_2452
21 SA Water Annual Report 2007 http://www.sawater.com.au/NR/rdonlyres/FFAE4759-C70E-4322-B6ED-00E74F92EA60/0/SAWater_AR_Parliament_2007.pdf
22 Australian Bureau of Statistics http://www.censusdata.abs.gov.au/ABSNavigation/prenav/ViewData?&action=401&tabname=Summary&areacode=405&issue=2006&producttype=QuickStats&textversion=true&navmapdisplayed=true&&breadcrumb=PLD&
23 SA Water Annual Report 2007 http://www.sawater.com.au/NR/rdonlyres/FFAE4759-C70E-4322-B6ED-00E74F92EA60/0/SAWater_AR_Parliament_2007.pdf
24 http://www.ministers.sa.gov.au/news.php?id=3228
25 http://www.ministers.sa.gov.au/news.php?id=2515

disadvantages more efficient water users. Pricing for commercial users also needs to be addressed. of 246 kL the direct unit charge for water supply would be only $203 per annum. However, the overall cost of water is much greater than the unit charge. There are annual fixed supply charges for water supply of $160 and sewer at $1.42 per $1,000 property value. Based on a median house price of $420,000 the fixed charges total $756 – this is almost four times the variable cost.
If a 50% reduction in household water use was targeted, the average household's water bill would only reduce by 10%. Again, this provides little incentive for householders to reduce use and would likely soon reduce the momentum of any demand management plan. Redressing the balance between fixed and variable charges is urgently required.

One option proposed by Mike Young (University of Adelaide) and Jim McColl (CSIRO) proposes a flat rate charged per kilolitre of water with no water supply charge. This has been modelled by Intelligent Software Development which has shown that the existing tariff structures disadvantage low income households and low water users and that shifting to a flat tariff would redress the balance significantly[26]. We believe this rationale could be taken even further by removing all standing water and sewer charges and putting in place a tariff that allows for a reasonable amount of water at a reasonable price and then rises steeply to provide incentives for water efficiency and management. The average cost per household could remain the same. Table 10 provides an assessment of demand management as an urban water option.

Table 10. Assessment of demand management
Category Assessment criteria Score
Reliability of services (5)
If well designed and implemented, demand management programs are a proven and reliable option
4
Affordability
(15)

Highly affordable option. Small changes made at the household level. No significant infrastructure required.
15 Current availability (5)
Demand management programs can be brought on-line quickly.
4
Human health
(5)
No issues with human health, if suitably structured.
5
Protection from flood damage (5)
No flood mitigation benefits.
0
Upstream and in-stream environmental protection (5)
Demand reduction will assist in returning water to upstream environments.
4
Downstream environmental protection (5)
Significant benefits in the reduction of effluent volumes.
4
Greenhouse emissions (5)
Lowest greenhouse emission option.
5

Overall (50) 41

26
http://www.intelligentsoftware.com.au/files/Fairer%20Water%20Pricing%20Policy%20for%20Adelaide%20Residents-Public.pdf

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5.6 Desalination

A $1.1 billion 50 GL desalination plant at Port Stanvac was recently announced. This option will provide a source of water regardless of rainfall. It is however very difficult and energy intensive to remove salt from water – it is much easier to remove other common impurities. The saltier the water the higher the difficulty and the greater the energy use. This means that desalinating groundwater, stormwater or even wastewater is much easier than desalinating sea water. Overall, this makes desalination of sea water a relatively high cost, high greenhouse intensity option.

An associated $304 million inter-connector pipeline, to be completed in 2014, is proposed to connect reservoirs in the North and South of Adelaide, providing greater flexibility in managing Adelaide's water distribution system27. This has been proposed as part of the sea desalination scheme. While not stated, the pipeline would presumably be needed as a result of the location of the desalination plant towards the south of Adelaide while the bulk of demand is in the north.

However, the bulk of the stormwater, wastewater and groundwater storage is in the north of Adelaide and thus the establishment of

the pipeline without taking future options into account could disadvantage the viability of these future options.

Table 11 provides an assessment of desalination as an urban water option.

Table 11. Assessment of desalination

Category Assessment criteria Score

Reliability of services (5)

Consistent flows regardless of rainfall and proven technologies provide a high level of reliability.

4

Affordability

(15)

Relatively expensive. WPA cost estimate $1.50-$2.00/kL (assume based on operating costs, excluding National Emissions Trading

Scheme). The true cost would be much higher as the $1 billion capital cost needs to be paid off.

6

Current availability (5)

Will take time to construct and commission proposed plant. 3 Human health

(5)

Water will be treated to meet potable standards. 4 Protection from flood damage (5)

No flood mitigation benefits. 0

Upstream and in-stream environmental protection (5)

Only marginal benefits on the upstream environment. 4

Downstream environmental protection (5)

Significant negative impacts on the downstream environment resulting from brine discharge to the Gulf. No improvement to existing impacts from stormwater and wastewater discharges.

1

Greenhouse emissions (5)

Highest greenhouse emission option. 3-5 kWh/kL for reverse osmosis of seawater[28]. Almost ten times more energy intensive than standard water treatment and four times more energy intensive than reverse osmosis of stormwater or wastewater.

0

Overall (50) 22

27 http://www.ministers.sa.gov.au/news.php?id=2515

28 http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

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5.7 Mt Bold expansion/increased reservoir storage

The State Government is continuing to pursue increased storage capacity. This was initially foreseen as involving the doubling of the capacity of the Mt Bold reservoir to two years of storage[29], but now appears to be including other possible sites with a target of 384 GL. Since increasing the storage associated with existing Mt Lofty catchment inflows will only provide a very small increase in supply, the storage is presumably to be filled with water from other sources. These have not been identified, but are believed to mainly involve the River Murray.

It is estimated such a project would take up to ten years to design and build. Given the long lead time, climate changes would need to be projected out to at least 2050 to determine the value of the project, which is highly sensitive to the effects of climate change. The authors share the Conservation Council of South Australia's (CCSA) concerns regarding destruction of unique habitat (in the case of Mt Bold) which will impact on threatened species[30].

The authors agree that additional storage is required to attain adequate water security for Adelaide. However, in semi-arid climates such as Adelaide's, groundwater storage is preferable to surface storage if it can be found. Investigations into increased surface storage capacity in the Mt Lofty

Ranges appear premature until the capacity of the groundwater aquifers and the sources of the waters to be stored have been adequately examined. Table 12 provides an assessment of increased storage capacity as an urban water option.

Table 12. Assessment of increased storage capacity

Category	Assessment criteria	Score
Reliability of services (5)	Provides additional storage but probably reliant on River Murray inflows which will be increasingly uncertain.	1
Affordability (15)	Highly expensive storage option at a minimum cost of $850 million with very little additional benefits.	1
Current availability (5)	Will take up to 10 years to construct.	0
Human health (5)	Water is assumed to be treated to potable standards. Refer River Murray.	4
Protection from flood damage (5)	Could be designed to have additional flood mitigation benefits.	2
Upstream and in-stream environmental protection (5)	Major negative impacts on the upstream environment through the possible destruction of habitat with dependant threatened species.	0
Downstream environmental protection (5)	No downstream environmental benefits.	0
Greenhouse emissions (5)	Claimed quadrupling of the carbon footprint[31].	1
Overall (50)		**9**

29 http://www.ministers.sa.gov.au/news.php?id=3228
30 Water in a Changing Climate, Conservation Council of South Australia, June 2008
31 Water in a Changing Climate, Conservation Council of South Australia, June 2008

6. Summary of options

The various water options have been ranked using the scores in the Tables in section 5.
The use of the sustainability criteria separates the options quite dramatically. While the scoring has been subjective, it is difficult to envisage that using the criteria others would not reach a similar overall ranking of the options. The authors believe that the criteria can be justified on the basis that their adoption will support the needs of present and future generations of Adelaideans.

While the amounts that can be supplied from the various high ranked ‘preferred’ options cannot be known accurately at this time, it is possible to suggest and examine a supply mix compatible with the ranking. The authors have therefore allocated a nominal preferred supply for each option assessed in Table 13 below. While these figures are based on limited information, they show that demand management, stormwater harvesting, wastewater effluent re-use and rainwater tanks have the capacity to augment existing supplies from the Mt Lofty catchments into a next era of urban water management, that is specifically directed towards long term sustainability. Neither augmentation from the River Murray or from desalination of sea-water will be required.

Only 15 GL/a of wastewater is initially included in this calculation. The reason for this is that wastewater is seen by the authors as the giant ‘sleeper’ amongst water supply options. Once sustainability has been accepted in some form as presented, the importance and potential of wastewater recycling will be fully appreciated. The challenge to the water industry will be to find ways to solve the actual and perceived problems of turning wastewater into a resource for public acceptance as a future water supply, recognising that this does not have to be as a potable supply. The implications for this transition are discussed in the next section. We recommend additional reuse outside of the metropolitan area to further reduce downstream environmental impacts in the interim.

The authors recognise that further investigation is required to clarify several areas of present uncertainty associated with making stormwater and wastewater primary water sources for future water supplies. However, these sources of water fit so closely the sustainability criteria that any present areas of uncertainty or ambiguity should be addressed as problems to be overcome rather than barriers to not proceeding at all.

Desalination and/or increasing reservoir storage in the Mt Lofty catchments do not fit with the sustainable directions outlined. Stormwater harvesting and temporary groundwater mining can be brought on line as quickly, at lower overall cost, and in a manner compatible with the longer term sustainability strategy outlined in this report.

The authors preferred supply mix will take some time to come on line. In the case of a short term emergency arising with the present water supply system, the mining and possible treatment of groundwater is recommended.

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Table 13. Summary and ranking of options assessed
Category Assessment
Score (out of 50) Gigalitres (GL)

Demand management
Highly cost effective. Using water more efficiently is hard to beat. Propose ‘supply’ of 64 GL based on reducing residential use to 140 litres/person/day and a twenty percent reduction in commercial and industrial water use. Comprehensive program required.
41 64

Stormwater harvesting
Offers a cost-effective water supply option and provides very significant downstream environmental benefits. Propose supply of 60 GL within estimates made by others based on 50% capture. Urgent action required to make this happen at a large scale.
41 60

Existing catchments
Existing catchments are a proven and reliable option. Propose supply of 82 GL after early climate change impacts taken into account and in the interim while larger volumes of wastewater are brought on line. Protection of catchments and reducing system losses a priority.
35 82

Wastewater reuse
Offers a cost-effective water supply option and provides very significant downstream environmental benefits. Propose supply of 15 GL based on 30% recycling with metropolitan areas post demand management. Recommend additional reuse outside of the metropolitan area to further reduce downstream environmental impacts.
32 15

Rainwater tanks
While popular with the community relatively expensive and difficult to manage. Propose supply of 6 GL additional to stormwater harvesting (up to 4 GL from mandated tanks, additional from point of sale legislation and voluntary take-up).
28 6

Groundwater use
Groundwater extraction without recharge is inherently unsustainable. Propose supply of 0 GL unless used as emergency supply or (coupled with stormwater or wastewater reuse).
26 0

Desalination
Reliable source of water regardless of rainfall. However, desalination of seawater is expensive and energy intensive. Useful measure of last resort but not immediate priority.
22 0
River Murray
The River Murray is failing and should not be relied on as a long term supply. Allow for environmental flows and other users. Propose supply of 0 GL per annum (except while in transition to new system).
19 0

Increased storage/Mount
Bold expansion
Storage relying on the River Murray and highly sensitive to climate change impacts is not sensible. Propose supply of 0 GL per annum. Redirect investment to other options.
9 0
Total Based on conservative estimates exceeds current water use. **227**
Current water use 216

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7. Transitioning to a sustainable urban water system

7.1 Principles

The authors have found that a very large body of research, discussion and practical experience with alternative urban water systems has been accumulated worldwide, in Australia and here in Adelaide.

The main interest in alternative systems has been driven by the realisation that they offer a potential quantum improvement in efficiency in delivering water services in urban areas. Seeking sustainability has been the goal of many researchers, entrepreneurs and innovative agencies in the face of growing and unsustainable demands for water, dwindling supplies, increasing costs, reducing biodiversity, escalating flood risks and damages, and general degradation to upstream, downstream and in-stream urban environments. ‘Total water cycle’, ‘closing the loop’, ‘integrated water systems’, and ‘water sensitive urban design’ are all names under which the general movement towards exploration and adoption of the alternative systems travel. Taken together the common theme for moving towards sustainable water supplies in urban areas is water recycling within an integrated multiple objective plan for the city and its water systems.

The workshop report of the US National Science Foundation “Creating Blue Waters in Green Cities” July 2006 is a very comprehensive source of information relevant to this report. The recommendations of the workshop cannot be bettered as recommendations for the future water supplies and water systems for Adelaide. Selected priority recommendations which are particularly relevant to the Adelaide situation are given below.

1. Water is a central and essential organising element in a healthy and sustainable urban eco-system.

2. New approaches are needed to manage urban water systems which should include: a. moving towards an integrated system approach based on the total hydrologic cycle that addresses all of the uses and impacts of water in the urban environment;
b. building multiple benefits into all water projects and programs that contribute to the economic, social and environmental heath of cities; and
c. promoting new, innovative water systems design concepts that incorporate natural system restoration, replication and enhancement.
3. A cornerstone of a realistic vision of future cities is the decentralisation of wastewater treatment and localisation of drainage networks to provide multiple benefits.
4. Considerations of healthy urban water systems should be incorporated into the 'front-end' of land-use planning and development decisions.
5. Institutional and regulatory barriers should be addressed where they inhibit trialling and adoption of non-traditional, innovative and competitive approaches.
6. Planning and regulating authorities should have skills and resources broad enough to encompass all components of, and interactions between, urban watersheds and receiving aquatic ecosystems and should move towards an integrated system approach addressing all uses and impacts of water.

The importance of integrating urban planning with water systems planning should not be underestimated. If stormwater and wastewater become the main supply sources, as is likely in many parts of the world, urban dwellers will have to recognise that they are inhabiting their own water supply catchments. The same rules and regulations that many city dwelling bureaucrats have imposed on rural dwellers in the name of catchment management will now have to be imposed on themselves and their urban neighbours.

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7.2 Network considerations

The present water supply system provides one quality of water, drinking quality, via a reticulation network that connects every customer to the single major supply system. A single quality of water is used for all purposes, even though most purposes do not require such a high standard. The potable water that is reticulated is gravity fed from the raw water source catchments to treatment plants located along the eastern side of Adelaide, where it is treated by disinfection, aeration, coagulation and filtration to drinking water quality. This water is then gravity and/or pump fed by an extensive pipe network to each service point.

A common justification for continuing with this system is a claim that it enjoys significant 'economies of scale'. However, CSIRO and others have demonstrated that our present urban water systems, when taken as a whole, do not have significant (if any) economies of scale. While economies of scale exist in individual components, this is largely offset by the need to join the enlarging system together by long lengths of ever increasing diameter pipes. In recognising this, the Productivity Commission also notes that a new generation of smaller scale, but more sustainable systems, based on local stormwater harvesting and wastewater recycling, intrinsically contain large opportunities for 'economies of scope' which will greatly exceed any real or imagined economies of scale [32]. The economies of scope, as defined, are those that accompany the breakup of large monopolies, freeing innovation and enterprise.

If stormwater and wastewater become primary sources of supply, a total re-design of the water systems is called for. This is because both the sources of these supplies and the demands for the services are spatially distributed and the storage and treatment infrastructure can be provided most economically when sited at a small scale within the local urban fabric.

At present, at least 70% of all the capital costs of urban water systems lie in the three sets of pipes and channels that bring water into, or take water back out of, the urban area. If the stormwater that is generated locally can be captured, treated, stored, used for in-house 'first-class' purposes, disposed via the wastewater system, then recaptured and treated again, stored again and re-used again, the off-site pipe networks would be very significantly reduced in size and cost.
In line with the above, several researchers have shown that the savings in the size and length of the import and export pipes and channels can more than counter any increased costs associated with the

greater complexity of the decentralised and integrated systems. However, there are two main options in respect to the design of the reticulation systems that will require a decision to be made:

a) Since the existing single pipe system exists, it may be cheapest to treat all additional water to drinking standard and inject it into the pipe network as close to the location as it is harvested.
b) Second class water for garden watering and toilet flushing could be reticulated via a second pipe running in parallel with the existing pipe network. This is the solution provided at Mawson Lakes and Rouse Hill in Sydney.

It is probable that different approaches could be adopted for different locations and for different stages of the progressive restructuring of the system.

A transition to this direction has been already started by some local governments in Adelaide. Longer term transition will require research and cooperation between all levels of government. The main cost reduction strategy will involve the progressive replacement of ageing components of the present ‘centralised’ water supply, sewerage and drainage systems with a new generation of decentralised, multi-objective water systems.
32 Productivity Commission “Toward Urban Water Reform”

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8. Conclusions and Recommendations

Section 6 of this report provides a ranking of the urban water supply options for Adelaide against the sustainability criteria and identifies that a mix of the higher ranking options that could form the basis of a new generation water supply system conforming to sustainability principles and public expectations.

It is concluded that demand management, stormwater harvesting, improved efficiency of existing catchments, wastewater reuse and rainwater tanks can supply all of Adelaide’s water requirements with excellent environmental, social and financial outcomes into the foreseeable future.

Desalination and/or increasing reservoir storage do not fit with the sustainable directions outlined.
Climate change is a reality and the focus needs to shift from knee-jerk drought response to long term planning under expectations of a changing climate and future population growth. This is a time of great opportunity to move to more productive and efficient water systems. The State and Federal governments have recognised that Adelaide is facing a water crisis and are prepared to invest in new infrastructure.

It is recommended that the following actions be undertaken in parallel as a matter of the greatest urgency:

- Establish a comprehensive long term demand management program with a residential target of 140 litres/person/day and a commercial/industrial target of 20% improvement in water use efficiency. As part of this, change the pricing structure for water by increasing the volumetric costs and reducing other charges to provide more incentive for users to reduce their demand to meet the overall target levels.
- Undertake an assessment of the capacity of the aquifers beneath Adelaide to support temporary groundwater ‘mining’, with treatment as necessary, as an emergency water supply, and commence determination of the limits of the aquifers for storing and recovering bulk water harvested from treated stormwater and wastewaters. Research means for exploring and raising the limits, as warranted.
- Commence implementation of a major metropolitan-wide stormwater harvesting program in partnership with local governments and SA Water.
- Identify and pursue strategies for making the total flow of treated wastewater acceptable for urban or peri-urban water supplies in a manner that directly or indirectly reduces the demand by the urban users on non-sustainable water sources by an amount equal to the total of the wastewater flow.
- Provide a single State government department with responsibility for multi-purpose, participatory, total water cycle planning, within the context of the State Water Plan. The Plan to cover the whole

gamut of natural and engineered water systems. The department to be responsible for the immediate Water Security investigations.

 Broaden the present Water Security investigations to better define the costs and benefits of the long-term water options for Adelaide using total water cycle principles and judged on sustainability criteria as laid out in this report, but with a greater level of resourcing including:

o consultation with Local Government and others who have successfully initiated and developed the more sustainable options to date; and

o a program of information and consultation with the broader community on the implications, benefits and costs of the options as they emerge and progress.

 Put on hold funding proposed for desalination and reservoir storage and redirect to more sustainable options once the above assessments have confirmed the preferred options as feasible.

 Protect and improve existing catchments.

 Prescribe quaternary aquifers to prevent excessive extraction (this will be a specific issue as other sources of water become more scarce).

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Richard Clark has 45 years of experience as a hydrologist and water systems planner. This has included 19 years in the EWS Department, and a further 8 years in the various State government water resources planning departments, before he took up consulting privately under the name Richard Clark and Associates. Over the past 15 years Richard has been involved as water systems performance modeller in the design of most of the 'alternative' water systems in Adelaide including, New Haven Village, Mawson Lakes, Parafield Airport, Morphettville Racecourse, Grange Golf Club.

Jake Bugden is the Managing Director of Sustainable Focus. Over the past seven years
Sustainable Focus has designed and managed numerous rainwater reuse and water efficiency projects. Jake has worked for a range of companies, NGOs and the Commonwealth government and has extensive project management experience in a range of environmental fields including energy efficiency, water efficiency, treatment and reuse, and the analysis of toxic chemicals. Jake holds a Bachelor of Chemical Engineering (honours) from the University of Adelaide and is a past recipient of the Young South Australian of the Year Environment Award.

The above paper just came out yesterday and is an example of what the Victorian Government should do when considering water options. Both the Sugarloaf pipeline proposal and the desal plant are ecologically unsustainable and harm the environment and are very energy intensive and socially and environmentally unacceptable. These options must be considered as last resorts if at all and this is not a last resort as the Victorian Government has not considered all options on the table. Melbourne has other options, our Murray-Darling and its rivers and the environment does not. This is just "business-as-usual" and the worst options.

Just in case you are still unclear as to what I am requesting: I request a NEW reconsideration because the material I present, in this email and in the hard copy I have just mailed on the 9th September 2008 further substantiates my claim that there is new evidence, information and circumstances are changing substantially. When the Commissioner for the Murray-Darling Basin Dr Wendy Craik herself says that we are entering "unchartered territories" I would believe that this can only be interpreted as these are times that have never happened before and since that is the case, we have absolutely no knowledge of what will happen from now on!

I ask a full EES with added sections as I have requested and better still I ask this proposal be but in the garbage bin where it belongs. It is totally unacceptable and irresponsible.

Kind regards

Maria I E Riedl
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Australian Bureau of Statistics

4610.0.55.007 - Water and the Murray-Darling Basin - A Statistical Profile, 2000-01 to 2005-06

Latest ISSUE Released at 11:30 AM (CANBERRA TIME) 15/08/2008 First Issue

NOTES

INTRODUCTION

The Murray-Darling Basin (MDB) is an area of national significance for social, cultural economic and environmental reasons. The social impacts of changes in agriculture and environmental events, such as drought, are important for people in the MDB. The MDB also contains nationally significant environmental assets which are reliant on water to maintain ecosystem health.

SUMMARY OF FINDINGS

Physical Attributes

- The Basin covers 1,059,000 square kilometres or 14% of Australia's land area. Most of the Basin's area is located in New South Wales (597,926 square kilometres or 56% of the Basin's area) and Queensland (259,313 square kilometres or 24% of the Basin's area) (BRS data available on request 2008).
- Australia's three longest rivers, the Darling (2,740 km), Murray (2,530 km) and Murrumbidgee (1,690 km) are found in the MDB (MDBC 2006).
- The 2005-06 ABS Agricultural Census found that 84% of the land in the MDB is owned by businesses engaged in Agriculture. Modelling by the Bureau of Rural Sciences (BRS) has identified that 67% of the MDB is used for growing crops and pasture.
- In 2005-06 temperatures recorded in the MDB were up to 2°C hotter than average.
- The MDB receives an average annual rainfall of 530,618 GL. Of this, 94% evaporates or transpires, 2% drains into the ground, and the other 4% becomes run-off.

People

- At the time of the ABS 2006 Census of Population and Housing there were 2,004,560 people living in the MDB - 10% of Australia's population.
- Most of the MDB population lived in New South Wales (39%) and Victoria (29%).
- Agriculture is a significant employer in the MDB. In 2006, 10% of all people employed in the MDB worked in Agriculture, compared to 3% Australia-wide.
- The other common industries of employment in the MDB were Retail (14% of all

people employed), Health and community services (11%), Government administration and defence (10%), and Manufacturing (9%).
- The mean equivalised household income of people in the MDB in 2006 was $675 per week compared to $732 per week for Australia as a whole.
- Almost two-fifths (38%) of Australia's farmers resided in the MDB.
- The number of people employed as farmers in the MDB decreased by 10% between 1996 and 2006. Over the same period the number of people employed in all other occupations increased by 18%.
- Nearly two-fifths (39%) of people employed and aged 65 years or over in the MDB were farmers.

Water Use

- In 2004-05, industries (including Agriculture) and households in the MDB used more than half (52%) of Australia's total water consumption.
- In 2004-05, 83% of water consumed in the MDB was consumed by the Agriculture industry.
- Other users of water in the MDB included the Water supply industry, which consumed 13% (predominantly through irrigation water supply losses), and Households (2%).
- In 2004-05, 3% of Australia's electricity and 33% of the nation's hydro-electricity was generated in the MDB.
- In 2005-06, 7,720 GL of water was consumed for agricultural production in the MDB, 66% of Australia's agricultural water consumption.
- In 2005-06, the majority of water consumed in the MDB originated from two main sources: surface water (6,499 GL or 84% of MDB agricultural water consumption) and groundwater (1,069 GL or 14%).
- In 2005-06, the majority of surface water consumed by Agriculture in the MDB was in New South Wales (57%) and Victoria (30%). Over 70% of the 1,069 GL of groundwater consumed in the MDB was in New South Wales.
- In 2005-06, the agricultural commodities that used the most water in the MDB were:
    - cotton - 1,574 GL or 20% of water used for agricultural production in the MDB;
    - dairy farming - 1,287 GL or 17%;
    - pasture for other livestock - 1,284 GL or 17%; and
    - rice - 1,252 GL or 16%.
- Between 2000-01 and 2005-06, water consumption by some agricultural commodities was more variable than others. For example:
    - cotton water consumption - ranged from 1,186 to 2,599 GL; and
    - rice - ranged from 615 to 2,418 GL.

Agriculture

- There were 61,033 farms in the MDB in 2005-06, accounting for 39% of all farms in Australia.
- A significant proportion of Australia's food production was grown in the MDB in 2005-06:
    - 100% of rice;
    - 95% of oranges;

  - 62% of pigs;
  - 54% of apples; and
  - 48% of wheat.
- In 2005-06, the MDB contained 65% of Australia's irrigated land.
- The 1.65 million hectares (ha) of irrigated crops and pasture in the MDB were distributed as follows:
  - pasture (43%);
  - cereals other than rice (20%);
  - cotton (15%);
  - rice (6%);
  - grapes (6%);
  - fruit and nuts (5%); and
  - vegetables (2%).
- In 2005-06, the Gross Value of Agricultural Production (GVAP) in the MDB was worth $15 billion, or 39% of the total Australian value of agricultural commodities.
- Between 2000-01 and 2005-06, the GVAP in the MDB increased by 7.3%, from $13,972 million to $14,991 million. Over the same period, the GVAP of all Australian Agriculture increased by 12.8%.
- Between 2000-01 and 2005-06, the total Gross Value of Irrigated Agricultural Production (GVIAP) in the MDB remained at approximately $4,600 million. GVIAP as a proportion of GVAP in the MDB decreased from 33% in 2000-01 to 31% in 2005-06.
- In 2005-06, irrigated agriculture in the MDB generated 44% of Australia's GVIAP. Of this:
  - dairy farming generated $938 million, or 20% of the total MDB GVIAP;
  - fruit and nuts generated $898 million, or 20%;
  - cotton generated $797 million or 17%; and
  - grapes generated $722 million or 16%.
- In 2005-06, some irrigated crops in the MDB accounted for relatively high levels of GVIAP using relatively low levels of water consumption. Examples included:
  - fruit and nuts (20% of total GVIAP; 5% of agricultural water consumption); and
  - vegetables (12% of total GVIAP; 2% of agricultural water consumption).
- Other irrigated crops in the MDB accounted for relatively low levels of GVIAP using relatively high levels of water consumption. Examples included:
  - rice (6% of total GVIAP; 16% of agricultural water consumption); and
  - cereals other than rice (2% of total GVIAP; 10% of agricultural water consumption).

Natural Resource Management

- In 2004-05, the vast majority of MDB farms (92% of total farms in the MDB) conducted NRM activities for preventative or remedial reasons, consistent with the proportion of all Australian farms (92%).
- Most NRM effort in the MDB during 2004-05 was spent managing weeds, pests, and land and soil. Farmers in the MDB reported the lowest effort expended on managing water issues (27 person days per farm on average) of all the NRM issues, equivalent to half of the effort put towards land and soil activities (54 person days per farm on average).

INQUIRIES

For further information about these and related statistics, contact the National Information and Referral Service on 1300 135 070 or Bernard Morrison on (02) 6252 5321 .

PREFACE

This publication provides environmental, economic and social information for the Murray-Darling Basin (MDB). It aims to provide statistics to inform decision-making, research and discussion about the Basin within governments and in the wider community. The publication is presented in five chapters:

- Chapter 1 presents a physical description of the MDB, including the area covered, land use, climate, water availability and environmental assets.
- Chapter 2 explores the characteristics of people living in the MDB. The chapter is divided into four main sections: population characteristics; education; work; and farmers. Data are presented for 1996, 2001 and 2006, and comparisons are provided with national level data.
- Chapter 3 examines water use by industries and households, using the most recent economy-wide water use data available. As a result of the significance of agricultural water use in the MDB, this chapter places a strong emphasis on water use by agriculture. Data presented include: water use for a range of crops and pastures, changes in water use over time, the location of water use, water sources, and irrigation practices.
- Chapter 4 outlines agricultural production in the MDB and includes comparisons with Australian totals and between irrigated and non-irrigated agriculture. It also outlines changes in agricultural area and production levels between 2000-01 and 2005-06. The economic contribution of irrigated agriculture in the MDB, including comparisons for different agricultural commodities, is also discussed.
- Chapter 5 presents information about natural resource management (NRM) activities that farmers in the MDB are implementing to address a range of NRM issues including water issues.

The ABS is indebted to a range of people and organisations that provided data for inclusion in this publication, and to those who refereed the manuscript. The organisations that provided data include the **Department of the Environment, Water, Heritage and the Arts** (DEWHA), **Bureau of Meteorology** (BoM), **Bureau of Rural Sciences** (BRS), and **Murray-Darling Basin Commission** (MDBC).

Suggestions or comments on this publication would be appreciated, and should be sent to the Director, Environmental Accounts and Water, Locked Bag 10, Belconnen ACT 2616.

This page last updated 15 August 2008

Slippery banks risky

By Sophie Bruns

Mooroopna resident Deborah Lynch is worried about the safety of people and animals around the plastic-lined channels that are appearing as part of the irrigation modernisation in northern Victoria.

Mrs Lynch realises the channel system upgrade is necessary, but the steep bank slope and the slippery plastic are major concerns.

"Everyone needs to be aware of the dangers,"Mrs Lynch said.

Goulburn-Murray Water modernisation executive manager Alex Marshall said it was illegal for people to swim in G-MW channels, regardless of whether they are lined or not, as "it is a fast flowing dangerous environment".

"Plastic lining does escalate the risk, however we have put in place as many safety measures as we practically can to reduce the risk," Mr Marshall said.

The risk mitigation measures include:

- Good quality eight wire stock fencing.
- Pool-type fencing 100 m either side houses.
- Escape mats at 50 m intervals on alternate sides of the channel.
- Warning signs located at road crossings, public access points and populated areas.

Channels are lined with plastic in high water loss sections to prevent seepage and improve efficiency.

There has been 30 km of channel lining completed in the Central Goulburn water district.

This process had been used in Queensland for 20 years and a trial site has been run in the area for two years.

"There have been no issues to date," Mr Marshall said.

Mrs Lynch raised her concerns after her dog was unable to get out of the channel located 150 m from her home.

Her dog Danny became quite stressed after continually slipping back to the centre of the channel.

"I do not believe that an eight strand wire fence will keep out all people or animals," Mrs Lynch said.

Mrs Lynch found the escape mats hard to use and is also concerned about the distance the escape mats were placed apart.

She doubts their ability to help people safely exit the channel when the channel is full or flowing rapidly.

"A non-swimmer would be unable to grab them and animals would not be aware what they are for," she said.

"These channels are an extremely hazardous place to be for our children, pets, our working dogs, stock, wildlife and us."

sophie.bruns@sheppnews.com.au

Concern ... Deborah Lynch from Mooroopna is urging people to be aware of the dangers the plastic-lined channels pose to residents, stock and animals.

Pictures: **Aaron Sawall**

Warning ... Signs are going up around the plastic-lined channels.

Help ... There was no way Deborah Lynch's dog Danny could find his way out. The steep banks and slippery plastic made it impossible for him to get traction.

Not enough water, says G-MW

From page 1

G-MW water delivery services manager Ian Moorhouse said operating plans were being developed for the 17 water districts so the authority could deliver maximum benefits from limited water.

The authority will develop the plans using local knowledge from both staff and customers and intends to circulate fortnightly bulletins and provide more regular updates on its website.

"We'll be telling our customers what to expect this year so they can make business decisions as early as possible," Mr Moorhouse said.

The authority will also talk to its water services committees and the catchment management authorities.

"We will still try to meet customer needs wherever we can."

Mr Moorhouse said said they would be drawing on experience from last year to develop the plans.

Some farmers will get stock and domestic water delivered by tankers because of the potential to lose too much water in the delivery of small amounts.

"Not all channels will operate and we will have only one or two feet of water in the bottom of the channel," he said.

"If customers want to access the water they will have to pump it out." Irrigators will have to provide the pumps.

Mr Moorhouse said they would have a goal to provide fresh stock and domestic water once a month.

G-MW strategy and stakeholder affairs manager Garry Smith also dispelled a rumour that carryover would not be provided unless allocations were made.

He said carryover was an entitlement that irrigators could still order.

Fruit growers will be told that under qualified rights rules, stock and domestic water cannot be used for frost control.

editor@countrynews.com.au

Rain is only patchy

Weather conditions for the past week have been cold and windy with patches of light showers in some areas.

Rainfall for the past week across the region to Sunday 9 am was Shepparton 3 mm, Echuca 2 mm, Kerang 3 mm, Rochester 12 mm, Tatura 2 mm, Wangaratta 10 mm and Deniliquin 2 mm.

The only centres to record rainfall in the last 72 hours to Monday 8.30 am were Strathbogie 2 mm and Benalla 2 mm.

Not enough water

Country News 18-24 August 2008

By **Geoff Adams**

Some farmers may have to use pumps to access irrigation or stock and domestic water from low running channels this season as Goulburn-Murray Water takes unusual steps to deal with a record low water allocation.

The water authority will deliberately run channels at minimum levels to conserve water, implement district by district water savings plans, and send out regular updates to irrigators.

G-MW will initially run their channel network as a stock and domestic supply system.

This is the first time in history the authority has had no water to allocate in all districts on August 15.

Although August 15 is the traditional start to the surface water season, the authority will only put water into channels where there is a demand.

Due to a range of commitments, the Goulburn System is still 126 Gl short of the point where allocations can begin to be made, and the Murray System, 144 Gl.

G-MW environment and planning manager Graeme Hannan said despite average July rainfall, the rain had not translated into average inflows into the Eildon reservoir.

"The catchments are not responding well and that's a result of the dry conditions," Mr Hannan said.

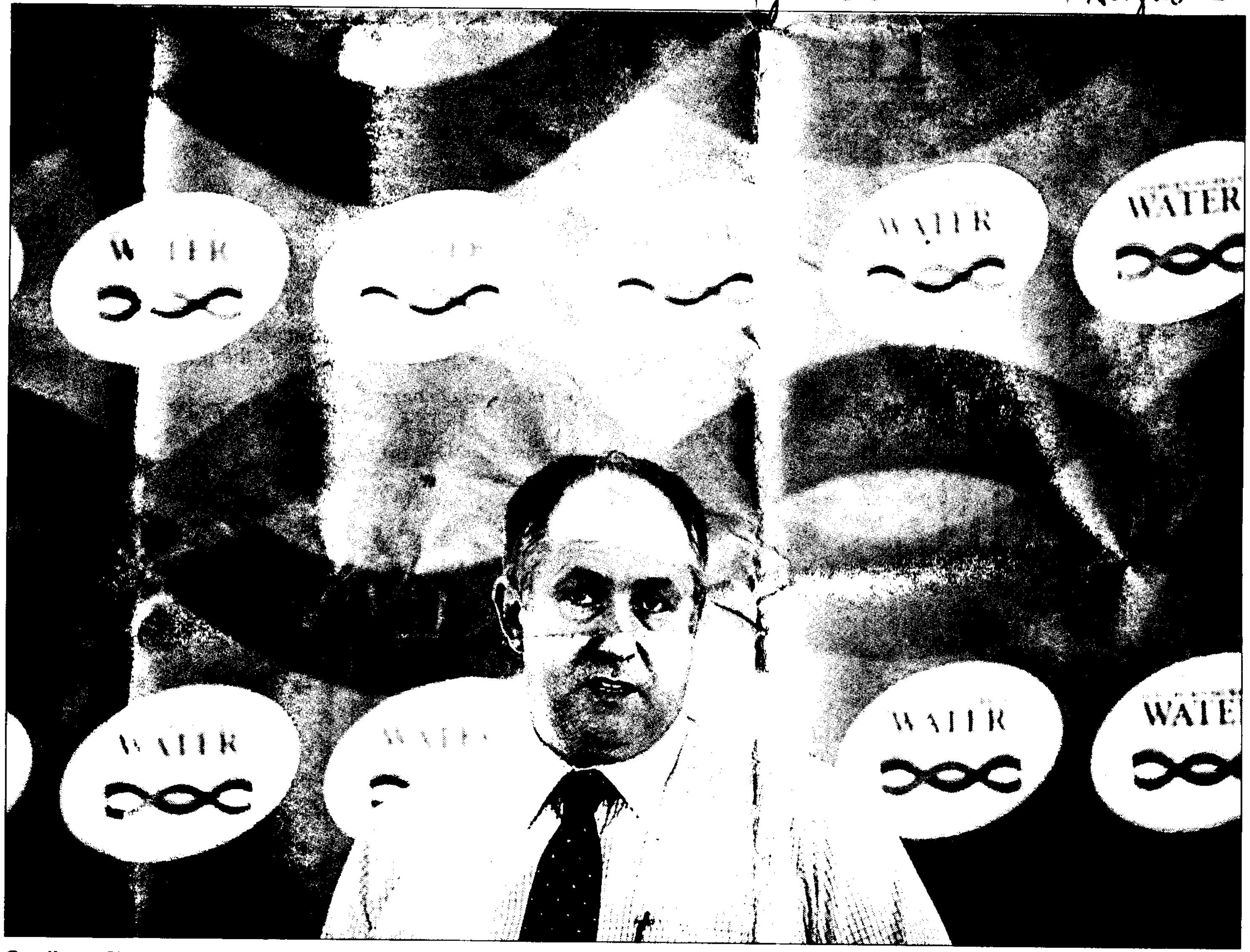
"Inflows are trending down. We need more rain."

Eildon was lower than at the same time last year and Eppalock is holding less than half of its comparative level last year.

Reservoir levels have only recently reached the point where the authority can offer to supply stock and domestic water and carryover water.

The authority said on Friday, however, that it could not guarantee channel delivery of stock and domestic supplies or carryover water to every irrigator.

Continued on page 3



Goulburn-Murray Water environment and planning manager Graeme Hannan . . . "We cannot allocate water because we haven't got enough water to meet our operating requirements. That gap is large but reducing." Picture: **Ray Sizer**

Printed September 02, 2008 01:10am AEST

Our watermark of dishonour

Bill Phillips | *September 02, 2008*

AUSTRALIA can expect international condemnation at the upcoming global conference of the Ramsar Convention on Wetlands for allowing the Coorong and Lakes regions to die.

Representatives of the 156 government signatories to what is otherwise known as the Ramsar Convention (after the city in Iran where it was first signed in 1971) will gather in Changwon, South Korea, from October 28 to review how each country has been applying the oldest of the international environment agreements.

Before this, each government submits a national report card on its performance, and it remains to be seen how transparent and honest Australia will be in relation to the Coorong and Lakes "wetland of international importance".

Unless there is a miracle and it rains heavily between now and summer, October 28 may be the date used on the headstone of the Coorong and Lakes as it is laid to rest as a significant wetland.

The only other hope rests with the governments responsible for the Murray-Darling Basin.

Despite what came out of the federal cabinet meeting in Adelaide last month in relation to water, ramping up acquisitions, I suspect it is still too little, too late.

In Changwon, the Australian delegation can expect to be challenged over why this situation has arisen, why no emergency response has been activated, why Australia has not used its Environment Protection and Biodiversity Conservation Act to protect this site - even though Ramsar wetlands were one reason it was enacted - why Australia has failed to use its external affairs power (as in the case of protecting the Franklin River) to secure the water needed to save the site and why Australia has failed to place this site on the convention's Montreux Record of threatened sites.

Unlike the International Whaling Commission, where we could take the moral high ground, one suspects Australia will be in the cross-hairs this time.

Don't expect to see Climate Change and Water Minister Penny Wong or Environment Minister Peter Garrett attending this international photo opportunity.

Another question Australia will be expected to answer is whether the Coorong and Lakes will be delisted as a Ramsar wetland and replaced with another site that retains qualities comparable to how the Coorong and Lakes used to be, assuming there is one.

In the nearly 40-year history of the Ramsar Convention, this will give us a very special black mark for being the first country to delist a site of this size due to mismanagement.

If the predictions are correct and by October 28 the lakes have turned into an acid bath, with the Coorong becoming more saline than the Dead Sea, the site will be unrecoverable. We will have contravened our fundamental Ramsar obligation, namely to keep wetlands of international importance in the condition they were (or better) at the time they gained international status. That was November 1, 1985.

Perhaps ironically, the anniversary of this occasion will fall during the Ramsar conference in South Korea. I wonder whether the Australian delegation will host a birthday party or a wake?

Bill Phillips is a former deputy secretary-general of the Ramsar convention on wetlands.

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Protecting Australia's rivers, wetlands and estuaries

"...the river and lagoons abound with fish and fowl..."

Explorer John Oxley's observations of the Lachlan River (Oxley, 1820)

"...nowadays the river has lost its charm. It's no longer a sweet smelling place."

Lance Parker, Hillston commenting on Lachlan River (Roberts and Sainty, 1996)

Protecting Australia's rivers, wetlands and estuaries of high conservation value

R.T. Kingsford, H. Dunn, D. Love, J. Nevill, J. Stein and J. Tait

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Contents

Executive summary

Australia has a rich variety of different rivers, wetlands and estuaries that support a significant amount of its biodiversity and industry. Important social values of Australia's Indigenous and European culture are also intimately linked to the integrity of our rivers. Despite this, compared with terrestrial conservation (e.g. national parks and reserves, and regional forest agreements), there has generally been a lessor focus on conservation of these ecosystems in Australia.

This report presents a conceptual framework for the protection of riversd, river reaches andestuaries of high conservation value. It was developed in conjunction with State and Territory agenciesduring 2003 and 2004 and provides an important foundation for developing future approaches to the conservation of these key areas.

Many of Australia's rivers, wetlands and estuaries are affected by river regulation, catchment disturbance and pest species, and opportunities to effectively conserve riverine biodiversity and landscapes are limited.. There are opportunities to protect Australia's most important aquatic areas so that future generations do not have to pay the high costs of rehabilitation (e.g. as has happened for the River Murray). This may begin with a comprehensive national framework that identifies and protects rivers, wetlands and estuaries that have high, national conservation value. States and Territories are primarily responsible for their protection, but a national framework could support consistent identification and strategic investment in the protection of nationally important aquatic ecosystems.

All Australian governments have invested in programs and projects aimed at protecting rivers, wetlands and estuaries. There is national recognition of the importance of this issue across all jurisdictions. In 1994, the Council of Australian Governments (CoAG) agreed that the environment was a legitimate user of water. In 2004, CoAG agreed to the National Water Initiative (NWI), which will chart the future responsibilities and progress towards sustainable management of the nation's rivers and aquifers. Provisions in the associated intergovernmental agreement commit most governments to identify, protect and manage high-conservation-value rivers and aquifers and their dependent ecosystems.

To effect protection of high-conservation-value rivers and their dependent ecosystems, national conservation goals are essential. They may be used also to determine short-term and specific goals developed from a national vision statement for rivers. This recognises that it is not possible to single out high-conservation-value rivers or their dependent ecosystems and expect to protect only these and achieve conservation of their values. River conservation requires a network approach that recognises that many processes and organisms may use all parts of rivers and even different rivers during their lives. A protection framework focused on only high-conservation-value rivers will not work.

Rivers and dependent ecosystems with nationally high conservation values are a subset of the country's aquatic ecosystems. Conservation value is a relative measure, established through a comparison of all rivers and dependent ecosystems. This discussion paper focuses on ecological conservation values, but recognises that rivers also have considerable cultural, economic and ecosystem service values.

There are two key questions for this framework.

- *What rivers, floodplains, wetlands and estuaries are of high conservation value?*
- *How can these be protected?*

Elements of a national framework

A national framework of river protection could be built around three main elements:

1 nationally consistent collection of information on rivers, wetlands and estuaries, which will entail agreement on spatial scale and classification and evaluation systems for identification of rivers and dependent

ecosystems of high conservation value

2 protection schemes that operate at different scales such as:
   – a ‘whole-of-river’ approach that could include establishment of an ‘Australian Heritage Rivers’ system
   – protection of high-conservation-value rivers, river segments and dependent ecosystems (floodplains, wetlands, estuaries) in a national, State, regional and local context (using current legislative and policy tools; i.e. environmental flows, protected areas, natural resource planning and management, and incentives)

3 operational and institutional arrangements—coordinated programs involving jurisdictions in implementation of a national framework.

Nationally consistent collection of information

All rivers, wetlands and estuaries have conservation values, but we need methods to identify which of them have the highest national conservation value to assist decision makers to determine priorities.. To do this, we must first have a method that can operate at various and agreed spatial scales. To achieve a relative comparison of conservation value, consistent and agreed approaches to classification and evaluation are needed to work across all rivers, wetlands, floodplains and estuaries. The following conservation criteria could be utilised to assess high-conservation-value rivers and their dependent ecosystems.

The river or dependent ecosystem:

- is largely unaffected by the direct influence of land and water resource development
- is a good, representative example of its type or class
- is the habitat of rare or threatened species or communities, or the location of rare or threatened geomorphic or geological feature(s)
- demonstrates unusual diversity and/or abundance of features, habitats, communities or species
- provides evidence of the course or pattern of the evolution of Australia’s landscape or biota
  OR
- performs important functions within the landscape.

Spatial framework

An agreed spatial framework is essential for undertaking national assessments.

Recommendations

a. *Use current drainage divisions, river basins and river segments for initial implementation of this framework. These map layers, and the sub-catchments and catchments they support, should be publicly available.*

b. *River ecosystem data should be labelled according to resolvable hierarchical scales, allowing for future evaluation and reassessment of classifications.*

c. *Develop a new hierarchical spatial framework for managing aquatic systems and rivers, based on topography and drainage networks and without the problems of current spatial layers.*

Classification and evaluation systems

Collation of all available attribute data for the criteria, and gap-filling where necessary, at the finest spatial scale possible (i.e. river segment), is important to make a national assessment of rivers, wetlands, floodplains and estuaries.

Recommendations

a. *Devlop agreed approaches for assessing criteria and use of attributes for rivers, river reaches and dependent ecosystems.*

b. *Develop agreed national classifications of rivers and dependent ecosystems, with agreed objectives, to support evaluation and assessment.*

c. *Apply a nationally agreed set of evaluation criteria and significance thresholds, compatible with Ramsar and National Heritage, with nationally available data, aggregated to the smallest resolvable scales of assessment (i.e. river segments and their sub- catchments). This could be done to assess all river segments to identify nationally important rivers, wetlands (greater than 200 ha) and large estuaries. This initial assessment could be reported at a range of scales, informing a national assessment but also State and regional assessments.*

d. *Establish long-term collection and storage of nationally consistent data on rivers and their dependent ecosystems that allows for comparison across the country.*

Protection scheme

Once identified, the challenge is to ensure protection of rivers, wetlands and estuaries at different scales and contexts. We propose consideration of a protection scheme with two approaches: establishment of an Australian Heritage Rivers system in conjunction with better use of existing protection mechanisms. There are generally sufficient mechanisms available within jurisdictions for protection of aquatic ecosystems, but implementation of a mulit-scale system would improve effectiveness at a catchment level.

Australian Heritage Rivers system

Potential candidate rivers could be identified that are of high conservation value, generally at a large scale (i.e. river basin, tributary river), using the methods identified above. While identification of candidates could be a national process, nominations for listing as Australian Heritage Rivers could also come from communities. Designation as an Australian Heritage River could signify sustainable use rather than a moratorium on development. There could also be parallel development of a process that identifies and assesses cultural values.

Recommendations

a. *Identify potential candidate river basins as Australian Heritage Rivers. This process could be done immediately, using current data, but nomination and designation would not occur without community support.*

b. *Identify institutional arrangements that would deliver an Australian Heritage River system, including current models, and whether there is a need for legislation. Essential steps in the arrangements would be nomination, designation, consultation and administration. The Canadian Heritage Rivers System is a model worth considering.*

c. *Largely unmodified river basins designated as Australian Heritage Rivers could be priority areas for funding river management plans that protect ecological values, prevent environmental problems, encourage uses compatible with protection of ecological values and promote understanding of ecological values and processes.*

Protecting nationally important rivers, river segments, floodplains, wetlands and estuaries using current mechanisms

There are many tools within jurisdictional, legislative and policy frameworks for protecting nationally important high-conservation-value rivers, wetlands and estuaries. These can be grouped under four, main, interrelated mechanisms: environmental flow management; protected area acquisition and management; natural resource management; and incentives. These preferably operate within a catchment planning and management framework that logically follows the rivers and recognises their connectivity.

Priorities for protection could be defined by working from quantitative national conservation targets for rivers, wetlands and estuaries. Actual protection may be effected through jurisdictional policies and management, and the regional bodies responsible for catchment management. The following recommendations for environmental flow management, protected areas, natural resource management and planning, and incentives could apply to rivers, river segments, floodplains, wetlands and estuaries identified as having high national conservation value.

Recommendations—environmental flow management

a. *Environmental flows for long-term sustainability of rivers and their dependent ecosystems need to be identified at catchment scales.*

b. *Environmental flows should be managed within an adaptive management framework that ensures the best environmental outcomes.*

c. *Targets for flow restoration may need to be developed with a focus on better management of flows and access to additional flows if required (e.g. improving water-use efficiency, purchase of water).*

Recommendations—protected areas

a. *Aquatic ecosystems should be considered for future acquisition of protected areas (e.g. national parks, nature reserves, conservation areas, or aquatic reserves), or nominations of important wetland areas (e.g. National Heritage, World Heritage and Ramsar sites). This may also include Indigenous protected areas.*

b. *Policies and management practices and* *documents for protected areas with rivers and dependent ecosystems should include how management or policies will meet long-term ecological outcomes of sustainability (e.g. upstream environmental flows, pest control strategies and impacts of catchment disturbance).*

c. *These ecosystems could be the focus for the development of cooperative protective management arrangements with landholders (e.g. voluntary conservation agreements and other protected area programs).*

d. *They could be considered for heritage listing under the National Heritage List of the* Environment Protection and Biodiversity Conservation Act 1999*.*

e. *They could be listed under relevant threatened-species legislation as endangered or threatened ecological communities if they satisfy appropriate criteria.*

Recommendations—natural resource management and planning

a. *Statutory resource and land-use plans, including river- management plans, should assess and control potentially deleterious impacts on these ecosystems at catchment scales.*

b. *Environmental objectives in water plans should adequately acknowledge high-conservation-value rivers and their dependent ecosystems and water regimes that maintain their ecological values.*

c. *River-management planning of these areas needs to explicitly incorporate rivers and their dependent ecosystems within management plans, recognising catchment processes and hydrological connections.*

d. *For those aquatic ecosystems that cross management borders, river planning should incorporate all of a catchment, taking account of different jurisdictional water legislation.*

e. *Water-quality policies and management should link to planning, assessment and controls that protect identified aquatic ecosystems.*

f. *Introduction of exotic species (plants or animals) should be controlled in these aquatic ecosystems and their catchments.*

g. *River management planning should involve communities early and involve effective community consultation and communication.*

h. *Planning should be culturally sensitive (e.g. respect Indigenous decision-making and governance processes) and involve traditional owners for identified ecosystems.*

i. *For improved management, research and development should focus on threats that affect conservation values of high-conservation-value rivers, reaches and dependent ecosystems.*

Recommendations—incentives

a. *These ecosystems need to be identified and included in Australian Government, State and regional investment frameworks.*

b. *These aquatic ecosystems could receive priority in monitoring and assessment of ecological values (e.g. Rivercare, Water Watch, auditing).*

c. *These ecosystems could be a focus for tax and rate- relief programs and new incentive schemes for landholders committed to protecting these areas.*

Making it happen

Implementation of the national framework would require cooperation between jurisdictions and the Australian Government. To that end, it could be best progressed under the aegis of the Natural Resource Management Ministerial Council and the National Water Initiative.

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Objectives

River conservation is difficult for many reasons, but the need for action is clear. A path forward that achieves stakeholder and public acceptance is crucial, but it must also effectively protect rivers. Existing mechanisms that strive to protect river values have sometimes succeeded, but have encountered significant difficulties or have failed. There is uncertainty as to whether the best conservation outcome has been achieved when the relative value of the system that has been protected is not considered, and management for conservation is not within a catchment context.

This discussion paper aims to identify key elements of a national framework that could assist Australian governments and communities in the protection of rivers and their dependent ecosystems of high conservation value. This framework takes a proactive approach to protection of rivers that are not yet degraded and identifies effective protective and restoration mechanisms for rivers or parts of rivers that are nationally important, even if degraded. The protection framework does not preclude economic development but it provides mechanisms that could assess potentially threatening developments and ensures that conservation targets inform river and catchment-management planning.

The ultimate objective of implementing such a framework is to protect Australia's high-conservation-value rivers, reaches, floodplains and estuaries—an objective requiring the cooperation of the States and Territories, which bear primary constitutional responsibility for land and water management. Consensus among jurisdictions on the essential elements of the framework of protection is important, followed by identification of what potential institutional and operational arrangements would give effect to a coordinated national approach. The framework needs to be sufficiently flexible to allow for application of different protection mechanisms among jurisdictions.

This proposed framework reflects discussions with jurisdictions and the deliberations of a national forum on the topic held in Canberra in 2004. Most responses from participants to the forum and information from discussions were recorded with a comment on how responses were considered (see Appendixes F & G). The authors hope this discussion paper provides a national framework that will garner support from all levels of government and the community and deal with the ongoing problem of degradation in the nation's high-conservation-value rivers.

Chapter 1. Introduction

Australian rivers: a brief history

Rivers are one of the most important natural features of the Australian environment. There are many different types of rivers in Australia, their character, dependent ecosystems, and unique flora and fauna determined by climate and geomorphology. Rivers in northern Australia are influenced by monsoonal rains; the arid interior receives sporadic, heavy rainfall from tropical cyclones, resulting in spectacular flooding (Puckridge et al., 2000; Roshier et al., 2001), while the southern parts of Australia receive more uniform rainfall in a temperate climate (Lake, 1995; NLWRA, 2002a).

Many Australian species thrive on highly variable flooding and drying regimes. The rivers that course through the continent bring water to areas that would otherwise be permanently dry, and their water supports tens of thousands of species, including algae, bacteria, plants, invertebrates, amphibians, reptiles, fish, birds and mammals, including people. Lake Eyre turns from the 'dead heart' of Australia into one of the most spectacular places on the continent when the rivers that feed it flow.

Rivers sustain billabongs, large floodplains, and lakes and estuaries, the nurseries of bountiful fisheries. Rivers are the home of red gum and coolibah trees. The spiritual role of rivers in Dreamtime stories of Aboriginal peoples is also very important. Rivers were the pathways for European explorers and subsequent colonists, and our largest rivers became important corridors of trade. Few Australian towns are far from a river, with many of them on a floodplain.

European settlers struggled to cope with the variability of river flow, suffering drought on one hand and the flooding of townships and agricultural lands on the other. The earliest colonists strived to improve the reliability of water supplies from rivers, and now few of the larger river systems in south- eastern Australia remain unregulated (Kingsford, 2000; Arthington & Pusey, 2003). Our ability to harness and use river flows for drinking water, industry, growing food and fibre, and producing electricity has produced wealth and improved our quality of life, but it has also contributed to considerable environmental problems in rivers.

Against this background of water-resource development, there is an increasing need to protect healthy, intact rivers from degradation. In Australia and elsewhere, there are three main threats to the ecological health of rivers and their dependent ecosystems: (i) alteration of flows; (ii) catchment disturbance and land-use change; and (iii) invasive pest species (Allan & Flecker, 1993; Richter et al., 1997). Water resource and catchment development, particularly in the highly populated and agriculturally developed areas of Australia, has caused immeasurable and sometimes irreparable damage to the ecology of rivers, much of which may take decades to be revealed.

1.1. Australian rivers in the 21st century

Many of Australia's distinctive and important rivers are severely degraded (Dunn, 2000; Kingsford, 2000; Arthington & Pusey, 2003). Australian rivers are under increasing pressure from over-extraction, pollution, catchment modification and river regulation (Ball *et al.*, 2001). Despite the findings of investigators and the introduction of the Council of Australian Governments' water industry reforms in 1994, those pressures continued to increase (Ball *et al.*, 2001).

All rivers within regions with intensive agriculture are degraded to some degree by human activity (Australian State of the Environment Committee, 2001). It is no coincidence that the most serious ecological problems occur in south-eastern Australia, particularly in the Murray–Darling Basin, where water resource and catchment development and the spread of pest species act together (Ball *et al.*, 2001; ASEC, 2001; NLWRA, 2002a). In the Murray–Darling Basin, only 3% of rivers remain largely unmodified (Norris *et al.*, 2001). The most widespread modifying factor identified is catchment disturbance (assessed on degree of vegetation clearance and the intensity of land use), while hydrologic disturbance (water regulation and extraction) affects more than half of the river reaches assessed (Norris *et al.*, 2001). Many of the major rivers have floodplain wetlands that are considerably reduced by declining river flows (Kingsford, 2000). Of the major river catchments in the Murray–Darling Basin, only the Paroo and Warrego remain largely unregulated by major government-built or private dams and are now the only catchments where most of the floodplain wetlands remain (Kingsford *et al.*, 2004b). Riparian vegetation is often dominated by introduced species, native fish populations are now about 10% of pre-European levels, largely replaced by exotic species such as European carp, *Cyprinus carpio* (Gherke & Harris 2001), and incidents of blue–green algal blooms are considerable and more frequent (Bowling & Baker, 1996).

1.1.1. Alteration of flows

Major impacts on rivers have been caused by alteration of flows through river regulation: the building of dams (and weirs), drainage and levees, floodplain development and water extraction. The primary impact of river regulation on the riverine environment is interruption of the natural flows of water, sediments, nutrients, energy and biota (Ligon *et al.*, 1995), leading to fundamental changes in channel characteristics, habitat availability and flow regime (Allan & Flecker, 1993; Bunn & Arthington, 2002). Alteration of the flow regime may include reversal of seasonality, attenuation of minor and moderate floods, reduced variability and altered rates of rise and fall of river levels (Walker, 1985; Maheshwari *et al.*, 1995; Kingsford and Thomas, 1995; Thoms & Sheldon, 2000). This affects the productivity and exchange of material between the floodplains and the river channel (Robertson *et al.*, 1999; Thoms, 2003).

Alteration of flows and reduced flooding has been shown to have ecological impacts on dependent ecosystems, affecting ecosystem services (Allan & Flecker, 1993; Lemly *et al*., 2000; Gillanders & Kingsford, 2002; Bunn & Arthington, 2002). In Australia, such impacts are particularly evident within the Murray–Darling Basin (Walker, 1985; Kingsford, 2000; Arthington & Pusey, 2003; Kingsford & Thomas, 2004).

Extensive floodplains, mostly located in the lowland parts of catchments, are the dominant type of freshwater-dependent ecosystem in the Basin (Kingsford *et al.*, 2004b). These are the areas where most biodiversity and dependent agrarian industries, such as grazing, reside. The diversion of water, predominantly for irrigated agriculture (NLWRA, 2001), in the upper and middle reaches of the catchments, deprives many of these floodplain ecosystems of water, resulting in major loss of biodiversity and ecosystem function (Kingsford, 2000).

1.1.2. Catchment disturbance

Catchment characteristics are the main factor influencing river flows. Alteration of catchments through grazing, vegetation clearing, urbanisation, mining and agriculture changes rivers (Richter *et al.*, 1997). For example, vegetation clearing alters physical habitat within riparian zones (Davis & Froend, 1999) and the hydrology of freshwater systems (Davis & Froend, 1999; Ogden, 2000; Malmqvist & Rundle, 2002). Sediment and nutrient loads from catchment disturbance have increased by an order of magnitude in many Australian river basins (NLWRA, 2002a). About 13% of native vegetation nationally has been cleared since European settlement, concentrated in large population centres and areas of agricultural production: the Murray–Darling Basin, the east coast and the south-west of Western Australia (NLWRA, 2002a). There are many examples of catchment disturbance and its impact on aquatic systems throughout Australia. The following examples illustrate some of the more severe impacts resulting from poor management and cumulative development of catchments.

- Faecal matter from poorly managed sewerage systems in adjacent rural and urban residential zones polluted Wallis Lake, on the central coast of NSW, one of the major fisheries of Sydney rock oysters: resulting in over 400 people contracting viral hepatitis A from contaminated oysters (Ebsworth & Ebsworth, 2001).
- Toolibin Lake, the last remaining example of a perched freshwater wetland in the south-east of Western Australia, is threatened by a rising watertable and increasing salinity caused by widespread clearance of native vegetation (Froend *et al.*, 1987; Boulton & Brock, 1999).
- The Great Barrier Reef World Heritage Area, one of the seven natural wonders of the world, is threatened by elevated sediment loads from Queensland coastal rivers in the wake of catchment clearing (Hendy *et al.*, 2003).
- In the Murray–Darling Basin, the ingress of nutrients from urban and agricultural areas, and extended periods of low or no flow intensified by high levels of water extraction, exacerbates development of potentially toxic, blue–green algal blooms (Ball *et al.*, 2001).

1.1.3. Pest species

Humans have a long history of the intentional or accidental introduction into ecosystems of exotic species that then become uncontrollable outside their natural range. Freshwater ecosystems in

Australia are no exception; in Australia there are now 20 species of exotic fishes and 65 species of exotic aquatic plants. Fifteen of these species are significant pests (Boulton & Brock, 1999). The following are some examples of pest species with the potential to have devastating effects on Australian freshwater and estuarine ecosystems.

- Eight NSW estuaries and at least one South Australian harbour are under threat from invasions of *Caulerpa taxifolia*, a noxious alga with the potential to grow rapidly and smother seagrass beds.
- Tropical rivers are at risk from a plethora of weed species: *Mimosa pigra,* whose seeds are spread by floodwaters (Cook *et al.*, 1996); rubbervine *Cryptostegia grandiflora,* which forms impenetrable thickets along watercourses; and *Parkinsonia aculeata,* found along watercourses, is one of the most troublesome weeds in the Northern Territory.
- Water hyacinth (*Eichhornia crassipes*), lippia (*Phyla canescens*), willows (*Salix* spp.) and alligator weed (*Alternanthera philoxeroides*) are among other weeds causing problems in riverine systems in parts of Australia.
- European carp (*Cyprinus carpio*) has spread throughout the Murray–Darling Basin in less than 40 years and is now a major aquatic pest species, competing with native fish, destroying aquatic vegetation and disturbing benthic sediments (Ball *et al.*, 2001). In a survey of fish communities in NSW in 1996–1997, 80% of the catch in the Murray catchment was made up of introduced species (Gherke & Harris, 2001).
- Other introduced vertebrate pests also threaten the ecological health of river ecosystems in Australia. including the cane toad (*Bufo marinus*), feral pigs (*Sus scrofa*), water buffalo (*Bubalus bubalis*) and banteng cattle (*Bos javanicus*).

1.2. Australian rivers: potential for national action

As a nation, Australia spends millions of dollars on degraded river systems and their catchments (e.g. $2.7 billion under the Natural Heritage Trust, $1.4 billion under the National Action Plan for Salinity and Water Quality, $0.5 billion on the Living Murray initiative). Communities and governments, supported by State and Australian Government funding programs, strive at local, catchment, regional and State levels to rehabilitate natural riverine environments and to sustain agricultural productivity. Such efforts usually aim to restore parts of already degraded environments rather than to protect high value intact or remnant ecosystems, and outcomes are patchy and difficult to quantify. The Prime Minister's Science, Engineering and Innovation Council has argued that it is 10 to 100 times cheaper to maintain ecosystems than to repair them (PMSEIC, 2002), yet relatively little is invested in the protection of our remaining, relatively undisturbed, functioning and diverse high-value aquatic ecosystems.

In the 21st century, Australia has an opportunity to learn from the past and build a framework that protects some of our most important ecosystems. While many of the rivers in the south-eastern, densely populated part of the continent are heavily developed, some rivers in the inland and northern half of the continent remain largely unexploited (Ball *et al.*, 2001; Stein *et al.*, 2001; NLWRA, 2002b; Dunn, 2003). There is growing recognition of the ecological value and conservation importance of these few, relatively unaffected rivers in Australia (Cullen, 2002: Hankinson & Blanch, 2002). As well, there is recognition of the importance of a national approach to aquatic ecosystems of national importance (e.g. estuaries; Smith *et al.*, 2001). However, a framework for the protection of high-conservation-value rivers should encompass undeveloped river basins, as well as nationally important rivers, reaches, wetlands, floodplains and estuaries within developed river basins.

While attention has been given to the conservation of rivers, there has been relatively little concerted strategic activity in river conservation at the national level in Australia (Schofield *et al.*, 2000). Many rivers in the highly populated parts of Australia are under pressure from the cumulative impacts of development, and proposal to develop the resources of undeveloped, high-yielding river basins continue, including to develop Australia's tropical rivers. River regulation is known to produce long-term and predictable ecological consequences for rivers and their dependent ecosystems (Lemly *et al.*, 2000). Several authors predict that these large tropical and subtropical river systems with natural flow regimes will suffer ecological damage and biodiversity losses if large-scale water development takes place (Allan & Flecker, 1993; Puckridge *et al.*, 1998; Bunn & Arthington, 2002; Arthington & Pusey, 2003).

The National Water Initiative (NWI) is a comprehensive strategy driven by the Australian Government to improve water management across the country. The National Water Initiative recognises that Australia's highly variable and often scarce water resources are crucial for economic, social and environmental wellbeing.

The National Water Initiative parties agree that the outcome for the integrated management of environmental water is to identify within water resource planning frameworks the *environmental and other public benefits* sought for water systems. The parties agreed to establish effective and efficient management and institutional arrangements to ensure the achievement of environmental and other public benefit outcomes, including any special requirements needed to *sustain high conservation value rivers, reaches and groundwater areas*.

1.2.1. Commitments

Successive Australian governments have committed to the protection of high-conservation-value ecosystems, including aquatic systems, through a range of measures including (but not limited to):

- Ramsar Convention 1971
- World Charter for Nature 1982
- Agenda 21 1992 (Rio Earth Summit)
- Intergovernmental Agreement on the Environment 1992
- United Nations International Convention on Biological Diversity 1992
- National Strategy for the Conservation of Australia's Biological Diversity 1996
- Natural Heritage Trust.

Similarly, government and non-government initiatives in all Australian jurisdictions increasingly recognise the need for protection of high-value rivers. Such initiatives include:

- the Prime Minister's Science, Engineering and Innovation Council recommendations for managing Australia's inland waters and measures for protection of heritage rivers
- the National Water Initiative 2004 (CoAG, 2004 <www.coag.gov.au/meetings/ iga_national_water_initiative.pdf>, accessed 18/8/04),
- Land & Water Australia projects by Bennett *et al.* (2002) and Dunn (2000), proposing methods to identify and protect high conservation value rivers
- the Living Murray's focus on protecting significant ecological assets
- the Natural Resource Management Ministerial Council 2004 plans for inclusions of freshwater environments in the national reserve system (Discussion paper: Directions for the National Reserve System—a Partnership Approach, <www.deh.gov.au/parks/nrs/directions/ index.html>, accessed 18/8/2004)
- Conservation Guidelines for the Management of Wild River Values 1998
- bilateral and multilateral agreements for the protection of the Paroo River and Lake Eyre Basin
- the marine park reserve system to protect high-value estuaries
- the Australian Capital Territory's river corridors
- the New South Wales' process to nominate wild rivers in national parks and reserves
- the Northern Territory's protection measures for the Daly River
- Queensland's wild rivers policy election commitment
- South Australia's commitment to the Lake Eyre Basin Agreement and the Living Murray initiative
- Tasmania's project on the conservation of freshwater ecosystem values
- Victoria's heritage river system
- Western Australia's wild rivers documentation and state of rivers reports.

1.2.2. Context for protection of high- conservation-value rivers

As well as these commitments, a considerable body of knowledge exists supporting the protection of high- conservation-value river ecosystems.

- 'Wild Rivers' was a national program initiated with the primary objectives of identifying and encouraging the protection of rivers that remained largely unaltered by European settlement (Stein *et al.*, 2001). It did not specifically identify high-conservation-value ecosystems or include wetland ecosystems. The wild rivers database used nationally available information to indicate the potential level of disturbance from human activities, but additional information is required to adequately assess the impacts of alteration of flows by dams and extractions relative to other threats. Although lists of wild rivers were produced for each jurisdiction (<http://www.heritage.gov.au/anlr/ code/arc-maps.html>, accessed 18/8/2004), protection of identified rivers and river reaches never eventuated.
- In 2001, the principles and tools for protecting Australian rivers were reviewed (Phillips *et al.*, 2001). This provided a comprehensive guide for the systematic protection of rivers, primarily for managers, but it did not focus on high-

conservation-value rivers. It advocated three levels of protection planning: conservation, sustainable use, and remaining use. It also provided guidelines for assessing ecological value, determining sustainability using a pressure– state–response model, selecting appropriate planning or protection tools and setting priorities for protection, and evaluating effects of development.

- In 2004, there was an extensive independent review of existing Australian mechanisms for protection of freshwater ecosystems (Nevill & Phillips, 2004). It advocated the need for comprehensive inventories of Australia's freshwater ecosystems so that key areas could be identified for a comprehensive, adequate and representative system of aquatic protected areas. It also considered the importance of protecting high-conservation-value rivers.
- In 2004, a discussion paper was released by the Natural Resource Management Ministerial Council in relation to the future of the national reserve system (NRMMC, 2004; <www.deh.gov.au/parks/nrs/directions/ index.html>, accessed 18/8/2004). Freshwater reserves were identified as an emerging issue for the national reserve system. The paper recommends the identification and mapping of freshwater systems, and a review of the comprehensiveness, adequacy and representativeness of the reserve network for freshwater biodiversity.
- The *Directory of Important Wetlands in Australia* lists wetlands of international and national significance in Australia. It was compiled by jurisdictional contributors (ANCA, 1996; <www.deh.gov.au/water/wetlands/database/ index.html>, accessed 18/8/2004) and provides an indication of key wetland assets. The directory uses the Ramsar definition of wetlands, which includes rivers and subterranean aquatic ecosystems. These lists were compiled using criteria modified from the Ramsar convention, but not applied objectively or comprehensively across all wetlands. As the list was assembled using the bioregional framework for terrestrial ecosystems, there are problems with overlapping catchment communities and with wetlands not set in a catchment framework for management.
- Australia is a signatory to the Ramsar Convention, and currently has a total of 64 listed wetlands, covering an area of almost 7.4 million ha. The nomination and management of Ramsar sites is the responsibility of the State or Territory in which they are located. These listed wetlands are distributed among different rivers and systems, but tend to be within current protected areas because of the relative ease of nomination processes where the site is already protected. While these wetlands have status as 'wetlands of international importance', they do not necessarily represent the highest conservation value wetlands or rivers at a national, State or Territory level, nor have they been subject to a consistent and systematic comparative assessment process.
- Wetland policy and funding processes have seldom adequately included the importance of river flows for long-term sustainability. For example, there is relatively poor coverage of the importance of river flows in the *Directory of Important Wetlands in Australia*, and no jurisdictional or national wetland policies adequately deal with the overriding importance of flows and their effects on biodiversity and wetland health.
- In 1994, CoAG agreed on a course of management for Australia's water resources. This included recognition that the environment was a legitimate user of water. In 2004, CoAG agreed to the National Water Initiative (NWI), which will chart the future responsibilities and progress towards sustainable management of the nation's rivers and aquifers. Provisions in the intergovernmental agreement (<www.coag.gov.au/meetings/ 250604/iga_national_water_initiative.pdf>, accessed 18/8/2004) on the NWI commit parties (all States and Territories apart from Tasmania and Western Australia) to identify, protect and manage high-conservation-value rivers and aquifers and their dependent ecosystems.
- Rivers of outstanding importance to the Australian community as a whole may be nominated under the new heritage provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under these provisions, anyone may submit a nomination for a river to be considered for inclusion on the National Heritage List. The Australian Heritage Council will assess the natural or cultural heritage values of nominated places against specific criteria and make recommendations to the Minister for the Environment and Heritage. The final decision on listing will be made by the Minister (<www.deh.gov.au/heritage/national/ index.html>, accessed 18/8/2004).

1.3. Why do we need a national framework?

There is no comprehensive or systematic protection of rivers of high conservation value in Australia or its constituent jurisdictions. However, four jurisdictions currently have or will have established individual approaches for wild or heritage rivers. Victoria has protected 18 rivers under its *Heritage Rivers Act 1992* (Appendix E). The Australian Capital Territory has established major river reserves. New South Wales has a commitment to designate parts of rivers within national parks and reserves, under the *National Parks and Wildlife Act 1974* (Appendix E). Queensland has a commitment to identify and protect wild rivers by designation of particular rivers (Appendix E). In contrast to the well-established system of conservation of terrestrial environments through reservation of lands, and progress on marine protected areas, there are few good models that have been adequately applied to the conservation of freshwater aquatic environments. In some parts of the country, whole river basins may be protected by virtue of land protection measures, such as the wilderness protection areas in Tasmania, large national parks in Queensland (e.g. Jardine River) and the Prince Regent Basin biosphere reserve in Western Australia.

In most areas, protection and management of rivers is delivered through a combination of environmental planning and assessment, environmental protection (water quality), vegetation management, water and river management, threatened species and wildlife protection legislation, and incentive-based restoration programs. In some cases these mechanisms have succeeded in protecting river values, but in many important instances they have encountered significant difficulties or have failed. Where protection has been successful, there is uncertainty whether the best conservation outcomes have been achieved, because the relative value of aquatic systems is unknown and because the conservation of rivers or ecosystems is seldom managed within a catchment context.

Conservation efforts in Australia have traditionally focused on terrestrial systems; 9.2% of Australia's total land area is protected within formally declared areas, as defined by the International Union for the Conservation of Nature (IUCN) (NLWRA, 2002b). Conservation value in an ecological sense has been widely applied to terrestrial ecosystems, contributing to reserve design and planning (Margules & Pressey, 2000). Conservation planning has evolved over time, moving from protection of scenic and recreational values towards conservation of species and communities. Over a similar period, conservation of rare species (often vertebrates with high popular appeal or attractive higher plants) has evolved towards conservation of communities and ecosystems. While protected areas have played an important role in securing biodiversity and the future of significant landscape components and vegetation communities, legislation and policies increasingly seek to mitigate potentially threatening processes (e.g. climate change, clearing, salinity) in a broad bioregional and catchment context. These changes in terrestrial conservation planning reflect advances in our knowledge of native species, their habitats, and the complex linkages and landscape-scale processes that drive and sustain our ecosystems.

To support future consideration of conservation of aquatic systems in this context in 2003/04 States, Territories and the Austrlian Government participated in the development of a conceptual framework for the protection of high conservation value rivers, river reaches and estuaries.

A protection framework for the conservation of the ecological values of aquatic systems can profit from the lessons learnt from terrestrial conservation. That is, an effective framework should focus on:

- conservation of habitat, ecosystem function and process to protect biodiversity rather than preservation of iconic species;
- systematic identification of priorities; and
- strategic application and integration of a range of suitable protection measures (protected areas, land-use planning and threat management) to effect conservation within a landscape context.

There are some significant advantages in adopting a national framework (see Box 1). As well as the plethora of potential measures for protection, there is no integrated framework showing where and at what scale such measures can be most effectively utilised, or how governments could reward good management through investment. All governments are investing considerable funds in the management of natural resources for conservation (e.g. Natural Heritage Trust, National Action Plan for Salinity and Water Quality) and high-conservation-value rivers need to be considered as priorities in such management. A national framework could clearly identify and strategically target management efforts at high- conservation-value rivers and help to establish interrelationships among various delivery bodies. It could help cross-border management of rivers and allow for better balancing of short-term gains against long-term degradation costs at a national level. It would assist in state-of-the-environment reporting and land and water management auditing, from jurisdictional to national scales.

1.4. Key concepts

A significant impediment to communication and discussion about the management of rivers is inconsistency in the meanings ascribed to technical terms used. This problem is often exacerbated by legislative and policy differences among jurisdictions. An agreed terminology for river protection is essential. Box 2 outlines the main terms used in this discussion paper.

Box 1: Reasons for a national framework

Prevention is better than cure—A national framework for the protection of rivers would help forestall degradation of national environmental assets that are becoming increasingly difficult and expensive to rehabilitate for future generations.

Strategic national investment—A national framework could help ensure that the limited resources available for river conservation are strategically targeted at nationally important rivers and dependent ecosystems, and provide the opportunity for a nationally coordinated support program.

National conservation—A national approach would allow a more comprehensive understanding of the need for conservation action that otherwise may be underestimated by regional or jurisdictional studies.

National and international obligations—Through treaties and conventions, the Australian Government has international responsibilities for rivers, dependent ecosystems and particular migratory species that depend on rivers and their dependent ecosystems (e.g. migratory wading birds), and biological diversity.

Consistent methodology—An agreed methodology would be useful in the setting of national conservation priorities and for consistent auditing at different scales. It would allow for strategic planning and for identification of high-conservation-value rivers and ecosystems at different spatial scales. It would also allow for state-of-the-environment reporting and auditing of natural resources at different spatial scales. This would allow different community and government groups to adopt a common currency, making assessment more consistent.

Sharing knowledge—A national framework would provide a way of sharing successful mechanisms for assessment and protection. Jurisdictional information systems can be enhanced by linkages established through a national framework.

Cross-border river management—Many of Australia's rivers basins straddle State borders. Cross- border river management continues to be problematic, primarily because each State or Territory has different priorities, policies and legislation. A national framework could assist with whole-river and basin management of high-conservation-value rivers.

Natural region boundaries—With a national framework, planning and assessment need not be limited by administrative boundaries and may conform to more natural boundaries of plants and animals.

Delivery relationships—Many different government and community groups are involved in the management of rivers, including catchment management authorities, regional bodies, local Aboriginal communities, government agencies and local government. A national framework could build essential synergies among different groups responsible for delivering programs for high-conservation-value rivers.

Box 2: Key terms

Rivers are complex but essentially linear bodies of water draining, under the influence of gravity, from elevated areas of land towards sea level.

Dependent ecosystems include river segments, wetlands, riparian zones, intermittently or seasonally inundated floodplains, estuaries and connected groundwater systems (e.g. karst). They also include temporary or permanent wetlands that may fill from local rainfall or groundwater. They include ephemeral streams and creeks and 1st and 2nd order streams.

Spatial scales for rivers are consistent with nationally accepted terminology. Drainage divisions, basins, catchments and sub-catchments are best defined topographically, reflecting the hydrology of rivers. Currently available and agreed spatial systems do not always respect this tenet. This paper refers to the Australian Water Resources Commission 12 drainage divisions covering Australia, and the 245 river basins, used in the National Land and Water Audit, because these are widely used and agreed upon. River segments and reaches and sub-catchments are any other nested smaller-scale parts of rivers, within the river basins.

Conservation value encompasses the conservation of cultural and ecological values of rivers. It is a measure of relative significance (Dunn, 2000). This discussion paper focuses primarily on ecological value, while recognising that the framework may be usefully adapted to recognise cultural values. Ecological values within the broad context of 'conservation value' are attributes of river system ecology that should be protected, maintained or restored for present and future generations.

Conservation criteria are broad categories of conservation importance for which rivers and their dependent ecosystems could be assessed to determine if they are of high conservation value. They are applied in an ecological sense in the discussion paper.

Attributes are actual measures that would be used for each conservation criterion and could be developed into a score that would allow high-value-conservation rivers and their dependent ecosystems to be identified. These equate to the 'indicators' used by Bennett *et al*. (2002).

High conservation value describes rivers or their dependent ecosystems (river segments, floodplains, estuaries) whose conservation value is objectively assessed and ranked highly, based on proposed criteria and national assessment.

Tools and mechanisms refer to the ways in which data may be collected and integrated, and the ways in which rivers may be protected through policy, management and legislation.

Protection means taking care of a place by managing impacts to ensure that natural values, ecological integrity and connectivity are maintained (Australian Natural Heritage Charter [1996]; Bennett *et al.*, 2002). Different mechanisms exist for protection at different scales, tailored to the context of threats to rivers.

Protected areas, as defined by the IUCN's six categories [see appendix in Nevill & Phillips (2004)] include jurisdictional national parks and conservation reserves, Ramsar sites, aquatic reserves and local- government reserves.

Jurisdictions are the State and Territory governments, which are primarily responsible for land and water management in Australia, local governments and the Australian Government.

Regional bodies are statutory or non-statutory bodies set up by the State and Territory governments to manage catchments and deliver funding for natural resource management. They include catchment- management authorities.

1.5. Conservation planning and protection

Conservation of biodiversity is the widely adopted nature conservation objective of many international conventions, national governments, state agencies and non-government organisations (Redford *et al*., 2003). Rigorous conservation planning leads to a vision that describes general conservation outcomes that may be easily communicated (Fig. 1). For example, the vision for the protection of the natural environment and biodiversity of the Cape (floristic region) in South Africa was to have "effectively conserved, restored wherever appropriate, and delivering significant benefits to the people of the region, in a way that is embraced by local communities, endorsed by government and recognised internationally" by 2020 (Pressey *et al*., 2003). Based on this model, a potential vision for protection of all rivers could be:

> *By 2020, riverine biodiversity, rivers, and their dependent ecosystems in Australia will be effectively protected and restored, where appropriate, delivering significant benefits to local people and the Australian community.*

Implementation of this vision depends on assessment of all rivers and dependent ecosystems to identify those of high conservation value. Such an assessment has the added benefit of identifying conservation values and appropriate management needs within all rivers. The Canadian Heritage Rivers System adopts a similar vision that focuses on "outstanding rivers" (Appendix D). A vision can then be translated into specific goals and measurable results, applied at different spatial scales, through conservation planning and management mechanisms (Fig. 1). In an operational sense, there are usually specific goals relating to conserving species (threatened or all species), ecological communities, ecological and evolutionary processes, natural features or sustainable use (Groves *et al*., 2000; Redford *et al*., 2003). Sometimes communities or ecological systems become the focus because they are assumed to be effective surrogates for sustaining biodiversity (e.g. St Louis River Citizens Action Committee, 2002).

Goals can be tied to quantitative targets, based on the best available information, to measure progress, effectiveness and accountability for conservation decisions (Margules & Pressey, 2000). They are more likely to initiate conservation actions by clearly specifying what planners are aiming for (Nix *et al.*, 2000). Trade-offs between conservation and competing land uses can be made explicit (Pressey *et al.*, 2003). Aims need to be focused so they recognise that some features may need greater levels of protection than others and do not potentially generate a false expectation that limited conservation action is sufficient (Pressey *et al.*, 2003). Targets can apply to distributions of populations, species, communities or ecological systems (Smith *et al.*, 2002; Pressey *et al.*, 2003; Weitzell *et al.*, 2003). Methods are available to set credible targets (Pressey *et al.*, 2003) for better-known species or systems that represent biodiversity, but uncertainty will always necessitate review.

Until relatively recently, management of natural resources was approached through a dichotomous process: areas were either protected (e.g. national parks, conservation reserves) or they could be developed given adequate safeguards (e.g. environmental assessment, land-use planning provisions and management plans). There is now a realisation that ecologically sustainable management is much more difficult — conservation and land and water management are inextricably linked. Further, many conservation reserves dependent on rivers were not adequately managed, because conservation managers had no control over the water (Barendregt *et al.*, 1995; Kingsford & Thomas, 1995; Kingsford, 2003).

To deal effectively with the major pressures on rivers and their dependent ecosystems, some key principles should be applied to management and protection of national rivers or dependent ecosystems (Box 4).

The challenge is particularly difficult for rivers where ecosystems are connected for sometimes more than a thousand kilometres. For effective protection of high- conservation-value rivers and their ecosystems, it becomes essential to tailor the protective mechanisms to the potential pressures. Following on from the broad categories of pressures that affect conservation values of rivers, it is possible to broadly define the types of protection measures that can be used (Box 5). The extent to which chosen mechanisms are implemented will depend on a variety of factors and, in particular, the level of protection the community or government wishes to afford a specific high- conservation-value river or its dependent ecosystem. This applies where measures may restrict water- resource development and/or land-use changes.

Natural resource management agencies have a strong interest in clear policy drivers that support the conservation of high-conservation-value river ecosystems. A national framework could foster involvement, understanding and commitment from communities and the various levels of government, by providing clear strategic direction for river conservation.

Box 3: Explanation of Figure 1

1. A vision statement provides an easily communicated description of desired conservation outcomes.
2. An evaluation system, based on agreed criteria and significance thresholds, identifies high-conservation-value rivers and dependent ecosystems and informs the selection of goals for conservation planning. Thresholds used for Ramsar (a convention for protection of wetlands of international importance) and the *Directory of Important Wetlands in Australia* (DIWA) may be used to inform this process.
3. Goals specify the values or features of rivers that are the focus of the conservation plan.
4. Targets make conservation goals operational and describe conditions necessary for persistence of desired values and features.
5. Evaluates whether targets for representation and design have been achieved by existing protection mechanisms, measures progress towards goals and identifies additional conservation needs.
6. A complementary set of priority areas that represents all remaining features according to the specified targets, preferably while minimising opportunity costs, is identified and prioritised for conservation action using criteria such as uniqueness, capacity for protection and vulnerability.
7. The Australian Heritage Rivers system protects whole basins of high conservation value.
8. Existing jurisdictional protection mechanisms, including reservation, are employed for other high-conservation-value rivers, river segments and dependent ecosystems. A conservation strategy could coordinate and provide direction for existing national (e.g. NRSMPA—National Representative System of Marine Protected Areas (<http://www.deh.gov.au/coasts/mpa/nrsmpa>, accessed 18/8/ 2004); NRS—National Reserve System, <http:// www.deh.gov.au/parks/nrs>, accessed 18/8/2004) and jurisdictional programs.
9. Monitoring and review are necessary to ensure the desired characteristics of high-conservation-value rivers are being maintained and to review the adequacy of goals and targets.

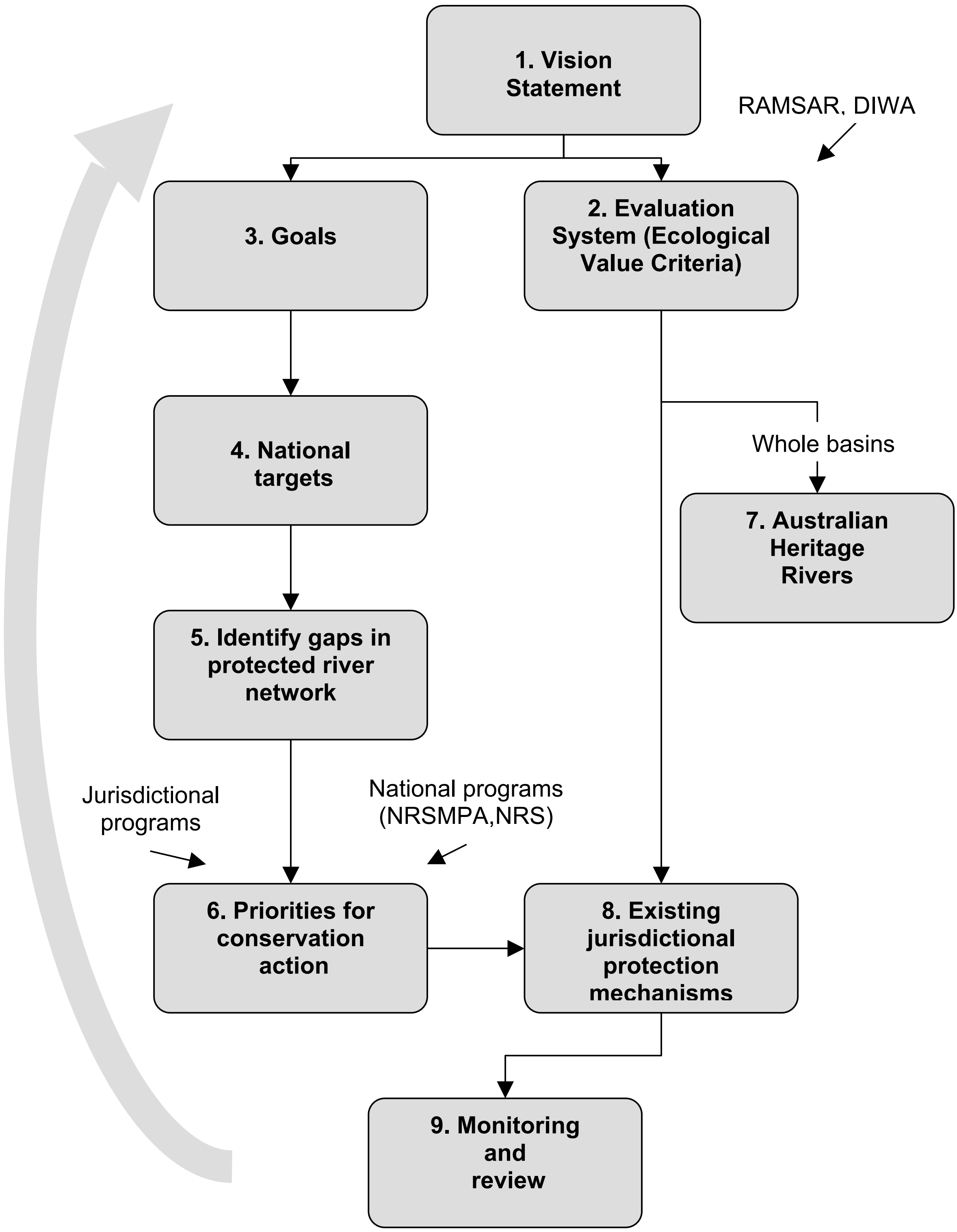


Figure 1. Parts of a national conservation strategy for rivers and dependent ecosystems. See Box 3 for explanation. Consultation and communication are essential at every stage.

Box 4: Proposed management principles for protection of high-conservation-value rivers, river reaches and dependent ecosystems

- Management of threats should be the main focus, using a catchment framework at an appropriate scale, and which recognises linkages between site values and catchment processes.
- Management approaches should, wherever possible, use available jurisdictional mechanisms, rather than develop new processes.
- Management plans, adopting protection of ecological assets and processes as the key defining goals and objectives, should take account of existing threatening processes, as well as guard against future detrimental processes.
- River flows should be protected at a level and regime that sustains all in-stream, floodplain and estuarine processes and functions (including long-term processes).
- Management should explicitly recognise the interdependence of surface river flows and subterranean catchments. Connected aquifers are part of the river.
- All proposed activities that affect ecological processes and values of identified systems should be adequately assessed and managed at a catchment scale if appropriate.
- Investment activities in restoration should target the nationally important high-conservation-value rivers, river segments and dependent ecosystems, prioritised according to imminence of threat and irreplaceability.
- Shared responsibilities between different tiers of government and the community should be developed and coordinated to protect rivers and dependent ecosystems that are nationally important.

Box 5: Protection mechanisms in relation to key pressures

Alteration of flows

- River management planning in different jurisdictions can protect essential flows to high-conservation-value rivers and their ecosystems. For effective flow protection to a high-conservation- value river or dependent ecosystem, near-natural flow regimes need to be maintained.
- Protected areas can be used to effect control over access to water or modification of the floodplain. Some rivers and their flows may be totally within a protected area.
- Environmental assessment can be designed to protect high-conservation-value areas from impacts of alteration of flows at different spatial scales. This should identify the potential cumulative impacts of small developments as well as large developments.
- Mechanisms that increase environmental flows to degraded iconic sites of national importance can be used to restore ecological health of high-conservation-value rivers and dependent ecosystems.
- For restoration activities, incentives could be used to purchase flow allocations, works that rehabilitate floodplain areas or increase ability to manage environmental flows (e.g. removal of‘chokes' that restrict channel capacity and constrain the delivery of downstream flows).

Catchment disturbance

- Local and regional environmental planning can ensure catchment areas, essential for protection of high-conservation-value rivers or ecosystems, are not affected by inappropriate development.
- Protected areas can control inappropriate development (causing degradation) in areas in the catchment that could affect high-conservation-value rivers or ecosystems.
- Environmental assessment of potentially detrimental catchment processes (e.g. mining, clearing, urbanisation) can protect high-conservation-value rivers and dependent ecosystems. It should identify the impacts of not only large developments, but also the potentially cumulative impacts of small developments.
- Incentives for restoration activities should target critical catchment areas, including riparian zones and floodplain wetlands, that are important for high-conservation-value rivers and their dependent ecosystems.

Pest species

- Control programs, including catchment-based quarantine measures, and funding (e.g. biological control) can prevent the introduction of invasive species or focus on the management of weeds or feral animals affecting high-conservation-value rivers and dependent ecosystems.
- Environmental risk assessment can test the potential for exotic species deliberately introduced, particularly plants, to invade high-conservation-value rivers and dependent ecosystems.
- Application of quarantine legislation seeks to avoid further introductions of pest species, including aquarium species, to high-conservation-value rivers and dependent ecosystems.

Chapter 2. A national protective framework

2.1. Principles of a national protective framework

A national protective framework for rivers and dependent ecosystems could be built on the following principles.

- The national framework should seek to protect those rivers and dependent ecosystems of high conservation value.
- Identification of high-conservation-value rivers and nationally important freshwater ecosystems should be based on scientific assessment using nationally agreed criteria.
- The evaluation and ranking of the conservation value of rivers should recognise the multiple spatial scales of aquatic ecosystem organisation.
- Evaluation and ranking of conservation of rivers should allow iterative analysis, accommodating further assessment and evaluation as new data become available.
- High-conservation-value rivers should be managed to sustain their ecological values and integrity.
- Protection mechanisms need to recognise that rivers and their ecosystems require catchment-based management: a river reach, floodplain wetland, dependent aquifer or estuary cannot be managed or protected in isolation from its catchment.
- A national framework should integrate and coordinate current arrangements and seek to support and augment them where necessary, rather than replace or downgrade existing programs of conservation.
- A national program should build on institutional and administrative arrangements currently in place for delivery of natural resource management, avoiding duplication.

2.2. Developing a national approach

A working group (see authors and acknowledgments section) with experience in river management and conservation developed the main elements of this discussion paper. Some members of the working group are involved within jurisdictions in the conservation of rivers and dependent aquatic ecosystems. Others have wide experience in the theory and practice of conservation management of aquatic ecosystems. Development of the main elements of the paper occurred over a series of meetings within the group. These were considerably augmented by workshops held in various jurisdictions across Australia (Appendix F) and a national forum where the essential elements of the approach proposed were debated (Appendix G). This discussion paper represents a culmination of these deliberations, within the context of national and international obligations and the current state of knowledge in the area.

2.3. Elements of a national protective framework

A national framework of river protection could be built around three main elements:

1. nationally consistent collection of information on rivers, wetlands and estuaries, which will entail agreement on spatial scale and classification and evaluation systems for identification of rivers and dependent ecosystems of high conservation value
2. protection schemes that operate at different scales such as :

   a 'whole-of-river' approach that could include establishment of an 'Australian Heritage Rivers' system

   protection of high-conservation-value rivers, river segments and dependent ecosystems (floodplains, wetlands, estuaries) in a national, State, regional and local context (using current legislative and policy tools; i.e. environmental flows, protected areas, natural resource planning and management, and incentives)
3. operational and institutional arrangements— coordinated programs involving jurisdictions in implementation of a national framework.

2.4. Nationally consistent river information

The availability of data and the capacity to make valid comparisons among sites are particularly problematic for aquatic systems. The Australian State of Environment Report (ASEC 2001) and the National Land and Water Resources Audit (NLWRA 2001) identified major deficiencies in our knowledge of the extent and condition of inland aquatic systems. Further, the taxonomy and ecology of many groups of aquatic taxa remain poorly known (Cullen & Lake, 1995; Kingsford & Norman, 2002), restricting efforts at objective assessment. Existing pockets of good data at local or regional scales cannot readily be combined to provide a national viewpoint. In particular, there is a lack of information about aquatic ecosystems in relatively undisturbed remote catchments: those that are most likely to satisfy our first evaluation criterion (see below).

There is a need to invest in the long-term collection and collation of ecological and biophysical data for objective assessment of condition and value. To objectively identify high-conservation-value rivers at the national scale will require relative assessment across jurisdictions.

There is little jurisdictional support for a centralised national system of data management and application that might replace existing data systems (Appendixes F and G). Most jurisdictions have well-established systems of data collection and management that do not need to be duplicated at a national level. In contrast, there is some support for a consistent approach to collection of river information (Box 6).

A nationally consistent river information system would help identify and manage nationally important high-conservation-value rivers and component ecosystems. With appropriate adjustment of attributes and significance thresholds, State and regional natural resource managers could also apply the framework to identify jurisdictional and regional high-conservation-value assets.

Three main elements, the foundation of agreed protocols, could make up an agreed nationally consistent information system:

1. a spatial framework
2. a classification system
3. an evaluation system.

2.4.1. *Spatial framework*

A consistent and applicable spatial framework is essential for river protection and assessment at different scales. It could operate across jurisdictional boundaries that might otherwise restrict the ecological or management frameworks for rivers (Kingsford *et al.*, 1998). The Australian continental limits define the spatial extent of the national framework, although a few patterns and processes may extend beyond the national border (e.g. fish (Unmack, 2001) and waterbirds (Halse *et al.*, 1996; Kingsford & Norman, 2002)).

Box 6: Rationale for nationally consistent information

Comparable assessment—High- conservation-value rivers and component ecosystems can be consistently identified across jurisdictions.

National importance—Attributes can be evaluated comprehensively for national significance.

Links among databases—Jurisdictional databases could be linked, enhancing their utility (e.g. assessment and modelling may require data beyond jurisdictional boundaries).

State, national and international targets—Reporting against national targets (e.g. National Action Plan for Salinity and Water Quality, Ramsar) may be easier. This may also include state-of-the-environment reporting.

Investment—Nationally strategic investment in high-conservation-value rivers could be targeted.

Gap analysis—It would be possible to clearly identify gaps in information that need to be filled for detailed assessments of rivers.

Management of cross-border rivers—Management of rivers that cross jurisdictional borders could use consistent information.

Potential scales for assessment and protection range from the whole river to individual river segments. Parts of rivers (e.g. wetlands) and riparian zones can be managed primarily for biodiversity conservation, while it is also possible to 'protect' some entire river systems from other threats (e.g. water-resource development) through river management. For example, Coongie Lakes and Currawinya Lakes are areas set aside specifically for biodiversity conservation on Cooper Creek and the Paroo River, respectively, and river agreements currently protect them from alteration of flows.

Rivers are currently defined in a nested hierarchy of units, each operating within characteristic spatial and temporal scales (Table 1). We propose use of three spatial scales for a national framework: drainage divisions, river basins and river segments (see Figs 2 and 3). Catchments are topographically defined areas draining to a specified outlet. Whereas a river basin refers to all of the area draining to a river mouth or a terminal lake, catchments may be delineated for streams of any size at any points along their length. Catchments may be subdivided into smaller areas known as sub-catchments. Ideally, after the river segment, topographically defined sub-catchments and catchments are the best scale for assessment. This is explained better in the case study (Fig. 4). Catchments provide a reasonable size unit for assessment and management while recognising within-basin heterogeneity. However, nationwide delineation of waterway units at these scales has been developed only recently (Hutchinson *et al.*, 2000; Stein, 2003) and is not yet widely recognised.

We recommend instead, use of the existing Australian Water Resource Commission (AWRC) drainage basin framework. Analysis at drainage division scale or river basin scale immediately allows nationwide assessment and identification of high-conservation-value rivers. In many cases, AWRC's river basins are broadly equivalent to catchment scale, but there are exceptions. Spatial information for drainage divisions, river basins and river segments is readily available (<http://www.ga.gov.au/ download/>, accessed 18/8/2004), with the two former scales widely used currently in river management. Finer scales (e.g. microhabitat) than river segments are impractical for large-area assessment. Even for small- area studies, the temporal instability of smaller units makes them unsuitable as planning or reporting units (Table 1). Similarly, it is not practical to use river reaches: lengths of channel with uniform channel morphology or a consistent pattern of alternating channel morphologies (Calvert *et al.*, 2001) (Table 1). River reaches are a common unit of description for both fluvial geomorphologists and aquatic ecologists, but usually require low-level aerial photography or field survey to identify (Brierley *et al.,* 1996; Frissell *et al.*, 1986). The high-resolution environmental data (e.g. terrain, geology) for more-automated reach delineation are not available continentally. However, river reaches and sub- catchments will be integral to reporting on river segments.

2.4.1.1. Drainage divisions

Drainage divisions are the largest units in AWRC's spatial framework (AUSLIG, 1997; Geoscience Australia, 2003) (Fig. 2c and 4) and are useful for national reporting. Until reviewed and updated (Box 7), drainage divisions provide the coarsest scale for a national framework for river protection. They are aggregations of river basins primarily defined by discharge points, climate or geography (AUSLIG, 1997; Geoscience Australia, 2003a).

2.4.1.2. River basins

River basins or catchments are the next-finest spatial scale in the hierarchy (Fig. 2b) and are widely used in natural resource planning and management. Primarily based on catchments of the major river systems, they also include catchment areas of small, independent coastal or inland drainage systems (Kingsford *et al.*, 2001). River basins are generally distinct and temporally stable geomorphic units, representing patterns of freshwater connectivity (Fig. 3). They may act as dispersal barriers for obligate freshwater species (Tait *et al.*, 2003). The current delineation of river basins is an adequate spatial framework for assessing relative ecological value, but has shortcomings (Box 7). Updated national catchment boundaries are essential for rigorous analysis of river protection and management (Norris *et al.*, 2001).

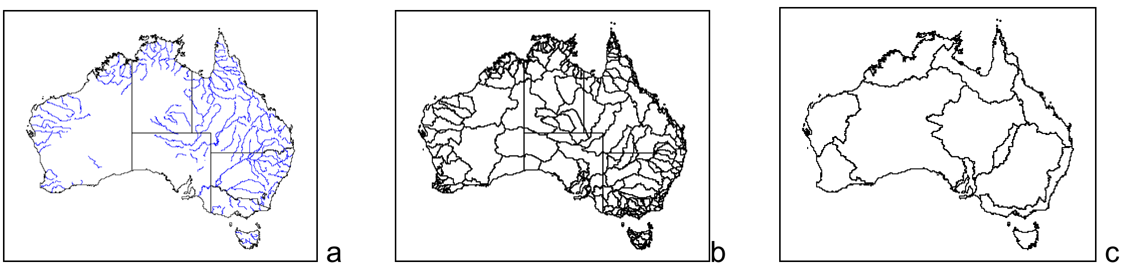


Figure 2. Australia's (a) major rivers, (b) 245 large river basins and (c) 12 major drainage divisions.

Table 1. A hierarchy of spatial units, comprising a drainage division.

Scale	Description	Time scale of continuous potential persistence[a] (years)	Linear spatial scale (stream length)[a]		Applicability at continental scale
			Small streams (m)	Large streams (km)	
Micro-habitat	Patch of similar flow velocity, substrate and cover	10^{1}–10^{0}	0.1	0.1	Not possible
Habitat/ bedform	Areas of relatively homogeneous bed material, flow velocity and depth	10^{0}–10^{1}	0.1–10	0.1–10	Not possible
Reach	Length of river exhibiting relatively homogeneous channel characteristics or a consistent pattern of repetitive/alternating characteristics	10^{1}–10^{2}	10–100	10 –100	Not possible currently, prohibitive resource requirements
Segment (link)	Portion of stream and its floodplain (including associated wetlands), bounded by tributary junctions, major waterfalls or lakes. The area of land draining to a segment or group of segments is a sub-catchment	10^{3}–10^{4}	100–1000	100–1000	Currently possible[b]
Catchment	The area of land drained by a stream to a particular point (e.g. a tributary junction). May include internal sub-catchments	10^{4}–10^{5}	> 1000	> 1000	Currently possible[b]
River basin	All of the catchment area that drains to a river mouth or terminal lake[c]	10^{5}–10^{6}	1–100 km	1000–10,000	Currently possible[b]
Drainage division	Grouping of river basins according to discharge point, geography and/or climate	10^{5}–10^{6}	na	> 10,000	Currently possible[b]

a Adapted from Frissell *et al.* (1986) and Calvert *et al.* (2001). Spatial and temporal scales are indicative only; actual values are appropriate to catchment size.

b At map scales of approximately 1:100,000 to 1:250,000.

c AWRC uses the term "river basins' to indicate a mix of sub-catchments, catchments and basins.

Box 7: Problems associated with existing hierarchical spatial data

1. Drainage divisions and river basins (AUSLIG, 1997) are well established as a catchment framework for planning and management, but have some problems.
2. here is a lack of adherence to topographically defined hydrological boundaries and errors in boundary location, with some boundaries delineating convenient administrative units, rather than catchments. For example, the Murray River forms the divide between river basins within the Murray–Darling Basin drainage division and the boundary between the Paroo and Warrego rivers severs a distributary that links the river basins (Kingsford *et al*., 2001).
3. River basins can represent a confusion of spatial scales. They include topographically defined basins (e.g. the Fitzroy River in Queensland), catchments of major rivers (e.g. the catchments of the major rivers of the Murray–Darling Basin) but also sub-catchments (e.g. the lower Avon River in Western Australia)
4. Drainage divisions are currently defined on the basis of broad regional proximity and climatic zones, and do not necessarily reflect river basin affinities in terms of geomorphology, hydrology, biogeography or past connectivity.
5. River segments exist as GEODATA TOPO-250K mapped streams (Geoscience Australia, 2003b) and as links in the stream networks delineated from a digital elevation model (DEM) for the National Land and Water Resources Audit (NLWRA) Assessment of River Condition (ARC) (Norris *et al*. 2001), <http://www.deh.gov.au/erin/edd/>, accessed 18/8/2004) and for the National Land and Water Audit set of nested catchments (Hutchinson *et al*., 2000).
6. There is significant variability in mapped drainage density among GEODATA 1:250,000 map sheet tiles attributed to cartographic interpretation. The revised data (Geoscience Australia, 2003b) did improve the consistency but some problems with streamline mapping remain.
7. The GEODATA stream coverages cannot be used for automated hydrological analyses, such as catchment delineation, and they are not readily compatible with the grid-based methods of drainage analysis of a DEM (Jenson & Domingue, 1988; Mark, 1988; Hutchinson & Dowling, 1991; Jenson, 1991; ESRI, 1996). For example, the GEODATA mapped streams were not used for the ARC because they did not always coincide with the valleys defined in the DEM, forcing errors and artifacts in the computation of other terrain derivatives (Norris *et al*., 2001).
8. The ARC stream network includes only large streams (minimum catchment area of 50 km^2) within the Intensive Landuse Zone (NLWRA, 2002a).
9. Anabranching streams and distributary channels are not represented in the stream networks delineated from the DEM using conventional methods.
10. Channel networks are not well defined by the DEM in some flat areas.

2.4.1.3. River segment

River segments are the finest scale in the hierarchy of a national framework, but they are the least well-developed or adopted scale within jurisdictions or nationally. River segments are the hierarchical level most useful for landscape-scale analysis (Maxwell *et al*., 1995), allowing for relative assessment within catchments. A fine scale for assessment and protection is necessary, as assessment at coarser scales will not identify river variation within catchments. A tributary in a river basin may be ecologically important (Meyer & Wallace, 2000) but overlooked as a candidate for conservation because ecological value is averaged

Natural discontinuities, such as abrupt changes associated with tributary inflows (Frissell *et al.*, 1986), major waterfalls and lakes, unambiguously delineate boundaries of river segments. They will be unique to a river system. Each segment has a contributing area or sub-catchment, that is the part of the catchment draining directly to the segment, and associated floodplain wetlands, lakes or estuaries (Fig. 3).

2.4.1.4. Data availability

Traditionally, paper maps were the source of spatial information at the finest scale of 1:250,000 for national coverage. This scale is consistent with the scientific guidelines developed for the National Reserve System Program of Australia (Peters & Thackway, 1998). Much of the information on these maps is now available digitally as separate geographical information system (GIS) layers,

across the catchment. For example, there may be distinct assemblages of aquatic fauna within headwater streams (Harding & Winterbourn, 1997). including streamlines (AUSLIG, 1992; Geoscience Australia, 2003b). These data are useful for continental classification and assessment. Catchment or river basin boundaries (Fig. 2b) can be accurately delineated from a topographic map or derived using drainage analysis software and a DEM. There is a set of nested sub-catchments (Hutchinson *et al.*, 2000), delineated for the National Land and Water Resources Audit, with sub-division of river basins (the smallest is about 2.5 km^2) derived from the national DEM. Like the AWRC river basins, their boundaries do not account for distributary drainage structures, and there are problems in areas of low relief (Box 7; Appendix A).

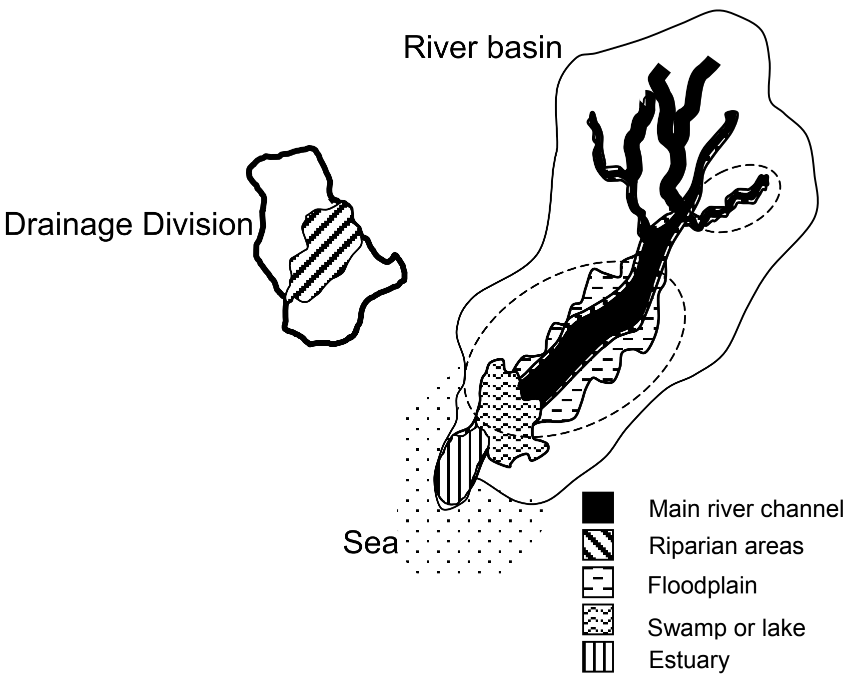


Figure 3. Diagram of theoretical river basin within a drainage division (inset), showing dependent ecosystems (main river channel, riparian areas, floodplains, swamps or lakes and an estuary). Dotted lines indicate potential river segments within this river basin.

Box 8: Catchment reference schemes

1. Various systems can delineate and/or codify topographically defined hydrologic units at continental scales (Appendix A, Table A2).

2. Important characteristics of a scheme chosen include:

i) the ability to automatically delineate and sub-divide hydrological units

ii) a numbering system that enables rapid assessment of tributary–main stem and up–downstream relations within the stream network.

3. The Pfafstetter scheme (Verdin & Verdin, 1999) is one such system that is widely adopted (e.g. Vogt *et al*., 2003; USGS, 2001). Hydrological units are delineated by successively dividing the catchment into topographically defined basins and inter-basins, as many times as supported by the DEM. The numbering system enables topological relationships in a catchment to be inferred using simple algebraic queries, making it possible to rapidly identify all sections of a river network either up or downstream of any feature of interest (e.g. a dam).

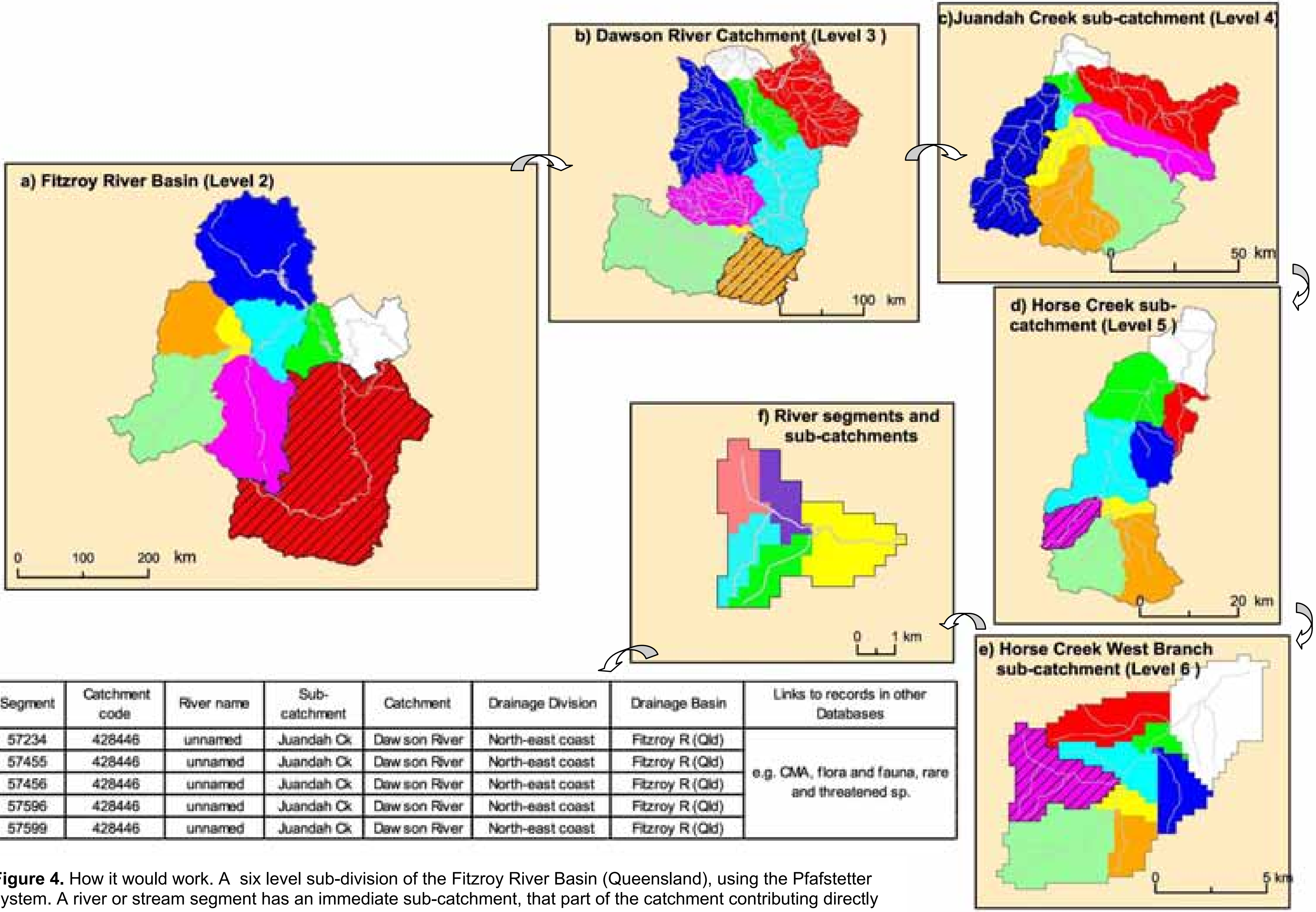
A continental-scale drainage analysis, with an improved DEM (M.F. Hutchinson, J.A. Stein & J.L. Stein, unpublished data) and accommodating distributary drainage patterns, has produced a better set of national catchments, and stream-segment delineation at a map scale of 1:250,000 (Stein, 2003). This new national catchment framework (Stein, 2003; see also Fig. 4) allows individual river segments to be related to their catchments through a spatially nested, hierarchical catchment reference system. Known as the Pfafstetter scheme (Box 8; Verdin & Verdin, 1999), mapping units can be used for conservation assessment (e.g. Burnett River catchment (Phillips *et al.*, 2002)). The Pfafstetter scheme has produced a European-wide database of stream networks and drainage basins (Vogt *et al.*, 2003); and global drainage basin coverage for continental and regional scale modelling and analyses (USGS, 2001). Until there is national agreement on a new set of hierarchically nested catchments (see options in Appendix A, Table A2), potentially using the new national catchment reference system (Stein, 2003), we advocate use of the AWRC drainage divisions and river basins and segments.

Mapping of dependent ecosystems is partly completed. Over 900 of the large Australian estuaries have been identified (Heap *et al.*, 2001) and another 48 moderate-sized estuaries were included in a study of Tasmanian estuaries (Edgar *et al.*, 1999). Estuarine areas were included in coastal wetland mapping in Queensland (Bruinsma, 2001), and a new project to map Western Australian coastal habitats will begin shortly. All wetland areas in New South Wales, including estuaries, and in the Murray–Darling Basin, have been mapped from satellite imagery (Kingsford *et al.*, 2004b) and wetlands, excluding most floodplains, are mapped for Victoria.

2.4.2. Classification system

Classification simplifies complexity by identifying homogeneous groups, according to defined attributes (O'Keefe & Uys, 2000). It enables assessment of rivers and dependent ecosystems, based on ecological values, including representativeness, rarity and diversity (see Box 9). This assessment can then be used to set conservation priorities within class types. Classification and evaluation can identify high-conservation-value rivers at different spatial scales. All classifications are affected by some measure of temporal variability in factors used and so they should allow for updating, or the attributes chosen should be relatively stable over time.

Regionalisation (e.g. bioregionalisation) is a form of spatial classification, with boundaries drawn around areas containing relatively homogeneous features (Bryce & Clarke, 1996). Agreement between State, Territory and Australian government nature conservation agencies to adopt the Interim Biogeographic Regionalisation of Australia (IBRA) classification was a significant breakthrough, enabling comprehensiveness, adequacy and representativeness of the Australian National Reserves system's cooperative program to be assessed and provide the basis for priority setting (Pigram & Sundell, 1997). Nevertheless, such terrestrial-based regionalisation has significant limitations for riverine biota because they are predominantly constrained by catchment processes.



Segment	Catchment code	River name	Sub-catchment	Catchment	Drainage Division	Drainage Basin	Links to records in other Databases
57234	428446	unnamed	Juandah Ck	Daw son River	North-east coast	Fitzroy R (Qld)	e.g. CMA, flora and fauna, rare and threatened sp.
57455	428446	unnamed	Juandah Ck	Daw son River	North-east coast	Fitzroy R (Qld)	
57456	428446	unnamed	Juandah Ck	Daw son River	North-east coast	Fitzroy R (Qld)	
57596	428446	unnamed	Juandah Ck	Daw son River	North-east coast	Fitzroy R (Qld)	
57599	428446	unnamed	Juandah Ck	Daw son River	North-east coast	Fitzroy R (Qld)	

Figure 4. How it would work. A six level sub-division of the Fitzroy River Basin (Queensland), using the Pfafstetter system. A river or stream segment has an immediate sub-catchment, that part of the catchment contributing directly to it, but nested successively within higher level sub-catchments, catchments and basins. Records within databases of conservation value attributes are linked via the river segment but conservation planning and assessment is likely to be undertaken using higher level units, for example a level 5 or 6 sub-catchment unit.

There is a long history of river classification around the world (see Naiman *et al.*, 1992), with many systems being proposed but few that are suitably generic. The more widely recognised classification systems were considered for their suitability for national implementation (Appendix B). While there are useful elements, none provides a universal system for classifying streams, stream habitats or their biotic communities (Jensen *et al.*, 2001b). Australian regional or State-wide classifications exist, but none is nationally consistent (Pressey & Adam, 1995). There are proposals for national classifications of river reaches (Calvert *et al.*, 2001) and wetlands (Semeniuk & Semeniuk, 1995), based on geomorphology, but none has been implemented (see Kingsford *et al.* (2004) for some of the challenges). The National Land and Water Resources Audit classified large estuaries in Australia but did not include the river systems that supplied them. Australian wetlands have often been surveyed and classified separately from flowing waters, usually only at regional scales (Pressey & Adam, 1995). More recently wetlands across all of New South Wales were mapped and classified within river basins (Kingsford *et al.*, 2004b). Although there are some examples of classifications of component freshwater ecosystems (e.g. wetlands in NSW (Kingsford *et al.*, 2004b)) and national classification of large estuaries (Heap *et al.*, 2001), few jurisdictions have a State-wide inventory or classification of rivers. Existing jurisdictional classification systems are not readily compatible in either scale or criteria. Classification will inevitably be required across jurisdictions, reflecting natural geomorphological, hydrological and ecological boundaries of rivers. Boundaries among classification groups should be consistently and transparently derived (Box 9). This requires knowledge of the range of spatial variation within and among river types, information that must transcend jurisdictional borders.

Once the objective of river classification is agreed on, choices need to be made about the river classification system. First, there needs to be a decision on what abiotic or biotic variables will form the basis of the classification. Second, the number of classification groups has to be chosen, as this affects conservation objectives. Too many groups will produce unrealistic conservation targets; too few will not adequately represent aquatic ecosystem variability. *A priori* definition of group boundaries assumes knowledge of all possible rivers and relies on expert knowledge (Phillips *et al.*, 2002). Numerical procedures (multivariate clustering, ordination) rely on the data and are less affected by biases or conspicuous features (Phillips *et al.*, 2002), even though there are subjective choices for groups (Nix, 1992). Numerical methods also integrate attributes consistently and are repeatable, allowing quantification of relationships among groups. They can reflect the continuum of river character and behaviour, and the clear demarcations of tributary–trunk confluences. By definition, numerical procedures are dependent on data, which may not be immediately available. There are essential elements for implementation of classification across the landscape (Box 9; Thackway (1992)). There are two main types of classification that may be attempted:

- biological classification, using the biota of rivers to define different bioregional types
- biophysical classification (includes geomorphic, hydrological and landscape classifications), which uses surrogate variables to define different types of aquatic systems.

Box 9: Essential elements for river classification

Scale—Classification requires hierarchical scales (Jensen *et al*., 2001a; O'Keefe & Uys, 2000), recognising spatial and temporal scales for stream ecosystem processes (Frissell *et al*., 1986), biotic processes and protection and management mechanisms. Our proposed national framework of drainage divisions, river basins and river segments is a suitable hierarchical spatial framework.

Attributes—Attributes should be temporally stable or integrate temporal variation (Bennett *et al*., 2002) and reflect ecosystem processes and distribution patterns of aquatic biota (Phillips *et al*., 2002). Data availability and practicality of measurement influence choice of attributes. The requirements for data or specialist knowledge must be commensurate with the scale and objectives of the classification.

Consistent methodology—Methods need to be clear and repeatable. The boundaries between groups should be consistently and transparently derived. They may be the outer limits of characteristic features (O'Keefe & Uys, 2000) or emergent properties of the primary data.

2.4.2.1. Biological classifications

Biological surrogates can be used to classify areas for terrestrial conservation (Margules *et al.*, 2002) but few national classifications of Australian rivers exist. National classifications have generally not been adopted because of lack of data and insufficient support by jurisdictions. Broad regions were identified for Victoria (Doeg, 2001), but limited data in the north-west of the State prevented State-wide coverage. Biogeographic regions can share a common evolutionary history, reflected in discontinuities in species distributions. For example, distribution of freshwater fish (obligates) reflects current and historical drainage connectivity across Australia, producing biogeographic provinces (Unmack, 2001) that may apply for other obligate freshwater biota (Tait *et al.*, 2003). Understanding of how biogeographical histories affect taxonomic surrogacy is still developing (Margules & Pressey, 2000). Data- sets for flora and fauna are patchy, although some taxa are sufficiently well-known to provide initial biogeographic regionalisations and identify places of high conservation value based on measures of diversity and endemicity (e.g. waterbirds, reptiles, fish, riparian vegetation, some invertebrates). Data gaps may sometimes be filled using modelling, but taxonomic and distributional knowledge for much of Australian freshwater biodiversity (Georges & Cottingham, 2002) remains poor. Existing data are often biased towards more-permanent streams or easily accessible locations. Except for some limited taxa (i.e. fish), inadequate data at a national scale makes biologically based classifications difficult today, but biological classifications will become increasingly possible with more data (i.e. Unmack, 2001). Even so, periodic updates or revisions will be needed because many biological communities are dynamic (Jensen *et al.*, 2001b). Caution should be exercised that perceived geographic variation is not a response to human activities, which are sometimes difficult to detect (O'Keefe & Uys, 2000).

2.4.2.2. Biophysical classifications

Biophysical classifications based on indirect physical measures of the habitat can be useful (Phillips *et al.,* 2002). For example, channel morphological criteria form the basis of many systems of river classification, including the RiverStyles™ framework (Brierley & Fryirs, 2000, 2002), the most widely used in Australia. Founded on a process-based understanding of river character and behaviour, these classifications provide an effective framework for assessing river condition and response at reach scales. Unfortunately, the time and cost involved in gathering data, and the expertise required (field survey, airphoto interpretation), preclude such classifications from nationwide application at this stage (see Appendix B for further discussion). Also, they may be affected by observer bias, reducing consistency within and among catchments. This scale can also be affected by temporal variability. Finally, the ecological relevance of channel morphological classes is poorly understood and so biotic responses may not reflect channel differences. Nevertheless, information gathered could be used to test the validity of classification at the river-segment scale for a national framework.

Flow is a critical factor in the composition and variation of biota in aquatic systems but there are few Australian examples of classifications based on hydrological indices (Puckridge *et al.*, 1998). Limited numbers of flow gauging stations undoubtedly contribute to the difficulties of using flow. Also, the relationships between ecology and hydrological indices may be complex (Puckridge *et al.*, 1998, 2000; Olden & Poff, 2003). In contrast, generic wetland-classification schemes (e.g. Semeniuk & Semeniuk, 1997) employ just a few broad categories of flow permanency as primary delineation criteria, with secondary criteria including soil, water chemistry or vegetation. Even for these, however, the data demands may be considerable (Kingsford *et al.*, 2004b).

Another basis for an ecological classification is use of landscape variables (e.g. climate, topography, geology). These variables exert primary control on aquatic ecosystem patterns and processes, and produce temporally stable groupings of waterways with similar response potential. Also, the data concerned are widely available and geographically referenced at national scales. Environmental domain analysis is a form of landscape classification that emphasises explicit and repeatable procedures, such as numerical clustering, to define classes as an emergent property of the primary data (Nix, 1992). The environmental domain approach has recently been adapted to classify rivers at State (Tasmania) (Jerie *et al.,* 2001, 2003) and national scales (Stein 2003). Biotic data can be used to verify or provide secondary stratifications of the environmental classifications (O'Keefe & Uys, 2000).

No single classification will suit all purposes, as classification is a tool not an end in itself. We caution against adopting a single classification, especially given the highly variable nature of the available data and expertise for Australian rivers and estuaries. Systematic conservation planning readily employs multiple classifications. We recommend the use of as many biodiversity surrogates for which data are available to maximise the likelihood of representing biodiversity in priority areas. For example, biodiversity priority areas in Papua New Guinea were selected using 608 environmental domains, 564 forest types and 10 species assemblages (Nix *et al.*, 2000). Using more than one classification also recognises the variable mobility and biophysical affinities of freshwater taxa (Tait *et al.*, 2003).

2.4.2.3. Interim classification of rivers and dependent ecosystems

To support the immediate task of identification of nationally important rivers, wetlands and estuaries, we recommend the development of interim national classifications, using available biotic and physical data. Combined landscape and biogeographic classifications would allow preliminary identification of representative conservation priorities for Australian rivers. Options include a river landscape classification (e.g. environmental domains) and biogeographic classifications for a range of aquatic and semi-aquatic taxa. These would complement established classifications—the fish bioregions (Unmack, 2001) and the NLWRA estuary classification (Heap *et al.*, 2001)—and could potentially be considered as the basis for an ‘interim freshwater bioregionalisation of Australia’ (Tait *et al.*, 2003).

Many of the data necessary to derive environmental domains have been compiled at the best available, nationally consistent scales, and preliminary environmental domain classifications exist (Stein, 2003). Revised classifications could be generated quickly. Broad-scale biogeographic classifications could also be derived using existing distributional data, a range of numerical procedures and expert knowledge. These could produce macro-scale groupings of drainage basins and information on sub- basin and inter-basins associations, potentially using obligate and non-obligate freshwater species (Tait *et al.*, 2003) and functional groups. The Australian Heritage Assessment Tool (AHAT), currently being developed, includes over 14 million survey records for a range of terrestrial and aquatic species, compiled from the Australian Biological Resources Study, the CSIRO Australian National Insect Collection and the major State museums (J. Ambrose, Australian Heritage Commission, pers. comm.). It uses drainage divisions and includes physical data. Analysis of the species data can include identification of endemism, species richness and Gondwanan relict species. AHAT is expected to be completed within the next 6–12 months.

A first task for biogeographic classification would be to use all such available data in addition to that held by jurisdictional agencies, and to review the state of the taxonomy for candidate taxa. For example, riparian tree species, which are important components of riverine ecosystems, are reasonably well known. A division of freshwater biodiversity components according to their vagility (i.e. obligate/non-obligate freshwater species) and associated biogeographic constraints (Tait *et al.*, 2003) may be a useful basis for identifying functional groups that can define biogeographic associations at different scales. In addition, there should be representation of major functional groups, whatever their mobility. For broad- scale conservation planning, wetland ecosystems could be included with the river systems on which they are dependent, or classified independently. Wetland ecosystems often comprise aquatic and terrestrial elements, so both terrestrial and aquatic biogeographic regionalisations and biophysical classifications could be used (Tait *et al.*, 2003). Estuaries probably require independent analysis because they are the interface between freshwater and marine ecosystems. Such an analysis could link the existing NLWRA energy-based classification with the river landscape and biogeographic classifications, and possibly with the Interim Marine and Coastal Regionalisation of Australia (IMCRA) (Interim Marine and Coastal Regionalisation for Australia Technical Group, 1998). These classifications are necessary to support an assessment of the conservation value of river basins and rivers (also possibly river segments).

In the long term, finer-scale classifications based on direct measures of stream ecological and geomorphological characteristics (biota, hydrology, biogeochemistry, physical habitat) should be developed for catchment planning and management, assessment of current condition, and design of appropriate targets for restoration or rehabilitation. Remotely sensed data will increase in importance as a tool for monitoring water properties, connectivity, inundation and flood dynamics (Mertes, 2002), allowing for classification of spatio-temporal variability (Handcock & Csillag, 2002) and habitats (e.g. Bruinsma, 2001; Kingsford *et al.*, 2004b). For the foreseeable future at least, the costs of acquiring these data may be prohibitive at national scales. Matching remotely sensed data to field surveys also remains a challenge (Mertes, 2002). River landscape and biogeographic classifications will also provide the basis for cost-effective biological and river-habitat surveys. Landscape classifications could also be improved with high-resolution biophysical information (e.g. terrain, substrate). Phylogenetic research on aquatic taxa representing key functional groupings can also help better define biogeographic boundaries (Tait *et. al*., 2003).

2.4.3. Evaluation system

Systematic conservation evaluation can be used to identify priorities for conservation by comparing ecological value, through established attributes (e.g. populations, species, assemblages or ecosystems) across the landscape, preferably using consistent data-sets (Pressey & Logan, 1998; Margules & Pressey, 2000). The aim is to identify areas of high conservation value. Conservation assessment ranges from small sub-catchments (e.g. Scientific Panel for Lower North Coast River Management Committee. 1999) to large continents (e.g. Commonwealth of Australia, 1999).

The spatial framework for rivers defines the context for the comparison of values among rivers, wetlands and estuaries at the scale of drainage divisions, river basins or river segments. A river type, determined by classification, might be unique within a river basin but common within a drainage division and, conversely, a river type might be common in one river basin but found nowhere else. These scales for conservation and management form the potential building blocks of a protected-area management system and for the management of threatening processes. Without relative comparisons, conservation importance may be underestimated (Hughes *et al.*, 2000) and catchment- scale threats not adequately considered. Ideally, assessment occurs at the river-segment scale as the finest scale of information, with integration for river- basin or drainage-division-scale assessments. Increasing availability of attribute data over time will support this approach.

2.4.3.1. Ecological values of river systems and dependent wetlands and estuaries

Ecological values within the broad context of 'conservation value' are attributes of river-system ecology that should be protected, maintained or restored for present and future generations. Natural or ecological values include the physical and biotic characteristics of river systems and their essential processes. Physical characteristics include hydrological regime, connectivity and geomorphological processes (e.g. erosion and deposition), while biotic characteristics include aquatic community composition, primary and secondary production, growth, reproduction, recruitment and survival. Healthy ecosystems also provide utilitarian values, as well as the opportunity to increase understanding of the characteristics and evolutionary history of the Australian landscape, and to monitor future change. All river systems have ecological values. It is necessary to rank their attributes to identify the highest conservation value areas, at different scales (e.g. national, State, regional, river segment, river basin, drainage division).

Ecological values require translation into definitional *criteria*, explained and exemplified with attributes. Wherever possible, these *attributes* should be quantitative, allowing comparison with other data, and have clearly defined thresholds. Quantitative attributes should ensure transparency and repeatability. Such an evaluation system can be tiered and iterative, with new information refining the process over time, enabling evaluation at progressively finer scales. Frameworks and projects that have helped us identify places of conservation value in Australia include:

- World Heritage Convention (international)
- Convention on Wetlands (Ramsar Convention) (international)
- Register of the National Estate (national)
- National Heritage List (national)
- Marine Protected Areas Strategy (national)
- Wild Rivers database (now Australia's Rivers and Catchment Condition Database) (national)
- Directory of Important Wetlands in Australia (national)
- Regional Forest Agreements (national and States)
- Heritage Rivers program (Victoria).

The proposed Wild Rivers program (Queensland) and the Conservation of Freshwater Ecosystem Values project (Tasmania) will contribute further to the idenfication of high-conservation-value rivers.

We also considered international frameworks for river protection, including the legislative framework in the United States and Canada, proposed protocols for river assessment (O'Keeffe *et al.,* 1987; Collier, 1993; Boon *et al.*, 1994) and evaluation of the conservation status of rivers in the United States (Abell *et al.*, 2000). At the national scale we also considered assessment of representation of rivers within protected areas using a biogeographic framework and river condition (Tait *et al.*, 2003). Common themes of ecological value occur through these existing frameworks. Different emphases reflect the primary conservation goals of the particular program or strategy.

Some important additional emphases emerge from assessment methodologies of Australian rivers (Bennett *et al.*, 2002), views of Australian river scientists and managers (Dunn, 2000), and current river policy and conservation in some Australian

States (Department of Natural Resources and Environment, 2002; Stressed Rivers Report NSW; Queensland Wild Rivers proposal; Wentworth Report, 2003). Firstly, river geomorphology and hydrology are essential and inherently valued components of river ecosystems. They define the ecology of the river system. Secondly, the importance of connectivity highlights differences between terrestrial and aquatic ecosystems and the nature of potential threats. The notion of connectivity highlights additional river conservation values and generates additional variables to be considered in threat management and protection.

Six criteria (see Box 10) are proposed to define ecological values of rivers. They can be applied at different spatial scales (see above) and for different management purposes, ranging from integrated, comprehensive and systematic conservation planning, to river management planning and environmental assessment. Thresholds can then be applied to these attributes to identify conservation importance at different spatial scales (drainage division, river basin or river segment).

Box 10: Criteria proposed for identifying natural conservation values of rivers or their dependent ecosystems

The river or dependent ecosystem:

- **is largely unaffected by the direct influence of land and water-resource development**

A river with a natural or near-natural flow regime and relatively little catchment disturbance is a large-scale ecosystem, retaining most natural features, processes and biota. Unaltered ecosystems that lie within highly altered river basins, can also retain natural features, processes and biota. Such undisturbed systems provide important reference points for assessing the health of modified systems. Undisturbed rivers from source to outfall are particularly valued, as they are rare, even at a global scale. Relatively few of the world's ecosystems are truly 'natural' because of pervasive threats (e.g. exotic species, climate change). This criterion applies to rivers and component ecosystems (river segments, floodplains, wetlands, estuaries) that are predominantly natural, rather than necessarily pristine.

- **is a good representative example of its type or class.**

Protecting the diversity of ecosystems and species is the cornerstone of most biodiversity conservation strategies. Conservation of representative ecosystems is a strategy to capture the range of biodiversity. Representative systems in good condition provide useful benchmarks for monitoring river management and restoration, and have very high conservation value where other examples of a system type in good condition are rare or non-existent. Note the application of this criterion is dependent upon river classification.

- **is the habitat of rare or threatened species or communities, or the location of rare or threatened geomorphic or geological feature(s).**

Protection of rare and threatened species and communities is essential to biodiversity conservation. Whole communities may be at risk by threats to riverine ecosystems in disturbed or undisturbed rivers. Disturbed systems may be more prone to localised species extinctions, and protection may mitigate threatening processes, though protection of communities in undisturbed rivers usually presents a more viable and cost-effective option. Some rare geomorphic or geological features are threatened by human impacts, with little likelihood of regeneration within human time scales.

- **demonstrates unusual diversity and/or abundance of features, habitats, communities or species.**

'Hot spots' or sites with highly diverse communities or abundance, can provide the most cost-effective way to conserve a large number of species or a significant percentage of a population of a species, feature or habitat.

- **provides evidence of the course or pattern of the evolution of Australia's landscape or biota.**

River form and behaviour and biota are markers of evolution. Taxa that are endemic or have Gondwanan affinities are considered to have particular value. Australia is noted for its unique terrestrial species and has many distinctive aquatic taxa. Some taxa, such as the lungfish (*Neoceratodus forsteri*) and the mountain shrimp (*Anaspides tasmaniae*) are of special phylogenic interest and have a limited natural range.

- **performs important functions within the landscape.**

Rivers and component ecosystems sustain habitats, communities and species at a landscape scale. Rivers and their dependent ecosystems can provide refugia within the landscape, especially during dry periods and, seasonally, in monsoonal Australia. They allow many terrestrial fauna to live in inhospitable environments because of the presence of water and abundant riparian and floodplain vegetation. Rivers and component ecosystems provide resources (e.g. food, habitat) for a range of fauna during different seasons or critical stages in their life history (e.g. breeding, recruitment, migration) and corridors for distribution and re-colonisation.

Chapter 3. Implementation of a national assessment of rivers

3.1. Identifying rivers of high conservation value

Given our broad criteria (Box 10), how could the system work? Once the criteria were agreed, they would require attributes for data collection and assessment of ecological value. Bennett *et al.* (2002) provide a comprehensive discussion and worked examples. For a national assessment, the number of ecological attributes likely to be available will be limited by the paucity of data, but the process has five essential components:

- agreement on the spatial scale for the assessment
- appropriate ecosystem classification for the spatial scale
- selection of relevant attributes for each criterion defining ecological value
- relevant data sets
- an agreed assessment protocol and clear decision rules.

The choices about these components would need to be explicit.

The evaluation process hinges on the scale and objective of this process, as this, with the spatial scale, will influence identification of rivers of high conservation value. We acknowledge that these components may work on scales from the finest (river segment) to the coarsest (continental). As jurisdictions overlap these natural hierarchical scales, the evaluation process needs to be adaptable for application at State, Territory or regional scale. For example, a State or Territory government may want to know which of the rivers (and dependent ecosystems) in its jurisdiction are of international, national or State-wide conservation importance. Similarly, a regional body seeking investment opportunities may want to know which rivers and dependent ecosystems are of regional importance.

While we recognise the potential application of this framework at progressively finer spatial scales, we believe that it is important to consider its applicability at the national scale. So the following process allows for identification of what we term 'rivers or dependent ecosystems of national importance'. A similar process could be used by a State or Territory to drive determination of 'rivers or dependent ecosystems of State-wide importance', as it could by a catchment management group or regional body at its scale of operations. Such a process may be developed for even finer spatial scales if a particular group wished to identify relative importance.

3.1.1. Selection of attributes

The criteria listed in Box 10 can be applied to the identification of rivers, estuaries and associated ecosystems of high ecological value, with high thresholds for nationally important systems. Attributes can include the full suite of abiotic and biotic variables relevant to a river or dependent ecosystem (e.g. hydrology, threatened species). We suggest that the following attributes could be used for the six different criteria for a river, wetland or estuary (see Box 10):

Unaffected by development. The river must have minimal disturbance in its catchment and have little or no regulation or abstraction, with predominantly natural flow regimes. This would be applied at river- segment scale. It would include an assessment of river flows diverted, barriers and catchment disturbance, upstream and downstream of river segments.

Representative. It is representative of its type or class, with demonstrably distinctive features and processes (e.g. biological, geomorphological or hydrological; see classification system) at the national scale. For example, a particular river might be predominantly (greater than 95% of flow) supplied by groundwater, a feature rare at the continental scale. Or the river may be the best remaining unregulated example of a typical river of the inland or of the south-eastern part of Australia.

Threatened species, communities, or ecological communities. It contains habitat of listed threatened species or communities (international (IUCN), national or State listed), or nationally important geomorphic or geological features that could be threatened.

High diversity and/or abundance. It provides habitat for a high abundance of organisms or has high species diversity, based on comparisons with similar habitats on a national scale. For example, abundant waterbird populations could be assessed using the threshold for Ramsar listing (i.e. regularly supporting more than 20,000 waterbirds).

Evolution of landscape or biota. It demonstrates outstanding evolution of Australian riverine and floodplain landscapes. The river geomorphology may demonstrate a style typical of ancient climatic conditions once widespread across the continent, or a landform that demonstrates large-scale past geomorphic processes such as glaciation or ancient sea levels. A candidate river could provide identified habitat for important populations of Australian taxa, especially those endemic at higher taxonomic levels (family and above), or have an unusually high range of related endemic taxa (centre of endemism). It could provide habitat for species endemic to Australia and of particular phylogenetic significance, including families with relationships with key taxa found in other southern lands and indicative of Gondwanan affinities. Some Australian taxa of limited distribution are of special interest for their place as 'living fossils'.

Important functions. Important functions within the landscape may include refugia, or sustenance of associated ecosystems. This may include refuge during extreme dry periods for populations of endemic species, or provision of water resources and a flow regime to sustain important associated ecosystems, including groundwater-dependent ecosystems and karsts of outstanding conservation value. Rivers and associated ecosystems play a critical role in providing resources for particular life-history stages of large populations of species seen as having high socio-ecological significance (feeding grounds or staging places for migratory birds, critical estuarine spawning areas or nesting areas for significant proportions of wetland birds). Australia has international obligations to protect critical habitat for migrating birds (Ramsar, Chinese Australia Migratory Bird Agreement (CAMBA) and Japanese Australia Migratory Bird Agreement (JAMBA)).

3.1.2. How it could work

A national evaluation system could be applied via a hierarchical spatial assessment framework (Fig. 3) across the continent. Ideally, information for conservation value criteria would be linked to individual river segments. Often, the data will not yet support this level of resolution, and so a sub-catchment, aggregating river segments, may be the basic waterway unit for initial conservation assessment. This is also a more effective scale for application of protective management. Dependent ecosystems (estuaries, riparian areas, floodplains, swamps or lakes) could be assessed either collectively with their associated river segment(s) (Fig. 3) or independently. AWRC river basins (i.e. catchment or basin scale) could be evaluated for potential designation as Australian Heritage Rivers on the basis of aggregated sub-catchment conservation values and disturbance.

The criterion of 'largely unaffected by development', where assessed as high for an entire river, specifically defines rivers of national importance that could be considered for nomination as Australian Heritage Rivers. This recognises their importance for ecological and cultural conservation as well as the industries they currently support. Candidates for designation as Australian Heritage Rivers are recommended to have more than 80% of natural mean annual flow, as lower relative flows may increase the risk of environmental degradation (Arthington & Pusey, 2003). Catchments are also recommended to have little intensive disturbance (less than 1% of the catchment area affected by intensive agriculture or urbanisation, deleterious point-source pollution (e.g. mining) or extensive diffuse deleterious impacts). Such thresholds could be determined by an interjurisdictional working group (see below). If a candidate for Australian Heritage River status exhibits some catchment disturbance, then:

i) the disturbance should have minimal impact on the river's present ecological values
and

ii) the river should meet at least one other criterion
or

iii) the river should represent the highest conservation value example of a particular class of river.

Rivers, river segments, wetlands and estuaries of high conservation value at national scales could be identified transparently using attributes, and could be primarily protected through protection-planning mechanisms available within jurisdictions.

High-conservation-value segments/sub-catchments, wetlands and estuaries could be identified and prioritised for protection by systematically assessing the conservation value of all sub-catchments. A catchment reference system that numerically links each river segment through increasingly coarse spatial scales can identify the network linkages. It is particularly useful in ensuring that connectivity between upstream and downstream parts of rivers is recognised (e.g. the Pfafstetter scheme (Verdin & Verdin, 1999); Box 8; see also Appendix A). A national overview of conservation value is provided by drainage-division summaries. The spatial assessment framework for rivers also defines the context for more detailed assessment and management at reach scales.

We illustrate this proposed spatial and assessment framework using the Fitzroy River Basin in Queensland (Fig. 4), but stress that a national assessment can be done only by comparing the relative value of all rivers across the continent, using consistent methods.

3.1.3. Case study—the Fitzroy River Basin

The spatial framework is built upon spatially referenced, uniquely numbered river segments and their associated catchment areas. Each river segment is nested within successively larger sub-catchments, the river basin and its drainage division. The spatial framework includes an associated database that labels each river segment with the AWRC drainage division and river basin number and the equivalent State or Territory waterway or catchment identifier (Fig. 4). This allows linkages within and potentially among existing jurisdictional databases.

The first stage is to access the river segments, sub-catchment and river basin boundary spatial layers (<http://data.brs.gov.au/asdd/index.php>, accessed 18/8/2004 for nested catchments; <http://www.ga.gov.au/>, accessed 18/8/2004 for AWRC basin boundaries) for the Fitzroy River Basin. This is the precursor to evaluation of each river segment in the basin. Spatial data layers for river segments could probably be accessed in the future. Assessment of river segments requires use of GIS commonly employed by all jurisdictions, already credibly demonstrated for the Burnett River Catchment (Phillips, 2001; Phillips *et al.,* 2002) and used in Tasmania in the project on Conservation of Freshwater Ecosystem Values.

Using the agreed criteria (Box 10), attributes are selected for assessment (see "Evaluation system") from potential candidates listed in Bennett *et al.* (2002) that could be applied consistently at a national scale. For the Fitzroy River Basin, this means collecting and reviewing all available data in national and jurisdictional databases and applying them to the appropriate spatial scale. Measures of catchment land use for each segment in the Fitzroy River Basin (e.g. National Land and Water Resources Audit, Bureau of Rural Science, wildlife atlases, fish databases, hydrological data) could be derived, but information on flow diversion may be available only for aggregated river segments (e.g. Juandah Creek catchment, Fig. 4c). As flow regulation affects all downstream river segments, these would need to be attributed as affected by flow regulation, depending on the degree.

Additionally, the natural integrity of population processes (dispersal, migration) might be denoted as disrupted upstream of major in-stream barriers.

Assessment could occur at coarse spatial scales, but all data should be attributed at river-segment scale so refinement with future data can occur easily at the finest resolution.

Qualitative information (e.g. the river is important for the maintenance of karst features) would be coded and spatially referenced to river segments within the Fitzroy River Basin. Linkages between river segments and the survey sites or mapping units of the attribute data are established by the GIS spatial overlay. This process may identify all river segments where the vulnerable Fitzroy River tortoise *Rheodytes leukops* has been recorded or is predicted to occur. Once a conservation value rating is derived for a river segment or the smallest unit resolvable for the particular attribute data (e.g. a sub-catchment), results can be aggregated into successively coarser scales. This produces a consistent rating of conservation value for sub-catchments (Fig. 4d), the major river catchments (Fig. 4b), the entire Fitzroy River Basin (Fig. 4a), or the North-east Coast Drainage Division. Once the conservation value is established, river segments can be ranked according to conservation value and managed for their different threats in a protection framework (see "Conservation planning and protection"). Because the information base covers all waterways, it will also support development of representative protected river systems and inform an integrated approach to river management.

3.2. National assessment

There are several different approaches to the selection of places for conservation action. The choice of an approach depends on the objective of the assessment. Four approaches, some of which may work together, are suggested as potentially applicable to river systems.

3.2.1. 'Comprehensive, adequate and representative' (CAR) principles

The application of comprehensive, adequate and representative (CAR) design principles (ANZECC/MCFFA, 1997) to selecting areas for conservation is well-established for terrestrial systems, especially forests, and for marine reserves (National Reserve System Marine Protected Areas, <http://www.deh.gov.au/coasts/mpa/nrsmpa>, accessed 18/8/2004; Great Barrier Reef Marine Park Authority Representative Areas Program, <http://www.reefed.edu.au/rap/>, accessed 18/8/

2004). It also forms the strategic foundation for targeting efforts to consolidate the National Reserve System (NLWRA, 2002b). More recently, CAR principles have been used to identify priority areas for freshwater conservation actions in the south- eastern United States (Smith *et al.*, 2002; Weitzell *et al.*, 2003). Identifying and protecting representative ecosystems is a key conservation priority, particularly for biodiversity conservation. Other values may be incorporated within or outside such representative areas, until all targeted conservation values are protected. It follows from the CAR principles that places with values not already captured within a protective management framework are rated at a high priority for identification and protection. Classification is a prerequisite for the assessment of representativeness. Algorithms based on complementarity ensure efficient representation of targets in priority areas and can be adapted to minimise opportunity costs (e.g. foregone timber production (Nix *et al.*, 2000)) and integrate the knowledge of local and technical experts to overcome limitations of available spatial data (Balram *et al.*, 2004).

The identification and protection of representative ecosystems is a strategic foundation to ecosystem conservation but, as yet, there have been limited attempts to apply such an approach to freshwater ecosystems in Australia or other parts of the world. Recent assessment of wetland classification and protection in New South Wales (Kingsford *et al.*, 2004b) provides baseline information on which a CAR-based wetland-conservation strategy could be developed for that State. Tait *et al*. (2003) assessed the representativeness of existing protected areas that include rivers, on the basis of fish biogeographic provinces (Unmack, 2001). In Tasmania, the Conservation of Freshwater Ecosystem Values project is working towards a strategic management system for conservation based on CAR principles. Measures for protection will not be limited to formal reserves but will also include informal reserves, covenants on private property, implementation under water-management protocols, and codes of practice, all of which can be delivered by a CAR model. CAR should not be seen as an opportunity for development where only high-conservation-value areas are protected. Most ecological processes, including those in rivers, require networks of sometimes insignificant habitats to support organisms and functions.

3.2.2. Categorisation

The US Wild and Scenic Rivers scheme is a classificatory system for identifying rivers of particular conservation value. Descriptive classifications are first established with agreed thresholds for various key criteria. Rivers (or river sections) demonstrated to fall above the agreed thresholds may be classed as ‘wild’, scenic’ or ‘recreational’. (Note that other procedures would be included before such a river was to be listed under the *Wild and Scenic Rivers Act 1968.*) Such a process enables a transparent process to identify rivers by degree of disturbance. It does not take account of other conservation values. There are at least two Australian examples of a classificatory approach: the Stressed Rivers program and the Statement of Intent for coastal lakes, both in New South Wales. In the Stressed Rivers program, rivers are classed on two key dimensions (hydrological stress and conservation value) and the resulting matrix interpreted to identify the broad management category for each river type. For the coastal lakes, all coastal lakes are classified into management categories: comprehensive protection, significant protection, healthy modified conditions and targeted for repair. Classification is based on natural sensitivity, current condition of lake and catchment, ecosystem and conservation values, and socio-economic factors.

3.2.3. Criterion-based approaches

International programs or frameworks for identification of places of conservation value often adopt a criterion-based approach. The World Heritage Convention and Ramsar Convention each set out several criteria and, for some values, recommend specific thresholds that a place must meet to be listed. Decision rules are specified, including the requirement for only one criterion to be met, and matters regarding the ecological condition of the candidate site are detailed. There is no limit to the number of places of particular kinds, nor a requirement to rate values of places against each other, although some comparison is implicit in order to identify outstanding places of a particular type.

In Australia, a criterion-based approach to sites of significance has been applied through the Register of the National Estate. Criteria and descriptive thresholds to assess significance are used to consider nominations for the National Heritage List established under the EPBC Act. Only places that meet criteria of outstanding heritage value to the nation are considered for listing, using comparative analyses.

Criterion-based approaches allow for common conservation themes (criteria) to be promoted while allowing for flexibility in the range of evidence provided. No comparisons are therefore required between, say, the relative importance of a rare bird taxon from northern Australia and an endemic crustacean of phylogenetic significance from the Tasmanian highlands. Once the criterion has been met at an agreed standard, then the place may be considered eligible for listing.

The key feature of a criterion-based system is that the values of the place are tested against the criteria, not against another place of the same type.

3.2.4. Scoring and ranking

Relative assessment is an essential part of criterion-based approaches, and scoring can be used to underpin comparisons. Some attempts to summarise the values of rivers by a system of scoring and ranking have been developed (O'Keefe *et al.*, 1987; Collier, 1993; Boon *et al.*, 1994, 1997; Bennett *et al.*, 2002), although not widely applied. A numeric index of ecological value has appeal as a simple means to convey an order of importance or significance. This can be done objectively by comparing variables (or measures) that describe each criterion's attribute (or indicator) among all rivers and dependent ecosystems (see methods in Bennett *et al.* (2002)). This method assigns a rating (1–5) to a series of measures (variables) that describe attributes (indicators) that produce an evaluation. To apply it consistently, explicit choices need to be made.

Benchmarks need to be defined for most attributes, but there are few established precedents that derive scientifically credible values. For quantitative measures such as the percentage of natural cover, a continuous scale could be employed, with the highest possible measures (100%) assigned a 5, the lowest (0%) a 1, and others scaled. The scale need not be linear; a step function might be appropriate. For example, effects of diversions on ecological functions in dryland rivers may be similar across a range of offtakes, until they drop flow below a flow level that has ecological significance (Thoms & Sheldon, 2002). Where the possible range of values cannot be set theoretically (common for measures of diversity and rarity), benchmarks could be defined from the distribution of measured values across all rivers, using natural breaks or percentiles. Rating diversity, rarity and naturalness requires standardisation to account for natural variation across river types. This could be done by comparing measured values to a reference condition (Bennett *et al.*, 2002) or expected classification (Chessman, 2002), or by comparing similar classes of river types.

Ratings for individual waterways tell a lot about the waterway, but this may not be useful for broad-scale planning or communication. Summary ratings of overall conservation value consisting of aggregations (e.g. summing, Bennett *et al.* (2002)) of individual criteria may produce simple rankings of waterway units. Such scoring approaches can be ambiguous where they combine heterogeneous ratings (Chessman, 2002). A river with medium ratings across all criteria may rate higher than one with outstanding values against one criterion but only poor values against others. These difficulties can be reduced by judicious choice of integration method. For example, integration of all criteria in the multivariate space represented by the values of their components (e.g. using a standardised Euclidean distance (Norris *et al.*, 2001)) may be more indicative of overall status than average measures. For some criteria, an aggregated rating may be the lowest rating of the component measures because this rating overrides other criteria.

While a numeric index offers an objective basis for judgment, misinterpretation of the numeric index is a drawback (Boon *et al.*, 1998). SERCON, a well-established system of rating rivers in the scientific literature, can be seen and used as "a generator of 'magic numbers'", where underlying data of final output scores and indices are hidden (Boon *et al.*, 1998, p. 611). The SERCON team rejected the reduction of the six indices to a single overall 'conservation score', unlike the system proposed for South Africa (O'Keefe *et al., 1*987), which was one of the earliest attempts at a systematic conservation assessment process. Recent developments may apply expert rule systems or advanced statistical techniques to rank sites or make comparisons among sites (O'Keefe & Uys 2000).

Ranking and scoring are generally not applied to assess values of terrestrial systems in isolation of a conservation strategy. A scoring system may be appropriate for site selection where other variables such as size, condition, threats, pressures and land tenure are included.

3.2.5. Deciding on an approach

The decision about which method, or combination of methods, to use should be made by jurisdictions in the knowledge that all methods will have advantages and disadvantages and are not mutually exclusive. A criterion-based approach could be developed with agreed criteria and significance thresholds. Such an approach is compatible with Ramsar, development of a National Rivers Heritage List and World Heritage listing, and will have some criteria in common. It does not guarantee representativeness, which would be delivered by a more inclusive CAR-based approach to identification and protection of river conservation values. The two could be complementary and represent important elements in a comprehensive conservation strategy for Australian rivers (Fig. 1). For example, a criterion-based approach could be used to select conservation priorities within classes of river types, ensuring that conservation efforts are delivered across a representative range of Australian riverine systems. This approach is being developed in Tasmania's Conservation of Freshwater Ecosystem Values project.

We recommend that a two-stage process — immediate and long term —be used to identify nationally important rivers, wetlands and estuaries. These stages are best achieved by following agreed protocols and processes that allow for consistent data collection. The absence of data should not constrain immediate identification of high-conservation-value rivers and component ecosystems, with long-term investment in data allowing revision of the outcomes of the immediate stage. The program should begin by using all available data, focusing on rivers, large wetlands and estuaries and producing a ranking of rivers, wetlands and estuaries, with the highest ranked being identified as nationally important. These stages would be the responsibility of jurisdictions. They would then provide the data and information for assessment at the continental scale. With suitable investment, Stage 1 would take two years, while Stage 2 requires long-term investment in river management and understanding. The second stage will make comparisons across all wetlands, estuaries and rivers. This is likely to be more intensive and require considerably more data, and is consistent with the approach of having an iterative process that can be updated with accumulating data.

Chapter 4. Protection scheme

The assessment process can identify whole rivers, river segments, wetlands and estuaries that are candidates for protection, based on the proposed criteria. Such an assessment would be targeted primarily at the identification of nationally important rivers, river segments, wetlands and estuaries, but could easily apply at finer scales, such as State or catchment. The next stage is to identify what, if any, mechanisms exist for protection planning of these aquatic ecosystems.

4.1. Potential for an Australian Heritage Rivers system

The sheer scale of river basins, sometimes thousands and frequently hundreds of kilometres in length, often makes traditional biodiversity conservation protection approaches, such as reservation, untenable at a whole-of-basin scale. There are outstanding exceptions, such as the inclusion of most of the Prince Regent and Shannon rivers in reserves in Western Australia. Existing approaches to conservation in Australia, such as reservation, play a very important role but need to be included within a broader strategy that reflects the scales involved in river system protection. Increasingly, communities and their governments around the world and in Australia are recognising the need for basin-scale protection (see Appendixes D and E). This is in recognition of the connectivity of the aquatic systems in river basins and the reliance on catchment processes for long-term ecological sustainability.

Models for whole-of-basin protection vary in terms of their degree of regulation and legislative backing. ‘Top-down’ approaches with nomination and designation by government can occur, but are usually limited in their appeal because of the potential for regulation and the lack of community support. In contrast ‘bottom-up’ models that are owned by the communities that live on rivers may not have the same legislative protection but can be extremely successful in terms of community ownership and protection against broad pressures (see discussion of national and international models—Appendixes D and E).

Whole river basins identified as largely intact (i.e. unregulated, limited diversions and little catchment development) and ranked highly in a national conservation assessment are potential candidates for protection at whole-of-river-basin scale. These could be called Australian Heritage Rivers (Box 11). For the most part, these would be river basins that are largely unmodified. A national framework could establish a formal, staged process by which a candidate for Australian Heritage River status may eventually be so designated. This process should engage jurisdictional governments and communities, and be voluntary. A system of national protection needs to allow the community, working with government, to take part in supporting the nomination and designation of a potential river system as an Australian Heritage River. Once identified, the community and their jurisdictional government(s) could receive support for nomination and designation, followed by the development and implementation of a management plan that conserves the integrity and natural assets of a river basin. This would not preclude use of currently available mechanisms for protecting parts of the river basin.

This proposed system is clearly differentiated from listing as National Heritage under the *Environment Protection and Biodiversity Conservation Act 1999* (Table 2). The proposed process is intended to be a community-led one with government assistance, allowing large, unregulated and relatively undisturbed river basins (see criteria) to be identified and managed sustainably by the communities and their governments.

The potential candidates for such a system would initially come from the 245 river basins across Australia. We acknowledge that it may be possible to similarly designate sub-basin areas (i.e. whole tributary rivers), but Australian Heritage River designations are primarily designed to allow for multi- use functions at large scales that promote long-term sustainability and do not degrade ecological values.

Box 11: Naming of high-conservation-value rivers unaffected by development

Various terms are used to describe rivers that are of high ecological significance and relatively unaffected by post-European development. These include ‘heritage’, ‘high-conservation-value’, ‘natural’, ‘pristine’, ‘undeveloped’, ‘unregulated’ ‘unspoilt’ or ‘wild’. Few of Australia’s rivers are truly ‘natural’, ‘pristine’ or ‘unspoilt’, due to the size of river catchments and the pervasiveness of key threats. Even the most remote rivers are likely to be affected directly or indirectly by human impacts (e.g. grazing, weeds, feral animals, climate change). The term ‘wild’ evokes images of rivers remote from any human settlement. Terms such as ‘pristine’, ‘natural’ or ‘wild’ fail to recognise the long history of Indigenous land and water management. ‘Heritage’ incorporates the notion of generational accountability. ‘Heritage’ applies to both natural and cultural values, considered essential partners in river protection.

The term ‘Australian Heritage Rivers’ is proposed for rivers that meet criteria for national recognition. The working group believed that this best expresses their continental significance, the role and importance of the community and the essential inheritance value of such protection. The concept of ‘Australian Heritage River’ best serves the importance of river protection at the basin scale.

A possible complication is the potential confusion with the National Heritage List, under the *Environment Protection and Biodiversity Conservation Act 1999* (Table 2). The working group believed that while this may present some problems in the short term, such differentiation would be resolved over time (Table 2). As evidence of this, it is noted that, at the time the Canadian Heritage River System (CHRS) was proposed, Canada had a system of national heritage listing. During development of the CHRS (Appendix D), Canada opted for the name Canadian Heritage Rivers to identify important rivers that the community wished to protect, recognising the arguments articulated above. In 2004, Canada celebrated 20 years of highly successful operation of the CHRS (Appendix D). Government and community in Canada now clearly differentiate between the CHRS and listed National Heritage Rivers.

Table 2. Differentiation between National Heritage listing under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* and the Australian Heritage Rivers system proposed in this discussion paper (continued next page).

Element	**National Heritage listing**[a]	**Proposed Australian Heritage Rivers system**[b]
Legislative policy context	*Environment Protection and Biodiversity Conservation Act 1999*, administered by the Minister for the Environment and Heritage	Non-statutory, sponsored by government program (Australian, State and Territory governments) and policy with incentives.
Identification	Objective continental assessment	Objective continental assessment provides a basis, as in the Canadian Heritage Rivers System, from which the community may nominate potential candidates.
Nomination	Anyone can nominate a river for listing, including the the Minister for the Environment and Heritage and the Australian Heritage Council[c]	Community instigation of the nomination process, including consultation and documentation of ecological and cultural values. Candidate rivers may be identified from an objective assessment of national conservation values. Government funding may be provided for background studies that assist communities in the nomination process. Nomination documentation must show community and jurisdictional support.
Values/criteria	These include natural, Indigenous and historic values of outstanding heritage significance to our nation.	It is proposed that a nominated river must meet criterion 1 (largely unaffected by development) and at least one other criterion (Box 10). Additional criteria for cultural values may also be included.
Assessment	The Australian Heritage Council assesses nominations, supported by the Australian Government. Only nationally outstanding or exceptional values are considered according to set criteria,[d] using thresholds of significance.	An Australian Heritage Rivers Board could be formed from jurisdictions (see Appendix D; Canadian Heritage Rivers System) to assess nominations against criteria (Box 10). Such nominations would have to demonstrate values and integrity (see Appendix D; Canadian Heritage Rivers System).

a Further information available at <http://www.deh.gov.au/heritage/national/index.html>.

b The proposed Australian Heritage Rivers System is primarily based on the Canadian Heritage Rivers System which has successfully operated for 20 years (see Appendix D and <www.chrs.ca>).

c The Minister for the Environment and Heritage appoints the Australian Heritage Council.

d Sites must meet one or more of nine criteria, with assessment against 'significance thresholds' that identify 'outstanding' heritage value.

Element	National Heritage listing[a]	Proposed Australian Heritage Rivers system[b]
Decision on listing	A river may be listed on the National Heritage List if it meets at least one criterion and is recommended by the Australian Heritage Council and the Australian Minister for the Environment and Heritage.	An Australian Heritage Rivers Board would assess the nomination against agreed criteria. It would also need to be convinced that a nomination was strongly supported by the relevant jurisdiction and the community. Designation would be a second step following nomination, and would occur only once a management plan was developed and approved by the responsible jurisdiction (see Appendix D; Canadian Heritage Rivers System). Such plans would need to demonstrate a commitment by the jurisdictional government and concerned stakeholders to conserve the river's values.
Management	After acceptance of nomination, a management plan is prepared based on the National Heritage Management Principles[e] that set out how the natural heritage values of the site will be protected or conserved. Values are protected by the *Environment Protection and Biodiversity Conservation Act 1999*.	The river would be managed by jurisdictions, according to a management plan prepared for designation. The management plan would target the sustainable management of the ecological values for which the nomination is proposed. There would be no overarching statutory basis for this plan although it would need to be embedded within jurisdictional planning and processes and be consistent with prevailing legislation and relevant strategies and policies.
Reporting and monitoring	There is a requirement under the National Heritage Management Principles for regular monitoring, review and reporting to the Australian Government on the conservation of National Heritage values.	Jurisdictions and communities may report to the community on the condition of designated Australian Heritage Rivers at intervals of up to 10 years. Monitoring should target the ecological values for which a river was nominated originally. De-listing would be a result of degradation of the values for which the river was listed.
Obligations	A person or agency must not take an action that has, will have, or is likely to have, a significant impact on the national heritage values of a national heritage place, without approval from the Australian Government Minister for the Environment and Heritage.	Communities and governments using the river and its resources, or operating or living in the river catchment would do so within the provisions of the designated management plan, protecting the ecological goals for river management, and ensuring that the values for which the river is listed are maintained.
Implications	Relatively few rivers may be listed because of high thresholds for significance, an expectation that limited rivers will be listed and the potential strictures of a Australian Government statutory basis for management.	The proposed Australian Heritage Rivers system is designed to better manage those of the nation's rivers that are in the best condition. It recognises that people need water and development within the catchment but that this should be achieved without further loss of aquatic biodiversity and the health of the entire landscape. The community must initiate the process with assistance from governments. In Canada, involvement of the community in the nomination and management processes has produced strong associations with rivers and encouraged community involvement in their management.

e National Heritage Management Principles include: protection for future generations; use of best available knowledge; integration with other government mechanisms; consistency with conservation of natural heritage values; provision for community involvement; active participation of Indigenous communities; and provision for regular monitoring.

4.1.1. Models for basin-wide protection of rivers

There are essentially only two international examples available: the Canadian Heritage Rivers System (CHRS) and the United States Wild and Scenic Rivers legislation (Appendix D). Our recommendations are modelled on the CHRS because this best reflects our system of government and, because it relies primarily on community input, and is less regulatory (Appendix D). While there are obvious differences between Australia and Canada, there are also striking similarities of culture and governance. The CHRS is a highly successful river protection framework that has evolved over 20 years. This successful framework should be recognised and used to inform this suggested scale of river protection in Australia.

Rivers nominated under the CHRS must meet prescribed value and integrity criteria. The Canadian (federal) Government, with the provincial and territorial (second tier) governments, has mapped river values across Canada but neither prepares heritage river nominations. Nominations are prepared by communities, assisted by local (third tier) governments and conservation organisations. Exceptions were the first nominations prepared by federal and provincial governments.

The CHRS has a two-phase process for listing Heritage Rivers: nomination then designation. Designation occurs only after a management plan aimed at protecting the river values and integrity has been developed jointly through government and community processes.

4.1.2. Parts of an Australian Heritage Rivers system

Stages in the process could include:

- scientific assessment of candidate river basins for designation as Australian Heritage Rivers through identification and analyses of value, condition and threat
- clear community interest in participating in the designation, with consultation of owners and stakeholders
- additional background studies and collation of existing information
- completion of nomination documentation showing evidence of jurisdictional and community support
- completion and implementation of an approved management plan for the maintenance of conservation values and integrity of the river
- designation of the river as an Australian Heritage River
- ongoing monitoring, evaluation and investment in designated rivers to ensure conservation values are maintained.

Designation as an Australian Heritage River would not signify a moratorium on development: rather it could encourage sustainable development, such as low-impact industries, and provide opportunities for improving catchment practices. Designation may also provide security for existing sustainable industries, allowing producers and communities to pursue sustainable marketing initiatives and enhanced opportunities with confidence in the long-term future of the resource.

A similar process is established already, through the Lake Eyre Basin Agreement (for the Georgina–Diamantina rivers and Cooper Creek) and the Paroo River Agreement. The Lake Eyre Basin Agreement has supporting legislation; the Paroo River Agreement does not. This Australian Heritage Rivers System element of the proposed national framework and the staged designation process (outlined above) are major features of the CHRS (see Appendix D; Nevill & Phillips, 2004).

4.2. Protection in a national, State, regional or local context: application of current legislative and policy tools

States and Territories have many protection tools, including legislative and non-legislative mechanisms and policies, to protect nationally important rivers or dependent ecosystems (see Appendix C, Table C2). However, these mechanisms are not always consistently applied across or within jurisdictions. In some jurisdictions, the mechanisms available are not applied effectively (Nevill & Phillips, 2004). Also, many mechanisms are applied at spatial scales that are smaller than the river basin and so protection of high-conservation-value rivers or dependent ecosystems is often inadequate even though protection is the goal.

There are four major ways currently in use that could more effectively protect high-conservation-value rivers, reaches and their dependent ecosystems following the principles for protection (see Box 4— Management principles for protection; Box 5— Protection mechanisms).

These four major approaches are:

- identification and management of

environmental flows

- the use of protected areas (as defined by the IUCN)
- natural resource planning and management at a catchment scale
- the use of incentives to rehabilitate systems and encourage sustainable practices.

4.2.1. Environmental flow management

There is an increasing focus on the importance of identifying the share of water in regulated rivers that should be dedicated as an environmental flow. This is usually done during an assessment of other extractive shares of water and then specified in a water-management or water-sharing plan.

This water can potentially be increased by water savings within delivery systems or by acquiring water from existing extractive shares. The Living Murray initiative represents a commitment by governments to increasing the environmental flow through water savings and possibly reductions in extractive shares.

Many of the large river systems that have identified environmental flows store this quantum of water in upstream dams. For example, in the Macquarie River there is a nominal environmental flow of 125,000 ML of general security water held in storage each year. The use of this water is often governed by different release rules that are aimed at producing various environmental outcomes. Increasingly, there is a need to use adaptive management processes for the release of this water, because it can produce quite different environmental outcomes. For example, three different environmental flow management options in the Macquarie River were predicted to produce quite different environmental outcomes for flooding and waterbird breeding in the Macquarie Marshes (Kingsford & Auld, in press).

Future management of environmental flows will inevitably be attempting to target high-conservation-value areas that are dependent on flows. The Living Murray initiative has identified five key sites for management of additional environmental flows. This is a recognition that there is insufficient water in the river to manage for all ecosystems on the river.

4.2.2. Protected areas

All Australian jurisdictions are committed, by the InterGovernmental Agreement on the Environment 1992, to the establishment of comprehensive, adequate and representative networks of protected areas in terrestrial, marine and freshwater environments.

Item 13 of the agreement (Commonwealth of Australia, 1992, p. 40) contains a schedule on nature conservation, which states:

> *The parties agree that a representative system of protected areas encompassing terrestrial, freshwater, estuarine and marine environments is a significant component in maintaining ecological processes and systems. It also provides a valuable basis for environmental education and environmental monitoring. Such a system will be enhanced by the development and application where appropriate of nationally consistent principles for management of reserves.*

Historically, the greatest development of protected areas has occurred in terrestrial ecosystems, with a CAR national reserve program focused through the bioregional framework of IBRA. This has led to bias against representation of aquatic ecosystems in protected areas (Tait *et al.*, 2003). For example in NSW, only about 3% of all wetlands (including estuaries and floodplains) are in reserves (Kingsford *et al*., 2004b), compared with about 7.6% of terrestrial areas. Nationally, mid and lower reaches of river basins (e.g. Murray–Darling, Fitzroy) are poorly represented in existing protected areas (Tait *et al.*, 2003). This problem was recognised in the discussion paper entitled *Directions Statement for the National Reserves System 2004* (NRMMC, 2004), which specifically refers to the need to ensure aquatic ecosystems are adequately represented in the National Reserve System.

All States have endorsed that commitment through policy statements (Nevill & Phillips, 2004), while Victoria and the Australian Capital Territory have funded programs to establish freshwater reserves. All jurisdictions have tools and mechanisms for identification of protected areas (Appendix C, Tables C1 and C2). Special-purpose legislation for the establishment of aquatic protected areas exists in several jurisdictions (Appendix C; Table C2) but, even when such areas are created, controlling catchment-scale processes to maintain the values within the protected areas remains a problem. Indigenous Protected Areas (IPA), under the National Reserve System, provide for Indigenous communities to pass on their traditional culture and knowledge to future generations through the land and aquatic ecosystems. Aquatic sites, principally wetlands, are also identified in the Directory of Important Wetlands in Australia (DIWA) and may be listed under the International Convention of Wetlands of International Importance (Ramsar) (Appendix C, Table C2). The management of these sites can link to jurisdictional planning frameworks, and increasingly regional natural resource management plans. Ramsar-listed wetlands are matters of national environmental significance under the EPBC Act.

4.2.3. Natural resource planning and management

All Australian States and Territories have statutory planning processes and impact-assessment procedures for assessing likely effects of large (‘State significance’) development proposals (Appendix C, Tables C1 and C2). They also have strategic land-use planning procedures for controlling cumulative effects of small developments, such as housing or small-scale water infrastructure (e.g. farm dams, agricultural drains, levee banks). Under the Natural Resource Management Ministerial Council’s National Action Plan for Salinity and Water Quality and CoAG’s water-reform agenda, regional natural resource management plans are now being developed and implemented, including issues of river management and integrated catchment management. CoAG has also agreed to the National Water Initiative. The intergovernmental agreement, signed by the Australian Government and the States and Territories (other than Tasmania and Western Australia), contains provisions committing signatories to identify and manage high-conservation-value rivers to protect and enhance those values.

Managing cumulative impacts of land use and development is one of the more urgent and intractable problems facing communities and government. The major threats facing river systems around the world include water extraction, floodplain drainage, diversion and impoundment, catchment disturbance and invasive pest species (Box 5). Even where there are statutory catchment planning frameworks, they seldom have effective mechanisms for managing cumulative effects. However, without a rigorous approach to the management of cumulative effects, and without the necessary information on the value and condition of freshwater ecosystems, environmental assessment of large and small-scale developments will continue to fail to effectively control cumulative, degrading impacts. Protection mechanisms must manage these threats in high-conservation-value rivers and component ecosystems. Currently, the management of different threats may be targeted by separate legislation and policy and is often the responsibility of different government agencies—as a result, integrated management of assets is seldom achieved.

The emergence of region-based, catchment-focused, natural resource management plans has the potential to provide for coordinated mitigation of these threats in ways not achieved with issue-based legislation and policy tools. However, unless regional natural resource management plans are supported by inventories of ecosystem value, condition and threats, their effectiveness in protection of high- conservation-value assets will be limited.

Good environmental assessment of potentially deleterious project proposals underpins sustainable management of all rivers. If a particular river or dependent ecosystem is identified to be of high conservation value, then the environmental assessment and rehabilitation processes implemented should maintain or restore the long-term sustainability of this asset at the relevant scale, which may often be the whole catchment.

4.2.4. Incentives

Opportunities exist for conservation and rehabilitation of degraded rivers and their dependent ecosystems (e.g. the Living Murray initiative). Identification of rivers and dependent ecosystems of high conservation value establishes important priorities for protective management and rehabilitation. Targeted investment is essential for delivery of the best environmental outcomes.

In addition to public initiatives, jurisdictions should act to protect high-conservation-value assets on private, freehold land through incentive programs such as landowner agreements (Appendix C, Table C1). For example, the Trust for Nature (Victoria) is a statutory corporation that operates under the *Victorian Conservation Trust Act 1972*. The Trust purchases land of high conservation value to manage as private conservation reserves, as well as entering into legally binding conservation covenants with private landholders. The Minister or the Trust can then invest in conservation measures identified in an agreed management plan. Other voluntary, non- binding ‘Land for Wildlife’ programs can also provide mechanisms for investment in aquatic sites. According to Victorian Department of Sustainability and Environment and the Bird Observers Club of Australia figures, more than 5800 private properties were registered at September 2003, covering 156,000 ha. A considerable number of other future opportunities exist for landholder agreements, reinforced by ‘payments for ecosystem services’, tax breaks, or other forms of environmental funding.

Chapter 5. Operational and institutional arrangements — recommendations

Current operational and institutional arrangements need to be used for delivery of this national framework. Implementation of the national framework would require cooperation between jurisdictions and the Australian Government. To that end, it could be best progressed under the aegis of the Natural Resource Management Ministerial Council and the National Water Initiative.

Protection of natural river assets is clearly a sound financial investment for governments. A national framework for the protection of high-conservation-value rivers and their dependent ecosystems will establish clear strategic direction, ensuring that river protection activities act to secure high-conservation- value assets, achieving the highest possible return on investment. This will also help to minimise major cost burdens for future generations.

This proposed national framework relies on national, State, Territory and regional institutional arrangements and resources for implementation. The framework would provide an institutional process and resources for development of the national classifications and assessment procedures for jurisdictions to identify high-conservation-value rivers and component ecosystems and to prioritise and evaluate protection activities. The program should also support communities that wish to identify and manage Australian Heritage Rivers at the whole-of-basin scale.

We have identified a number of key parts to this framework throughout this discussion paper and we summarise how these could best be implemented.

5.1. Major recommendation

Implementation of the national framework would require cooperation between jurisdictions and the Australian Government. To that end, it could be best progressed under the aegis of the Natural Resource Management Ministerial Council and the National Water Initiative.

5.2. Spatial framework

Recommendations

a. Use current drainage divisions, river basins and river segments for initial implementation of this framework. These map layers , and the sub-catchments and catchments they support, should be publicly available.
b. River ecosystem data should be labelled according to resolvable hierarchical scales, allowing for evaluation and future reassessment of classifications.
c. Develop a new hierarchical spatial framework for management of aquatic systems and rivers, based on topography and drainage networks, without many of the problems identified for current spatial layers.

5.3. Evaluation and classification

Recommendations

a. Develop agreed approaches for assessing criteria and use of attributes for rivers, river reaches and dependent ecosystems.
b. Develop agreed national classifications of rivers and dependent ecosystems, with agreed objectives, to support evaluation and assessment.
c. Apply a nationally agreed set of evaluation criteria and significance thresholds, compatible with Ramsar and National Heritage, with nationally available data aggregated to the smallest resolvable scales of assessment (i.e. river segments and their sub-catchments). This could be done to assess all river segments to identify nationally important rivers, wetlands (>200 ha) and large estuaries. Continental data are available in the water body layer (AUSLIG 1:250,000), DIWA and some jurisdictional data sets (e.g. NSW (Kingsford *et al.*, 2004b), OzEstuaries, and National Land and Water Resource Assessments). This initial assessment could be reported at a range of scales, informing a national assessment but also State and regional assessments.

d. Establish long-term collection and storage of nationally consistent data on rivers and their dependent ecosystems that allow for comparison across the country.

5.4. Proposed Australian Heritage Rivers system

While some States have, or will soon have, heritage or wild rivers programs (Appendix E, Table C2), there is currently no clearly defined operational or institutional framework for how 'whole-of-basin level' protection may be implemented at the national level. There are currently some *ad hoc* frameworks for whole of river basin protection, like the Lake Eyre Basin and Paroo River agreements. The Australian Government has primary administrative responsibility for the former, while the latter is administered currently through the Border Catchments Ministerial Agreement between New South Wales and Queensland. Establishment of different models could be explored and possibly implemented under the Natural Resource Management Ministerial Council. These may or may not have a legislative basis (see Appendixes C, D & E, Table C2). Given the voluntary nature of this mechanism, and community involvement, it is likely that this part of the framework may take time but nevertheless may deliver the best environmental outcomes for protection of high-conservation-value rivers in the long term.

Recommendations

a. Identify potential candidate river basins for nomination and designation as Australian Heritage Rivers. This process could be done immediately, using current data. Note that designation would not occur without community support.
b. Identify institutional arrangements that would deliver an Australian Heritage River system, including current models and whether there is a need for legislation. This would have the essential steps for nomination, designation, consultation and administration. The Canadian Heritage Rivers System is a model worthy of consideration.
c. Largely unmodified river basins designated as Australian Heritage Rivers could be priority areas for funding river management plans that protect ecological values, prevent environmental problems, encourage uses compatible with protection of ecological values and promote understanding of ecological values and processes.

5.5. Protecting nationally important rivers and their dependent ecosystems using current mechanisms

State, Territory and Australian governments could protect nationally important rivers, reaches, wetlands and estuaries (identified through a national assessment) through targeted establishment of protective areas, effective implementation of natural resource planning and management, and incentive programs.

No new legislative mechanisms or institutional arrangements are needed to effect protection of nationally important rivers and their dependent ecosystems, except possibly in the control of diffuse cumulative impacts. Existing mechanisms need to be more effectively implemented for ecological outcomes. The specific initiatives that could be implemented include recommendations for environmental flows, protected areas, natural resource management and planning, and incentives.

5.5.1. Environmental flow management

a. Environmental flows for long-term sustainability of rivers and their dependent ecosystems need to be identified at catchment scales.
b. Environmental flows should be managed within an adaptive management framework that ensures the best environmental outcomes.
c. Targets for flow restoration may need to be developed with a focus on better management of flows and access to additional flows if required (e.g. improving water-use efficiency, purchase of water).

5.5.2. Protected areas

The following initiatives could be made for rivers and dependent ecosystems that are nationally of high conservation value.

a. Aquatic ecosystems should be a considered for future acquisition of protected areas (e.g. national parks, nature reserves, conservation areas, or aquatic reserves), or nominations of important wetland areas (e.g. National Heritage, World Heritage and Ramsar sites). This may also include Indigenous protected areas.
b. Policies and management practices and documents for protected areas with rivers and dependent ecosystems should include how the management plans or policies will meet long-term ecological outcomes of sustainability (e.g.

upstream environmental flows, pest control strategies and impacts of catchment disturbance). This could be done under current or developed planning provisions for protected areas that focus on potentially detrimental ecological impacts caused by upstream catchment pressures or downstream barriers. This may include protection of the reserve through catchment-based management of weeds, protection of natural river flows, floodplain and groundwater connectivity, translocation of biota and water quality.

c. These ecosystems could be the focus for the development of cooperative protective arrangements with landholders (e.g. voluntary conservation agreements and other incentive programs).

d. They could be considered for heritage listing under the National Heritage List of the *Environment Protection and Biodiversity Conservation Act 1999*.

e. They coulod be listed under relevant threatened species legislation as endangered or threatened ecological communities if they satisfy appropriate legislative criteria.

5.5.3. Natural resource planning and management

The following improvements to natural resource management and planning could be made for rivers and dependent ecosystems that have high conservation value at a national level.

a. Statutory resource and land-use plans, including river-management plans, should assess and control potentially deleterious impacts on these ecosystems at catchment scales.

b. Environmental objectives in water plans should adequately acknowledge high-conservation-value rivers and their dependent ecosystems and water regimes that maintain their ecological values.

c. River-management planning of these areas needs to explicitly incorporate rivers and their dependent ecosystems within management plans, recognising catchment processes and hydrological connections.

d. For those aquatic ecosystems that cross management borders, river planning should incorporate all of a catchment, taking account of different jurisdictional water legislation.

e. Water-quality policies and management should link to planning, assessment and controls that protect identified aquatic ecosystems. The revised Victorian State Environment Protection Policy (Waters of Victoria) provides a good model for jurisdictions to consider (Nevill and Phillips, 2004).

f. Introduction of exotic species (plants or animals) should be controlled in these aquatic ecosystems and their catchments.

g. River-management planning should involve communities early and involve effective community consultation and communication.

h. Planning should be culturally sensitive (e.g. respect Indigenous decision-making and governance processes) and involve traditional owners for identified ecosystems.

i. For improved management, research and development should focus on that affect conservation values of high conservation rivers, reaches and dependent ecosystems.

5.5.4. Incentives

The following incentive initiatives could be considered for rivers and dependent ecosystems nationally of high-conservation value.

a. Rivers and dependent ecosystems of high conservation value at national, State and catchment scales need to be identified and included in Australian Government, State and regional investment frameworks. This may mean providing priority funding for protection and rehabilitation works (e.g. riparian management, weed management, erosion control, run-off detention, revegetation, land-use change, reinstatement of wetland hydrology, environmental flows and management planning).

b. These aquatic ecosystems could receive priority in monitoring and assessment of ecological values (e.g. Rivercare, Waterwatch, Auditing).

d. These ecosystems could be a focus for tax and rate-relief programs and new incentive schemes for landholders committed to protecting these areas.

References

Abell, R. A., Olson, D. M., Dinerstein, E., Hurley, P. T., Diggs, J. T., Eichbaum, W., Walters, S., Wettengel, W. W., Allnutt, T., Loucks, C. J. and Hedao, P. (2000) *Freshwater ecoregions of North America. A conservation assessment.* Island Press, Washington, D.C.

Alabyan, A. M. and Chalov, R. S. (1998) Types of channel patterns and their natural controls. *Earth Surface Processes and Landforms,* 23, 467–474.

Allan, J.D. and Flecker, A.S. (1993) Biodiversity conservation in running waters. *BioScience* 43, 32–43.

ANCA (Australian Nature Conservation Agency) (1996) A directory of important wetlands in Australia. Second Edition. *Australian Nature Conservation Agency, Canberra.*

ANZECC/MCFFA (1996) National Forest Policy Statement Implementation Sub-committee (JANIS). Proposed nationally agreed criteria for the establishment of a comprehensive, adequate and representative reserve system for forests in Australia. Report of the Subcommittee, Canberra. (*Now available as: Nationally Agreed Criteria (JANIS) for the Establishment of a Comprehensive Adequate and Representative Reserve System for Forests* (<http://www.affa.gov.au/corporate_docs/publications/pdf/forestry/rfa/national/nat_nac.pdf>, accessed 18/8/2004).

Arthington, A.H. and Pusey, B.J. (2003) Flow restoration and protection in Australian rivers. *River Research and Applications* 19, 377–395.

AUSLIG (1992) *GEODATA TOPO-250K User Guide*. Australian Survey and Land Information Group, Canberra.

AUSLIG (1997) *River Basins of Australia*. Australian Survey and Land Information Group, Canberra.

Australia State of the Environment Committee (2001) *Australia State of the Environment 2001*: *independent report to the Commonwealth Minister for the Environment and Heritage*. CSIRO Publishing: Canberra. (http://www.deh.gov.au/soe/2001/, accessed 18/8/2004).

Bailey, R. G. (1996) *Ecosystem Geography.* Springer-Verlag, New York.

Ball, J., Donnelly L, Erlanger, P. Evans, R., Kollmorgen, A., Neal, B. and Shirley, M. (2001) *Inland Waters.* Australia State of Environment Report 2001 (Theme Report). CSIRO Publishing on behalf of the Department of the Environment and Heritage, Canberra.

Balram, S., Dragicevic, S. and Meredith, T. (2004) A collaborative GIS method for integrating local and technical knowledge in establishing biodiversity conservation priorities. *Biodiversity and Conservation,* 13, 1195–1208.

Barendregt, A., Wassen, M.J. and Schot, P.P. (1995) Hydrological systems beyond a nature reserve, the major problem in wetland conservation of Naardermeer (the Netherlands). *Biological Conservation* 72, 393–405.

Begg, G. W., van Dam, R. A., Lowry, J. B., Finlayson, C. M. and Walden, D. J. (2001) *Inventory and risk assessment of water dependent ecosystems in the Daly basin, Northern Territory, Australia*. Supervising Scientist 162, Supervising Scientist Division, Environment Australia, Darwin.

Behrendt, J. and Thompson P. (2003) *The recognition and protection of Aboriginal interests in NSW Rivers.* Occasional Paper 1008, Healthy Rivers Commission of New South Wales, Sydney, 95pp.

Belbin, L. (1993) Environmental representativeness – regional partitioning and reserve selection. *Biological Conservation,* 66, 223–230.

Bennett, J., Sanders, N., Moulton, D., Phillips, N., Lukacs, G., Walker, K. and Redfern, F. (2002) *Guidelines for protecting Australian waterways*. Land and Water Australia, Canberra, pp. 191.

Biggs, B. J. F., Snelder, T., Weatherhead, M. A., Niven, K. and Elosegi, A. (2002) Eutrophication of streams and rivers: hierarchical river environment classification to identify and map reference conditions and state of impairment (abstract). *Current and Future Approaches for Using Benthic Algae to Monitor and Assess Aquatic Ecosystems. NABS Annual meeting*. Pittsburgh, Pennsylvania, May 28–June 1, 2002, available from: <http://www.benthos.org/ database/allnabstracts.cfm/db/ Pittsburgh2002abstracts/id/22>, accessed 18/8/2004.

Blackman, J. G., Gardiner, S. J. and Morgan, M. G. (1995) Framework for biogeographic inventory, assessment, planning and management of wetland systems – the Queensland approach: In *Wetland research in the wet– dry tropics of Australia. Workshop, Jabiru NT 22–24 March, 1995. Supervising Scientist Report 101,* ed., Finlayson, C. M., Supervising Scientist, Darwin, pp. 114–122.

Blackman, J. G., Perry, T. W. and King, S. M. (2002) *Wetland component. Northern Brigalow Belt – priorities for remnant vegetation protection. Final report for NHT Project No. 972132*. Technical Report Queensland Environmental Protection Agency, Pallarenda, Queensland.

Blackman, J., Spain, A. and Whiteley, L. (1992) *Provisional handbook for the classification and field assessment of Queensland wetlands and deepwater habitats*. Wetland Inventory Team, Conservation Strategy Branch, Department of Environment and Heritage, Pallarenda, Queensland.

Boon, P. J., Davies, B. R. and Petts, G. E. (eds.) (2000) *Global perspectives on river conservation: science, policy and practice.* John Wiley & Sons, Chichester.

Boon P.J., Holmes N.T.H., Maitland P.S. & Rowell, T.A. (1994) A system for evaluating rivers for conservation (“SERCON”): an outline of the underlying principles. *Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie* 25, 1510–1514.

Boon P.J., Holmes N.T.H., Maitland P.S., Rowell T.A. & Davies J. (1997) A system for evaluating rivers for conservation (SERCON): Development, structure and function. In *Freshwater quality: defining the indefinable?* eds, Boon, P.J. and Howell, D.L., The Stationery Office, Edinburgh, pp. 299–326.

Boon P.J. Wilkinson J. & Martin J. (1998) The application of SERCON (System for Evaluating Rivers for Conservation) to a selection of rivers in Britain. *Aquatic Conservation: Marine and Freshwater Ecosystems* 8: 597– 616.

Boulton, A. J. and Brock, M. A. (1999) *Australian freshwater ecology: processes and management.* Gleneagles Publishing, Adelaide.

Bourgeron, P. S., Humphries, H. C. and Jensen, M. E. (2001a) Ecosystem characterization and ecological assessments. In *A guidebook for integrated ecological assessments* eds, Jensen, M. E. and Bourgeron, P. S., Springer-Verlag, New York, pp. 40–54.

Bourgeron, P. S., Humphries, H. C. and Jensen, M. E. (2001b) Elements of ecological land classifications for ecological assessments. In *A Guidebook for Integrated Ecological Assessments* eds, Jensen, M. E. and Bourgeron, P. S., Springer-Verlag, New York, pp. 321– 337.

Bowling, L.C. and Baker, P.D. (1996) Major cyanobacterial bloom in the Barwon–Darling River, Australia, in 1991, and underlying limnological conditions. *Marine and Freshwater Research* 47, 643–657.

Brierley, G. J. and Fryirs, K. (2000) River styles, a geomorphic approach to catchment characterization: implications for river rehabilitation in Bega catchment, New South Wales, Australia. *Environmental Management,* 25, 661–679.

Brierley, G. J. and Fryirs, K. (2002) *The River Styles® Framework: The Short Course Conceptual Book.* Macquarie University, Sydney.

Brierley, G. J., Fryirs, K. and Cohen, T. (1996) *Geomorphology & river ecology in southeastern Australia: An approach to catchment characterisation. Part One. A geomorphic approach to catchment characterisation*. Working Paper 9603, Graduate School of the Environment, Macquarie University, North Ryde, pp. 54.

Brooks, R. (2003) *Processing hydrologic networks (draft)* [online] Available from: <http://www.cim.mcgill.ca/ ~rbrook/atlas_gen/hydrology.html>, accessed 18/8/2004.

Bruinsma, C. (2001) *Queensland Coastal Wetland Resources: Cape Tribulation to Bowling Green Bay*. Information Series Report No. QI01064, Department of Primary Industries, Queensland, Brisbane.

Bryce, S. A. and Clarke, S. E. (1996) Landscape-level ecological regions: linking state-level ecoregion frameworks with stream habitat classifications. *Environmental Management,* 20, 297–311.

Bunn, S.E. and Arthington, A.H. (2002) Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. *Environmental Management* 30, 492–507.

Burrows, D. (2002) Translocated native fish in waterways of Northern Queensland. *Australian Society for Fish Biology Annual Conference, 14–17th. August, 2002*. Cairns, Queensland.

Butcher, R. J., Davis, J. A. and Lake, S. P. (2001) Assessing biodiversity in Australian wetlands: trials and tribulations. *Fenner Conference on the Environment 2001. Biodiversity Conservation in Freshwaters, Canberra, 5–7th, July, 2001.*

Calvert, S., Erskine, W. and Junor, B. (2001) *Development of a national river classification system – final report. Consultancy report prepared by PPK Environment and Infrastructure*. Murray–Darling Basin Commission, Environment Australia and the Land and Water Resources, Research and Development Corporation, Sydney, Australia, pp. 68.

Chessman, B. (2002) *Assessing the conservation value and health of New South Wales rivers. The PBH (Pressure– Biota–Habitat) project*. NSW Department of Land and Water Conservation, Parramatta, pp. 56.

Clarke, S. E., White, D. S. and Schaedel, A. L. (1991) Oregon, USA, ecological regions and subregions for water quality management. *Environmental Management,* 15, 847–856.

Cleland, D. T., Avers, P. E., McNab, W. H., Jensen, M. E., Bailey, R. G., King, T. and Russell, W. E. (1997) National hierarchical framework of ecological units. In *Ecosystem management: applications for sustainable forest and wildlife resources*, eds, Boyce, M. S. and Haney, A., Yale University Press, New Haven, pp. 181–200.

Cohen, P., Andriamahefa, H. and Wasson, J. G. (1998) Towards a regionalization of aquatic habitat: distribution of mesohabitats at the scale of a large basin. *Regulated Rivers: Research and Management,* 14, 391–404.

Collier K.J. (1993) *Towards a protocol for assessing the natural value of New Zealand rivers.* Science and Research Series No.58. Department of Conservation, Wellington, New Zealand.

Commonwealth of Australia (1992) *National strategy for ecologically sustainable development*. Australian Government Publishing Service, Canberra.

Commonwealth of Australia (1999) *Australian Guidelines for Establishing the National Reserve System*. Environment Australia, Canberra.

Cook, G., Setterfield, S.A. and Maddison, J. (1996) Shrub invasion of a tropical wetland: implications for weed management. *Ecological Applications* 6, 531–537.

Corkum, L. D. (1999) Conservation of running waters: beyond riparian vegetation and species richness. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 9, 559–564.

Cowardin, L. M., Carter, V., Golet, F. C. and LaRoe, E. T. (1979) *Classification of wetlands and deepwater habitats of the United States. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page.* [online].U. S. Department of the Interior, Fish and Wildlife Service. Available from: <http://www.npwrc.usgs.gov/resource/ 1998/classwet/classwet.htm>, accessed 18/8/2004.

Croke, B. F. W. and Jakeman, A. J. (2001) Predictions in catchment hydrology: an Australian perspective. *Marine and Freshwater Research,* 52, 65–79.

Cullen, P. (2002) The Heritage River Proposal: Conserving Australia's undamaged rivers. In *World Congress on Aquatic Areas, 14–17th, August, 2002, Cairns*, eds, Beumer, J. P., Grant, A. and Smith, D. C., Australian Society for Fish Biology, University of Queensland Printery, St Lucia, pp. 513–520.

Cullen, P. and Lake, P.S. (1995) Water resources and biodiversity: past, present and future problems and solutions. In *Conserving Biodiversity: Threats and Solutions,* eds Bradstock, R., Auld, T.D, Keith, D.A., Kingsford, R.T., Lunney, D. and Sivertsen, D. Surrey Beatty & Sons, Sydney, pp.115–125.

Davies, N. M., Norris, R. H. and Thoms, M. C. (2000) Prediction and assessment of local stream habitat features using large-scale catchment characteristics. *Freshwater Biology,* 45, 343–369.

Davis, J.A. and Froend, R. (1999) Loss and degradation of wetlands in southwestern Australia: underlying causes, consequences and solutions. *Wetlands Ecology and Management* 7, 13–23.

Digby, M. J., Saenger, P., Whelan, M. B., McConchie, D., Eyre, B., Holmes, N. and Bucher, D. (1999) *A* *physical classification of Australian estuaries. National River Health Program – Project E1. Urban Sub-Program Report No.9*. Occasional Paper 16/99, Land and Water Resources Research and Development Corporation, Canberra, pp. 47.

Doeg, T. (2001) *Representative rivers of Victoria: Selection of regions – A Discussion Paper*. Department of Natural Resources and Environment, Melbourne.

Dovciak, A. L. and Perry, J. A. (2002) In search of effective scales for stream management: does agroecoregion, watershed, or their intersection best explain the variance in stream macroinvertebrate communities? *Environmental Management,* 30, 0365–0377.

Dowling, T., Summerell, G. K. and Walker, J. (2003) Soil wetness as an indicator of stream salinity: a landscape position index approach. *Environmental Modelling & Software,* 18, 587–593.

Downes, B. J., Hindell, J. S. and Bond, N. R. (2000) What's in a site? Variation in lotic macroinvertebrate density and diversity in a spatially replicated experiment. *Austral Ecology,* 25, 128–139.

Downs, P. W. (1995) River channel classification for channel management purposes. In *Changing river channels* eds, Gurnell, A. M. and Petts, G. E., John Wiley & Sons, Chichester, pp. 347–366.

Dunn, H. (2000) *Identifying and protecting rivers of high ecological value.* LWRRDC Occasional Paper 01/00. Land and Water Resource and Research Development Corporation, Canberra.

Dunn, H. (2003) Can conservation assessment criteria developed for terrestrial systems be applied to riverine systems? *Aquatic Ecosystem Health and Management* 6, 81–95.

Ebsworth and Ebsworth Lawyers (2001) *Ebsworth & Ebsworth Insurance Review*, April, Article 13.

Edgar, G. J., Barrett, N. S. and Graddon, D. J. (1999) *A classification of Tasmanian estuaries and assessment of their conservation significance using ecological and physical attributes, population and land use*. Technical Report 2, Tasmanian Aquaculture and Fisheries Institute Marine Research Laboratories, Hobart, pp. 205.

Elliott, M. and McLusky, D. S. (2002) The need for definitions in understanding estuaries. *Estuarine Coastal and Shelf Science,* 55, 815–827.

Environment Australia (2000) *Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the development of version 5.1. – summary report*. Department of Environment and Heritage, Canberra.

ESRI (1996) *Arc/Info*. Environmental Systems Research Institute, Inc., Redlands.

Faith, D. P., Margules, C. R., Walker, P. A., Stein, J. L. and Natera, G. (2001) Practical applications of biodiversity surrogates and percentage targets for conservation in Papua New Guinea. *Pacific Conservation Biology,* 6, 289– 303.

Fatchen, T. J. and Lustig, T. L. (1986) *Towards a system of reference catchments in eastern New South Wales*. New South Wales National Parks and Wildlife Service, Sydney, pp. 180.

Ferrier, S., Drielsma, M., Manion, G. and Watson, G. (2002a) Extended statistical approaches to modelling spatial pattern in biodiversity in northeast New South Wales. II. Community-level modelling. *Biodiversity and Conservation,* 11, 2309–2338.

Ferrier, S., Watson, G., Pearce, J. and Drielsma, M. (2002b) Extended statistical approaches to modelling spatial pattern in biodiversity in northeast New South Wales. I. Species-level modelling. *Biodiversity and Conservation,* 11, 2275–2307.

FGDC (2002) *FGDC Proposal, Version 1.0. Federal standards for delineation of hydrologic unit boundaries* [Online] Available from: <http://www.fgdc.gov/standards/ status/huc.html>, accessed 18/8/2004.

Fischer, J., Lindenmeyer, D. L., Nix, H. A., Stein, J. L. and Stein, J. A. (2001) Climate and animal distribution: a climatic analysis of the Australian marsupial *Trichosurus caninus*. *Journal of Biogeography,* 28, 293–304.

Frissell, C. A., Liss, W. J., Warren, C. E. and Hurley, M. D. (1986) A hierarchical framework for stream habitat classification: viewing streams in a watershed context. *Environmental Management,* 10, 199–214.

Frissell, C. A., Poff, N. L. and Jensen, M. E. (2001) Assessment of biotic patterns in freshwater ecosystems. In *A guidebook for integrated ecological assessments*, eds, Jensen, M. E. and Bourgeron, P. S., Springer-Verlag, New York, pp. 390–403.

Froend, R.H., Heddle, E.M., Bell, D.T. and McComb, A.J. (1987) Effects of salinity and waterlogging on the vegetation of Lake Toolibin, Western Australia. *Australian Journal of Ecology* 12, 281–298.

Fryirs, K. and Brierley, G. (2000) A geomorphic approach to the identification of river recovery potential. *Physical Geography,* 21, 244–277

Gallant, J. C. and Dowling, T. I. (2003) A multi-resolution index of valley bottom flatness for mapping depositional areas. *Water Resources Research,* 39, article No. 1347.

Gehrke, P.C., Brown, P., Schiller, C.B., Moffatt, D.B. and Bruce, A.M. (1995) River regulation and fish communities in the Murray–Darling River system, Australia. *Regulated Rivers: Research and Management* 11, 363–375.

Gehrke, P. C. and Harris, J. H. (2000) Large-scale patterns in species richness and composition of temperate riverine fish communities, south-eastern Australia. *Marine and Freshwater Research,* 51, 165–82.

Gehrke, P.C. and Harris, J.H. (2001) Regional-scale effects of flow regulation on lowland riverine fish communities in New South Wales, Australia. *Regulated Rivers Research and Management* 17, 369–391.

Georges, A., Bradley Shaffer, H., Adams, M., Thomson, S. and Storz, B. (2001) Phylogeography of Australian freshwater turtles. *Fenner Conference on the Environment 2001. Biodiversity Conservation in Freshwaters*, *5–7th, July, 2001, Canberra*.

Georges, A. and Cottingham, P. (2002) *Biodiversity in inland waters – priorities for its protection and management. Recommendations from the 2001 Fenner Conference on the Environment*. Technical Report 1/2002, Cooperative Research Centre for Freshwater Ecology, Canberra.

Geoscience Australia (2001) *GEODATA 9 Second DEM Version 2* [online]. Geoscience Australia. Available from: <http://www.ga.gov.au/nmd/products/digidat/dem_9s.htm>, accessed 18/8/2004.

Geoscience Australia (2003a) *Australian Surface Water Management Areas (ASWMA) 2000 Product User Guide*. Geoscience Australia, Canberra, pp. 20.

Geoscience Australia (2003b) *GEODATA TOPO 250K series 2 topographic data*. Geoscience Australia, Canberra.

Gerritsen, J., Barbour, M. T. and King, K. (2000) Apples, oranges, and ecoregions: on determining pattern in aquatic assemblages. *Journal of the North American Benthological Society,* 19, 487–496.

Gillanders, B.M. and Kingsford, M.J. (2002) Impact of changes in flow of freshwater on estuarine and open coastal habitats and associated organisms. *Oceanography and Marine Biology: an Annual Review* 40, 233–309.

Goodwin, C. N. (1999) Fluvial classification: Neanderthal necessity or needless normalcy. In *Wildland Hydrology, TPS-99-3* eds, Olsen, D. S. and Potyondy, J. P., American Water Resources Association, Herndon, Virginia., pp. 229–236.

Gordon, N. D., McMahon, T. A. and Finlayson, B. L. (1992) *Stream hydrology. An introduction for ecologists.* John Wiley & Sons, Chichester.

Groves, C., Valutis, L., Vosick, D., Neely, B., Wheaton, K., Touval, J. and Runnels, B. (2000) *Geography of hope: a practitioner's handbook to ecoregional conservation planning.* The Nature Conservancy.

Growns, J. and Marsh, N. (2000) *Characterisation of flow in regulated and unregulated streams in eastern Australia*. Technical Report 3/2000, Cooperative Research Centre for Freshwater Ecology, Canberra, pp. 66.

Halse, S.A., Pearson, G.B., Jaensch, R.P., Kulmoi, P., Gregory, P., Kay, W.R. and Storey, A.W. (1996) Waterbird surveys of the Middle Fly River floodplain, Papua New Guinea. *Wildlife Research* 23, 557–569.

Handcock, R. N. and Csillag, F. (2002) Ecoregionalization assessment: spatio-temporal analysis of net primary production across Ontario. *Ecoscience,* 9, 219–230.

Hankinson, A. and Blanch, S. (2002) *Establishing freshwater aquatic reserves in New South Wales.* Issues paper prepared by the Inland Rivers Network and the Australian Conservation Foundation, Sydney, 40pp.

Harding, J. S. and Winterbourn, M. J. (1997) An ecoregion classification of the South Island, New Zealand. *Journal of Environmental Management,* 51, 275–287.

Hart, D. D. and Finelli, C. M. (1999) Physical–biological coupling in streams: the pervasive effects of flow on benthic organisms. *Annual Review of Ecology and Systematics,* 30, 363–395.

Hawkins, C. P., Norris, R. H., Gerritsen, J., Hughes, R. M., Jackson, S. K., Johnson, R. K. and Stevenson, R. J. (2000) Evaluation of the use of landscape classifications for the prediction of freshwater biota: synthesis and recommendations. *Journal of the North American Benthological Society,* 19, 541–556.

Hawkins, C. P. and Vinson, M. R. (2000) Weak correspondence between landscape classifications and stream invertebrate assemblages: implications for bioassessment. *Journal of the North American Benthological Society,* 19, 501–517.

Heap, A., Bryce, S., Ryan, D., Radke, L., Smith, C., Smith, R., Harris, P. and Heggie, D. (2001) *Australian Estuaries & Coastal Waterways: A geoscience perspective for improved and integrated resource management*. Record 2001/07, Australian Geological Survey Organisation, Canberra, pp. 126.

Heino, J., Muotka, T., Mykrä, H., Paavola, R., Hämäläinen, H. and Koskenniemid, E. (2003) Defining macroinvertebrate assemblage types of headwater streams. implications for bioassessment and conservation. *Ecological Applications,* 13, 842–852.

Hendy, E.J., Gagan, M.K. and Lough, J.M. (2003) Chronological control of coral records using luminescent lines and evidence for non-stationary ENSO teleconnections in northeast Australia. *The Holocene* 13: 187–199.

Heritage, G. L., Charlton, M. E. and O'Regan, S. (2001) Morphological classification of fluvial environments: An investigation of the continuum of channel types. *Journal of Geology,* 109, 21–33.

Holmes, N. T. H. (1999) British river macrophytes—perceptions and uses in the 20th century. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 9, 535– 539.

Holmes, N. T. H., Boon, P. J. and Rowell, T. A. (1998) A revised classification system for British rivers based on their aquatic plant communities. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 8, 555–578.

Hughes, J. M. R. and James, B. (1989) A hydrological regionalization of streams in Victoria, Australia, with implications for stream ecology. *Australian Journal of Marine and Freshwater Research,* 40, 303–326.

Hughes, R. M., Paulsen, S. G. and Stoddard, J. L. (2000) EMAP-Surface Waters: a multiassemblage, probability survey of ecological integrity in the USA. *Hydrobiologia,* 422, 429–443.

Humphrey, C. (1997) *Temporal variability of macroinvertebrate communities in Australian streams: implications for the prediction and detection of environmental change*. Research and development final report ARR1, Land and Water Resources Research and Development Corporation, Canberra, pp. 8.

Hutchinson, M. F. and Dowling, T. I. (1991) A continental hydrological assessment of a new grid-based digital elevation model of Australia. *Hydrological Processes,* 5, 31–44.

Hutchinson, M. F., Stein, J. L. and Stein, J. A. (2000) *Derivation of nested catchments and sub-catchments for the Australian continent.* [online].Centre for Resource and Environmental Studies, Australian National University. Available from: http://cres.anu.edu.au/ outputs/audit/index.php, accessed 18/8/2004.

Hutchinson, M. F., McIntyre, S., Hobbs, R. J., Stein, J. L., Garnett, S. and Kinloch, J. (2005) An agro-climatic classification incorporating bioregional boundaries in Australia. *Global Ecology and Biogeography*, 14, 197-212

Interim Marine and Coastal Regionalisation for Australia Technical Group (1998) *Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. version 3.3*. Environment Australia, Commonwealth Department of the Environment, Canberra, pp. 104.

IWSRCC (Interagency Wild and Scenic Rivers Coordinating Council) (1998) *An introduction to Wild and Scenic Rivers*. Technical Report of the Interagency Wild and Scenic Rivers Coordinating Council. (<http://www.nps.gov/ rivers/publication.html(wsr-primer.pdf)>, accessed 18/ 8/2004)

Jeffers, J. N. R. (1998) Characterization of river habitats and prediction of habitat features using ordination techniques. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 8, 529–540.

Jensen, M. E., Christensen, N. L. J. and Bourgeron, P. S. (2001a) An overview of ecological assessment principles and applications. In *A guidebook for integrated ecological assessments*, eds, Jensen, M. E. and Bourgeron, P. S., Springer-Verlag, New York, pp. 13–28.

Jensen, M. E., Goodman, I. A., Frissell, C. A., Brewer, C. K. and Bourgeron, P. S. (2001b) Ecological classification and mapping of aquatic systems. In *A guidebook for integrated ecological assessment*, eds, Jensen, M. E. and Bourgeron, P. S., Springer-Verlag, New York, pp. 352– 366.

Jenson, S. K. (1991) Applications of hydrologic information automatically extracted from digital elevation models. *Hydrological Processes,* 5, 31–44.

Jenson, S. K. and Domingue, J. O. (1988) Extracting topographic structure from digital elevation data for geographic system analysis. *Photogrammetric Engineering and Remote Sensing,* 54, 1593–1600.

Jerie, K., Household, I. and Peters, D. (2001) Stream diversity and conservation in Tasmania: Yet another new approach. *Third Australian Stream Management Conference*, *Brisbane*, eds Rutherfurd, I., Sheldon, F., Brierley, G. J. and Kenyon, C., Cooperative Research Centre for Catchment Hydrology, Melbourne, pp. 329– 336.

Jerie, K., Household, I. and Peters, D. (2003) *Tasmania's river geomorphology: stream character and regional analysis. Volume 1*. Nature Conservation Report 03/5, Nature Conservation Branch, Department of Primary Industries, Water and Environment, Hobart, pp. 126.

Joy, M. K. and Death, R. G. (2002) Predictive modelling of freshwater fish as a biomonitoring tool in New Zealand. *Freshwater Biology,* 47, 2261–2275.

Karr, J. R. and Chu, E. W. (1999) *Restoring life in running waters.* Island Press, Washington DC.

Kingsford, R.T. (1995) Ecological effects of river management in New South Wales. In *Conserving biodiversity: threats and solutions*, eds Bradstock, R., Auld, T.D., Kingsford, R.T., Lunney, D. and Siversten, D. Surrey Beatty & Sons, Sydney, pp. 144–161.

Kingsford, R.T. (2000) Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia. *Austral Ecology* 25, 109–127.

Kingsford, R.T. (2003) Social, institutional and economic drivers for water resource development – case study of the Murrumbidgee River, Australia. *Aquatic Ecosystem Health and Management* 6, 69–79.

Kingsford, R.T. and Auld, K.M. (in press). Waterbird breeding and environmental flow management in the Macquarie Marshes, arid Australia. *Rivers Research and Applications*

Kingsford, R.T., Boulton, A.J. and Puckridge, J.T. (1998) Challenges in managing dryland rivers crossing political boundaries: lessons from Cooper Creek and the Paroo River, central Australia. *Aquatic Conservation: Marine and Freshwater Ecosystems* 8, 361–378.

Kingsford, R. T., Brandis, K., Thomas, R. F., Crighton, P., Knowles, E. and Gale, E. (2004b) Classifying landform at broad spatial scales: the distribution and conservation of wetlands in New South Wales, Australia. *Marine and Freshwater Research,* 55, 17–31.

Kingsford, R.T., Jenkins, K.M. and Porter, J.L. (2004a) Imposed hydrological stability imposed on lakes in arid Australia and effects on waterbirds. *Ecology* 85, 2478– 2492.

Kingsford, R.T. and Norman, F.I. (2002) Australian waterbirds – products of the continent's ecology. *Emu* 102, 47–69.

Kingsford, R.T. and Thomas, R.F. (1995) The Macquarie Marshes in arid Australia and their waterbirds: a 50 year history of decline. *Environmental Management* 19, 867–878.

Kingsford, R.T. and Thomas, R.F. (2004) Destruction of wetlands and waterbird populations by dams and irrigation on the Murrumbidgee River in arid Australia. *Environmental Management* 34, 383–396.

Kingsford, R.T., Thomas, R.F. and Curtin, A.L. (2001) Conservation of wetlands in the Paroo and Warrego catchments in arid Australia. *Pacific Conservation Biology* 7, 21–33.

Kirkpatrick, J. B. and Brown, M. J. (1994) A comparison of direct and environmental domain approaches to planning reservation of forest higher plant communities and species in Tasmania. *Conservation Biology,* 8, 217–224.

Lake, P.S. (1995) Of floods and droughts: river and stream ecosystems of Australia. In *River and stream ecosystems,* eds, Cushing C.E., Cummins, K.W. & Minshall, G.W. Elsevier, Amsterdam, pp. 659–694.

Land Conservation Council (1989) *Rivers and streams special investigation*. Land Conservation Council, Melbourne, pp. 316.

Landsberg, J. and Kesteven, J. (2002) Spatial estimation of plant productivity. In *Biomass estimation: approaches for assessment of stocks and stock change. National Carbon Accounting System, Technical Report No. 27* ed, Richards, G. P., Australian Greenhouse Office, Canberrra, pp. 33–50.

Leathwick, J. R., Mc.Overton, J. and Mc.Leod, M. (2003) An environmental domain classification of New Zealand and its use as a tool for biodiversity management. *Conservation Biology,* 17, 1612–1623.

Lemly, A.D., Kingsford, R.T. and Thompson, J.R. (2000) Irrigated agriculture and wildlife conservation: conflict on a global scale. *Environmental Management* 25, 485– 512.

Lewis, A., Stein, J. L., Stein, J. A., Nix, H. A., Mackey, B. G. and Bowyer, J. K. (1991) *An assessment of regional conservation adequacy: Tasmania*. Consultancy Series FTC91/17, Resource Assessment Commission, Forest and Timber Inquiry, Canberra, pp. 106.

Ligon, F.K., Dietrich, W.E. and Trush, W.J. (1995) Downstream ecological effects of dams. *Bioscience* 45 183–192.

Lindenmayer, D. B., Cunningham, R. B., Donnelly, C. F. and Lesslie, R. (2002) On the use of landscape surrogates as ecological indicators in fragmented forests. *Forest Ecology and Management,* 159, 203–216.

Mackey, B. G., Nix, H. and Hitchcock, P. (2001) *The natural heritage significance of Cape York Peninsula.* ANUTECH Pty Ltd, Canberra, pp. 194.

Mackey, B. G., Nix, H. A., Hutchinson, M. F., MacMahon, J. P. and Fleming, P. M. (1988) Assessing Representativeness of Places for Conservation Reservation and Heritage Listing. *Environmental Management,* 12, 501–514.

Mackey, B. G., Nix, H. A., Stein, J. A. and Cork, S. E. (1989) Assessing the representativeness of the wet tropics of Queensland World Heritage Property. *Biological Conservation,* 50, 279–303.

Mackey, B. G., Stein, J. A., Stein, J. L. and Gilles, J. (2000) *A scientific assessment of the conservation value of Monga and Buckenbowra State Forests, NSW, Australia – with a particular emphasis on adequacy and representativeness*. Working Paper, Centre for Resource and Environmental Studies/ Department of Geography, Faculty of Science, Australian National University, Canberra.

Macmillan, L. and Kunert, C. (1990) *Conservation values and status of Victorian rivers. Part 1: methodology: classification, nature conservation evaluation and strategies for protection*. Royal Melbourne Institute of Technology. Faculty of Environmental Design and Construction, Melbourne, pp. 140.

Maddock, I. (1999) The importance of physical habitat assessment for evaluating river health. *Freshwater Biology,* 41, 373–391.

Maheshwari, B.L., Walker, K.F. and McMahon, T.A. (1995) Effects of regulation on the flow regime of the River Murray, Australia. *Regulated Rivers – Research and Management* 10, 15–38.

Makaske, B. (2001) Anastomosing rivers: a review of their classification, origin and sedimentary products. *Earth- Science Reviews,* 53, 149–196.

Malmqvist, B. and Rundle, S. (2002*)* Threats to the running water ecosystems of the world. *Environmental Conservation* 25(2) 134–153.

Marchant, R., Hirst, A., Norris, R. and Metzeling, L. (1999) Classification of macroinvertebrate communities across drainage basins in Victoria, Australia: consequences of sampling on a broad spatial scale for predictive modelling. *Freshwater Biology,* 41, 253–268.

Margules, C. R. and Nicholls, A. O. (1987) Assessing the conservation value of remnant habitat 'islands': mallee patches on the western Eyre Peninsula, South Australia In *Nature conservation: the role of remnants of native vegetation* eds, Saunders, D. A., Arnold, G. W., Burbidge, A. A. and Hopkins, A. J. M., Surrey Beatty & Sons, Chipping Norton, NSW, pp. 89–102.

Margules, C. R. and Pressey, R. L. (2000) Systematic conservation planning. *Nature,* 405, 243–253.

Margules, C. R., Pressey, R. L. and Williams, P. H. (2002) Representing biodiversity: data and procedures for identifying priority areas for conservation. *Journal of Biosciences,* 27, 309–326.

Margules, C. R. and Stein, J. L. (1989) Patterns in the distributions of species and the selection of nature reserves: An example from Eucalyptus forests in south- eastern New South Wales. *Biological Conservation,* 50, 219–238.

Mark, D. M. (1988) Network models in geomorphology.

In *Modelling Geomorphological Systems*, ed., Anderson, M. G., Wiley, Chichester, pp. 73–97.

Matthaei, C. D. and Townsend, C. R. (2000) Long-term effects of local disturbance history on mobile stream invertebrates. *Oecologia,* 125, 119–126.

Maxwell, J. R., Edwards, C. J., Jensen, M. E., Paustian, S. J., Parrott, H. and Hill, D. M. (1995) *A hierarchical framework of aquatic ecological units in North America (Nearctic Zone)*. GTR-NC-176, U.S. Department of Agriculture Forest Service, North Central Forest Experimental Station, St Paul, MN, pp. 72.

Mertes, L. A. K. (2002) Remote sensing of riverine landscapes. *Freshwater Biology,* 47, 799–816.

Meyer, J. L. and Wallace, J. B. (2000) Lost linkages and lotic ecology: rediscovering small streams. In *Ecology: achievement and challenge. The 41st Symposium of the British Ecological Society, Orlando, Florida*, eds Press, M. C., Huntly, N. J. and Levin, S., Blackwell Science, London. pp. 295–317.

Miller, J. R. and Ritter, J. B. (1996) An examination of the Rosgen classification of natural rivers. *Catena,* 27, 295– 299.

Montgomery, D. R. and Buffington, J. M. (1997) Channel- reach morphology in mountain drainage basins. *Geological Society of America Bulletin,* 109, 596–611.

Morgan, G. (2001) *Landscape health in Australia. A rapid assessment of the relative condition of Australia's bioregions and subregions*. Environment Australia and the National Land and Water Resources Audit, Canberra, pp. 109.

Mosley, M. P. (1987) The classification and characterization of rivers. In *River channels: environment and process*, Vol. 18 eds, Richards, K., Basil Blackwell, Oxford, pp. 295–320.

Myers, T. J. and Swanson, S. (1997) Precision of channel width and pool area measurements. *Journal of the American Water Resources Association,* 33, 647–659.

Naiman, R. J., Lonzarich, D. G., Beechie, T. J. and Ralph, S. C. (1992) General principles of classification and the assessment of conservation potential in rivers In *River conservation and management* eds, Boon, P. J., Calow, P. and Petts, G. E., John Wiley, Chichester, pp. 93–124.

Nanson, G. and Croke, J. (1992) A genetic classification of floodplains. *Geomorphology,* 4, 459–486.

Nanson, G. C. and Knighton, A. D. (1996) Anabranching rivers: their cause, character and classification. *Earth Surface Processes and Landforms,* 21, 217–239.

Nevill, J. and Phillips, N. (Eds.) (2004) *The Australian Freshwater Protected Area Resourcbook: the role and importance of protected areas for inland aquatic ecosystems.* OnlyOnePlanet Australia, Hampton, Melbourne

Newall, P. and Wells, F. (2000) Potential for delineating indicator-defined regions for streams in Victoria, Australia. *Journal of the North American Benthological Society,* 19, 557–571.

Newson, M. D. and Newson, C. L. (2000) Geomorphology, ecology and river channel habitat: mesoscale approaches to basin-scale challenges. *Progress in Physical Geography,* 24, 195–217.

New Zealand Ministry for the Environment (2003). The water programme of action. Ministry for the Environment; Wellington, 4pp.

Nix, H. A. (1986) A biogeographic analysis of Australian elapid snakes. In *Atlas of elapid snakes of Australia. Australian flora and fauna series No. 7*, ed., Longmore, R., Australian Government Publishing Service, Canberra, pp. 4–15.

Nix, H. A. (1992) Environmental domain analysis. In *Environmental regionalisation. Establishing a systematic basis for national and regional conservation assessment and planning*, ed., Thackway, R., Environmental Resources Information Network, Canberra.

Nix, H. A. (1997) Management of parks and reserves for the conservation of biological diversity. In *National parks and protected areas: selection, delimitation, and management,* eds, Pigram, J. J. and Sundell, R. C., Centre for Water Policy Research, University of New England, Armidale, pp. 11–36.

Nix, H. A., Faith, D. P., Hutchinson, M. F., Margules, C. R., West, J., Allison, J., Kesteven, J. L., Natera, G., Slater, W., Stein, J. L. and Walker, P. (2000) *The BioRap Toolbox. A National Study of Biodiversity Assessment and Planning for Papua New Guinea. Consultancy Report to the World Bank.* Centre for Resource and Environmental Studies, Australian National University, Canberra, pp. 48.

NLWRA (National Land and Water Resources Audit) (2001) *Australian water resources assessment 2000,* edn. National Land and Water Audit, Commonwealth of Australia, Canberra.

NLWRA (National Land and Water Resources Audit) (2002a) Australian catchment, river and estuary assessment 2002. National Land and Water Resource Audit, Commonwealth of Australia, Canberra.

NLWRA (National Land and Water Resources Audit) (2002b) Australian terrestrial biodiversity assessment 2002. National Land and Water Resource Audit, Commonwealth of Australia, Canberra.

Norris, R. H., Prosser, I., Young, B., Liston, P., Bauer, N., Davies, N., Dyer, F., Linke, S. and Thoms, M. (2001) *The assessment of river condition (ARC). An audit of the ecological condition of Australian rivers. Final Report submitted to the National Land and Water Resources Audit Office*. CSIRO Division of Land and Water, Canberra, pp. 274.

NRMMC (Natural Resource Management Ministerial Council) (2004) Directions for the National Reserve System – a partnership approach. Natural Resource Management Ministerial Council, 49pp (<www.deh.gov.au/parks/nrs/directions/index.html>, accessed 18/8/2004).

Ogden, R.W. (2000) Modern and historical variation in aquatic macrophyte cover of billabongs associated with catchment development. *Regulated Rivers: Research and Management* 16, 497–512.

O'Keefe, J. H. and Uys, M. C. (2000) The role of classification in the conservation of rivers. In *Global perspectives on river conservation: science, policy and practice*, eds, Boon, P. J., Davies, B. R. and Petts, G. E., John Wiley & Sons, Chichester, pp. 445–458.

O'Keeffe, J.H., Danilewitz, D.B. and Bradshaw, J.A. (1987) An 'Expert System' approach to the assessment of the conservation status of rivers. *Biological Conservation* 40, 69–84.

Olden, J. D. and Jackson, D. A. (2002) A comparison of statistical approaches for modelling fish species distributions. *Freshwater Biology,* 47, 1976–1995.

Olden, J. D. and Poff, N. L. (2003) Redundancy and the choice of hydrologic indices for characterizing streamflow regimes. *River Research and Applications,* 19, 101–121.

Olsen, G. and Skitmore, E. (1991) *State of the rivers of the south west drainage division*. Publication 2/91, Western Australia Water Resources Council, Perth, pp. 171.

Olson, D. M., Dinerstein, E., E, E. D. W. K., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P. and Kassem, K. R. (2001) Terrestrial ecoregions of the world: a new map of life on earth. *BioScience,* 51, 933–938.

Omernik, J. M. (1995) Ecoregions: A spatial framework for environmental management In *Biological assessment and criteria: tools for water resource planning and decision making* eds, Davis, W. S. and Simon, T. P., Lewis Publisher, Boca Raton, pp. 49–65.

Omernik, J. M. and Bailey, R. G. (1997) Distinguishing between watersheds and ecoregions. *Journal of the American Water Resources Association,* 33, 935–950.

O'Neill, R. V., DeAngelis, D. L., Waide, J. B. and Allen, T. F. H. (1986) *A hierarchical concept of ecosystems.* Princeton University Press, Princeton, New Jersey.

Ormerod, S. J. (1999) Three challenges for the science of river conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 9, 551–558.

Outhet, D., Fryirs, K., Massey, C. and Brierley, G. (2001) Application of the River Styles framework to river management programs in New South Wales. *Third Australian Stream Management Conference, Brisbane*. eds Rutherfurd, I., Sheldon, F., Brierley, G. J. and Kenyon, C. Cooperative Research Centre for Catchment Hydrology, Melbourne, pp. 489–492.

Oxley, J. (1820) *Journals of two expeditions into the interior of NSW*. Albermarle, London.

Paavolo, R., Muotka, T., Virtanen, R., Heino, J. and Kreivi, P. (2003) Are biological classifications of headwater streams concordant across multiple taxonomic groups? *Freshwater Biology,* 48, 1912–1923.

Pegg, M. A. and Pierce, C. L. (2002) Classification of reaches in the Missouri and lower Yellowstone Rivers based on flow characteristics. *River Research and Applications,* 18, 31–42.

Perera, A. H., Baker, J. A., Band, L. E. and Baldwin, D. J. B. (1996) A strategic framework to eco-regionalize Ontario. *Environmental Monitoring and Assessment,* 39, 85–96.

Peters, D. and Thackway, R. (1998) *A new biogeographic regionalisation for Tasmania*. Tasmanian Parks and Wildlife Service GIS Section, Hobart, pp. 42.

Phillips, N. (2001) Determining the conservation value of rivers – trial of a new method in the Burnett catchment, central Queensland. In *Third Australian Stream Management Conference, Brisbane*, eds Rutherfurd, I., Sheldon, F., Brierley, G. J. and Kenyon, C. Cooperative Research Centre for Catchment Hydrology, Melbourne, pp. 513–519.

Phillips, N., Bennett, J. and Moulton, D. (2001) *Principles and tools for protecting Australian rivers*. Land & Water Australia, Canberra.

Phillips, N., Redfern, F. and Bain, J. (2002) *Determining the conservation value of waterways – Burnett River catchment trial*. Queensland Environmental Protection Agency, Brisbane.

Pigram, J. J. and Sundell, R. C. (1997) Introduction. In *National parks and protected areas: selection, delimitation, and management*, eds, Pigram, J. J. and Sundell, R. C., Centre for Water Policy Research, University of New England, Armidale, pp. 1–3.

PMSEIC (Prime Minister's Science, Engineering and Innovation Council). (2002). *Sustaining our natural systems and biodiversity. Report from the Eighth Meeting, 31 May*, 2002, Canberra.

Poff, N. L., Allan, J. D., Bain, M. B., Karr, J. R., Prestegaard, K. L., Richter, B. D., Sparks, R. E. and Stromberg, J. C. (1997) The natural flow regime. *BioScience,* 47, 769– 784.

Pressey, R. L. and Adam, P. (1995) A review of wetland inventory and classification in Australia. *Vegetatio,* 118, 81–101.

Pressey, R. L., Cowling, R. M. and Rouget, M. (2003) Formulating conservation targets for biodiversity pattern and process in the Cape Floristic Region, South Africa. *Biological Conservation,* 112, 99–127.

Pressey, R.L. and Logan, V.S. (1998) Size of selection units for future reserves and its influence on actual vs targeted representation of features: a case study in western New South Wales. *Biological Conservation* 85, 305–309.

Prosser, I. P., Rustomji, P., Young, B., Moran, C. and Hughes, A. (2001) *Constructing river basin sediment budgets for the National Land and Water Resources Audit*. Technical Report 15/01, CSIRO Land and Water, Canberra, pp. 35.

Puckridge, J. T., Sheldon, F., Walker, K. F. and Boulton, A. J. (1998) Flow variability and the ecology of large rivers. *Marine Freshwater Research,* 49, 55–72.

Puckridge, J.T., Walker, K.F. and Costelloe, J.F. (2000) Hydrological persistence and the ecology of dryland rivers. *Regulated Rivers: Research and Management* 16, 385–402.

Pusey, B. J., Kennard, M. J. and Arthington, A. H. (2000) Discharge variability and the development of predictive models relating stream fish assemblage structure to habitat in northeastern Australia. *Ecology of Freshwater Fish,* 9, 30–50.

Rabeni, C. F. and Doisy, K. E. (2000) Correspondence of stream benthic invertebrate assemblages to regional classification schemes in Missouri. *Journal of the North American Benthological Society,* 19, 419–428.

Ramsar Convention Secretariat (2003) *The Ramsar Convention Manual: a Guide to the Convention on Wetlands (Ramsar, Iran, 1971).* Ramsar Convention Secretariat, Gland, Switzerland.

Read, M. (2001) *Australia wide assessment of river health Tasmanian program. Final report. Submitted to Environment Australia*. Water Assessment Section, Water Management Branch, Water Resources Division, Department of Primary Industries, Water and Environment, Hobart.

Redford, K. H., Coppolillo, P., Sanderson, E. W., Da Fonseca, G. A. B., Dinerstein, E., Groves, C., Mace, G., Maginnis, S., Mittermeier, R. A., Noss, R., Olson, D., Robinson, J. G., Vedder, A. and Wright, M. (2003) Mapping the conservation landscape. *Conservation Biology,* 17, 116–131.

Reid, J., Bailey, V., Costelloe, J., Good, M., Hudson, P., Powling, J., Pritchard, J., Puckridge, J. and Shiel, R. (2003) Drivers of aquatic biodiversity in the Lake Eyre Basin: hydrology and other environmental factors (abstract). *Ecological Society of Australia Annual Conference*. Armidale, New South Wales.

Richards, B. N., Bridges, R. G., Curtin, R. A., Nix, H. A., Shepherd, K. R. and Turner, J. (1990) *Biological conservation of the south-east forests. Report of the Joint Scientific Committee*. Department of Primary Industries and Energy, Canberra.

Richter, B.D., Braun D.P., Mendelson M.A. and Master L.L. (1997) Threats to imperilled freshwater fauna. *Conservation Biology* 11, 1081–1093.

Riley, S. J., Warner, R. F. and Erskine, W. (1984) *Classification of water bodies in New South Wales*. Water Resources Commission NSW, Sydney.

Roberts, J. and Sainty, G. (1996). *Listening to the Lachlan*. Sainty and Associates, Sydney.

Robson, B. J. and Chester, E. T. (1999) Spatial patterns of invertebrate species richness in a river: the relationship between riffles and microhabitats. *Australian Journal of Ecology,* 24, 599–607.

Roshier, D.A., Whetton, P.H., Allan, R.J. and Robertson, A.I. (2001) Distribution and persistence of temporary wetland habitats in arid Australia in relation to climate. *Austral Ecology* 26, 371–384.

Rosgen, D. L. (1994) A classification of natural rivers. *Catena,* 22, 169–199.

Rosgen, D. L. (1996) *Applied River Morphology*. Wildland Hydrology, Pagosa Springs, Colorado.

Roux, D., Moor, F. d., Cambray, J. and Barber-James, H. (2002) Use of landscape-level river signatures in conservation planning: a South African case study. *Conservation Ecology,* 6, 6. [online] <http://www.consecol.org/vol6/iss2/art6>, accessed 18/8/2004).

Ryan, D. A., Heap, A. D., Radke, L. and Heggie, D. T. (2003) *Conceptual models of Australia's estuaries and coastal waterways: applications for coastal resource management*. Record 2003/09, Geoscience Australia, Canberra, pp. 136.

Sandin, L. and Johnson, R. K. (2000) Ecoregions and benthic macroinvertebrate assemblages of Swedish streams. *Journal of the North American Benthological Society,* 19, 462–474.

Savery, T. S., Belt, G. H. and Higgins, D. A. (2001) Evaluation of the Rosgen stream classification system in Chequamegon–Nicolet National Forest, Wisconsin. *Journal of the American Water Resources Association,* 37, 641–654.

Scarsbrook, M. R. (2002) Persistence and stability of lotic invertebrate communities in New Zealand. *Freshwater Biology,* 47, 417–431.

Scientific Panel for Lower North Coast River Management Committee (1999) *Assessment of Toorumbee subcatchment for high conservation value status. Final draft. 15th November 1999*. Biodiversity & Conservation Unit, Centre for Natural Resources, Sydney, pp. 42.

Scott, D. and Drielsma, M. (2003) Developing landscape frameworks for regional conservation planning; an approach integrating fauna spatial distributions and ecological principles. *Pacific Conservation Biology,* 8, 235–254.

Schofield, N.J., Collier, K.J., Quinn, J., Sheldon, F. and Thoms, M.C. (2000) Australia and New Zealand. In *Global perspectives on river conservation: science policy and practice,* eds, Boon, P.J., Davies, B.R., Petts, G.E., John Wiley & Sons Ltd, Chichester; pp. 311–333.

Semeniuk, C. A. (1988) Consanguineous wetlands and their distribution in the Darling System, south western Australia. *Journal of the Royal Society of Western Australia,* 70, 69–87.

Semeniuk, C. A. and Semeniuk, V. (1995) A geomorphic approach to global classification. *Vegetatio,* 118, 103– 124.

Semeniuk, V. and Semeniuk, C. A. (1997) A geomorphic approach to global classification for natural inland wetlands and rationalization of the system used by the Ramsar Convention – a discussion. *Wetlands Ecology and Management,* 5, 145–158.

Sheldon, F., Boulton, A. J. and Puckridge, J. T. (2002) Conservation value of variable connectivity: aquatic invertebrate assemblages of channel and floodplain habitats of a central Australian arid-zone river, Cooper Creek. *Biological Conservation,* 103, 13–31.

Smith, M. J., Kay, W. R., Edward, D. H. D., Papas, P. J., Richardson, K. S., Simpson, J. C., Pinder, A. M., Cale, D. J., Horwitz, P. H. J., Davis, J. A., Yung, F. H., Norris, R. H. and Halse, S. A. (1999) AusRivAS: using macroinvertebrates to assess ecological condition of rivers in Western Australia. *Freshwater Biology,* 41, 269–282.

Smith, R. K., Freemna, P. L., Higgins, J. V., Wheaton, K. S., FitzHugh, T. W., Ernstrom, K. J. and Das, A. A. (2002) *Priority areas for freshwater conservation action: a biodiversity assessment of the southeastern United States*. The Nature Conservancy,

Smith, T. F., Sant, M. and Thom, B. (2001) *Australian estuaries: a framework for management*. Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management; Brisbane.

Snelder, T. H. and Biggs, B. J. F. (2002) Multi-scale river environment classification for water resources management. *Journal of the American Water*

Resources Association, 38, 1225–1239.

Snelder, T., Mason, C., Woods, R. and Robb, C. (2001) *Application of the river ecosystem management framework to water allocation management*. Client Report CHC01/ 24, National Institute of Water & Atmospheric Research, Christchurch, New Zealand, pp. 44.

St Louis River Citizens Action Committee (2002) *Lower St. Louis River Habitat Plan*. St. Louis River Citizens Action Committee, Duluth, MN.

Stein, J. L. (2003) A continental landscape framework for river and stream conservation (abstract). *International Association for Landscape Ecology World Congress*, *14– 16th July, 2003, Darwin*.

Stein, J.L., Stein, J.A. and Nix, H.A. (2001) Wild rivers of Australia. *International Journal of Wilderness* 7, 20–24.

Strahler, A. N. (1957) Quantitative analysis of watershed geomorphology. *American Geophysical Union Transactions,* 38, 913–920.

Tait, J. T. P., Choy, S. and Lawson, R. (2003) Bioregional frameworks for assessments of freshwater biodiversity in Australia. In *World Congress on Aquatic Areas, 14– 17th, August, 2002, Cairns*, eds, Beumer, J. P., Grant, A. and Smith, D. C., Australian Society for Fish Biology, University of Queensland Printery, St Lucia, pp. 155– 169.

Thackway, R. (Ed.) (1992) *Environmental regionalisation. Establishing a systematic basis for national and regional conservation assessment and planning. Proceedings of an Australian Workshop, Canberra 11–12 May 1992.* Environmental Resources Information Network, Canberra.

Thackway, R. and Cresswell, I. (1995) *An Interim Biogeographic Regionalisation for Australia: a framework for setting priorities in the National Reserves System Cooperative Program Version 4*. Australian Nature Conservation Agency, Canberra

Thoms, M. (2003) Floodplain–river ecosystems: lateral connections and the implications of human interference. *Geomorphology* 56, 335–349.

Thoms, M., Foster, J. and Coysh, J. (2001) Appendix 2. Functional process zone conceptual models of river function. In *Development of a framework for the Sustainable Rivers Audit. A Report to the Murray–Darling Basin Commission*. Technical Report 8/2001, Cooperative Research Centre for Freshwater Ecology, Canberra, pp. 329.

Thoms, M. C. and Parsons, M. (2003) Identifying spatial and temporal patterns in the hydrological character of the Condamine–Balonne River, Australia, using multivariate statistics. *River Research and Applications,* 19, 443–457.

Thoms, M. and Sheldon, F. (2000) Water resource development and hydrological change in a large dryland river: the Barwon–Darling River Australia. *Journal of Hydrology* 228, 10–21.

Thoms, M. C. and Sheldon, F. (2002) An ecosystem approach for determining environmental water allocations in Australian dryland river systems: the role of geomorphology. *Geomorphology,* 47, 153–168.

Thomson, J. R., Taylor, M. P. and Brierley, G. J. (2004) Are River Styles ecologically meaningful? A test of the ecological significance of a geomorphic river characterization scheme. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 14, 25 – 48.

Thomson, J. R., Taylor, M. P., Fryirs, K. A. and Brierley, G. J. (2001) A geomorphological framework for river characterization and habitat assessment. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 11, 373–389.

Thorne, C. R. (1997) Channel types and morphological classification. In *Applied fluvial geomorphology for river engineering and management,* eds, Thorne, C. R., Hey, R. D. and Newson, M. D., Wiley, Chichester, pp. 175–222.

Thuiller, W. (2003) BIOMOD – optimizing predictions of species distributions and projecting potential future shifts under global change. *Global Change Biology,* 9, 1353–1362.

Timms, B. V. and Boulton, A. J. (2001) Typology of arid- zone floodplain wetlands of the Paroo River (inland Australia) and the influence of water regime, turbidity, and salinity on their aquatic invertebrate assemblages. *Archiv für Hydrobiologie,* 153, 1–27.

Turak, E., Flack, L. K., Norris, R. H., Simpson, J. and Waddell, N. (1999) Assessment of river condition at a large spatial scale using predictive models. *Freshwater Biology,* 41, 283–298.

U.S. Environmental Protection Agency Office of Science and Technology (1998) *U.S. EPA reach file 1 (RF1) for the conterminous United States in BASINS. Metadata* [online].U.S. Environmental Protection

Agency. Available from: <http://www.epa.gov/OST/BASINS/metadata/rf1.htm>, accessed 18/8/2004.

U.S. Geological Survey (2001) *HYDRO1K Elevation derivative database* [online].U.S. Geological Survey EROS Data Center. Available from: http://edcdaac.usgs.gov/gtopo30/hydro/, accessed 18/8/2004.

Uhlig, P. W. C. (1996) A spatial hierarchical framework for the co-management of ecosystems in Canada and the United States for the Upper Great Lakes region. Environmental Monitoring and Assessment, 39, 59–73.

Unmack, P. J. (2001) Biogeography of Australian freshwater fishes. *Journal of Biogeography,* 28, 1053– 1089.

USDA Forest Service Stream Systems Technology Center (2001) Forest Service stream classification: adopting a first approximation. *Stream Notes*, April 2001.

Verdin, K. L. and Verdin, J. P. (1999) A topological system for delineation and codification of the Earth's river basins. *Journal of Hydrology,* 218, 1–12.

Veitch, S. M. and Walker, J. (2001) *Continental scale data – an under-valued resource for environmental indicator and multi-criterion natural resource assessments.* ISESS 2001, Banff, Canada.

Vogt, J., Colombo, R., Paracchini, L., de Jager, A. and Soille, P. (2003) *CCM River and Catchment Database. Version 1.0*. Institute for Environment and Sustainability, EC Joint Research Centre, Ispra (Varese), Italy, pp. 31.

Walker, K.F. (1985) A review of the ecological effects of river regulation in Australia. *Hydrobiologia* 125, 111– 129.

Warry, N. D. and Hanau, M. (1993) The use of terrestrial ecoregions as a regional-scale screen for selecting representative reference sites for water-quality monitoring. *Environmental Management,* 17, 267–276.

Weitzell, R. E., Khoury, M. L., Gagnon, P., Schreurs, B., Grossman, D. and Higgins, J. (2003) *Conservation priorities for freshwater biodiversity in the Upper Mississippi River basin*. NatureServe and the Nature Conservancy, Arlington, Virginia.

Wells, F., Metzeling, L. and Newall, P. (2002) Macroinvertebrate regionalisation for use in the management of aquatic ecosystems in Victoria, Australia. *Environmental Monitoring and Assessment,* 74, 271–294.

Wells, F. and Newall, P. (1997) *An examination of an aquatic ecoregion protocol for Australia*. Australian and New Zealand Environment and Conservation Council, Canberra. Available from: <http://www.deh.gov.au/water/rivers/nrhp/ecoregion/>, accessed 18/82004.

Whiting, P. J. and Bradley, J. B. (1993) A process-based classification system for headwater streams. *Earth Surface Processes and Landforms,* 18, 603–612.

Whittington, J., Coysh, J., Davies, P., Dyer, F., Gawne, B., Lawrence, I., Liston, P., Norris, R., Robinson, W. and Thoms, M. (2001) *Development of a Framework for the Sustainable Rivers Audit. A Report to the Murray–Darling Basin Commission*. Technical Report 8/2001, Cooperative Research Centre for Freshwater Ecology, Canberra, pp. 329.

Williams, S. E. and Hero, J.-M. (2001) Multiple determinants of Australian tropical frog biodiversity. *Biological Conservation,* 98, 1–10.

Williams, W.D. (1988) Limnological imbalances: an antipodean viewpoint. *Freshwater Biology* 20, 407–420.

Wilson, J. P. and Gallant, J. C. (2000) Digital terrain analysis In *Terrain analysis: principles and applications* eds, Wilson, J. P. and Gallant, J. C., John Wiley & Sons, New York, pp. 1–27.

Young, W. J., Ogden, R. W., Prosser, I. P. and Hughes, A. O. (2001) Predicting River channel type from flow and sediment regime attributes. In *MODSIM 2001*., eds, Ghassemi, F., Whetton, P., Little, R. and Littleboy, M., Modelling and Simulation Society of Australia and New Zealand Inc.Canberra, Australia. pp. 855–860.

Zonneveld, I. S. (1994) Basic principles of classification. In *Ecosystem classification for environmental management*, Vol. 2, ed., Klijn, F., Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 23–48.

Appendices

Appendix A. Information for the spatial framework

Table A1. Sources of digital information for a national spatial framework for Australian rivers

Data-set	Description	Applicable scales	Spatial coverage	Limitations
GEODATA 250K (Geoscience Australia, 2003b)	Digital (GIS) vector coverage of information from the 1:250,000 scale topographic map series. Includes lakes, reservoirs, swamps, streams and canals.	Segment to drainage basin	Continental	Mapping variability, compatibility with drainage analysis procedures, currency
Nested catchments (Hutchinson *et al.*, 2000)	A network of river links and nested series of drainage basins, catchments and sub-catchments derived from the national 9' DEM version 2. Drainage basins linked to the AWRC drainage basins	Segment to drainage basin	Continental	Does not adequately reflect low drainage density in low relief areas or accommodate distributary channels or anabranching systems
Pfafstetter nested catchments (Stein, 2003)	A network of river links and nested series of drainage basins, catchments and sub-catchments derived from the national 9" DEM version 3 using the Pfafstetter delineation and coding system. First level sub-division based on the AWRC drainage divisions	Segment to drainage basin	Continental	Under development (completion mid 2004), needs evaluation
AWRC Drainage division and river basins (AUSLIG, 1997; Geoscience Australia, 2003a)	Drainage basins for 245 major rivers delineated from topographic maps of various scales. Basins aggregated into 12 drainage divisions.	Drainage basin	Continental	Boundary errors, distributary channels and anabranching systems, confuses basins and catchments; 'basins' also include catchments of adjacent smaller coastal streams
Assessment of River Condition (NLWRA) (Norris *et al.*, 2001)	A network of river links with catchment area >50 km^2 defined from the national 9" DEM (Geoscience Australia, 2001).	Segment to drainage basin	Intensive Landuse Zone	Flow through flat areas, distributary channels and anabranching systems, larger streams only
OZESTUARIES (Heap *et al.*, 2001)	Location and extent of 974 estuaries and other coastal waterways, includes mapping of geomorphic and sedimentary facies (habitat) areas for 405 estuaries.	Segment	Continental	Only larger estuaries

Table A2. Systems for delineation and/or codification of topographically defined hydrologic units at national scales

System	Description	Automated delineation/ coding	Information conveyed by unit coding scheme		
			Membership of higher levels	Tributary/main stem relations	Up/down stream relations
Pfafstetter (Verdin & Verdin, 1999)	Drainage basins successively divided into tributary basins and mainstem inter-basins on the basis of catchment area and drainage network topology	Y	Y	Y	Y
USGS Hydrologic Unit System (HUC) (FGDC, 2002)	Numbers of units and area guide division into smaller watershed (catchments) and sub-watersheds (sub-catchments), downstream boundary decisions made using local knowledge, inter-agency standards and guidelines facilitate consistency	N	Y	N	N
U.S. EPA Reach File 1 (RF1) (U.S. Environmental Protection Agency Office of Science and Technology, 1998)	Stream reach indexing system using a unique reach number for stream reaches and relative position (latitude/longitude), pro-rated against the full computed reach length	Y	N	N	Y
Catchment area thresholds (e.g. Hutchinson *et al.*, 2000)	Unit downstream boundaries located at confluences where the tributary upstream catchment area exceeds specified threshold	Y	Y	N	N
AWRC drainage basins and divisions (AUSLIG, 1997; Geoscience Australia, 2003a)	Based on catchment area of largest rivers, adjacent small catchments merged. Basins numbered sequentially within drainage divisions. First digit indicates drainage division.	N	Y	N	N
Brooks, 2003	Hydrological coding system similar to Pfafstetter using base 64 numbering system requiring less sophisticated operators for up/downstream queries	Y	N	Y	Y

Appendix B. River classification—a review

In the main classification system section, we discussed classification of riverine systems and provided immediate and long term options for identifying representative high conservation rivers and dependent ecosystems at a national scale. The classification options arose from this review of river classification, focused on conservation application. Further information is provided by Australian (Nevill and Phillips, 2004; Pressey & Adam, 1995; Tait *et al.*, 2003) and international reviews (Mosley, 1987; Gordon *et al.*, 1992; Naiman *et al.*, 1992; Downs, 1995; Thorne, 1997; O'Keefe and Uys, 2000; Jensen *et al.*, 2001b; Makaske, 2001; Elliott and McLusky, 2002).

Classification approaches

Classifications may apply to a single scale or, in a hierarchical framework, link rivers explicitly to the surrounding catchment and terrestrial landscape (Jensen *et al.*, 2001b), making them effective at local to continental scales. Stream order, a simple enduring single-scale classification scheme, measures relative position in the drainage network (Strahler, 1957). It can indicate biotic and physical characteristics of a river segment but is less reliable at regional scales (Naiman *et al.*, 1992). Similarly, river zonations using presence of one or more species (Mosley, 1987) seldom apply beyond where they were developed (Naiman *et al.*, 1992). The hierarchical structure in classification may be divisive or agglomerative (Bourgeron *et al.*, 2001a).

Divisive or 'top down' approaches start from large, ecologically heterogeneous areas, successively dividing them into lower more homogenous levels. This widely adopted method (e.g. Blackman *et al.*, 1992; Calvert *et al.*, 2001; Frissell *et al.*, 1986; Maxwell *et al.*, 1995; Snelder & Biggs, 2002) uses ecological units, mapping them progressively and with increasing resolution, data and analysis requirements. Classifications can be produced for entire continents with limited data while providing for finer selected delineations (Cleland *et al.*, 1997). A top down approach accords with theories of the hierarchical organisation of ecological systems (O'Neill *et al.*, 1986). Higher levels functionally constrain lower levels, but because of the asymmetry in the relationships between the levels of ecological hierarchies, emergent properties of higher levels cannot be predicted from the properties of the lower levels (Bourgeron *et al.*, 2001a; Perera *et al.*, 1996; Zonneveld, 1994).

There are drawbacks. The emergent properties of the higher levels may be difficult to characterize when applied to the hierarchical structure of river systems. Classification differentiating criteria are applied using summary values at high levels, although you need to ensure that basin average values are not meaningless for large and heterogeneous basins. Climatic criteria often differentiate high levels of hierarchical classifications (Bailey, 1996; Calvert *et al.*, 2001; Cleland *et al.*, 1997; Snelder and Biggs, 2002) but these are not readily applied to large river basins that include climatic types ranging from montane to tropical lowland (Omernik & Bailey, 1997). Further, this 'top down' approach starting with a grouping of river basins may obscure similarities more closely associated with habitat characteristics than patterns of drainage system connectivity. For example, distinctive montane fish communities span drainage divides (Gehrke & Harris, 2000). Sequential divisive approaches are also sensitive to the order in which classification criteria are specified (Phillips *et al.*, 2002). For example, the particular importance of criteria may vary with valley substrate (Cohen *et al.*, 1998; Heritage *et al.*, 2001).

In contrast, agglomerative or 'bottom up' approaches successively integrate the objects of the classification, according to their shared similarities. As implied, this begins from the lowest levels in the hierarchy, leading to progressively higher levels. The approach follows a view that the character and behaviour of the river reflect the collective characteristics of the tributary sub-catchments (Brierley & Fryirs, 2002). It is inductive and generally independent of spatial constraints (Bourgeron *et al.*, 2001a), except through the spatial dependence of the classificatory variables. However, these approaches depend on data availability at the finest scales of a river to be classified at any level in the hierarchy.

The attributes used to discriminate groups may be direct measures of river ecological characteristics ('response' variables) or the principal factors responsible for the river's characteristics ('driving' or 'controlling' variables) (Bourgeron *et al.*, 2001b; O'Keefe & Uys, 2000). Response variables include descriptors of biotic community structure (taxon distribution and abundance) or of habitat, principally hydrology or geomorphology. Controlling factors operate over a range of spatial and temporal scales (Naiman *et al.,* 1992). Ultimate controls, regional geology, climate and zoogeography, operate across large areas and are stable over long time scales (centuries to millennia). Proximate controls include the local geomorphic processes (e.g. channel migration, sediment transport) and biotic processes (e.g. reproduction, competition, predation) that alter river characteristics over short time periods (decades or less) and are important at small spatial scales.

National classification of rivers and dependent ecosystems

Australia has examples of regional (Riley *et al.*, 1984; Fatchen & Lustig, 1986; Macmillan & Kunert, 1990; Olsen & Skitmore, 1991) or State-wide classifications (Doeg, 2001; Hughes & James, 1989; Jerie *et al.*, 2003; Land Conservation Council, 1989; Kingsford *et al.*, 2004b) but no nationally consistent mapping of river types. A national scheme was developed (Calvert *et al.*, 2001) but has not been implemented. Internationally, there are few examples of river classifications for national scale conservation application (Boon *et al.*, 2000). Two exceptions include classification of British rivers for statutory conservation, based on aquatic plant communities (Holmes *et al.*, 1998; Holmes, 1999), and the freshwater ecoregions developed for conservation assessment in North America (Abell *et al.*, 2000).

Unlike rivers, large Australian estuaries have been classified nationally. Over 700 estuaries in the Australian Estuarine Database (AED, <http:// www.ozestuaries.org/> (updated version), accessed 18/8/2004) were classified using a statistical analysis of biologically important physical characteristics (climate and inter-tidal range) (Digby *et al.*, 1999). The classification explained nearly half of the variation in estuary, saltmarsh and mangrove proportions. These estuaries were also classified into six classes according to the relative dominance of the wave, tide and river energies responsible for shaping their form and function (Heap *et al.*, 2001). A geomorphological classification derived from Landsat TM satellite imagery, aerial photographs, and topographic maps confirmed the energy classification. This classification was also applied to an additional 190 estuaries not included in the AED and is now accompanied by conceptual models of the biophysical processes that operate in estuaries and coastal waterways (Ryan *et al.*, 2003). None of these classifications directly considered the regional variation in biologically important catchment inputs such as sediments, nutrients or the seasonal variability of run-off.

Biological classification

Classifications of rivers based on the distribution pattern of biota are often favoured for conservation applications (Olson *et al.*, 2001; Tait *et al.*, 2003). They may use dominant species, indicator species or assemblages of organisms (commonly fish or macro- invertebrates) to discriminate groups (Gordon *et al.*, 1992; Naiman *et al.*, 1992). For example, Gehrke and Harris (2000) identified four broad groups of rivers, Montane, North Coast, South Coast and Murray– Darling, from the fish assemblages recorded in a systematic survey across NSW and Marchant *et al.* (1999) classified Victorian rivers according to macro- invertebrate communities found in edge and riffle habitats (199 sites). Biological survey data are notoriously poor and usually confined to a small number of sites making conservation planning, based on a classification across all rivers difficult. Wider spatial distributions for biota may be predicted from site records by bioclimatic modelling (e.g. Nix, 1986 (BIOCLIM); Fischer *et al.*, 2001; Lindenmayer *et al.*, 2002) or statistical modelling (e.g. Thuiller, 2003). Modelled distributions of terrestrial species and communities can help conservation planning at regional (Margules & Nicholls, 1987; Margules & Stein, 1989; Ferrier *et al.*, 2002a,b; Scott & Drielsma, 2003) and national scales (Faith *et al.*, 2001; Nix *et al.*, 2000). Similar techniques can predict fish distribution (Joy & Death, 2002; Olden & Jackson, 2002). For example, the structure of fish communities in four Queensland rivers was predicted from regional or catchment scale factors (Pusey *et al.,* 2000). Models could be developed for many riverine taxa if suitably representative site data exist, matched to environmental attributes (Mackey *et al.*, 2001).

Achieving the level of sampling in both space and time necessary for modelling the continental distribution of highly dynamic taxa is problematic. For example, variation in macro-invertebrates community structure occurs at fine spatial (Robson & Chester, 1999; Dovciak & Perry, 2002) and temporal (Scarsbrook, 2002) scales, reflecting discharge variability (Humphrey, 1997) or local disturbance (Matthaei & Townsend, 2000). Survey sites are seldom 'representative' of larger spatial units, such as river segments (Downes *et al.*, 2000). Statistical models can predict the expected macro-invertebrate community at a test site (AUSRIVAS bioassessment program, <http://ausrivas.canberra.edu.au/ index.html>) but they require both coarse-scale, map based variables and local scale field measures of water quality and substrate composition (Read, 2001; Smith *et al.*, 1999; Turak *et al.*, 1999). Models of macro-invertebrate community structure using remotely mapped environmental variables alone were less successful with less than half of the regional models for the NLWRA Assessment of River Condition considered satisfactory (Norris *et al.*, 2001).

In lieu of comprehensive data, expert judgement can derive boundaries around broad regions of relatively homogeneous biological assemblages. For example, a regionalisation using macro-invertebrate survey sites and their groupings for Victoria was based on professional judgement (Wells *et al.,* 2002), by positioning boundaries following the method of Newall and Wells (2000). Combined with regional fish distribution maps, the resulting regions underpin selection of representative rivers in Victoria (Victorian Riverine Biological Regions; Doeg 2001). Unfortunately, with limited data State-wide coverage was not possible and "a considerable amount of latitude" was required to reconcile boundaries between component regionalisations (Doeg 2001). A drawback for regionalisation is that geographic proximity may not be the overriding factor driving similarity. For example, complex distribution patterns of macro-invertebrate distribution may reflect the longitudinal gradients and connectivity of rivers (Marchant *et al.*, 1999), rather than geographic proximity (Heino *et al.*, 2003; Turak *et al.*, 1999). Spatial organisation in biological communities is a function of the spatial scale over which data are gathered (Marchant *et al.*, 1999) and the accepted level of within group heterogeneity.

Alternatively, biogeographic methods can delineate region boundaries by identifying concordant taxonomic distributions, rather than community similarity. Biogeographic methods identify constraints, that may be difficult to incorporate into models of species' or communities' distributions using abiotic factors. Boundaries essentially reflect the 'ultimate' controls on rivers (Naiman *et al.*, 1992),such as major geological events, glaciations, and land bridges and can define the highest levels in a hierarchical classification scheme (Naiman *et al.*, 1992; Maxwell *et al.*, 1995; Tait *et al.*, 2003). So, fish provinces exemplify biogeographic regionalisation in Australia (Unmack, 2001). They represent areas with a distinctive recent evolutionary history, reflected by characteristic fish species and subspecies (Unmack, 2001). The provinces were derived from regional groupings of the AWRC drainage basins (see above), guided by concordance among distributions of obligate freshwater fish species. Poor fish data availability for inaccessible regions remains a challenge (Unmack, 2001). Also regionalisation could be improved with better delineations of river basins (Geoscience Australia, 2003a; Hutchinson *et al.*, 2000; see spatial scale). These provinces could delineate 'macro-regions' of an Interim Freshwater Biogeographic Regionalisation for Australia (IFBRA) (Tait et. al., 2003). Lower levels in the proposed IFBRA hierarchy would be based on position in the catchment (Tait et. al., 2003). Biological classifications based on one or two taxonomic groups may inadequately represent other aquatic taxa (Butcher *et al.*, 2001; Paavolo *et al.*, 2003; S. Halse, pers. comm. in Pressey & Adam, 1995). Other faunal groups may also be candidates for bioregionalisation using new phylogeny (e.g. turtles, Georges *et al.,* 2001), that is not confounded by spatial and temporal variability (Tait *et al.*, 2003). Such descriptions may also require separation into ecological subsets of taxonomic groups to account for important patterns and processes (Williams & Hero, 2001). Unfortunately, we know relatively little of how geographical scale and biogeographical histories affect taxonomic surrogacy (Margules & Pressey, 2000).

Fine scale (e.g. river segment, reach) biological classification of rivers is currently not possible because of the lack of comprehensive inventory of Australian rivers and their dependent ecosystems (Nevill & Phillips, 2004) and our poor taxonomic knowledge of freshwater biodiversity (Georges & Cottingham, 2002). Further, comprehensive surveys are rare. Existing survey data are often biased towards easily accessible locations or larger, permanent streams (Williams, 1988; Kingsford, 1995). Even the collections of aquatic macroinvertebrates for the National River Health Program (NRHP) (Read, 2001; Smith *et al.*, 1999; Turak *et al.*, 1999) concentrate on areas of greatest management need and include few temporary streams, especially in arid regions. Low levels of taxonomic resolution (e.g. family) characteristic of many macroinvertebrate data-sets, including the NRHP, may be inadequate for useful generalisations (Hawkins & Vinson, 2000; Tait *et al.*, 2003).

Even with a large investment in inventory, two important factors affect biological classifications. Firstly, the distribution patterns of many biota have been modified by anthropogenic activities in ways that are difficult to detect (O'Keefe & Uys, 2000). For example, deliberate (stocking) or accidental (e.g. aquaria, escapees from fish farms) releases of native fish species are widespread (Burrows, 2002) and distributions of native fish species are considerably affected by river regulation (Gehrke *et al.*, 1995; Gehrke & Harris 2001). Similarly waterbird distribution and density is affected by river regulation (Kingsford *et al.*, 2004a; Kingsford & Thomas, 2004). Secondly, population fluctuation can be mistakenly ascribed to geographic variation because there are seldom extended time series (Frissell *et al.*, 2001). Such fluctuations are extreme in many floodplain wetlands with shifting spatio-temporal mosaics of assemblages reflecting complex patterns of connectivity dependent on highly variable flooding (Puckridge *et al.*, 2000; Timms and Boulton, 2001; Reid *et al.*, 2003; Sheldon *et al.*, 2002; Kingsford *et al.*, 2004a). Stochastic processes may structure biotic communities in intermittent or episodic rivers. Two adjacent pools in a temporary river can have entirely different faunal assemblages dependent upon colonisation (Roux *et al.*, 2002). Biological classifications are inherently dynamic snapshots of ecosystems patterns, requiring periodic updating (Jensen *et al.*, 2001b).

Geomorphic and hydrological classifications

There are many geomorphic classifications, using geomorphological characteristics of rivers (Rosgen, 1994; 1996; Montgomery & Buffington, 1997; Brierley & Fryirs, 2000; Heritage *et al.*, 2001; Whittington *et al.*, 2001). They are used to assess river condition (Fryirs & Brierley, 2000), manage rivers and environmental flows (Calvert *et al.*, 2001; Outhet *et al.*, 2001; Thoms & Sheldon, 2002), report on rivers (Whittington *et al.*, 2001), identify targets for river restoration and rehabilitation (Rosgen, 1994) and do ecological inventory (Savery *et al.*, 2001).

River Styles is a generic non-prescriptive approach for evaluating the geomorphic character of rivers (Brierley & Fryirs, 2002), applied State-wide in rivers of New South Wales (Outhet *et al.*, 2001) and catchments in Tasmania, Queensland and South Australia (Brierley & Fryirs, 2002). River Styles are relatively homogenous reaches, identified by river planform, geomorphic unit assemblages and bed material texture—the differentiating criteria depend on the valley setting (Brierley & Fryirs, 2000). Although River Styles recognises a hierarchy of nested spatial scales (catchment, landscape unit, reach, geomorphic unit and hydraulic (habitat) unit), the classification is not a nested hierarchy- a River Style might occur in more than one landscape unit (Thomson *et al.,* 2001; Jerie *et al.*, 2003). Inconsistent interpretation and labelling among catchments occurs with applications of River Styles (Jerie *et al.*, 2003). Accredited training programs, trademarking (Brierley & Fryirs, 2002) and standard rules for categorising reaches and labelling basic styles (Outhet *et al.*, 2001) aim for consistency. With limited time or inexperienced application, River Styles becomes mechanical, predominantly using visual assessment of the river planform and valley confinement with little consideration of the influence of the wider landscape and geomorphic history (Jerie *et al.*, 2003).

The proposed National River Classification System for Australian rivers, designed for environmental flow management, was based on the geomorphology of river reach types (Calvert *et al.*, 2001). The top down hierarchical scheme places channel reaches into 50 *a priori* types, nested within higher levels defined successively by climatic, geomorphic region, flow regulation and valley setting. It covers the full length of rivers from source to the ocean and recognises estuarine and marine reaches. Differentiating criteria are not specified although a list of geomorphic attributes that may form these criteria are given. Establishing uniformly interpreted criteria remains problematic. For example bedrock and alluvial reach types are presented as uniquely nested within associated bedrock and alluvial valley segments (Figure 4, p. 20, Calvert *et al.*, 2001). But, then some of the classified reaches on the Snowy River below Jindabyne Dam, have mixed labelling (e.g. Bedrock Confined Channel within a Bedrock/ Alluvial valley).

In the United States, the Rosgen stream classification system (Rosgen, 1994; 1996) is used for inventories and assessment of streams (Jensen *et al.*, 2001b), particularly by the USDA Forest Service (Savery *et al.*, 2001; USDA Forest Service Stream Systems Technology Center, 2001). It specifies quantitative delineative criteria for measured attributes of channel form (entrenchment, channel planform, width:depth ratio, sinuosity, slope and dominant substrate) to classify reaches. Although quantitative, criteria may not be consistently applied because methods to measure attributes (e.g. bankfull width) vary (Savery *et al.*, 2001) and bias due to unrepresentative field measurements (Myers & Swanson, 1997). The prescriptive classes may be region specific and will not be applicable to unique river forms in Australia (Brierley & Fryirs, 2002; Calvert *et al.*, 2001). Rivers that do not conform to criteria could be assigned a predefined type, with potentially serious consequences for management (G. Brierley, pers. comm. Nov. 2002) or classes must be added or modified (e.g. Savery *et al.*, 2001). The geomorphic significance of the delineative criteria are also questionable (Miller & Ritter, 1996). Channel forms are the end products of a complex dynamic system and may not uniquely reflect controlling factors and processes and so use of fluvial processes or controlling factors for classification may be more productive (Goodwin

1999).

Process based frameworks related to sediment transport on hillslopes and in rivers are reasonably commonly used to classify channel morphology (Nanson & Croke, 1992; Whiting & Bradley, 1993; Nanson & Knighton, 1996; Alabyan & Chalov, 1998; Montgomery & Buffington, 1997). Such classifications may effectively be used to assess channel condition, management response and relationships with ecological processes (Montgomery & Buffington, 1997) but threshold values for geomorphological processes may not be uniform across large areas (Jerie et al., 2003). Functional Process Zones (FPZ) were mapped for the major rivers of the Murray–Darling Basin, as lengths of river with similar discharge and sediment regimes defined by gradient, stream power, valley dimensions and boundary material (Whittington *et al.*, 2001). They are nested within three valley process zones, broadly identified by their sediment transport characteristics (source, transport and deposition). The classification stratifies river valleys for reporting of the Murray–Darling Basin Sustainable Rivers Audit (Whittington et al., 2001) and provides an ecosystem approach for environmental water allocations (Thoms & Sheldon, 2002). Its value is enhanced by accompanying conceptual models of river function, that relate physical factors within each FPZ to ecosystem structures and processes (Thoms et al., 2001).

The mapping of geomorphologic classifications and FPZs, depends on expert interpretation of field data, complemented by remotely sensed imagery, aerial photographs and historical data. Field observations must be sufficiently representative of a reach to ensure unbiased type assignments (Brierley & Fryirs, 2002). For example, a full River Styles assessment may take up to a day per reach (Brierley & Fryirs, 2002). Such requirements restrict the number of streams that are classified. The probability of occurrence of geomorphic types at reach (Young *et al.*, 2001) and geomorphic unit (habitat) scales (Davies *et al.*, 2000; Jeffers, 1998) may be modelled using larger scale landscape variables. Also new techniques for terrain analysis (Wilson & Gallant, 2000; Dowling *et al.*, 2003; Gallant & Dowling, 2004) and sediment modelling (Prosser *et al.*, 2001) offer opportunities for improved representation of critical variables. Modelling geomorphic process types using temporally stable landscape attributes may overcome another difficulty of classifications based on channel form—the low temporal stability of classified forms (< 10 years) (Naiman *et al.*, 1992). Modelling could indicate the types expected and provide a basis for assessing current condition (Davies *et al.*, 2000). Such model development depends on the availability of suitably representative site data, largely unaffected by human activities accompanied by high resolution terrain and substrate spatial data.

The physical features that are the basis of geomorphological classifications also form the habitat of biota and so may be important determinants of biological variation (Maddock, 1999; Newson & Newson, 2000). Geomorphological diversity contributes to the complexity of riverine habitats (Thoms & Sheldon, 2002). However, the geomorphologists' view of river channel types may not equate with those that biota respond to (Karr & Chu, 1999). For example, River Styles did not well represent macro-invertebrate distribution, even within a single bioregion (Thomson *et al.,* 2004). Geomorphic elements are only one of the physico- chemical factors that determine ecological habitat (Thomson *et al.*, 2004). The interaction between geomorphology and hydrology produce a mosaic of hydraulic features (depths, velocities, shear stresses) (Maddock, 1999). Semeniuk and Semeniuk (1995) recognise a high-level interaction between geomorphology and hydrology in the primary delineative criteria they adopt for generic wetland classification (Semeniuk & Semeniuk, 1997). The classification defines 13 primary classes from the combination of five broad landform types (basin, channel, flat, slope, highland) and four classes of water permanence. Vegetation cover (spatial arrangement and internal organisation of vegetation assemblages), salinity and morphology (planform and shape) are secondary classification descriptors for differentiating riverine types. The classification ignores the functional linkages between the river and its floodplain by separating floodplain and channel types at the highest level. Although this separation may be justified for some wetlands on old floodplains controlled by groundwater rather than fluvial processes (Cowardin *et al.*, 1979) this is certainly not the case for most wetlands in Australia (Kingsford *et al.*, 2004a). Semeniuk's (1988) regional classification of wetlands into suites of similar or related types ('consanguineous suites') is more useful for conservation because they probably represent functional ecological units. The classification has been used in regional studies in Western Australia (Nevill & Phillips, 2004) and the Northern Territory (Begg *et al.*, 2001) but it does not provide a workable basis for a national classification of Australian river systems. It is seldom feasible to collect the data for the secondary descriptors over large areas (Kingsford *et al.*, 2004a) and, despite its intended global applicability (Semeniuk &

Semeniuk, 1997), additional types and terminology was required for classification of wetlands in the Daly River Basin (Begg *et al.,* 2001).

Similar criticisms apply to the wetland classification of Blackman *et al.* (1992). Like many wetland classifications, they adopt the broad RAMSAR definition of wetlands (Ramsar Convention Secretariat, 2003), recognising riverine and estuarine as one of five major wetland systems with lacustrine, palustrine, and marine. Riverine systems include only wetlands flowing within an open channel. Secondary criteria of hydroperiod, substrate and dominance (flora or fauna) type subdivide these major systems, with modifiers describing the water regime, soil, water chemistry and anthropogenic influence. The modifying criteria refer to average conditions of dynamic wetland properties and require extended time series of observations. The system uses field description of representative sites from assemblages of wetlands delineated on remotely sensed images. A biogeographic regionalisation and geomorphic land types stratify selection of survey sites. While not providing an exhaustive inventory of all wetlands, the classification produces a framework for systematic regional scale assessment of wetlands (Blackman *et al.*, 1995).

The classification was applied to regions in Queensland (Nevill & Phillips, 2004) and uses a hierarchical wetland classification from the United States (Cowardin *et al.*, 1979). Associations of wetland types and geomorphic land types within wetland aggregations form 'regional wetland habitats' that could be useful for protection of wetlands (Blackman *et al.*, 2002). The sensitivity of the classification to the order in which the differentiating criteria are applied may be a problem (Phillips *et al.*, 2002). As with many classifications using prescriptive, *a priori* categories, the system is open-ended and incomplete at lower levels (Blackman *et al.*, 1992). We also have reservations about the ecological significance of the class divisions. For example, the class 'unconsolidated bottom' includes all wetlands with at least 25% cover of particles smaller than stones, and a vegetative cover less than 30% (Blackman *et al.*, 1992). These values, derived from the United States system (Cowardin *et al.*, 1979), are unlikely to be universally appropriate. Still, field survey data maintained in a spatially referenced database (Wetland Information System, Blackman *et al.*, 1995) allows flexible access and analysis for alternative classification. The database is also linked to remote sensing and other natural resource, cadastral and cultural information providing a powerful tool to support conservation. The classification is not applicable nationally but the system may be a model for wetland inventory and development of a national wetland information system for *a posteriori* classification, although a primary objective may be first to identify the extent and distribution of wetlands (Kingsford *et al.*, 2004a). Also, like many generic wetland classifications, the classification uses simple, broad categories of hydroperiod to characterise flow. But hydroperiod is just one of the ecologically important components of flow (Hart & Finelli, 1999; Poff *et al.*, 1997) operating over multiple temporal scales (Puckridge *et al.*, 1998; Thoms & Parsons, 2003) used to classify rivers. For example, Puckridge et al (1998) used a set of hydrological measures to describe facets of flow variability that clustered global rivers. A hydrological classification of Victorian river gauges used flow statistics for annual, monthly and low flows and peak (daily) discharges to derive five hydrologically distinct regions (Hughes & James, 1989). Such classifications can only be produced for a small sub- set of gauged streams although methods to extend flow parameters to ungauged streams are developing (see review in Croke & Jakeman, 2001). Also, alteration of flows and catchment disturbance confound detection of natural spatial variation. There is increasing understanding of which hydrological indices may characterise flow (Puckridge *et al.*, 1998; Growns & Marsh, 2000; Pegg and Pierce, 2002) and represent ecologically meaningful variation (Olden & Poff, 2003).

Landscape classifications

Landscape or environment classifications primarily use meso-scale attributes of the physical environment, including geology, climate, topography and vegetation types. Ecoregions are landscape regionalisations, within which the mosaic of ecosystem components (biotic and abiotic, terrestrial and aquatic) are relatively homogeneous and different from adjacent regions (Omernik & Bailey, 1997). Many countries use such classifications to support an ecosystem based approach to natural resource planning and management (Clarke *et al.*, 1991; Warry and Hanau, 1993; Omernik, 1995; Bailey, 1996; Bryce & Clarke, 1996; Uhlig, 1996; Harding & Winterbourn, 1997; Wells & Newall, 1997; Sandin & Johnson, 2000).

The Interim Biogeographical Classification of Australia (IBRA) is a continent-wide regionalisation of landscape patterns, inferred from regional and continental scale data on climate, geomorphology, landform, lithology and expert knowledge of characteristic flora and fauna

(Thackway & Cresswell, 1995). It supports the national reserves system program (Pigram & Sundell, 1997) but it poorly represents biotic patterns of rivers (Marchant *et al.*, 1999; Turak *et al.*, 1999; Wells & Newall, 1997). Similarly, a review of international aquatic studies found that broad landscape regionalisations did not effectively partition biotic composition (algal, invertebrate and fish) among sites (Hawkins *et al.,* 2000). Ecoregions do not seem to adequately represent longitudinal gradients (Snelder & Biggs, 2002) or dispersal barriers between rivers (Tait *et al.*, 2003) or within region variation in local habitats (Hawkins *et al.*, 2000). This may not be universal as benthic invertebrate assemblages showed "remarkably good concordance" with terrestrial ecoregions in Missouri that followed major catchment boundaries and where there was low within-region altitudinal variation (Rabeni and Doisy 2000). So sub-regions of IBRA (Morgan, 2001) that divide major geomorphic units may perform better, particularly if entirely aquatic organisms are separated from those with terrestrial life stages or distributional abilities (Tait *et al.*, 2003). As a national classification, IBRA is inconsistently applied and does not communicate decisions rules for boundary placement well. So there are methodological variations, most marked in the IBRA sub-regions along some state borders (Environment Australia, 2000). For example, Victoria uses detailed vegetation mapping to define particular regions, whereas New South Wales and South Australia use coarser land system mapping and geological or geomorphological mapping to define boundaries. Some IBRA regions also cross several different climatic regions (Hutchinson, M. F., McIntyre, S., Hobbs, R. J., Stein, J. L., Garnett, S. and Kinloch, J., unpubl. data; Landsberg & Kesteven, 2002).

IBRA and the Interim Marine and Coastal Regionalisation of Australia (IMCRA) use several variably applied factors to define individual ecoregions. Like IBRA, IMCRA integrates state and territory regionalisations, adjusting the boundaries as necessary on the basis of commonalities in region descriptions (Interim Marine and Coastal Regionalisation for Australia Technical Group, 1998). As with IBRA, there was no consistent national approach adopted. The individual regionalisations that form IMCRA cover a range of spatial scales, using different combinations of biological and/or physical environmental data and approaches. Some were qualitative expert-driven, others quantitative and analytical. IMCRA provides a broad bioregional context for estuaries but the extent to which these regions reflect intrinsic patterns of estuarine biota remains to be tested.

The River Environment Classification (REC) (Snelder & Biggs, 2002) employs the 'top down' hierarchical controlling factor method of ecoregion definition (Bailey, 1996), recognising particular environmental factors as controlling ecological variation at characteristic scales. REC classifies river segments using six broad classes that characterise the dominant climate of the upstream catchment. These climate classes are successively sub-divided using prescriptive categories of source of flow, geology, land cover, network position and valley landform. The classification differs from other regionalisations because it assigns individual river segments to a class independently using specified criteria, producing classes that may show wide geographic dispersion. It also recognises the river as a network of linked river segments, better representing the longitudinal gradients in aquatic ecosystems. The approach classified all the rivers of New Zealand at a mapping scale of 1:50,000 (Snelder & Biggs, 2002), providing a useful management framework for water allocation (Snelder *et al.*, 2001) and identifying reference and impaired reaches for stream eutrophication (Biggs *et al.*, 2002). There are some concerns about its application to Australian rivers. It uses catchment averages for grouping in the first four system levels which may be meaningless, particularly in large catchments and not representative of the integrated effect of controlling factors. For example, the 'dry' climate class encompasses all rivers with a value of 500 mm or less mean annual effective precipitation, effectively 70% of Australia. The developers acknowledge that different criteria need to be developed for applications outside New Zealand (Snelder and Biggs 2002), but few data are available to set ecologically relevant class boundaries. Furthermore, thresholds in stream ecosystem characteristics will vary because of the complex interaction of environmental variables (Jerie *et al.*, 2003; Omernik, 1995).

Numerical procedures (e.g. clustering) provide an alternative approach to landscape classification. Waterways can be grouped using similarities across a range of attributes. The number of groups may be chosen to suit specific objectives and the relationship between them quantified. Numerical agglomerative classification procedures were preferred over *a priori* intuitive classification to delineate river types ("bioregional aquatic systems") in a trial in the Burnett River catchment (Phillips *et al.*, 2002). Also, field measures of channel form and dominant substrate with derived landscape attributes (mean annual rainfall, slope, catchment area upstream, distance to sea) were required to delineate ecologically meaningful types but, field measures were available for less than one quarter of the sub- catchment units. This may not be a problem for landscape classifications where attributes represent the range of controlling factors that drive stream ecosystem processes (e.g. Jerie *et al.*, 2003) (see below).

The definition of classes numerically, as an emergent property of the primary data, is a feature distinguishing environmental domain analysis from other ecoregion approaches. Environmental domains are spatial units, for which attributes of meso-scale climate, substrate (regolith and soils) and topography are relatively homogenous at a prescribed level of dissimilarity. These attributes integrate effects of primary environmental attributes (e.g. light, mineral nutrients, moisture, temperature) that drive landscape physical and biological processes, defining ecosystem patterns (Mackey *et al.*, 1988, 1989;\, 2001; Nix, 1992, 1997). Environmental domain analysis also differs from ecoregion approaches in two other important respects. Firstly, classes are delineated in environmental rather than geographic space and secondly, hierarchical levels are defined using an agglomerative 'bottom up' approach. Environmental domains can represent patterns of biodiversity (Mackey *et al.*, 1989; Lewis *et al.*, 1991; Belbin, 1993; Kirkpatrick & Brown, 1994; Mackey *et al.*, 2000; Nix *et al.*, 2000; Mackey *et al.*, 2001; Leathwick *et al.*, 2003) and assess representativeness of biological survey data (Richards *et al.*, 1990; Mackey *et al.*, 2001). The classification focuses on collating primary attribute data at highest possible spatial resolutions, rather than producing a single generic classification. By varying the numbers of groups, weightings, or choice of clustering strategy a classification can be produced for different objectives.

Two recent studies adapted the environmental domain approach to address variation in rivers in Tasmania (Jerie *et al.*, 2001; 2003) and across Australia (J.L. Stein, unpubl. data). Variables, numerical procedures and spatial units (grid cells versus river segments and catchments) varied but both studies chose variables that controlled river characteristics and recognised the influence of the broader catchment. The two studies could be usefully compared in the future. Early results from Tasmania suggest environmental domains can describe regional variation in river character and behaviour (Jerie *et al.*, 2003). Continent-wide application is currently limited by the coarse resolution or absence of national coverage for some key data layers, notably geology, soils and landscape history. Other supporting areas for investment include the representation and mapping of the environmental variables that control rivers, identification of regionally appropriate combinations and relative weightings of these variables and the effect of the mapping scales used.

Regardless of approaches, we need to validate the utility and accuracy of all classifications, their usefulness as functions of the variables chosen, the strength of the assumed relationship between variables and ecosystem characteristics, the estimation procedures and spatial data resolution used (Bourgeron *et al.*, 2001b). An iterative process that generates hypotheses, includes exploratory data analysis, and evaluates and modifies hypotheses will probably produce the most robust classifications (Gerritsen *et al.,* 2000).

Conclusions

We reviewed different approaches to river classification for conservation use. There is no universal system for classifying streams, stream habitats or their biotic communities (Jensen *et al.,* 2001b) and none provide a sufficient basis for all of the conservation tasks for which a classification is needed.

Landscape classifications, environmental domains or the River Environment Classification, utilise existing, geographically referenced sources of data and an automated spatial analysis framework making it feasible to classify all rivers. They address the spatial distribution of relatively stable associations of environmental factors that drive the pattern of flow, channel morphology, substratum, temperature and mineral nutrients that collectively define the physical habitat template of rivers. As a result, they produce temporally stable groupings with similar response potential (i.e. range of possible states), regardless of current natural or anthropogenic disturbances (Bailey, 1996). Biogeographic classifications reflect historical effects of processes that limit the pool of species within a river. Together, landscape and biogeographic classifications represent the range of ultimate controls on aquatic ecosystem patterns and processes. They could support conservation applications at regional to national scales, including assessment of ecological value, design of comprehensive surveys, reporting progress towards conservation targets and helping co-operation and co-ordination among jurisdictions. They also provide the landscape scale context for the finer scale classifications, based on direct measures of ecological and geomorphological characteristics of rivers for catchment specific planning and management, assessment of condition and design of appropriate targets for restoration or rehabilitation. These direct measures integrate the proximate factors that control aquatic ecosystems.

The full range of ultimate and proximate controls are necessary for effective river classification

(Naiman *et al.,* 1992). If only limited controls are used to define a stream type, the management tools or prescriptions may be too broad or too specific to be effective. A single integrated classification could be developed, by overlaying individual classifications (landscape, biogeographic, habitat/ species assemblages). It may help with communication and adoption but still need arbitrary decisions on boundaries (e.g. Doeg, 2001) and it will confound a range of spatial and temporal scales. We prefer independent classifications linked via a multi-scaled hierarchical framework. This is exemplified by use of independent classifications (ecoregion, flow and geomorphic units) to identify representative rivers in the Greater Addo Elephant National Park in South Africa (Roux *et al.*, 2002).

This paper recommends the methods and data currently available are used to develop a national landscape classification for Australian rivers. Biogeographic classifications, preferably for functional groupings of aquatic and semi-aquatic taxa, should be developed using existing data and expert knowledge, to complement the existing fish biogeographic provinces (see Unmack 2001). Together, these classifications will support a preliminary national assessment of conservation value. In the long term, we recommend major investment in systematic and comprehensive inventory of rivers and associated ecosystems, using nationally agreed survey protocols, for river classification based on species assemblages and habitats. This depends on the collection and storage of primary attribute data rather than assigning *a priori* categories. Classification must be an emergent property of the data for a range of objectives and should be iterative with updated data and knowledge.

Appendix C. Protection tools for Australia's high conservation value rivers

Each of Australia's States and Territories have complex statutory and administrative mechanisms aimed in part at providing 'general' and 'site-specific' protection to natural assets such as soil, water and biodiversity, partly protecting our rivers (Table C1). Jurisdictions can also protect special places. Through these protective processes, it is possible to encourage sustainable activities using incentives, such as funding or tax concessions, or controls on deleterious activities, usually through legislation (Table C1). Different institutional arrangements involving the Australian Government; State and Territory Governments; Local Government or Regional bodies deliver these incentives (Table C1).

Bilateral agreements exist between the Australian Government and the States and Territories providing the heads of authority under which Australian Government funds are allocated. Also, the Australian Government accredits regional natural resource management plans developed by regional bodies established under State legislation. The regional plans are aimed at delivering State and Australian Government natural resource management objectives and are the basis for regional investment by Australian Government, States and Territories or private capital. State agencies, Local Government or the community (e.g. farmers, non-government organisations, contractors or corporations) carry out the activities. Regional bodies can spend and sometimes raise public money but they also have to be accountable and report appropriately.

Table C1. General (G) and site-specific (S) protective mechanisms for rivers that may be applied at national, State, Local Government or regional jurisdictional scales.

Scale	Type	Incentives	Controls
Australian Government	G	Funding programs (e.g. National Action Plan, Natural Heritage Trust) and bilateral agreements for good natural resource management.	*Environment Protection and Biodiversity Conservation Act 1999*. May be used to assess development proposals that affect sustainability of world heritage areas, Ramsar, threatened species and communities and Heritage sites.
	S	Funds may be directed to purchase of protected areas, plans or works. Funding may also be provided to reduce allocation of water (e.g. Living Murray)	For land where the Australian Government has jurisdiction, specific statutory prohibitions may be applied.
States and Territories	G	Jurisdictions have regional Natural Resource Management frameworks for sustainable environmental management. Some are established through policy (e.g. Western Australia) while others have legislation (e.g. South Australia and Tasmania).	A complex array of jurisdictional statutes can be used to control or stop activities. They include: fisheries controls; environmental assessment of major projects; land use planning; pollution control; control of invasive species; native vegetation management; protection of threatened species and communities and water resource management. Controls may include the setting of diversions limits on rivers (e.g. Murray–Darling Basin Cap)
	S	Some States (e.g. Victoria and NSW) have joint management areas, Ramsar sites and voluntary conservation agreements that encourage sustainable activities on privately-owned land. Potential Sustainability Trusts for accessing water for the environment may become established.	All States have statutes enabling the declaration of protected areas (or reserves). Many of these protect rivers and their dependent ecosystems. Some States can designate aquatic protected areas (see Table C2). There are potential applications of environmental flows to particular sites of importance (e.g. Macquarie Marshes, Living Murray, Narran Lakes).
Local Government	G	They can raise money through rates and sometimes environmental levies and offer rates concessions. They can also manage targeted funds from Australian Government and States.	They are often determining authorities on land use planning and developments, influencing threats to rivers and dependent ecosystems. Local government may have delegated responsibilities for pollution control, providing opportunities to influence water quality.
	S	They may provide rate relief in exchange for conservation work or environmental programs on private land.	Local governments can create and manage conservation reserves on municipal land.
Regional bodies	G	They can sponsor or partner programs (e.g. Landcare and Waterwatch) and projects.	In some jurisdictions, regional bodies will take an active role in assessment of vegetation clearing and river management (e.g. NSW).
	S	This is the main mechanisms for delivery of investment programs to individual areas for conservation (e.g. National Action Plan for Salinity and Water Management, Natural Heritage Trust 2).	

Table C2. Legislative and some policy tools for protection of high conservation value rivers and dependent ecosystems, that apply to sites, catchments and water supply (continued next page).

Location	Legislation	Protection of values							Application
		Biodiversity	Geodiversity	Recreation	Cultural	Site specific	Catchment[a]	Water supply[b]	
All States and Territories	Protected Area legislation[c]	✓	✓	✓	✓	✓	✗	✗	Public
Western Australian reserves	Land Administration Act 1997	✓	Unclear	✓	✓	✓	✗	✗	Public
Queensland fish habitat areas	Fisheries Act 1994	Fish only	✗	✗	✗	✓	✗	✗	Public and private
Tasmanian Fauna Reserve	Inland Fisheries Act 1995	✓	✗	✗	✗	✓	✓	✓	Public and private
Victorian Fisheries Reserves	Fisheries Act 1995	✓	✗	✓	✗	✓	✗	✗	Public and private
NSW Aquatic Reserves	Fisheries Management Act 1994	✓	✗	✓	✗	✓	✓	✗	Public and private
Most States and Territories	Threatened Species	✓	✗	✗	✗	✓	✗	✗	Public and private
Australian Government, States and Territories	Directory of important wetlands in Australia[d]	✗	✗	✗	✗	✓	✗	✗	Public and private
Australian Government, States and Territories	Convention on Wetlands of International Importance[e]	✓	✗	✗	✓	✓	✗	✗	Public and private
All States and Territories	Environmental Assessment	✓	✓	✓	✓	✓	✓	✓	Public and private

a Controls relate to specified activities to protect designated site values

b Also includes identification and provision of environmental flows

c Includes designation of national parks and reserves

d Identifies key wetlands in each jurisdiction but generally does not afford any protection value

e Effected through the *Environment Protection and Biodiversity Conservation Act 1999* but limitations exist on applicability

Location	Legislation	Protection of values							Application
		Biodiversity	Geodiversity	Recreation	Cultural	Site specific	Catchment[a]	Water supply[b]	
All States and Territories	Water management[f]	✓	✗	✓	✓	✓	✓	✓	Public and private
All States and Territories	Pollution control	✓	✗	✓	✓	✓	✓	✓	Public and private
Commonwealth	Environment Protection and Biodiversity Conservation Act 1999[g]	✓	✓	✗	✓	✓	✓	✓	Public and private
NSW Wild Rivers	National Parks and Wildlife Act 1974	Application of this section is under review							Public
Queensland Wild Rivers	Legislation developing	✓	✓	?	✓	✓	?	?	Public and private
Victorian Heritage Rivers	Heritage Rivers Act 1992[h]	✓	✓	✓	✗	✓	✓	✓	Public
Canadian Heritage Rivers	No specific enabling legislation[i]	✓	✓	✓	✓	✓	✓	✓	Public and private
USA Wild and Scenic Rivers	Wild and Scenic Rivers Act 1968[h]	✓	✓	✓	✓	✓	✓	✓	Public and private

f Recreational and cultural values have variable coverage in different jurisdictions

g *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)

h Sites and catchments are only partially protected

i Through a management plan

Appendix D. International systems for the protection of heritage or wild rivers

Most countries have similar mechanisms to Australia for the protection of river systems. Some countries have also embarked on national assessments of aquatic ecosystems. For example, New Zealand has initiated a *Waters of National Importance Project* (New Zealand Ministry for Environment 2003) assessing water bodies of national importance against a series of values: tourism; irrigation; energy generation; industrial uses; recreation; natural heritage, and cultural heritage. High conservation value waterways may be protected by the Minister for the Environment under the *Resource Management Act 1991*. In Europe, there was commitment to conservation of the last wild rivers at the IUCN World Congress 2000 in Amman, Jordan. Specific implementation measures are not obviously in place.

We are aware of only two existing systems, the Canadian Heritage Rivers System and United States Wild and Scenic Rivers legislation, that focus on entire river systems. We review main elements of these and their applicability to a national Australian framework.

D1. The Canadian Heritage Rivers System

Overview

We focus on this system because Canada, like Australia, is a Federal jurisdiction (10 Provincial and 3 Territory jurisdictions, and local and city governments) and has broadly similar government structures and responsibilities. The Canadian Heritage Rivers System (CHRS) was created by an agreement between the Federal and Provincial and Territory governments in 1984 and is a good example of a non-statutory model for river conservation. It came into effect with the signing of *Canadian Heritage Rivers System Objectives, Principles and Procedures* by chief ministers from the participating jurisdictions. There is more detail in Nevill and Phillips (2004), and at <www.chrs.ca> (accessed 18/8/2004).

The term ‘river’ refers to either the entire length or a segment of a river and its immediate environment and includes the lakes, ponds, estuaries, canals or other bodies of water through which it flows. French River in Ontario was the first heritage river nominated in 1986. By January 2003, there were 39 designated heritage rivers, with additional nominations pending. Designated rivers include a wide range from Arctic barrens, southern Ontario’s fertile farmlands, Newfoundland’s rocky hills, and the mountains and glaciers of the Yukon.

The CHRS creates an administrative structure, based on jurisdictional cooperation rather than legal or funding arrangements, to protect Canada’s outstanding rivers. It aims to strengthen existing river legislation and management. The Canadian Heritage Rivers Board (two federal and 13 provincial and territorial representatives) administers CHRS with federal and provincial funding focused (apart from Board expenses) on supporting community involvement in the nomination and designation of heritage rivers. Parks Canada (a federal agency) supplies a secretariat and funds the preparation of some consultancy studies. The constitution of the Board is defined by *Policies and guidelines of the Canadian Heritage Rivers System* (revised January 2000) with three main parts: the charter; policies and principles; and operational guidelines. The charter, signed by Ministers of all provincial and territorial governments in 1997, establishes the importance of rivers to the heritage of Canada and the importance of cooperation. It is to be reviewed in 2006. It also includes a vision, purpose and principles.

> *Canada’s outstanding rivers will be nationally recognized and managed through the support and stewardship of local people and provincial, territorial and federal governments to ensure the long-term conservation of the rivers’ natural, cultural and recreational values and integrity. (Vision statement).*

The CHRS aims to sustainably protect and manage Canada’s important rivers, including their natural heritage, human (cultural/historical) heritage and recreational values (purpose). The objectives of the CHRS are to recognise Canada’s outstanding natural and cultural rivers so they may be conserved and interpreted and provide opportunities for recreation and heritage appreciation. Under the principles, the system is voluntary, participants retain jurisdictional powers, and there is respect for original peoples and other stakeholders during the nomination, designation and management of heritage rivers. The CHRS is a cooperative system between Governments and communities. Indigenous communities and other stakeholders must support nominations that are then included on advice of the Canadian Heritage

Rivers Board. Without community support a river cannot be nominated. The CHRS recognises three essential values: natural heritage, cultural heritage and recreation. A river can be included if it satisfies the first two. Consultation between jurisdictions is essential for rivers that cross borders and jurisdictions are responsible for monitoring.

Identification of candidate rivers

Provinces and territories prepare river inventories including information about natural heritage, cultural heritage and recreational river values and condition. Framework documents map the occurrence of the key CHRS values, but these values are not enough to justify listing. A river must also meet integrity criteria. Listed rivers or river reaches must be sufficiently large to encompass surrounding ecosystems and landscapes linked to the river's values, to buffer the river against temporal changes.

Natural values include rivers that

- are outstanding examples demonstrating the major stages and processes in the earth's evolutionary history;
- contain outstanding representations of significant ongoing fluvial, geomorphological and biological processes;
- contain unique, rare or outstanding examples of biotic and abiotic natural phenomena, formations or features; or
- contain habitats of rare or endangered species of plants and animals, including outstanding concentrations.

Cultural values include rivers that

- are of outstanding importance owing to their influence on the historical development of Canada through a major impact upon the region in which they are located or beyond; or
- are strongly associated with persons, events or beliefs of Canadian significance; or
- contain historical or archaeological structures, works or sites which are unique, rare or of great antiquity; or
- contain concentrations of historical or archaeological structures, works or sites which are representative of major themes in Canadian history.

Recreational Values include rivers that have river-related recreational opportunities and related natural values which together providing an outstanding recreational experience.

Rivers may be nominated that have

- recreational opportunities include water-based activities such as canoeing and other forms of boating, swimming and angling, and other activities such as camping, hiking, wildlife viewing, and natural and cultural appreciation which may be part of a river-touring experience;
- Natural values include natural visual aesthetics, and physical assets such as sufficient flow, navigability, rapids, accessibility and suitable shoreline.

To establish river natural integrity, a river must have the following characteristics:

- the nominated area must be of sufficient size and contain all or most of the key interrelated and interdependent elements to demonstrate the key aspects of the natural processes, features, or other phenomena which give the river its outstanding natural value;
- the nominated area must contain those ecosystem components required for the continuity of the species, features or objects to be protected;
- there should be no man-made impoundments within the nominated section;
- all key elements and ecosystem components should be unaffected by impoundments located outside the nominated section;
- natural values for which the river is nominated should not be created by impoundments; and
- natural aesthetic values should not be compromised by human developments.

For cultural integrity values, a river must have the following characteristics:

- the nominated area must be of sufficient size and must contain all or most of the key interrelated and interdependent elements to demonstrate the key aspects of the features, activities or other phenomena which give the river its outstanding cultural value;
- the visual appearance of the nominated section of river should enable an appreciation of at least one of the periods of the river's historical importance;
- the key artefacts and sites comprising the values for which the river is nominated should be unimpaired by impoundments and human land uses; and
- the water quality of the nominated section must not detract from the aesthetic appearance or the cultural experience provided by its cultural values.

For recreational integrity values, a river must

- possess water of a quality suitable for contact recreational activities including those recreational opportunities for which it is nominated;

- have a visual appearance capable of providing river travellers with a continuous natural experience, or a combined natural and cultural experience, without significant interruption by modern human intrusions;
- be capable of supporting increased recreational uses without significant loss of or impact on its natural, cultural or aesthetic values.

Nomination

A heritage river is listed through the two stages of nomination and designation. A river must possess either natural or cultural (or both) values to be nominated. Provincial governments nominated the first heritage rivers but now communities predominantly prepare nominations. A nominated river must be of 'outstanding value' and supported strongly by the community and the provincial government. Even if a river has high natural and cultural values, and can meet integrity criteria, a listing cannot proceed without grass-roots support. This is largely outside government control. If a community group wishes to nominate a river, they check river values and integrity, and compare this to two national framework documents, and the provincial river system plan and the CHRS Board's 10 year strategic plan are examined. For rivers wholly on crown land, the nomination initiative originates and is led by the jurisdiction. A nomination must also be supported by a jurisdiction on the CHRS Board.

A background study must be prepared which comprehensively details the river's natural, cultural, recreational and economic values, its integrity, and suitability as a heritage river. Nomination is granted if the Board considers the river meets the required level of values and integrity criteria, and that plans can be prepared which can effectively protect the river's values and integrity. The Board must be convinced that the nomination is strongly supported by both the jurisdiction and the community.

Designation

The river is not designated until the development and approval of a river management plan by the responsible jurisdiction that protects its nominated values. Provincial and territorial governments may develop these, but now that the CHRS has the maturity of a 20 year history, it is more common that the plans are developed by communities, facilitated by Governments. These plans provide an avenue for both provincial and local governments to provide detailed information to the public and other government agencies and allow for the setting of policies and priorities for heritage rivers. The plan's implementation schedule must demonstrate a commitment by the host government and concerned stakeholders to conserve the river's heritage and recreational values. The approved plan is normally lodged with the Board within 1–3 years after the river's nomination.

Reporting

Provincial governments report on the condition of heritage rivers at one year (short report) and ten year (long report) intervals. Rivers in the System should also have their original nomination values maintained. A river can be de-listed if its nominated values degrade. No special federal funding is provided for the management of heritage rivers.

Benefits

The advantages to the community of heritage river listing are the strengthening of existing river protection frameworks, linked to river tourism and recreation. Limited special federal funding (about 2.75 staff and $Can 160,000 per year) is provided for the management of heritage rivers. Most funding ($Can 80,000) is for joint studies (background and systems studies, nomination documents, management plans and ten year monitoring reports); $Can 25,000 for Board Administration and remaining funding for communications and marketing.

- The system has produced a solid focus on river health and management across Canada, through conferences, awards and music.
- The Canadian Heritage Rivers are a significant catalyst for community action.
- There is a strong sense of identity forged between communities and their rivers.
- Listing of particular rivers has discouraged some inappropriate developments.
- Canadian Heritage Rivers are promoted nationally and internationally as adventure travel destinations. This has had a positive economic spin-off for local communities, particularly in remote areas. A CHRS Economic Impact Study in 1997 concluded that the CHRS contributes $32 million a year to the Canadian economy (D. Gibson, pers comm.).
- There are growing opportunities for stewardship by local communities of parts of rivers.
- There have been considerable successes in rehabilitation efforts, particularly focused on water quality.
- Non-government groups within communities

provide a powerful force in the nomination, designation and ongoing management of rivers.

- The system is effective in uniting different tiers of Government and the community towards common objectives.
- The community is still strongly driving further nominations, after 20 years of the system.

Potential disadvantages

- There is no clear framework on which to judge relative importance of different rivers that may be designated as Canadian Heritage Rivers.
- Some rivers are highly modified with river regulatory structure and poor water quality, as they may meet criteria for cultural importance of natural importance. For example the constructed Rideau Waterway is listed because of its cultural importance. This could redirect scarce funding away from higher conservation value rivers. However, listing of some of these rivers (e.g. The Grand River) has successfully resulted in considerable restoration of water quality.
- Parts of rivers can be designated although this is generally discouraged.
- Monitoring and assessment are generally patchily implemented because of difficulties in obtaining resources and identifying key indicators for measurement.
- Some rivers have not progressed towards designation because community support is lacking.

Summary

According to Don Gibson (National Manager CHRS Program 2003):

> *The Canadian Heritage Rivers Scheme is a model of increased intergovernmental cooperation in conservation. Intergovernmental charters among all jurisdictions are a rare achievement in Canada, especially in heritage conservation, and this charter was a major step forward. The program fosters close cooperation and consensus building between federal and provincial governments which, like Australia, are sometimes conflicting jurisdictions.*
>
> *One of the greatest strengths of the system is the community support it receives from local citizens who want to be proactive in protecting and promoting the heritage values of their community rivers. Significant and diverse support for the System has come from every level of government; national and grassroots non-governmental organisations; Aboriginal organisations, rural and urban communities, and industry including tourism, agriculture, forestry and local businesses.*
>
> *The Canadian Heritage Rivers Scheme is a tool of community revitalisation and increased quality of life for residents. It is a designation which communities can use to market their river as tourism destinations. Communities such as St. Stephen, New Brunswick and Cambridge, Ontario have used the designation as an important component of their long-term economic development strategies. Economic impact studies on the CHRS have been very positive and demonstrate that the program is an excellent investment for governments.*

Potential application to Australia

A system modelled on the Canadian Heritage River System could be implemented within Australia. Australia is a federal system, similar to that found in Canada. Implementation in Australia should address some of the potential disadvantages of the Canadian Heritage Rivers System (see above) while utilising its successful processes. As with the Canadian Heritage Rivers System, it may be important to begin with nominations by jurisdictions and the Commonwealth to develop impetus for the new program.

D2. National Wild and Scenic Rivers System (United States)

Overview

This legislation was enacted in 1968 and is the main law for river conservation in the United States, primarily to balance existing policies for building dams on rivers for water supply, power, and other benefits with new directions protecting free-flowing rivers and other outstanding rivers values. Such rivers and their immediate environments possess remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values. Once designated, these rivers are to be preserved in their free-flowing condition. Eight rivers were designated initially but there are now more than 150 rivers listed, including more than 17,000 km of river. Designation may not include an entire river but it often includes tributary streams.

Designation explicitly prohibits the federal government from licensing or permitting hydroelectric dams or major diversions on these rivers. Similarly, federal agencies cannot assist in any water resource projects on these rivers. Public lands within an average stream corridor of 0.4 km (0.25 miles) are also managed to protect outstanding scenic, recreational, historical/ cultural, fish, wildlife, ecological, geological and hydrological values. There are no mandatory prohibitions on private land or state water resource projects. More detailed information is available (<www.nps.gov/rivers/ information.html>, accessed 18/8/2004).

Designation

There are two mechanisms for designating rivers. Federal Congress designates rivers through legislation or it can direct federal agencies to study the values of rivers and recommend appropriateness of designation. The legislation requires all federal agencies to identify, study and recommend potential Wild and Scenic Rivers in all land, water and resource planning programs. State-designated rivers can be added to the national list, through a request of the state's Governor and approval by the Interior Secretary. For this to occur, a river must meet the same eligibility criteria as Congressionally designated rivers. Small dams, diversion works and other minor structures in existence do not automatically stop proposed designation of a river.

Classification

Three classifications are used for rivers and parts of rivers: wild, scenic and recreational, although all rivers under this classification are usually referred to, as wild and scenic rivers (IWSRCC 1998).

- *Wild river areas* are free of impoundments and generally inaccessible by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of 'primitive America'.
- *Scenic river areas* are free of impoundments and generally inaccessible by trail, with watersheds or shorelines still largely primitive and shorelines largely undeveloped, but accessible in places by roads.
- *Recreational river areas* are readily accessible by road or railroad, with some development along their shorelines, and may have undergone some impoundment or diversion in the past.

Management

Every designated river in the national system has a federal management agency responsible for its protection, unless it was a state-designated river originally. The federal manager cooperates with state agencies and private landholders. There are boundaries established for each designated river but these include no more than about 0.65 ha per river kilometre (IWSRCC 1998). Logging, road building, new mining claims, development of campgrounds and motorised access are usually prohibited from sections of rivers classified as wild. As long as a wild river's free-flowing condition and outstanding values are not affected, grazing, mining of existing claims, hunting and other non-motorised recreation are permitted on public lands. Motorised trails may or may not be allowed in scenic sections, while most other activities are allowed as long as they protect the visual quality, free flowing conditions and outstanding values. All activities usually allowed on public lands can occur on recreational sections of rivers, provided they do not affect the free-flowing condition or outstanding values of the river.

Private land is not affected by designation, as the legislation does not provide for federal jurisdiction of private land use or zoning. Complementary land use and planning are encouraged but are not mandatory. .A state's authority to regulate water rights is unaffected by designation, although reserves of water in designated rivers may need to be managed to give effect to the purposes of the legislation.

Potential application to Australia

The legislation is a 'top-down' approach to river conservation, driven primarily by Federal Congress. It does not require cooperation from the states. Management of designated rivers is also a federal responsibility. The designation tends to emphasise recreational and aesthetic criteria over cultural and natural values. The legal framework is primarily regulatory and may be analogous to National Heritage listing under the EPBC legislation in Australia.

We believe this is an inappropriate model for an Australian national framework because it has minimal involvement of river communities and so ownership of the process can be foregone.

Appendix E. Wild and Heritage Rivers legislation in Australia

Two states have focussed conservation on whole river basins. Victoria was the first state to enact legislation on heritage rivers. Queensland is currently drafting legislation for wild rivers. New South Wales has a provision within the *National Parks and Wildlife Service Act 1974* for the declaration of wild rivers within National Parks. In New South Wales, water sources may also be classified for their conservation value under the *Water Management Act 2000* where their values may be at risk. Western Australia has identified 26 wild rivers, mostly in remote areas, that have not been affected by significant river regulation. The Western Australian government has a commitment to develop a wild rivers strategy. Many rivers or parts of rivers in Tasmania are either within reserves or part of the Regional Forest Agreement. We have reviewed what is accessible for each of these instruments and its applicability for implementation at a national scale.

E1. Victorian Heritage Rivers

Overview

Victoria passed its *Heritage Rivers Act* in 1992, resulting in the declaration of 18 Heritage Rivers, after extensive public investigation by the Land Conservation Council (LCC). This independent State agency appointed above functional agencies had a specific mandate to recommend 'best use' of Victoria's natural resources. Rivers designated under the Act complement rivers and wetlands protected through other reservation and land-use planning mechanisms, within the framework of the Victorian government's wider system of terrestrial reserves, and its biodiversity and wetlands strategies. The purpose of the Act is to protect parts of rivers and river catchment areas in Victoria with significant nature conservation, recreation, scenic or cultural heritage attributes.

The Victorian *Heritage Rivers Act* attempts to maintain the high natural values of the designated rivers and catchments by (a) requiring management compatible with protection of their values, and (b) prohibiting or controlling threats. No other Australian jurisdiction has been successful in developing similar legislation.

The *Heritage Rivers Act* was underpinned by the *Heritage Rivers Program* which aimed to protect the values of the State's rivers and wetlands, a commitment of the 1987 State Conservation Strategy *Protecting the Environment*. The Strategy foreshadowed the referral of two freshwater issues to the Land Conservation Council: (a) rivers, and (b) wetlands. The first investigation of rivers started in 1988 and finished in 1991. The second investigation of wetlands never started, due to the replacement of the LCC with the Environment Conservation Council, an agency with similar aims but a new political mandate.

The State Conservation Strategy set out the aims of the Heritage Rivers Program:

- to protect those rivers and streams that essentially remain in their natural condition;
- to ensure that rivers and streams of special scenic, recreational, cultural, and conservation value are maintained in at least their present condition; and
- to ensure that representative examples of stream types in the State are protected.

The *Heritage Rivers Act* identifies 18 Heritage Rivers and 25 Essentially Natural Catchments for protection. The Act does not designate Representative Rivers, which were established by order of Governor in Council following the LCC's final report (Nevill and Phillips 2004). The Heritage Rivers and Natural Catchments were selected on the basis of natural, landscape and recreational/cultural values, while representative rivers were selected as good examples of the river type (classification) derived largely from hydrological and geomorphological information. Neither Heritage Rivers nor Representative Rivers are protected by specific reservation as they overlay existing land tenures.

Despite the intent of the legislation and the legal designation of heritage rivers and natural catchments, implementation of protective management by state agencies has not been enthusiastic (Nevill and Phillips 2004). The original intent of the Heritage Rivers Program in 1989 saw implementation of protective regimes through management plans on Crown Land and land-use planning controls on private land, sometimes reinforced by formal joint management agreements with landholders. The preparation of final management plans has been delayed for a decade, while controls over private land never systematically started.

The data-set on river values prepared by the LCC in 1989 was by far the most advanced in any Australian State, but the Victorian Government did not incorporate this information into local water assessment and planning processes. There was also no attempt made to update spatial information on values, with the result that the 1987 maps are now somewhat out of date.

Unlike Heritage Rivers and Natural Catchments, the State's representative rivers were not afforded protection under the Heritage Rivers Act. The Victorian State government instructed its agencies in 1992 to prepare plans for the protection of the 15 representative rivers designated by the LCC. However, after over 10 years, four of the fifteen rivers remain without protective arrangements (Nevill and Phillips 2004). Consequently, the system does not currently represent adequate, comprehensive and representative coverage of the State's river ecosystems. The original intention of the 1987 State conservation strategy (*Protecting the Environment)* to protect representative wetland ecosystems as well as rivers has not been realised, because the State's wetland reserves have never been comprehensively assessed against this objective.

Identification of candidate rivers

The selection of rivers was based on an investigation and public inquiry by Victoria's Land Conservation Council (LCC). The LCC examined and mapped rivers according to attributes, including values of nature conservation (highly natural catchments, native fish rarity or diversity, botanical significance, geological or geomorphological significance), landscape (high scenic value, waterfalls) and recreation (whitewater canoeing, car-based camping, recreational fishing for exotics, recreational fishing for natives). The initial report included maps of public land use, water use, aboriginal sites, geomorphic units and hydrological regions, water regulation and in-stream barriers.

From these data, 'river basin values', natural, landscape and recreational values were mapped. This initial identification, selection and management of representative river reserves was based primarily on geomorphological and hydrological assessments, because of paucity of biological data existing at that time (1989) and the strong dependence of freshwater ecosystems on these factors.

Management

A management plan for a heritage river area or natural catchment area must state how the areas will be managed in accordance with the purpose of this Act. Certain land and water activities are not permitted in heritage river areas, such as timber harvesting, dams, and new water diversions that significantly affect the values for which it was designated. In natural catchment areas, certain activities are not permitted: clearing of native vegetation, plantation and harvesting of timber, mineral exploration (except if approved by the State government) and mining, extractive industry, dams and new diversions, waterway management, grazing by livestock, building or upgrading roads, discharging effluent, introducing exotic species, stocking with native species except for conservation, powered water craft.

Potential application as a national system

Some elements in the Victorian Heritage Rivers legislation could be applied at a national scale. The catchment focus of the legislation is particularly important as is the commitment to representativeness. The main detraction is that it is a 'top-down' process and so it is likely to be contentious. Implementation of the legislation in Victoria has been slow. Similarly, implementation in other parts of Australia would probably be difficult if a similar model was applied. Community involvement and ownership are not necessarily incorporated well.

E2. Wild Rivers in Queensland

Overview

A commitment of the Queensland Government before the 2004 election was to "identify and protect our wild rivers for generations to come" (<http:// www.teambeattie.com/10_policies/ policies_index.asp>, accessed 18/8/2004). This would be done through legislation that

- allows limited agricultural, urban and industrial development;
- limits regulated water allocations or extractions;
- does not allow river management (e.g. stream alignment, de-snagging, levee banks);
- no further development of floodplains that would restrict floodplain flows;
- protects associated wetlands;
- does not allow stocking of wild rivers with exotic species;
- does not allow use of exotic plant species in ponded pastures;
- limits the capacity of new off-stream storages, primarily for stock and domestic purposes and;
- does not allow in-stream mining.

Designation

Eighteen 'example' rivers were listed as potential wild rivers under the legislation with final designation dependent on extensive community consultation and introduction of the legislation. Three categories will potentially be established (pristine, natural, heritage) for these rivers.

Potential application as a national system

The main detraction is that it is a 'top-down' process and so it is likely to be contentious in its implementation in some parts of Australia if a similar model was applied. Community involvement and ownership are not necessarily incorporated well.

E3. Wild Rivers in New South Wales

Overview

The purpose of declaring a wild river under the New South Wales National Parks and Wildlife Act 1974 (amended 2002) is:

> *to identify, protect and conserve any water course or water course network, or any connected network of water bodies, or any part of those, of natural origin, exhibiting substantially natural flow (whether perennial, intermittent or episodic) and containing remaining examples, in a condition substantially undisturbed since European occupation of New South Wales, of:*
>
> *(a) the biological, hydrological and geomorphological processes associated with river flow, and*
>
> *(b) the biological, hydrological and geomorphological processes in those parts of the catchment with which the river is intrinsically linked.*

Declaration

Declaration is confined to protected areas. The Government is committed to protect 'wild rivers' in the following protected areas: Colo, Kowmung, Grose, Paroo, Macdonald, Upper Brogo, Upper Hastings and Forbes Rivers and Washpool Creek. The philosophy primarily follows that in the *Wilderness Act 1987* with similar nomination and consultation processes. Declaration of wild rivers must be consistent with the *Water Management Act 2000* and the *Mining Act 1992*, with concurrence of respective Ministers.

Potential application as a national system

Declaration is primarily confined to parts of rivers within protected areas and so it does not necessarily deal with the potential threats to rivers and their values, with limited application to entire river basins. The approach is also a 'top-down' process and so it is likely to be contentious in its implementation in some parts of Australia if a similar model was applied. Community involvement and ownership are not necessarily incorporated well.

Appendix F. Jurisdictional workshops

Workshops and/or presentations were held within jurisdictions and preliminary direction presented for comment. These are summarised according to the major sections of the discussion paper. Italicised comments identify how this paper considered each point.

Overview

1. National approach for protection of high conservation value rivers supported by jurisdictions (*acknowledged and followed).*
2. The most valuable part of a National Framework is to stimulate protection of high conservation value rivers and dependent ecosystems *(acknowledged and followed).*
3. Clear objectives for a national framework are essential if jurisdictions are to participate *(acknowledged and followed).*
4. Cultural values are important but should be considered separately. (e.g. Victorian experience) *(acknowledged and followed).*
5. Some concern that history of national approaches and personnel on working group may bias development of a true national framework *(acknowledged and every effort was made to access as much input into this discussion paper as possible).*
6. A National Framework can resolve interstate cross border issues (e.g. River Murray, Cooper Creek) but it is not a universal problem across jurisdictions *(acknowledged and followed).*
7. Concern that a future national system might not lead anywhere and did not adequately 'move on' from work already done in this area *(acknowledged, hence this attempt).*
8. In eastern States, many developed catchments potentially affected by cumulative impacts while fragmentation affects rivers in Western Australia *(acknowledged).*
9. Sustainable management seldom followed in practice because of poor implementation *(acknowledged).*
10. The role of the Australian Government is to coordinate, ensure consistency and develop strategic processes that guard national interests that jurisdictions cannot deal adequately with *(acknowledged and followed).*

Terminology

1. Definitions in expression are critical because of variable jurisdictional and regional terminology and to avoid misinterpretation *(acknowledged and followed).*
2. The term 'river' must be inclusive of all surface water streams regardless of size or permanence (e.g. ephemeral creeks, 1st and 2nd order streams) *(acknowledged and followed).*
3. Concern that a narrow definition may not include wetland systems on Western Australia's coastal plain *(acknowledged and followed).*
4. Groundwater resources should be included, particularly in the arid zone (groundwater dependent ecosystems) *(acknowledged but the working group believed this outside the terms of reference; there is nothing to stop the application of this framework to assessment of groundwater dependent ecosystems).*

Scale

1. A hierarchical spatial framework is important because it can be integrated and disintegrated, with National, State, Regional, catchment, reach levels *(followed).*
2. Spatial scale is important with water resource planning often conducted at a catchment level, but only addressing regulated reaches *(followed).*

Classification

1. None of the existing classifications are particularly useful and any national classification needs to be purpose-built *(acknowledged and followed)*.
2. The cost-benefit of classification was raised,

given the amount of potential data required to objectively classify aquatic ecosystems across all attributes. A rapid classification could be done and progress identification *(acknowledged and followed—this is an iterative approach)*.

3. Classification was considered not particularly useful at the national scale and should be low priority *(argument is put that classification can be done quickly and is essential for objective assessment)*.
4. Costs and benefits of classification should be considered. It may translate to high effort and cost for low benefit *(data are available to make this process reasonably rapid with high benefit because of objectivity)*.
5. Classification is important for representativeness but may not be for practical application to large scales and community-backed processes (e.g. whole river basins) *(even at large scales, classification may be important but point acknowledged by establishment of whole river basin scale protection for largely natural rivers—this remains the only criteria that needs to be met)*.

Evaluation

1. The main value of a national framework is an agreed listing of criteria that are important, as this does not yet exist *(acknowledged and provided)*.
2. Most rivers have ecological value and a relative measure is important to identify the conservation importance at different scales *(recognised and followed)*.
3. Subjective and informed assessment by the jurisdictions could provide as good (or indeed better) an assessment as the data driven approach because our national databases are so patchy. Systems that are least disturbed are likely to have the least data) *(indirect methods of rapid evaluation that account for poor data, with informed review are recommended)*.
4. To align assessments among jurisdictions, the Australian Government could provide broad assessment guidelines for scoring catchments with outputs cross-checked with Wild Rivers assessment and NLWRA outputs *(recommended with the setting up of an interjurisdictional working group to provide assessment protocols)*.
5. Objective data driven assessment will require high effort which translates to high cost but will produce high benefit. The alternative might be jurisdictional nomination with low effort translating into low cost and high benefit *(combination approach recommended)*.
6. A regionally-based nomination process might be effective for high conservation value identification but jurisdictions and community would need to be aware of the implications *(the scale of regions adopted but assessment needs to be across regions, basins and drainage divisions for objectivity)*.
7. Appropriate scale for assessment and management may vary *(true-according to objectives required for assessment across scales)*.
8. Assessment scale will be driven by data availability *(incorporated in methods)*.
9. Appropriate scale for assessment influenced by the measures of ecological value *(jurisdictional advisory group to provide agreed protocols)*.
10. Consistency between jurisdictions is important *(recognised throughout—jurisdictional advisory group to provide agreed protocols)*.
11. RiverStyles can provide an indication of sensitivity to disturbance that could be refined and possibly target sensitive areas *(note discussion of RiverStyles and appropriateness and cost)*.

12. Identification of threats is critical to management of high conservation value rivers but not necessarily essential for their identification. Establishing triggers to threats is beyond the scope of the project and numbers may be too prescriptive and inflexible. A focus on threats may discount importance of other ecological values. A pressure–response gradient might be a useful alternative to defined trigger values. A technical assessment panel or expert panel approach may be useful for assessing values and threats but it is necessarily subjective *(comments noted and threats treated through assessment process. The framework does provide options for mitigating threats through whole river basin identification, based on river regulation thresholds and catchment disturbance. These rivers are potentially the most cost effective for conservation)*.

Data availability

1. Wild Rivers database (including disturbance index) and the National Land and Water Audit databases are useful *(acknowledged and followed)*.
2. Users need to be cognisant of the data limitations *(acknowledged)*.
3. Queensland has an existing state-wide assessment of change from natural in relation to hydrology, weeds, water quality, floodplain development and aquatic ecology. Data rigour is also considered *(acknowledged and should be used in a national assessment)*.

Protection Planning

1. River protection should start at the largest scale because this is most effective *(acknowledged and followed).*
2. Consideration should be given to a hierarchical approach where river basins attract a general level of protection while iconic sites require more stringent management *(acknowledged and followed).*
3. In Tasmania, whole rivers can be protected by reservation as 40% of the state is in reserves, including two entire bioregions *(acknowledged and followed).*
4. Protected areas over large landscapes is not considered politically possible *(acknowledged and hence establishment of whole of river basin protection level).*
5. 'National' branding will enhance the protection-trigger value and also adds to tourism value *(acknowledged and followed).*
6. Rivers and dependent ecosystems that are not identified as high conservation value still maintain some conservation value and should be managed accordingly *(acknowledged in principles).*
7. Protection of high conservation systems may pressure unprotected systems (e.g. embargos of surface water development in New South Wales resulted in immediate and significant demands on groundwater) *(acknowledged and provided for through identification of natural systems as important).*
8. Some industries supportive of conservation management of rivers (e.g. organic beef industry, fisheries, tourism) *(acknowledged and may be implemented through whole river basin scale of protection).*
9. Trade-offs will occur between protection and the number of high conservation value systems identified. These need to be managed across Governments and communities (*acknowledged*).

1. Listing of areas should involve the community but assessment and identification of potential candidates should be objective to avoid parochial interests (*acknowledged and followed*).

2. Implications of nomination or listing of high conservation value rivers or dependent ecosystems would influence which systems are identified (*acknowledged and hence the importance of an objective assessment process*).
3. The national framework should use existing national frameworks for protection (e.g. national reserve system) (*acknowledged and followed*).
4. Changes to hydrology are currently the main consideration for river protection *(acknowledged in threat section).*
5. An optimal scale of management should be defined, even if protection applies to a range of scales management *(acknowledged that generally River basin scale is the optimum).*
6. There is increasing focus on management and protection of 'icon' sites (e.g. Living Murray, Narran Lakes, Macquarie Marshes) *(acknowledged and incorporated into proposed framework that allows such 'icon' sites to be identified and managed within a catchment context).*
7. Use of existing frameworks such as the National Water Quality Management Scheme and Directory of Important Wetlands in Australia should be utilised to avoid additional frameworks (*acknowledged and recommended for use in assessment as a data source but these systems are not necessarily objective or adequately linked to river management in all jurisdictions*).
8. There was concern in jurisdictions about tying management of high conservation value rivers into regulatory schemes such as the E*nvironment Protection and Biodiversity Conservation Act 1999* (*acknowledged but the aim of national protection legislation is to protect areas of national significance*).
9. There should be discussion of different legislative tools and policies in each jurisdiction. These vary from integrated models (e.g. *Natural Resource Management Act* in South Australia) to theme specific legislation (e.g. conservation, water) *(acknowledged and followed).*
10. Important to also use incentive schemes for delivery of protection *(acknowledged and followed).*
11. A low conservation value for a river may be politically difficult *(acknowledged but important to develop strategic direction for river conservation).*
12. Ramsar listed wetlands have degraded in many areas with lessons for listing processes that are not linked to management. It is essential to link listing to real management processes *(acknowledged and followed).*
13. Sustainable limits of surface water systems should be applied (e.g. Victoria's Sustainable Development Levels) *(acknowledged and followed).*
14. There should be development limits for listed high conservation value catchments, not just for water resource development but also unsustainable land use *(acknowledged as an important issue that would be tackled through catchment planning primarily and linking of sites to environmental assessment processes).*

Operational and Institutional Arrangements

1. River basin scale is the most appropriate scale for river management (*acknowledged and followed*).
2. A national framework should be progressed through the CoAG agenda, the National Water Initiative and/or Natural Resource Management Ministerial Council for implementation and support *(acknowledged and followed).*
3. Investment in rivers will mainly be through Natural Resource Management Regions (*acknowledged and followed*).

4. River conservation investment will compete with other natural resource management within regions and so it is important to direct investment to rivers if appropriate *(acknowledged and identification of important areas will assist with targeting)*
5. Heritage Rivers models (e.g. Victoria) have not generally delivered on promises but national investment and support could assist *(acknowledged).*
6. There should be a national funding program that specifically lists protection as a priority, as current funding criteria are not about protection (*acknowledged and followed*).
7. Any new or additional program needs to have compatible institutional arrangements, crafted around how the States/Regional NRM groups manage rivers (*acknowledged and followed*).
8. Time frames from classification, data collection, planning, consultation, negotiation, listing and active management may be too long. We need to be prepared for a long national process or design a more rapid process. The consultation/negotiation phase often takes most time (*acknowledged and followed*).
9. There is a risk that work will be redone and there will be no equity between jurisdictions in terms of investment in protection (*acknowledged and hence need for objective assessment that also incorporates developed rivers*).
10. Regional River Health Planning is operational in the Victorian CMAs where plans seek to identify assets including ecological, social and economic, identify the threats to those assets and plan for investment in protection and rehabilitation for those assets. They focus first on the high value— high threat assets and monitor the status of the low value assets (*acknowledged and followed*).
11. Tying protection of high conservation value rivers into National Competition Council payments would be a disincentive and fail (*acknowledged and not recommended*).
12. Need to consider the Victorian model (plans, targets, investment strategies, community engagement) in implementation at the regional scale (*acknowledged and followed*).

Appendix G. Feedback from a national forum[a]

The forum was primarily held for jurisdictional people and a presentation given on the direction of the framework, followed by a workshop. The following points represent individual's comments at, before or after the forum about key areas of the discussion paper.

Points are followed by a response comment in italics and parentheses of how the comment has been incorporated or considered within the final discussion paper.

Overview comments

1. There is clearly a pressing need for an Australian Government–State framework but it needs to be reasonably loose and incorporate jurisdictional needs *(agreed).*
2. Overall support for a national framework but detail is critical *(agreed).*
3. Important to have a national framework for the protection of high conservation value rivers because it saves funding in terms of rehabilitation *(agreed).*
4. It is more strategic to look after the healthy river systems *(agreed).*
5. Arguments about maintaining high conservation value rivers rather than investing in restoration are very important and need to be emphasised in a rationale *(agreed and followed).*
6. The framework aims to cover rivers, river reaches and estuaries but 'freshwater' implies that estuaries and primary saline systems which are important in the Australian landscape are not considered *(estuaries specifically included).*
7. The Canadian Heritage Rivers System is mentioned but with no detail (*agreed and provided*).
8. The discussion paper needs to acknowledge the jurisdictional input and extent of consultation, possibly in the form of an appendix (*agreed and followed*).
9. Whole river systems, including their catchments, not bits and pieces need to be identified. (*It is important to encompass the range of different aquatic systems that could be of national importance at different scales, not just whole river systems. These dependent ecosystems are currently where most of the protection effort is concentrated. It is important to have the range of options*).

National River Information System

Forum summary

- It is essential to have national evaluation and assessment criteria that can operate at different spatial scales (hierarchical).
- There is little support for a national database and no need for a new database. Existing systems (e.g. nationally available databases—Wild Rivers, National Land and Water Audit) should be used. There is a need for compatibility in data sets for auditing and management of cross border rivers. There is a need to identify gaps in knowledge.
- Identification of rivers or dependent aquatic ecosystems should depend on systematic scientific input.
- Classification should be applicable to a range of different systems.

The following arguments were based on a preliminary view that there should be a national information system but this has been modified on the basis of the comments below to nationally consistent information.

Numbered points below represent written feedback from the forum.

a The forum was held at Old Parliament House in Canberra on 1 April 2004.

Advantages

1. Nationally agreed assessment criteria for objective comparisons *(agreed).*
2. Useful to have a national assessment process that could then be carried out by the jurisdictions *(agreed).*
3. Consistent data is the key not a national database *(agreed).*
4. Would allow monitoring and evaluation to provide national reporting *(agreed).*
5. Could guide national investments *(agreed but could do so with nationally consistent information as well).*
6. Consistent with the aims of CoAG agreements on water management *(agreed).*
7. It would be useful to have a spatial system that lists all the protected rivers and their values like the Directory of Important Wetlands in Australia *(agreed—could be further developed).*
8. It would be useful but not essential because regional databases often have more information and are used more *(agreed).*
9. It could enforce jurisdictions to contribute to data collection and updating *(agreed but national program would do the same).*
10. There is a clear need for a consistent data platform among states because data are fragmented, for comparability *(agreed).*
11. Important to be able to share data across jurisdictions *(agreed).*

Disadvantages

1. A national database that requires updating and significant co-ordination, when jurisdictions have constitutional responsibility for land and water management *(agreed).*
2. National spatial framework would serve no purpose *(disagree—a national spatial framework would allow more logical assessment and analysis that recognised real connections between rivers)*.
3. Jurisdictions will resist because of potential loss of control over information and there would be concerns about custodianship of data *(agreed).*
4. Such a database would be too difficult to manage and maintain, need jurisdictional carriage *(agreed).*
5. State databases already exist and do not need to be replicated *(agreed).*
6. There will be issues of compatibility in terms of data collected and methods used as well as among databases held by jurisdictions *(agreed but could develop links and agree to consistent use of criteria).*
7. Need to be sure that current systems are failing *(agreed).*
8. Information is usually required at sub-catchment or catchment scales for decisions and so a national database may be an unnecessary expense *(agreed).*
9. Jurisdictions will have different issues that may not be compatible with a national database *(agreed).*
10. An information system is needed that can be populated by jurisdictions according to nationally agreed processes *(agreed).*
11. One size will not fit all. There needs to be a system of database that targets different spatial scales *(agreed).*
12. Needs to be an information reporting system that allows for updating of databases and data collection (e.g. National Land and Water Audit, Murray–Darling Basin Audit)
13. Access to data and not a new national system is the critical issue *(agreed).*

Scale

1. A national typology is important *(agreed and followed).*

2. Need to be able to operate at various scales, particularly regional implementation scales *(agreed and followed).*
3. Spatial scale needs to be appropriate to threat levels *(agreed but evaluation of ecological value can be independent of threat analysis)*.
4. Catchment scale the most useful for implementation. Drainage divisions not useful and no data exist for river segments (*acknowledged there is a paucity of data but it is important to use the finest scale data available for assessment*).
5. Needs to be relevant to all rivers across Australia *(agreed).*
6. There is an emphasis on whole river systems which is not consistent with the framework working at different scales. (*This is not the case. The framework works at different scales*).
7. There is no reference to the National Estuaries Network (*agreed and rectified*).

Classification

1. Better definition of type and class needed (*type or class would be defined empirically by the data).*
2. Class and types should include hydrology, geomorphology and physical and biological *(agreed and followed).*
3. Classification needs to be kept as simple as possible to begin with, restricting it initially to drainage divisions *(believe more sophisticated classifications are possible using available data with better outcomes).*
4. A national classification systems allows legitimate comparisons to be made and is critical for guiding funding and management *(agreed).*
5. Classification should be based on geomorphic and biotic combinations with an IBRA like process *(see Appendix B in relation to problems associated with such an approach).*
6. There are insufficient data to adequately classify rivers meaningfully (*this can be attempted with current data and will provide useful information for the first step*).
7. Needs to accommodate different types of rivers such as spring-fed rivers compared with catchment fed rivers *(agreed).*
8. Classification systems are always challenging and may not be useful for everyone *(acknowledged but dependent on the objective).*
9. The framework needs to define river types (i.e. Alpine, coastal, arid, estuary, floodplain etc.) (*the framework allows classification to be done using different methodologies that depend on the objective but allow the data to produce the classification*).
10. Data availability is a major problem for classification. For example, macroinvertebrate data are problematic for defining bioregions, mainly because of low sampling effort and low taxonomic resolution *(agreed).*
11. It is important and urgent that a national-scale river classification system be developed to allow representativeness to be assessed *(agreed).*

Conservation criteria
There were originally 7 criteria but criteria 6 and 7 were combined.

1. Criteria should only concentrate on ecological values as other criteria (aesthetic and recreational) are identified in other regional processes *(agreed).*
2. It would be useful to have nationally agreed assessment criteria *(agreed and followed).*
3. There was support for tightening up or collapsing of some criteria (*for consideration*).
4. Criteria needs to cater for needs of all jurisdictions *(agreed and followed).*
5. Criteria based on providing important resources

for particular life-history stages of biota or important functions within the landscape could apply to all Australian rivers so are pointless (*the criteria allow relative assessment which reflects the reality of these systems and so the highest ranked systems will be of national importance. This also allows recognition that all systems have value*.)

6. Criteria need to be measurable and quantifiable *(agreed—see discussion of attributes and rating).*
7. Criteria comparable to widely used criteria (e.g. Ramsar) *(agreed, that is why they were chosen).*
8. Criteria 2–7 are reductionist. High conservation value should be about protecting whole relatively intact landscapes not protecting species. We already have ways of protecting rare species *(we believed some merit for large river basins but would preclude important parts of rivers in potentially degraded systems).*
9. Criteria 5–7 could be combined possibly *(we believed that there was value in having some further discrimination power but this could be further investigated by the interjurisdictional group)*.
10. Criterion 6 could be combined with 3 and criterion 7 combined with 3 and then separate criterion 3 into two biological and geomorphic criteria. *(we believed that there was value in having these separate but this could be further investigated by the interjurisdictional group)*.
11. It is impossible to get the communities to agree on values, even at a regional or local scale (*agreed, hence the need to have agreed criteria that may be objectively assessed at a national scale*).
12. Cultural values are important *(agreed but outside terms of reference and require different expertise but believe that if this framework is adopted they can be included relatively easily).*
13. There should also be indigenous values not just western scientific conservation values *(agreed but outside terms of reference and require different expertise).*
14. Agree strongly with inclusion of geomorphic *(agreed and followed).*
15. Rare and threatened species should be managed under different regime not protection *(this group of organisms are acknowledged as a conservation priority, so are included in criteria).*
16. The broad criteria will be met by any river in Australia (*disagree when thresholds are applied this should allow the selection of the best of the best*).
17. Rare and threatened species can be identified at state and national levels (*agreed but this framework is meant to be a national one and so the national threatened species would be used but note assessment of high conservation rivers at state level may use state identified threatened species).*
18. Need to quantify a word such as ‘unusual’ in criterion 4 *(agreed but this would be done during assessment as a relative assessment).*
19. Not support nomination based on unusual diversity or abundance of features—this is relevant to National Parks and should be managed under that regime (*only a small portion of high conservation value areas are within National Parks and others may not be in the future. Unusual diversity allows for relative identification of important areas*).
20. Unsure that criterion 5 should be included *(believed that this was important in terms of Australia’s evolutionary history).*
21. It is important to convince regional bodies of reasoning behind selection of criteria *(we drew on a number of widely accepted criteria—see discussion paper).*

22. Can the framework use or modify the Ramsar criteria? *(we believed that these needed to be extended to other areas in recognition of Australia's rivers).*
23. There should be spiritual criteria considered *(we believed that this was outside the terms of reference but acknowledge its importance for consideration under cultural values).*
24. A further eighth criterion should be added—imminent threatening processes *(we believed that this is primarily part of the management response once high conservation value rivers are identified).*
25. Rivers or dependent ecosystems need to meet more than one criterion, other than the first *(we believed at least one was important but such rules could be determined by the data and ranking).*
26. The criteria are not sufficiently discriminatory. For example a highly modified system could qualify just as easily as an undisturbed system (*a high conservation value river or dependent ecosystem could occur in a highly modified system*).
27. Criteria need to build on threat level at different scales (*the criteria are primarily centred on ecological value, not threats*).
28. Identification of high conservation value rivers should not hinge on simply meeting one of the criteria. This could overemphasise the importance of threatened species (*agreed*.)
29. National significance is essential if the framework is to be non-threatening to state/territory jurisdictions, who are responsible for their own river protection programs, policies and legislation. They are more likely to contribute to a Australian Government-funded national program than to accept a nationally-derived set of criteria to drive their own river protection programs (a *nationally derived set of conservation criteria should cater for all jurisdictions but it is an essential step in deriving a nationally consistent and objective assessment. An interjurisdictional group may decide on the final format of these*).

Evaluation

Forum summary

- There should be a focus on compiling existing knowledge about conservation values, representativeness, and threatening processes to identify candidates for high conservation value.
- This will identify knowledge gaps that can be filled.

1. An assessment of nationally significant rivers could be relatively easily done with an expert panel (Delphi method) *(may warrant further consideration).*
2. There is a clear need to identify rare and relatively undisturbed rivers across Australia, without becoming slowed down by an involved process of data collection *(agreed but we require objective processes for identification. An immediate stage is identified*).
3. First priority should be to identify intact catchments, rather than reaches *(agreed in first stage but need to use the data available at the finest scale).*
4. National assessment important because it allows for objective comparisons *(agreed).*
5. Need investment to provide required supporting data *(agreed and followed).*
6. Absence of data should not prejudice assessment of a river or dependent ecosystem (a*greed and covered by surrogates. Also rivers likely to be considered important can be targeted for data collection*).
7. Identify gaps in information and invest in further data collection if required (*agreed but need to begin with existing data otherwise*

there will be paralysis in progress).

8. Use expert opinion and data for assessment *(agreed but believe that data is preferred for objectivity, expert opinion to test validity).*
9. Use existing databases of information *(agreed and followed*).
10. It is important to examine how well a river meets each criterion and then weight *(agreed but there is a need for transparency and objectivity).*
11. Assessment needs to build on existing work in jurisdictions that has tested application of criteria (e.g. Directory of Important Wetlands in Australia) *(agreed and to be followed).*
12. Strengths and weaknesses of criteria need to be tested *(agreed and should be the focus of future work).*
13. Criteria need to be tightly defined and establish how each criterion will be applied *(agreed, but some further work needed to determine the exact guidelines)*.
14. During assessment any criteria should be met for a river qualifying as high conservation value, not all criteria *(agreed).*
15. Many of the criteria are point locations and so their identification could be driven too much by threatened species *(agreed but other criteria should balance out the effects of threatened species).*
16. We do not necessarily know that much about threatened species *(agreed—data sets will be poor but this group of organisms are acknowledged as a conservation priority, note the comments about data in discussion paper).*
17. We should not worry much about the rules by which agencies apply criteria; different states will have different priorities (weightings) *(agreed, but further work needed to determine guidelines to ensure comparability for a national assessment)*.
18. There is a need for a scoring system or weightings for a number of the criteria (*see discussion about different assessment methodologies).*
19. Measurable thresholds are needed against which each criterion can be assessed *(agreed and preliminary discussion of this presented but necessary for interjurisdictional steering group to determine appropriate thresholds).*
20. Criteria of representativeness and criteria for particular life history stages need well defined guidelines to ensure that the highest conservation value rivers are identified *(detailed agreement by inter jurisdictional steering committee required).*
21. Rivers or dependent ecosystems should meet at least two criteria but it is not important which two *(we believed at least one was important but such rules could be determined by the data).*
22. Rivers or dependent ecosystems should meet criteria 1 (naturalness) and one other *(we believed some merit for large river basins but would preclude important parts of rivers in potentially degraded systems)*.
23. Use separate data layers so information can be analysed separately and then use GIS to combine for scoring *(agreed depending on the final methodology used for assessments).*
24. Natural Resource Monitoring and Evaluation can inform the use of criteria *(recognised through the importance of using all existing databases).*
25. High conservation value river seems to imply systems that are not heavily utilised but mention is made of the River Murray which preempts prioritisation (*agreed—the framework incorporates whole rivers as well as dependent ecosystems wherever they may be because they may still be of high conservation value in a heavily utilised system. The River Murray reference was supposed to be by way of example but has been removed).*

Protection Planning
Whole river protection

Forum summary

The concept has merit at whole river or sub-catchment scale for iconic undeveloped catchments (some cross border rivers) of high conservation value. Majority of river protection needs to apply at the sub- catchment or river segment scale, relevant to the community and regional management. Whole river protection is not applicable to all high conservation value rivers. Management depends on the scale and source of threats.

Whole basin protection requires integrated suite of statutory and non statutory tools covering

- protective legislation (protective areas useful within whole basins)
- water planning and legislation
- catchment and land use planning
- information and incentives
- Delegates to the forum commented on advantages and disadvantages of whole river basin protection.

Advantages

1. This is a useful and optimum concept particularly applied to areas not yet developed with wide-scale benefits *(agreed).*
2. Could work for a small number of river basins but other mechanisms also required *(agreed).*
3. Need to set objectives at the basin scale *(agreed).*
4. Usefulness will depend on what threat the river needs to be protected from *(agreed).*
5. Basin wide is the logical starting point but may need to use catchment scale as the largest scale for implementation *(agreed).*
6. Community support is essential and the system could work at sub-catchment scale *(agreed).*
7. It usefully incorporates a sense of upstream and downstream connectivity between ecosystem types and processes *(agreed).*
8. It potentially accounts for whole of catchment processes and issues *(agreed).*
9. It would be easier to achieve in high conservation value rivers without many development threats *(agreed).*
10. Queensland is currently looking at a number of river basins for catchment/ basin scale protection (*acknowledged*).
11. It could be tailored to suit community aspirations *(agreed).*
12. This has the advantage in that it could incorporate notions of wise use and stewardship *(agreed).*
13. Success or otherwise will depend on trade-offs in the community *(agreed).*
14. There could be educational and industry advantages with such a designation *(agreed).*

Disadvantages

1. Unlikely to occur in highly developed river systems *(agreed).*
2. Land tenure issues likely to be important *(recognised hence the need for broad river planning framework, supported by the community).*
3. Would need to break it down into catchments and reaches for management *(agreed but an overall protection plan for the river would guide such management).*
4. Reference to the Canadian Heritage Rivers System is unhelpful as the Canadian culture and their attitude to rivers is vastly different to Australia's, making comparison a nonsense (*the broad framework provided by the Canadian Heritage Rivers System could be applied within Australia, as discussed. The criteria used for evaluation will vary reflecting the different nation's rivers and culture*).
5. It will depend on the aim of protection and political and community support *(agreed).*
6. Development of community support processes essential so there is clarity *(agreed).*

7. Catchment scale may be too large because too many communities involved with different objectives and aspirations as well as different components of condition from degraded to pristine *(agreed but still believe some communities may see advantages that overcome these drawbacks).*
8. There is a lack of relevance at this scale to current natural resource planning and management so jurisdictional support will be poor *(this is not necessarily true—e.g. Lake Eyre Basin where catchment and natural resource planning processes are built around whole of river protection of river flows. It is a new concept that may require time to develop).*
9. The scale may be too broad to adequately address specific threats *(agreed but it could provide an overarching framework).*
10. Data at large scales may not be consistent and rigorous (*this is a problem associated with all scales*).
11. It may require a single legislative tool to declare areas (*this is not necessarily true—see Canadian system of Heritage Rivers).*
12. Whole of river basin should require development of protection mechanisms to be successful *(agreed—would be carried out with a river management plan).*
13. Requires community ownership and backing *(agreed).*
14. Not appropriate in all cases, it should reflect the nature and scale of the threat. So some threats may be site specific and managed through protection mechanisms *(agreed).*
15. Need to be clear about what a basin is where it moves over biophysical and institutional boundaries *(agreed—need to reflect topography).*

Application of current policy and legislative tools

Forum summary

There is a need to manage cumulative impacts using appropriate mechanisms. After developing overarching policy and directions, a representative system of freshwater dependent ecosystems (also estuaries) is best identified and then protected via a nested approach to

- scales of planning and protection and
- appropriate protection mechanisms

Delegates to the forum gave advantages and disadvantages of using current legislative and policy tools.

Advantages

1. They are cost effective and there is familiarity with implementation of current processes *(agreed).*
2. Current catchment scale processes for planning are an appropriate scale for implementation *(agreed).*
3. Need to be able to apply a suite of tools and mechanisms for protection from formal and informal reserves to planning at landscape scales *(agreed).*

Disadvantages

1. They are not always adequate because of lack of linkages between catchment-based planning and the controls *(agreed and addressed).*
2. Protective tools are often not able to manage increasing threats *(agreed).*
3. Threat management tools are inadequate. They currently focus on sites and not on integrated processes *(agreed).*
4. There is a lack of enforcement with many current legislative and policy tools *(agreed and partly addressed).*

Numbered points below represent comments about protection of rivers and dependent ecosystems.

5. There should be a hierarchy of rivers

established for protection *(the assessment can establish relative conservation value of different rivers and dependent ecosystems).*

6. Formal listing of rivers is not proposed and yet this was a useful mechanism for the Directory of Important Wetlands in Australia (*this could be an outcome*).
7. It is important to articulate the range of management options *(agreed and presented)*.
8. Threats to values need to be considered in priority action planning *(agreed and followed)*.
9. Should focus on whole catchments or sub-catchments as anything smaller is difficult to protect and manage *(agreed for management but for assessment it is important to use the finest data available)*.
10. Recognise social and economic impacts of conservation *(agreed—this will be clearer through potential delivery of incentives and providing communities with the option of recommending whole river basins protection).*
11. Should examine the vulnerability and irreplaceability of the area and prioritise management *(agreed as an important test for prioritising action, requires further development for implementation)*.
12. It is important to ensure appropriate legislative enforcement is available to support protection *(agreed—this is why most of the recommendations refer to currently available legislative and policy tools).*
13. Success of the framework will depend on institutional and high level political commitment. *(agreed—that is why we recommend that subsequent actions involve all the states and the Australian Government, through the Natural Resource Management Ministerial Council).*
14. It is important to have community support *(recognised particularly in relation to whole of river basin protection requiring community involvement and support).*
15. The framework must build on jurisdictional investments *(agreed and wherever possible we have tried to recognise this).*
16. Protection of whole river basins would require statutory primacy over water sharing and allocation plans *(not necessarily just compatibility—e.g. Lake Eyre Basin Agreement, Paroo River Agreement)*.
17. Protection of river basins implies 'locking up' rivers which is inappropriate *(this is not the case, it is only a broad commitment to maintaining the values of the river, e.g. Lake Eyre Basin Agreement).*
18. Incentive opportunities need to be explored for protecting high conservation value rivers (e.g. tax, lease arrangements, stewardship) *(agreed).*
19. Need to be able to integrate the tools for protection. Too much emphasis is placed on individual tools and not the overall protection *(agreed).*
20. A table of advantages and disadvantages of various protective tools would be useful with some case studies exemplified *(we did not take this approach because most jurisdictions have similar tools and mechanisms which may not have been adequately used. We focused on better implementation of tools.)*
21. First high conservation value rivers must be identified and then assessed to see if current management objectives maintain these values *(agreed—but also possible to be proactive in management).*
22. Need to recognise current tools such as Ramsar and Heritage amendments to the *Environment Protection and Biodiversity Conservation Act 1999* that may be used *(agreed).*
23. Essential that protection is linked to land and water use planning *(agreed).*
24. Nominations of whole river basins should be by the jurisdiction and supported by data (*the*

Canadian Heritage River system allows communities to nominate with jurisdictional support and data that show high value).

25. Identification of high conservation value rivers is dependent on the implications of this identification *(it is important to make the identification independent of management so there is transparency and objectivity)*.
26. Is the suite of tools available the right type or do we need new ones? (*we believed there were sufficient tools and wished to work within current legislative and policy frameworks in jurisdictions. Better implementation of current tools could achieve protection*).
27. Whole of river basin protection needs to involve industry, particularly agriculture *(agreed).*
28. The framework does not have to address cross-border issues. We already have mechanisms such as agreements to deal with these (e.g. Murray– Darling, Lake Eyre, Paroo) (*a comprehensive national framework should allow for all protective mechanisms to be incorporated as does the one proposed as we cannot predict the future. Currently the Lake Eyre Basin Agreement and Paroo River Agreement do not fit well into any type of framework. A cross-border framework provides for better recognition of the ecological connectivity of rivers*).
29. Investment should focus on protection of high conservation value rivers with additional funding for monitoring *(agreed).*
30. Important to reward people for good stewardship of rivers *(agreed).*
31. There may be a need to collaboratively establish formal duty of care responsibilities for private landholders or leaseholders *(agreed).*
32. The framework should be operationalised (needs to assist managers) and not just be conceptual *(agreed. It needs to have sufficient high level structure so that all elements of protecting high conservation rivers can be identified but also provide sufficient detail that the programs can be put into effect).*
33. Reliance on communities to drive a nomination process for whole river systems is flawed. Many communities do not have the resources especially in remote areas (*acknowledged and Governments will need to resource the community, as in the Canadian Heritage River system for this process*).
34. It is important to recognise the role of stream buffers for ensuring river health and riparian condition and this may be a good way of protecting conservation values *(agreed and included).*
35. Rivers identified for whole basin river protection should also be candidates for higher levels of protection for key sites *(agreed and followed).*
36. The framework should primarily use existing Directory of Important Wetlands in Australia and Ramsar mechanisms for protection (*there is variable uptake and effectiveness of these processes among jurisdictions. Also there are many other ways of effecting protection*).
37. Not all 'pristine' river systems need to be 'locked up' against development as this will put future development pressure on remaining systems, possibly to the point of extinction. (*agreed—the discussion paper identifies a number of different protection mechanisms that encourage sustainable development, if supported by communities and Governments*).
38. Managing parts of a river system for high conservation values is problematic due to upstream and downstream influences. These values will constantly be under threat unless the whole catchment and river system is managed as a unit—hence a preference for only declaring whole systems (*agreed about pressures and management but not all dependent ecosystems depend on the whole*

catchment and increasingly communities are focussing on key assets).

Operational and institutional arrangements

Forum summary

- Need for coordination of a National framework by the Australian Government.
- Recognition of constitutional realities is essential.
- States need flexibility matched to national interests.
- Need to use the framework to improve existing mechanisms and strategies (e.g. National Action Plan for Salinity and Water Management, Natural Heritage Trust.
- Different elements of a national framework may require different institutional arrangements.
- Involvement of the Natural Resource Management Ministerial Council is important for ownership.
- Identification in the National Water Initiative is important.

Numbered points below represent comments by delegates on institutional and operational arrangements and challenges for implementing a national framework for the protection of high conservation value rivers.

1. The institutional arrangements need to recognise constitutional realities, avoid duplication and accommodate social and environmental values *(agreed).*
2. The framework needs to link in with the National Water Initiative and the funding arrangements through the National Action Plan and Natural Heritage Trust *(agreed).*
3. The framework needs to be simple and clear but not prescriptive (e.g. Lake Eyre Basin Agreement) *(acknowledged for whole of basin protection, but other tools may be prescriptive within a jurisdictions legislative and policy context).*
4. The framework should complement existing arrangements and only augment where there is a clear need. It needs to be owned and supported by all jurisdictions *(agreed).*
5. The framework requires political commitment to ensure resourcing and jurisdictional commitment *(agreed).*
6. There needs to be opportunity to build in community support and involvement (*agreed, see comments about whole of river protection and delivery through regional frameworks)*.
7. Such a framework could benefit from evaluation of National Reserve system applied to terrestrial landscapes *(agreed—attempted to draw on this experience but also recognised that water transcends many boundaries)*.
8. The Australian Government can provide some funding and a national model. The states and territories can also provide funding but contribute to policies and priorities while regional bodies can implement and integrate protection *(agreed).*
9. The framework needs to be robust enough to outlive this present project and engage and influence the future *(agreed).*
10. There are existing arrangements but these are not used due to lack of political will, poor marketing and poor awareness *(agreed).*
11. National framework important to jurisdictions for funding opportunities and through application of further protection tools from elsewhere *(agreed).*
12. A national framework would allow for a consistent approach to protecting ecological assets throughout Australia *(agreed).*
13. Needs to take into account the evolving regional arrangements for natural resource management *(agreed).*
14. National Reserve Scheme should provide a

process for implementation *(agreed).*

15. Australia is a federal system and so funding should be provided by the Australian Government with jurisdictions providing expertise and input data (*all governments provide funding for natural resource management*).
16. Socio-economic values as well as conservation values need to also be assessed in the framework (*this is not necessary to establish ecological value but it is important for management actions*).
17. Important that the framework is engaged by key stakeholders *(agreed).*
18. Federal–State and regional arrangements allow for accountability and setting of standards in relation to protection of high conservation value rivers *(agreed).*
19. Need for a communication program that advertises the main elements and advantages of the framework (*for future consideration*).
20. There is a need to engage key stakeholders early in the process *(agreed).*
21. The National Framework could be broken down into its elements to allow for iterative discussion and agreement at interjurisdictional and Australian Government level *(agreed and followed).*
22. Consider the model of developing the process and then allow implementation by jurisdictions (e.g. National Reserve System) *(agreed and followed).*
23. Resourcing will be essential for such a system to be implemented and major players to engage *(agreed).*
24. Important to strengthen existing partnerships and possibly develop new partnerships but not new institutions *(agreed and followed).*
25. There is a need for strategic decisions on protection of high conservation value systems which may be difficult from an equity standpoint *(agreed and could follow once high conservation value rivers are identified).*
26. Need to develop national standards for information systems *(agreed and followed).*
27. Need to develop a national program of information collection *(agreed and followed).*
28. Need to scope investment in National Reserve System in relation to rivers and dependent ecosystems *(agreed and followed).*
29. Important to sign formal links between National Water Initiative, water plans and land use and land planning *(agreed and followed).*
30. Need agreement on Australian Government and State funding arrangements in relation to protection of high conservation value rivers *(agreed and followed)*
31. Timelines need to be developed for implementation *(agreed and could be considered by interjurisdictional steering committee).*
32. Accountability of Australian Government and State is important for implementation of a national framework *(agreed and followed).*
33. There is currently sufficient information to implement a national framework even if it is fragmented and not easy to access data *(agreed and followed).*
34. Need scientific based objective assessment with community endorsement and support for whole river basin protection (*agreed and followed*).
35. Important to ensure that there is jurisdictional commitment to accessing all available databases *(agreed and followed).*

36. There is general consensus that Wild Rivers was not effective in protecting high conservation value rivers but no analysis of why it and other attempts have not worked *(this issue is difficult because of the large scales, inter and intra- jurisdictional responsibilities and potential impacts on users. We believed we had sufficient experience to provide a way forward in protection of high conservation rivers)*.
37. There is no explanation of how the national framework will foster involvement, understanding and commitment and yet this is an important element *(agreed—this has been done through recognition of jurisdictional investments and using incentives as well as controls for protection).*
38. It would be of value for pilot assessments to be done with rivers considered to be of low conservation value and high conservation value in different regions of Australia *(agreed).*
39. Nomination of protected river systems will be political decisions rather than technical ones (*agreed but we need to allow for objective analysis of likely candidates*).

ALP Discussion Paper

Protecting and Restoring Our Precious Natural Environment and Water Supplies

Anthony Albanese MP
Shadow Minister for the Environment and Heritage
Shadow Minister for Water

6 December 2006



CONTENTS

EXECUTIVE SUMMARY

A healthy environment is essential to our economy and the living standards which future generations of Australians will enjoy.

Our magnificent landscapes and wildlife are the heritage of all Australians.

After ten years of neglect by the Howard Government, Australia's natural environment is under enormous pressure.

The *2006 State of the Environment Report* confirms climate change is real and is happening now. Nearly all the measures of Australia's environmental health are going backwards.

Healthy river systems and waterways contribute to sustainable communities and strong economic growth. Where there is water, there is life – and when the water dries up, towns close and businesses leave. However, Australia's precious water systems remain over-allocated, undervalued and misdirected.

According to the Murray Darling Basin Commission, Australia is facing a 1 in 1000 year drought. Perth's water supply catchments are yielding 50% less water than in the mid 1970s.

Climate change and water are two sides of the one coin, and Australia desperately needs a strategy for both.

Climate change is cutting the precious water supplies for Australia's cities and towns and the once mighty Murray River is at its lowest level since records started 100 years ago**,** reduced to a trickle in some places. A quarter of Australia's surface water management areas are close to or have exceeded sustainable extraction limits.

Australia is facing a plant and animal extinction crisis.

Twenty per cent of our species are threatened with extinction by the end of this century and the number of terrestrial bird and animal species listed as extinct, endangered or vulnerable rose by 41 per cent from 1995 – 2005. Australia 'leads' the world in mammal extinctions.

According to the 2006 State of the Environment report, Australia has 56% of its vegetation in its river systems and wetlands.

Some of our outstanding protected areas are under-managed, and even the most remote are threatened by a nationwide problem of invasive plants and animals.

Climate change will worsen this situation, with a potentially devastating impact on our natural environment and precious water resources. We could lose many of our majestic wetlands, including those in Kakadu, and we could lose up to 50 per cent of the Wet Tropics rainforests. According to the Science journal *Nature*, more than 90 Australian animal species are at risk from climate change.

Dryland salinity is spreading like a cancer through our productive lands. Currently, dryland salinity is damaging 5.7 million hectares, and 17 million hectares of productive Australian land could be afflicted by dryland salinity by 2050.

Ten Years of Inaction by the Howard Government

The Howard Government has no plan to address Australia's significant environmental challenges. Despite being in office for ten years, the Howard Government has failed to halt the decline in our natural environment and best agricultural land.

Australia's environment is suffering because the Government is not focused on sustaining it for future generations. To make matters worse, there is a lack of national targets for environmental improvement and a lack of accountability for the expenditure of significant amounts of taxpayers' money. The Government hasn't got its priorities right, and environmental outcomes aren't being delivered on the ground.

These are critical national challenges, but the Howard Government has failed to provide national leadership.

A streamlining of administration is needed, rather than the creation of more tangled bureaucracy. There is an argument for the establishment of a single agency to coordinate Commonwealth water, land and biodiversity programs and policies, ensuring that money allocated delivers environmental benefits.

Labor's Plan

Labor has an alternative vision for Australia – a healthy environment and a healthy economy.

Labor is committed to immediate and long term action to restore our natural environment and water resources. Labor will:

- deliver a healthier environment through a comprehensive and integrated land, water and biodiversity program;
- provide greater accountability for the expenditure of taxpayer funds through the establishment of national targets for environmental improvement and the creation of a National Sustainability Council;
- ratify the Kyoto Protocol and take action within Australia and internationally to help avoid dangerous climate change;
- bring the once mighty Murray River back to life by putting 1,500 gigalitres per annum back into the Murray within ten years;
- protect our wild rivers;
- establish a national water recycling target of 30% by 2015;
- end large scale land clearing;
- consider introducing a national environmental stewardship program;
- address Australia's plant and animal extinction crisis by making the protection of our unique biodiversity a national environmental priority;
- protect our coasts and beaches by establishing a national coastal policy, investing in high conservation value areas and, where possible, opposing inappropriate development;
- support the expansion of a national system of land and marine protected areas covering public and private lands and Indigenous lands and sea country; and

- encourage corridors of conservation efforts to maximise the possibilities of plants and animals coping with climate change.

This discussion paper outlines Labor's draft proposals for long term action to restore our natural environment and precious water systems.

The policy options in this paper are not exhaustive, nor are they necessarily Labor Party policy. Responses to the policy options will be important in finalising Labor's policy.

Natural resource management in the context of this paper means the ecologically sustainable management and use of Australia's water, biodiversity and land for the benefit of current and future generations. It covers the full spectrum from conservation management of reserves to sustainable agriculture.

This discussion paper has links to other Labor policies and discussion papers. These include:

- *Building Australia: Labor's Infrastructure and Investment Blueprint* (Kim Beazley MP, 24 November 2005)

- *Australia's Future Cities* (ALP Discussion Paper December 2005, released by Senator Kim Carr)

- *Protecting Australia from the Threat of Climate Change. Blueprint Number Six* (Kim Beazley MP, 7 March 2006)

- *Meeting the Challenge of Coastal Growth* (ALP Discussion Paper May 2006, released by Anthony Albanese MP and Jennie George MP)

- *Regional Development* (speech by Simon Crean MP to *Australian Financial Review's Developing Australia's Regions* Conference, 19 July 2006)

- *Labor's Innovation Blueprint* (Kim Beazley MP, 10 July 2006)

- *Australia's Water Crisis: Planning for Future Sustainability* (speech by Anthony Albanese MP to *Australian Financial Review's National Infrastructure Summit*, 23 August 2006)

The discussion paper also takes into account the conclusions of two recent Federal Government reports, *Review of Arrangements for Regional Delivery of Natural Resource Management Programmes* (the Keogh Review - 1) and *Creating our Future: agriculture and food policy for the next generation* (the Corish Report - 2).

Responding to the Discussion Paper

We welcome your feedback on this discussion paper. We particularly invite feedback on the role of the Commonwealth Government in protecting and restoring our precious natural environment and water supplies and on the draft proposals outlined in this paper.

How to provide feedback:

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HOWARD'S LEGACY: A DECAYING ENVIRONMENT

Responsibility for Australia's land, water and biodiversity is shared between the Commonwealth and State and Territory Governments. However, the Commonwealth Government is increasingly involved in land and water management issues through the Council of Australian Governments, through legislative reform and through joint Commonwealth-State funding programs.

Under the Hawke and Keating Labor Governments, a comprehensive national approach to land and natural resource management in Australia was developed. These initiatives included an Intergovernmental Agreement on the Environment and a National Strategy for Ecologically Sustainable Development.

While the Howard Government has introduced the National Water Initiative (NWI), the National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (NHT), it is clear from a series of reports and evaluations (3) that the state of Australia's environment has deteriorated since 1996.

The 2006 *State of the Environment Report* confirms Australia continues to lose ground in protecting its natural environment.

- Greenhouse emissions are set to rise by 22% of 1990 levels by 2020;
- Ocean temperatures increased 0.28 degrees Celsius since 1950;
- The last 5 years has seen lower than average rainfall over eastern Australia.
- Perth's water supply catchments yielding 50% less water than in the years before the mid-70s.
- Australia has lost 56% of its vegetation in river systems and wetlands.
- 20 new pests and diseases are introduced each year into Australia.

The 2006 *Measures of Australia's Progress* report, published by the Australian Bureau of Statistics, indicates that:

- Australia's biodiversity has declined in the past decade;
- The number of terrestrial bird and mammal species listed as extinct, endangered or vulnerable rose by 41% between 1995 and 2005;
- In 2000, about 5.7 million hectares were assessed as having a high potential to develop dryland salinity;
- In 2000, about one-quarter of Australia's surface water management areas were close to, or had exceeded, sustainable extraction limits.

In total, some $6 billion has been allocated to the NHT, NAP and National Water Initiative between 1996 and 2010. Despite this, nearly all the indicators of environmental health are going backwards. This represents a significant policy failure by the Howard Government.

Environmental outcomes are not being delivered because the Government is focussed on short-term politics, not the environmental health of Australia. There is a lack of strategic vision, national targets and performance indicators.

The Liberal Party Chair of the House of Representatives Standing Committee on Environment and Heritage, Dr Mal Washer, criticised this lack of national leadership on 4 September 2006:

> *"what has become clear to this Committee…is the void that exists when it comes to national leadership on…wider environmental performance issues"*

The Australian Conservation Foundation (ACF) has expressed its concern about the effectiveness of the Government's environmental programs (4):

> *"It is not at all clear that Australia's rural landscapes are on track to sustainability as a result of the…NAP and NHT."*

The deterioration of Australia's natural resources under the Howard Government is also shown by the 2001 State of the Environment Report which includes comments on the state of Australia's environment between the period of 1996 and 2001 (3).

The 2001 Report stated:

- "there is still a net loss of vegetative cover"

- "surface water quality has deteriorated further in many areas because of increasing salinity"

- "Many of the key threats to biodiversity identified in State of the Environment (1996) still persist".

More importantly, Australia's rural industries and the natural environment are at great risk because of the Howard Government's wilful refusal to recognise the accelerating threat of climate change.

Failure to Address Climate Change

Australia is being affected by climate change right now.

Scientists agree that climate change is making Australia hotter and drier. The 10 hottest years ever have occurred in the last 14, and 2005 was the hottest year on record. August and September 2006 were the hottest and driest months ever, meaning lower dam levels and increased bushfire risk.

Rising sea levels threaten our Pacific neighbours and Australia's coast.

The number of Category 4 and 5 cyclones have doubled in the last 30 years.

The 2006 grain harvest was cut by 36% due to reduced rainfall and ongoing drought, reducing Australia's export income by $2 billion.

According to the CSIRO and the Government's own reports, if action is not taken:

- Temperatures could rise by 2ºC by 2030 and up to 6ºC by 2070 cutting food and water supply, and increasing the spread of dangerous disease.

- By 2030 water supply for cities will drop by 25% while population has increased by over 20%.

- Rising sea levels will damage the Australian coast.

- The Great Barrier Reef could be devastated by coral bleaching, losing one of Australia's great environmental and economic treasures.

- Half of North Queensland's upland rainforests could disappear.

- Kakadu's wetlands will be destroyed.

- National parks, which remain Australia's most important tourism asset for a $70 billion industry, could be fundamentally degraded.

Between 1990 and 2004 Australia's greenhouse gas emissions rose by 25.1%, excluding the decisions of the New South Wales and Queensland governments on land clearing.

Faced with these facts, a responsible Government would put in place strong measures to cut Australia's greenhouse pollution, however the Howard Government has no strategy to cut emissions and no plan to minimise the impact of climate change.

The Howard Government has refused to ratify the Kyoto Protocol and refused to set a national target for reducing greenhouse pollution, introduce a national emissions trading scheme or increase the Mandatory Renewable Energy Target.

The Howard Government has failed to develop a climate change adaptation strategy to help conserve and manage our precious land, water and biodiversity.

Climate change is an economic and environmental challenge, and delaying action will only increase the economic costs.

Conversely, taking action now will bring economic benefits and build a more productive and sustainable resource base.

The Australian Business Roundtable on Climate Change found early action to address climate change would mean 250,000 more jobs would be created than if action were delayed.

Other economic costs from climate change come in the form of higher insurance premiums, water shortages and restrictions, heavier burdens on the bush as droughts become the norm, rising food prices as a result of the drought, rising oil prices as a result of extreme weather events, damage to national treasures like the Reef and Kakadu and the spread of tropical diseases.

All around us, other governments and business are taking the lead, while the Howard Government relegates us to a back seat, isolating Australia.

Failure to Address Our Water Crisis

One of the Howard Government's greatest natural resource management failures has been its failure to address our water crisis.

The National Water Commission has stated "*the risks to Australia's water resources are increasing, especially in the form of reduced reliability due to long term changes in climate, and growing demand*". (5)

There is a political drought in Commonwealth Government water policy. The announcement of a new Office of Water Resources adds another layer of bureaucracy to an already complex web of bureaucracy, which has failed to deliver results on the ground.

1. Murray Darling Basin

The Howard Government has stood on the sidelines for a decade while the health of the Murray River has declined and our cities and towns have become drier. The Murray is at its lowest level since records started 100 years ago.

In 2006, inflow to the Murray is at a record low 550 gigalitres, compared to the long term average of 11,200 gigalitres. Without further inflows, the Murray storages will be effectively empty by the end of the irrigation season in April 2007.

A repeat of 2006/07 inflows to the Murray will pose a critical situation for Adelaide and other South Australian towns dependent on the Murray.

Not one extra drop of water has been sent down the River Murray as a result of the Howard Government's Living Murray initiative.

The Howard Government has made announcement, after announcement, after announcement but hasn't delivered the results on the ground.

In November 2003 the Howard Government promised to give the Murray 500 gigalitres (billion litres) within five years.

In July 2004, the Prime Minister told the people of Adelaide:

> *"there is no issue long-term that is more important to many people in South Australia than to get the River Murray flowing again…we are able to see the way ahead [to]…the day when the water will flow more freely again…You deserve it, and you've been delivered it" (Address at Hindmarsh Community Morning Tea, 7 July 2004).*

They certainly deserve it, but they haven't been delivered it.

To be "a healthy working river" the Murray River needs 1,500 gigalitres more water per year. That's the view of the Expert Review Panel appointed in 2001 by the Murray Darling Basin Commission.

Labor is committed to putting 1,500 gigalitres per annum back into the Murray within ten years.

2. Urban water

Addressing Australia's national water crisis is an urgent task, requiring leadership and action from all levels of Government, especially from the Commonwealth.

Our cities and towns face severe water constraints, but the Howard Government has done little to help for ten years. There's no national strategy for our cities, no Better Cities program, no real infrastructure support. There's no national water recycling program, no national urban water policy and no strategy to help our urban waterways.

The urban water reform section of the National Water Initiative has been sidelined by the Howard Government for the last three years. National targets, guidelines and investment in water recycling are needed to get the National Water Initiative out of its political and bureaucratic swamp.

The National Water Initiative has the potential to address some of these issues. Its stated objective is to create more certainty for water users that would result in more productive use of water, healthy rivers and aquifers, and a self adjusting water trading system that is fair to all users. To date, however, the Howard Government has had a confused position on water trading, with Ministers openly advocating different views.

The Failure of Natural Resource Management Programs

The Commonwealth Government's principal national natural resource management programs include: the National Water Initiative, the National Action Plan for Salinity and Water Quality, the Natural Heritage Trust, the National Landcare Program, the Murray- Darling Basin Initiative and the National Reserve System Framework.

Although these programs are targeting similar problems, the programs have different structures, different departments, different Ministers, different accountability mechanisms and different timelines. The Natural Heritage Trust and the National Salinity Action Plan are administered jointly, but still operate as separate programs.

The lack of coherence in programs means there is more red tape than water going into the Murray, and there is a lack of commitment and consistency in addressing the overarching problem of climate change.

Australia's water, biodiversity and land resources need to be administered in a comprehensive and integrated manner if we are going to restore our degraded natural resource base. The Howard Government's natural resource management programs fail to do this.

Water is dealt with under three programs, salinity under a separate program and for our important coastal areas, the Howard Government has no policy.

There is an argument for the establishment of a single agency to coordinate Commonwealth water, land and biodiversity programs and policies.

Restoring our water, biodiversity, and land resources will take time, particularly when climate change impacts are factored in. It will take many decades, before Australia's natural resources are restored to an acceptable state. Labor acknowledges this.

Our criticism of the Howard Government is that they have the wrong programs, they are badly coordinated, unaccountable, badly targeted and inefficient. The Government is not doing enough to counteract the impact of climate change on water supplies, biodiversity and land. As a result, vast amounts of taxpayer's money are spent without clear national targets, timetables and performance indicators.

Restoring our natural resources will take even longer unless Government programs and administration are dramatically changed.

Apart from some Parliamentary inquiries, there has not been a large, independent inquiry on natural resource management in Australia for many years. Most natural resource management assessment reports (6,7) have been done in-house, undertaken as a result of government commissions and consultancy requirements and hence lack some independence and do not look at big picture questions.

The 2001 and 2006 State of the Environment reports highlight serious shortcomings, but the Government appears to be ignoring the alarm bells.

The Government has failed to examine the extent to which natural resource management programs are delivering environmental outcomes. Instead these reports focus on changes to the margins of existing programs and when they have contained constructive criticism they have been dismissed. Most critically, the government has failed to initiate any major studies on the impact of climate change on our precious water, land and biodiversity.

The Keogh Review found "*overwhelming support for the regional delivery of NRM across Australia*". It noted that natural resource management "*is an issue of national importance and worthy of a continued and sustained commitment from the Australian Government*". However, it also found key land managers, including primary industry and local government "*are yet to be fully engaged*" in natural resource management.

Importantly, except in limited circumstances, the Keogh Review was unable to outline the environmental achievements of the Government's natural resource management programs. The Keogh Review notes that regions are crying out for more direction from government in natural resource management. It notes "*the areas where they are particularly keen to have greater direction are in governance arrangements, target setting and project reporting [and] determining priorities for investment*".

Toyne and Farley (8) suggested that a process such as the Hawke Government Resource Assessment Commission should be restored, to give Federal Cabinet an independent view which could be drawn on in taking major resource decisions and in developing new natural resource management policies.

Labor will encourage and listen to independent voices. We will rebuild the CSIRO and guarantee its integrity. Unlike the Howard Government's manipulation of CSIRO for its own ends, Labor will restore and maintain scientific integrity as the primary focus of the CSIRO. No more Ministerial gagging of CSIRO scientists; no more appointments to the Board from lobby or interest groups.

LABOR'S APPROACH

In the face of the increasing impacts of climate change on Australia's environment and economy, and the failure of the Howard Government's natural resource management programs to reverse the deterioration of our water, biodiversity and land, a new national approach to sustaining our natural resources is urgently required.

Labor has an alternative vision for Australia – a healthy environment and a healthy economy.

Labor is committed to immediate and long term action to restore our natural environment and water resources. Labor will:

- deliver a healthier environment through a comprehensive and integrated land, water and biodiversity program;
- provide greater accountability for the expenditure of taxpayer funds through the establishment of national targets for environmental improvement and the creation of a National Sustainability Council;
- ratify the Kyoto Protocol and take action within Australia and internationally to help avoid dangerous climate change;
- bring the once mighty Murray River back to life by putting 1,500 gigalitres per annum back into the Murray within ten years;
- protect our wild rivers;
- establish a national water recycling target of 30% by 2015;
- end large scale land clearing;
- consider introducing a national environmental stewardship program;
- address Australia's plant and animal extinction crisis by making the protection of our unique biodiversity a national environmental priority;
- protect our coasts and beaches by establishing a national coastal policy, investing in high conservation value areas and, where possible, opposing inappropriate development;
- support the expansion of a national system of land and marine protected areas covering public and private lands and Indigenous lands and sea country; and
- encourage corridors of conservation efforts to maximise the possibilities of plants and animals coping with climate change.

Responsible and prudent management of Australia's environment requires the impact of known climate change risks to be factored into policies and decisions relating to water, biodiversity and land.

We need a comprehensive, integrated and long term approach to the management of Australia's water, biodiversity and land resources in rural and urban areas, including coastal lands. This must encompass the impacts of climate change, but also provide innovative measures to reverse current natural resource degradation and ensure our land and water resources are sustainably managed for the future.

Labor's approach will deliver national leadership and ensure the achievement of national goals and priorities within a regional approach.

Labor’s approach will deliver appropriate pricing of our precious energy and water resources in recognition of their finite nature. We will give greater prominence to the use of market based instruments; payment for stewardship services; leverage of ecologically sustainable private land use investments; backed by a strong regulatory framework.

Labor will act before it is too late, giving proper emphasis to protecting our unique biodiversity.

Labor’s approach to natural resource management will also correct the Howard Government’s lack of interest in our precious coastal lands and the neglect of our urban environment.

Labor will ensure that key rivers and waterways are protected and that sustainable solutions are put in place to address the critical water security issues facing urban and rural Australia.

National Vision and Goal

Labor will seek to ensure Australia’s precious natural environment and water systems, our globally significant biodiversity, and our productive land are maintained in an ecologically sustainable basis into the future.

Options for achieving that vision include:

- Mitigating and responding to the impacts of climate change;
- Establishing through a comprehensive and integrated natural resource management policy, management systems that maintain our water, biodiversity and land in an ecologically sustainable state;
- Setting national goals and targets for restoring our precious natural environment and water supplies, establishing priority areas for protection and restoration and ensuring proper reporting of progress against national benchmarks;
- Providing strong Commonwealth Government policy leadership and direction in environment and resource management and working with the States and Territories to achieve high standard outcomes;
- Ensuring Commonwealth spending is directed toward maximising public environmental benefits;
- Supporting regulatory approaches where required;
- Maintaining and enhancing community and regional group action as well as individual action directed at ecologically sustainable water, biodiversity and land management;
- Encouraging a major involvement of Indigenous people in land and sea resource protection and management;
- Providing a policy environment that encourages private sector investment in ecologically sustainable water and land use;
- Promoting market based instruments with pricing that reflects the finite nature of our natural resources; and
- Establishing effective monitoring and evaluation systems and promoting targeted scientific research in order to provide accurate knowledge of the state of our water and land and the outcomes of Government and non-government management interventions.

Ecological Sustainability

Labor is committed to national leadership in ecological sustainability. Labor will consider developing an Ecological Sustainability Policy to help guide our natural resource management policy and provide a supporting institutional arrangement.

Labor will develop, with States and Territories, a National Sustainability Charter that sets key national targets across a number of areas which impact on Australia's environmental, social and economic sustainability, including water, biodiversity and land management.

Labor will establish an independent statutory National Sustainability Commissioner and Council to monitor and drive Australia's performance against sustainability targets and to evaluate Commonwealth Government policies in terms of their impact on ecological sustainability and agreed national targets.

Labor will explore the concept of incentive payments to State and Territory Governments to support the achievement of targets identified in the National Sustainability Charter.

The National Sustainability Council could establish high level time bound targets which are outcome focussed for our water, biodiversity and land management and use. These goals and targets would directly apply to Commonwealth responsibilities, but would also be relevant to the states and territories and regional bodies.

The National Sustainability Council could conduct high level inquiries into national natural resource management issues and report to relevant Commonwealth Ministers and to the Parliament, as well as possibly to COAG. The Council could also report periodically on performance against the targets and be responsible for producing periodic State of the Environment reports.

Labor is committed to sustainable regional development, underpinned by four regional development priorities:

1. Restoring the role of the Commonwealth in regional development;

2. Supporting a location-responsive approach to regional development;

3. Addressing market failures in our regions including infrastructure bottlenecks and skill shortages; and

4. Ensuring the economic, social and environmental sustainability of our regions and natural resources base

Labor's Approach to Natural Resource Management

Labor's commitment to long term action to restore our natural environment and precious water resources is underscored by a strong commitment to maximise the impact on the ground of every dollar of taxpayers' money that is spent.

Labor supports community involvement and the regional delivery model, and it is critical that the national objectives in providing funding to communities are clear and guide projects.

Unless there are clear statements of national objectives and accountability mechanisms, the Commonwealth's objectives may not be effectively delivered.

Key elements of Labor's model for natural resource management program delivery could include:

1. **Stronger Commonwealth leadership and direction.**

Addressing the crisis affecting the nation's water, biodiversity and land resources requires strong Commonwealth leadership.

The Commonwealth could identify high value natural areas (including biodiversity, water and coastal areas) which will guide Commonwealth funding decisions, but also provide a mechanism for the operation of the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) through the possible establishment of new matters of national environmental significance.

The Commonwealth should lead in ensuring Australia meets its international obligations on the protection of the environment, including World Heritage sites and Ramsar listed wetlands, and targets under the Convention on Biological Diversity.

Under Labor, the Commonwealth will be more active in ensuring its national program goals and priorities are met. The Commonwealth, through representation on the regional boards, would make it a requirement that taxpayers funds are allocated to national priorities, taking into account regional input.

2. **Integrated delivery of funds and programs through national, regional and local/community streams**.

As far as possible, programs dealing with water, biodiversity and general land issues such as salinity and sustainable agriculture for rural inland, coastal and urban areas would be delivered in an integrated manner. There would be close links between the National Water Initiative and other natural resource management programs.

Under the Howard Government, biodiversity conservation has not been well integrated into the Government's natural resource management program delivery. The Terrestrial Biodiversity Assessment found that effective integration of biodiversity has only occurred in 1.5 per cent of biodiversity sub regions.

Responsibility for the administration of all natural resource management programs (water, land and biodiversity) could rest with a single Minister. At present, responsibility is split between three Ministers, a Parliamentary Secretary and the Prime Minister, with limited accountability for the expenditure of taxpayer funds.

A streamlining of administration is needed, rather than the creation of more bureaucracy. There is an argument for the establishment of a single agency to coordinate Commonwealth water, land and biodiversity programs and policies, ensuring a much higher percentage of taxpayer money is directed toward on the ground environmental protection. This must be integrated with action on climate change.

Labor will consider strengthening the national priority funding stream to ensure national environment and natural resource priorities are properly supported. This funding stream could be directly delivered by the Commonwealth.

Labor recognises the important contribution that community groups make to conservation and natural resource management. It was the Hawke/Keating Labor Government which created the successful Landcare initiative, a showcase for community action in restoring our land, which now includes around 130,000 people in about 4,500 groups.

Labor supports the regional delivery model and would consider providing targeted funding through a single reformed regional delivery model.

WATER

> *"The Murray-Darling is Australia's greatest river system, a basic source of our wealth, a real and symbolic artery of the nation's economic health, and a place where Australian legends were born. Nowhere is the link between the Australian environment, the Australian economy and Australian culture better described."*
> *(Paul Keating, 21 December 1992)*

Labor's Record

Labor has been at the forefront of water reform in Australia. In 1973 it was the Whitlam Labor Government, with Premiers from South Australia, Victoria and NSW, which initiated the River Murray Working Party. This was the first time governments looked at water quality and salinity in the Murray Darling basin.

Labor played a critical role in the establishment of the Murray Darling Basin Ministerial Council, which was the first body to look at the Murray-Darling Basin from a catchment-wide perspective.

In 1994, further significant water reforms were initiated when the Keating Labor Government and State Premiers agreed in COAG to develop a more competitive water industry, and included broad issues of water management including allocations of water to the environment.

Paul Keating understood that the great Murray River was being exploited, and was dying. He funded the Murray Darling Basin Commission to undertake the structural reform necessary to protect the Murray Darling system, to model the social, economic and environmental impacts of its exploitation, and to determine how that could be turned around.

While some of these reforms have been continued by the Howard Government, the ongoing problems of salinity, the developing impacts of climate change and the growing water shortages all point to a failure in water management.

Need for National Leadership

Addressing Australia's national water crisis is an urgent task, requiring leadership and action from all levels of Government, especially from the Commonwealth.

Just as Australia's water crisis presents an economic, social and environmental danger, it also presents an opportunity to shatter our complacency that fresh water is an infinite resource.

There is one fact which governs the development of water policy in Australia and investment in water infrastructure - while Australia has enough water, it's a long way away from where most Australians live.

Australia's water resources are highly variable and range from heavily regulated rivers and groundwater resources, to rivers and aquifers in almost pristine condition.

Over 65% of Australia's water runoff is in the sparsely populated tropical north.

But Australia's large urban areas are in southern Australia and irrigated agriculture is principally located in the Murray Darling Basin, where only 6.1% of the national run-off occurs.

Climate Change and Water

Climate change means declining rainfall in southern Australia - the evidence of which we see most spectacularly in Western Australia. Climate change will cut rainfall and increase temperatures. Australia will have less water and more will evaporate.

The Bureau of Meteorology believes that climate change is one of the main reasons for the long trend of dry weather and that it is contributing to the drought.

As scientists Chartres and Williams state: "*The evidence is that climatic change will increase the difficulties Australia faces to secure adequate water supplies for cities and irrigation*" (1).

Climate change severely threatens Australia's inland water environment and the viability of irrigated agriculture and other industries. The Howard Government's water policies do not take into account threats to water quantity and quality posed by climate change.

Failure to Address Water Crisis

Dr Shabaz Khan of CSIRO Land and Water (9) has highlighted the current failures on water management:

- "Under the present water reforms longer-term water security is not guaranteed since these reforms do not explicitly take into account threats to water quantity and quality due to enhanced climate variability and change."
- "There is a need for Australian water legislation and policy to be revisited to incorporate innovative climate change and adaptive management options to promote urban water use and efficiency."
- "Given our small population base the recurring water scarcity points towards inadequate water policy and management."

As a nation, Australia has never really valued water. Our water supplies have been taken for granted: undervalued, over-allocated, and misdirected.

The Wentworth Group of Concerned Scientists stated five guiding principles for the foundation for a National Water Plan (10):

1. All Australians have a right to an adequate supply of safe water for domestic use;
2. We all have a responsibility to use water efficiently;
3. Our rivers, groundwater systems and landscapes must be managed to maintain the health of our ecosystems so they can provide for the variety of current and future human needs;
4. Those who use fresh water to create wealth need investment security and should take responsibility for their part in sustainable water management; and
5. Australians must become water literate and understand the effects that water use has on our environment and other people.

The Howard Government is failing against these principles. The Prime Minister's speech on energy and water to the Committee for Economic Development of Australia (11) offered no new measure to assure Australians of a water secure future.

National Water Initiative

The principles behind the National Water Initiative are sound. They emphasise the need for cooperative effort and highlights the importance of community education about the critical water balance of this nation. The NWI recognises the importance of investment in water infrastructure to deliver efficiencies and water savings and it acknowledges the social, economic and environmental aspects of water policy.

The National Water Initiative puts public and environmental needs into an economic system – it attempts to establish structures to manage growing demand for water and a diminishing supply, in a way that uses water efficiently and productively.

There is a direct connection between our water and climate change, and there is a synergy between developing trading systems for water and carbon. The truth is we need to get the price right for all our natural resources.

If we promote market based solutions with pricing that reflects the finite nature of our natural resources then significant productivity and environmental gains can be achieved.

Despite national water reform being touted as a priority for the Howard Government, in practice there is little to show for it over the past 10 years. River systems, and in particular the Murray Darling system, are thirsty for water - yet water trading has hardly progressed.

The National Water Initiative remains deficient in a number of areas:

- Slow pace in securing investor confidence in water title arrangements and in the establishment of a water trading system.
- Negligible action on returning environmental flows to inland water systems.
- Not providing a means for protecting Australia's heritage rivers.
- Negligible consideration of water quality factors.
- Neglect of the serious water supply issues in Australia's capital cities.
- Neglect of climate change considerations.

The Wentworth Group of Concerned Scientists in their 'Blueprint for a National Water Plan' (10) recommended to COAG that "*the environmental needs of Australia's rivers [should] have guaranteed first priority call on water required to keep them healthy*." This priority has been lost under the Howard Government. Labor will give environmental flows the priority required.

Labor will ensure that National Water Initiative water planning is integrated into overall natural resource management planning.

Water for Regional Australia

Progress with improving approaches to water prices and in setting up a system of tradeable water rights has been disappointing.

In partnership with State and Territory Governments, Labor will work towards establishing a timetable for achieving the COAG water pricing principles.

Efficient water markets should reflect resource constraints and scarcity and should enhance the longevity of rural communities through more sustainable practices. Water markets also appear to be more cost effective mechanisms for returning environmental flows (34). As suggested by the Government's own Productivity Commission (12) the Howard Government has focused on infrastructure improvement, to the exclusion of market based instruments.

Labor supports investment in infrastructure, but believes the establishment of economic frameworks is critical to achieving long term objectives.

A Labor Government would use the most cost effective mechanisms for achieving environmental flows, and would use the water purchase mechanism if this appropriate.

Floodplain harvesting and cropping works on floodplains is of great concern to many farmers and environmentalists.

Floodplain harvesting and cropping can significantly stress rivers and wetlands and damage communities and the operations of other water users downstream that rely on healthy ecosystems, such as appears to be occurring with floodplain graziers around parts of New South Wales.

This ongoing and often unregulated capture of water, at low or zero cost, and at the expense of downstream rivers, wetlands and other water users may not be consistent with the National Water Initiative.

Governments could consider measures to cap the level of floodplain harvesting and where the floodplain harvesting is ecologically unsustainable, water could be recovered and returned to the environment using the full suite of water recovery mechanisms set out in the National Water Initiative.

Labor will consider enhancing on-line monitoring of water flows and farm demand in regional Australia with a view to improving irrigation efficiency and making more water available for environmental flows. This could assist in releasing more water into rivers at times of higher rainfall thus providing additional water at terminal parts of river systems, such as the Coorong, which are the river areas that are most severely degraded and most severely affected by drought.

Many regional towns and settlement are also facing chronic water supply problems. Labor will ensure that regional towns are a key part of both our regional and urban water policies.

The Murray Darling Basin

The Howard Government is failing to protect the Murray River. In November 2003 the Howard Government promised to give the Murray 500 gigalitres within five years. So far not a single drop has actually been returned as a result of the Living Murray First Step program.

To be “a healthy working river” the Murray River needs 1,500 gigalitres more water per year. That’s the view of the Expert Review Panel appointed in 2001 by the Murray Darling Basin Commission.

Labor is committed to returning 1,500 gigalitres per annum back into the Murray River within ten years.

Climate change will have major impacts on the Murray. The Intergovernmental Panel on Climate Change suggest that water flows to the Murray could decrease by as much as 35 per cent by 2050 (13).

An August 2006 report from the Murray Darling Basin Commission advised that flow into the Murray system in July 2006 of just 130 gigalitres instead of the long term July average of 1,400GL is the lowest since records began in 1891. The report also states that “*the River Murray system is now entering its sixth consecutive year of drought, which is collectively shaping to be the worst since that observed between 1895 and 1903*” (36).

The Howard Government appears to be putting its faith in infrastructure improvements in irrigation areas as a way of obtaining the 500 gigalitres, rather than focussing on establishing a market mechanism whereby government can buy allocations and return water to the Murray. However the Productivity Commission has questioned this approach suggesting that water savings through improvement to infrastructure could be illusory (13, 14, 15). Instead the Commission suggests that the Living Murray Initiative could be more effective if existing water sourcing arrangements were supplemented by market mechanisms such as trading allocations.

The Howard Government is dangerously split on this issue of how to return water to troubled rivers.

In relation to the Murray River, the Prime Minister's web site refers to purchase of water on the market, with recovered water to be set aside for environmental purposes. However, the Minister for Agriculture Peter McGauran was reported (16) as dismissing proposals to buy water for environmental purposes.

In a speech in Adelaide on 28 April 2006, the Parliamentary Secretary for Water, Malcolm Turnbull, stated in relation to the Living Murray Initiative:

> "*To date, the focus has been on funding water efficiency infrastructure projects to be presented by the States. Only one project has reached a point where investment can be committed. At the current rate of progress, it is likely that we will miss the 500 GL target by at least 200 GL or more.*"

As of November 2006, the Howard Government has not spent one dollar of Murray River funds for purchasing water.

Regrettably, in September 2006, the Parliamentary Secretary for Water backed away from his previous support for purchasing water for environmental flows.

Labor will reinvigorate progress towards setting up a market for water allocations in the Murray Darling Basin, so as to return 1,500 gigalitres to the Murray as efficiently as possible.

Labor will give consideration to the need for a 'Living Darling' initiative, similar to the 'Living Murray' initiative and strongly supports the current work of the Murray Darling Basin Commission on this matter. Labor would also consider options for enhancing the sustainability of Menindee Lakes, a chain of natural lakes in far west NSW covering more than 500 square kilometres. Coupled with the prolonged drought, Menindee Lakes is experiencing the longest zero inflow for 100 years. Action needs to be taken to consider the best future for the Menindee Lake's system.

Water for Urban Australia

The National Water Commission stated in its July 2006 report to COAG:

> *"Work should be directed at supporting – rather than distracting from – the important work already underway by most State and Territory Government to secure the water supplies of highly populated regions."*

The truth is, the Howard Government has paid little interest in urban water issues. Urban water management gets limited coverage in the National Water Initiative.

The Prime Minister has suggested Australians shouldn't tolerate water restrictions. Labor's approach is very different. Demand management for water is important, and water restrictions help raise awareness of how precious water really is.

For a Government that has been in power for 10 years and claims to have water as a high priority this urban water neglect is a failure of policy. In most capital cities surface reservoirs were less than 50% full in winter of 2006.

The Parliamentary Secretary for Water, Malcolm Turnbull (17) has advised that on current projections, demand is projected to exceed supply from existing water sources in nearly all major Australian cities within 20 years and in most cities there are limited opportunities for new dams.

Labor considers urban water is vital and will ensure the National Water Initiative prioritises urban water, with the aim of ensuring sustainable water security for all of Australia's human settlements- capital cities, large regional centres and smaller regional towns and settlements.

Conservation of Rivers and Wetlands

Given Australia is the driest inhabited continent and is threatened by climate change, our rivers and wetlands are a precious resource. Sadly, many of our rivers and wetlands are in a degraded condition.

Despite a National Water Initiative commitment to identify freshwater ecosystems of high conservation values and manage these systems to protect these values, the Howard Government has done little to fulfil this commitment.

There is no national program on freshwater ecosystems of high conservation value. Approximately half of the 64 Australian wetlands inscribed on the Ramsar list have management issues and a quarter of the 64 sites have serious issues.

Labor's Approach

Labor would re-energise the national government's approach to water management.

Labor's policy on water has as its cornerstone meeting the water security needs of Australia's people and environment in an ecologically sustainable manner and as efficiently and productively as possible.

To that end, Labor will

1. Set a national target of 30% of wastewater being recycled by 2015.

2. Develop consistent, comprehensive national guidelines for water recycling. This is critical for building public confidence in recycling and increasing water security in all urban areas.

3. Provide the leadership, support and investment necessary to achieve the 30% recycling target.

4. Encourage innovation and new technological solutions to deliver a sustainable water supply for Australia.

5. Return 1,500 gigalitres per annum back into the Murray within ten years.

Federal Labor has called on the Federal Government to immediately commit up to $500 million from the $2 billion Australian Water Fund to support the Queensland Government's Western Corridor Recycled Water Scheme.

If the Howard Government does not commit funding to this important nation-building project, and there is funding available in the Australian Water Fund, a Federal Labor Government will go ahead with the project in partnership with the Queensland Government.

A Federal Labor Government would exercise a strong leadership role in considering ways to achieve the following:

- Improved catchment management

- Demand management- promote water efficiency measures in all facets of our activities- irrigation and other forms of agriculture; industry; domestic use; recreational use.

- Continued movement towards appropriate cost pricing, economic, social and environmental, of water purchased.

- Tradeablity and security of water entitlements.

- Accessing groundwater and groundwater recharge;

- Capture of stormwater;

Desalination systems are available to supply water where appropriate, although energy costs and emissions from energy use are important considerations. The WA Labor Government's desalination project will be delivered through the use of wind power, providing an important boost to WA's renewable energy industry.

In consultation with State and Territory Governments, Labor will consider initiating a national program for protecting high conservation value freshwater areas in Australia. Labor will examine the feasibility of providing matching funds with the States and Territories for a program that would:

- Identify high conservation value freshwater areas, including a national scheme to grade areas.

- Develop with States and Territories regimes to protect the values and restore as appropriate these areas.

- For high conservation value freshwater areas of national priority the Commonwealth would consider utilising its own protection regime, such as listing such areas as trigger points for action under the EPBC Act.

Labor will review the implications of climate change for our water resources and in particular examine the need for changes in Australia's land and water policies, programs and legislation. In particular we will examine:

- Programs to assist changes in land use.
- Scope for innovative land uses in areas impacted by climate change.
- Promotion of adaptive farm management.
- Using more effective 'on-line' climate and water flow information to land managers so that needs and constraints can be more accurately predicted.

LAND MANAGEMENT

> *"There is a golden opportunity here - to come together in an act of national will to create a priceless legacy for future generations; to cement part of the foundation for a modern Australian culture and identity. One that builds on the past, but can deal with the new realities we face."*
> *(Rick Farley, 26 January 2003)*

Labor's Record

The Hawke/Keating Labor Government was the architect of Landcare, guided by a unique partnership between the National Farmers Federation and the Australian Conservation Foundation.

In 1989, Bob Hawke identified land degradation as the major environmental issue facing Australia. He declared the 1990s as the Decade of Landcare, with the aim of working towards achieving sustainable land use throughout Australia. Bob Hawke also launched the One Billion Trees Program, with the goal of establishing one billion trees in Australia by 2000 through natural regeneration, direct seeding, or planting.

While Landcare has been successful in mobilising local communities, Australia still faces major land management challenges, including the cancer of salinity, the devastation of drought and the threat of dangerous climate change. National leadership is required to address these national challenges.

Climate Change and Drought

2006 was the driest winter on record in some parts of the country, and August 2006 was the hottest and driest in 106 years. 2005 was the hottest year on record because of climate change. The current drought which commenced in 2001 is the worst in Australia since accurate records have been compiled.

The Bureau of Meteorology reports that climate change is one of the main reasons for the long trend of dry weather and that it is contributing to the drought.

Climate change is real and it is impacting right now on Australia's economy and environment.

Australia's 2006 grain harvest is projected to be cut by 36% because of reduced rainfall and ongoing drought linked to climate change. The cut in Australia's wheat exports will cut Australia's export income by almost $2 billion.

The drought is significantly affecting the social and economic fabric of rural Australia. It is making many farms unprofitable and having severe environmental impacts in some grazing and agricultural areas. It is also having significant social and health effects, including an increase in rural suicide rates.

Labor supports the system of drought relief payment and assistance. It is should be noted, however, that the 24 October 2006 statement on further drought assistance failed to acknowledge the contribution that climate change is making to the drought.

Labor is concerned it may not be helpful either to people or to the environment to continue such drought assistance arrangements indefinitely. The eminent water and natural resource scientist Professor Peter Cullen has said (18):

> "*We should look at these signals and if any area needs assistance more than 5 years in say 25, we should seriously consider focussing our assistance on getting people off the land, not propping them up in a way that maximises human misery and maximises land degradation*."

Mr Bill Murray, the NSW Farmers Association Western Division Chairman said (18) he wants government support to continue through this current drought but "after that I think there should be a review of it".

Labor will work with communities and farming organisations, including the National Farmers' Federation, to ensure cooperative approaches to these issues.

Salinity

Salinity remains a major challenge in Australia, even though it appears to have lost priority on the Howard Government's agenda. Rainfall, stream-flow and other related climate change factors could have significant impacts on salinity patterns.

One study in south west Western Australia on the impacts of climate change on farm profitability with particular reference to dryland salinity (19) indicated that farm profitability might fall by 50 per cent. This study suggests that the decline in farm profitability will affect the capacity of farmers to adopt practices to prevent dryland salinity. Despite the negative impact of salinity on Australia's primary industries there has been no overall assessment of how climate change will affect salinity (20).

Salinity prevention and remediation will be a priority under Labor. We will seek to ensure Commonwealth funding produces public benefit, such as reduction of salinity loads in the River Murray. Labor will consider funding through regional integrated plans in line with Commonwealth targets and priority bioregions as a principal delivery mechanism.

Labor will consider policy proposals in areas such as vegetation retention and environmental stewardship which will contribute to salinity prevention and restoration of lands affected by salinity.

Sustainable Agriculture

The farming sector has a critical role to play in natural resource management.

The Australian Bureau of Statistics has suggested Australian farmers reported spending $3.3 billion on natural resource management in 2004-05. The Corish Report noted that approximately $220 million was spent by farmers on natural resource management and environmental protection measures, such as fencing, earthworks and weed management in 1999-2000.

Sustainable agricultural practices are critically important in assisting landholders adapt to climate change and to achieving a wide range of natural resource and environmental benefits.

We need to look towards changes in our agricultural and grazing landscapes with the aim of achieving greater mosaics of native vegetation, more attune with water-use patterns of the original vegetation (Chartres and Williams (3) and Williams and Saunders (21)).

Overgrazing is one of the key threats to biodiversity. Under the Howard Government, support for sustainable agriculture has been a low priority. Labor will give support for sustainable agriculture a higher priority.

Environmental Stewardship Programs and Market Based Instruments

The scale of Australia's environmental problems is so vast that public investment alone will not be nearly sufficient to bring about a more ecologically sustainable future. There has been and will continue to be a huge amount of private interest or voluntary activity. Private landholders will continue, and increasingly move to, implement sustainable land use and management activities in the interests of maintaining profitable farm outcomes and in the more altruistic interest of maintaining public environmental benefits.

Market based instruments are increasingly being used to positively influence behaviour. There is a large range of market based instruments, including those based on price and those based on quantity, such as cap and trader and offsets.

Another type of instrument is an environmental stewardship type of program with the provision of public funds to a landholder to provide environmental services such as retention of habitat on a farm. There could also be a role for stewardship programs for private lands that are marginal in commercial production, but contain important public good assets. Stewardship type programs need to backed by management agreements between the landholder and government.

The Corish Report was right to note that farmers may, in the future, derive an income stream from providing the community with a combination of agricultural and environmental services.

A number of States have introduced environmental stewardship programs that provide support to private landholders. To date, however, Commonwealth, State and Territory programs have been largely pilot programs only. This is acknowledged in the Commonwealth Government's response to the 2006 Corish Report, which refers the National Market Based Instruments Pilot Program, the NHT Native Vegetation Regional Pilot Program and the Environmental Management Systems National Pilot Program.

After ten years in power, the Howard Government should have moved beyond an ad hoc series of pilot programs. The scale of our natural resource and environmental problems is so large and urgent that a national market based instruments program should be considered as soon as possible.

Labor will consider introducing a national environmental stewardship and market based instrument program with matching funding from State and Territory Governments to assist in securing public environmental benefits.

Such a program will need to be transparent and competitive, with outcomes backed by management agreements. The public will need to be confident that it is not paying for what the landholder should be doing anyway. Funds should support landholder actions with significant public environmental benefits.

The funding of any such program would need to be linked with national sustainability targets and goals and facilitate the protection of 'high value natural areas'.

Leveraging Private Investment in Ecologically Sustainable Land Use

The scale of our environmental problems is so vast that public funding and normal private behaviour will be insufficient.

Various reports (4, 22) have pointed to the large potential in providing measures that leverage large scale private investment in more sustainable and profitable land use and management. A large range of measures have been suggested such as creating new institutions linking capital markets, and use of taxation provisions.

Labor will consider establishing a national program to leverage large scale private investment in sustainable land use and land management practices.

Indigenous Natural Resource Management

Indigenous land and water management is essential to a comprehensive approach to protecting and restoring our precious natural environment and water supplies.

The role of Indigenous people in natural resource management has been downgraded under the Howard Government. This is despite the fact there are significant Indigenous communities in our nation's north, where biodiversity is particularly rich, but vulnerable to many threats from invasive species, inappropriate fire regimes and climate change.

Involvement in constructive work which builds on cultural knowledge is socially positive for communities and has significant environmental benefits, and should be encouraged.

The Wilderness Society has noted that the Western Arnhem Land Greenhouse Gas Abatement Project, which seeks to reduce greenhouse gas emissions by managing wildfires, is delivering environmental and social benefits. Under this project, Traditional Owners receive funds to implement patch burning on Aboriginal freehold.

CSIRO research demonstrates a reduction in Australia's greenhouse gas emissions by up to 3% if such a project was to be implemented across the 100 million hectares of Northern Australian savannahs.

Labor would consider a range of actions to address this neglect.

Labor will consider revitalising the *Caring for Country* concept as this has tremendous significance for Indigenous people.

Through the National Reserve System program, Labor will consider providing funding to Indigenous people to manage Indigenous Protected Areas and in so doing, provide valuable employment opportunities.

Labor will consider re-introducing the Contract Employment Program for Aboriginals in Natural and Cultural Resource Management or a program of similar nature that provides funds for Aboriginal and Torres Strait Islanders to do worthwhile NRM activities, such as rangers paid to be the eyes and ears of the north with respect to illegal fishing; payments for Indigenous people to act as stewards for certain areas and certain activities such as weed control on traditional lands.

Weeds and Feral Animals

Invasive weeds and feral animals are key threats to primary production, wetlands, riparian zones, threatened species and threatened ecosystems across much of Australia, as well as threats to agricultural and pastoral activities (23).

WWF considers weeds and invasive pests to be the second biggest threat to Australia's biodiversity after land clearing (WWF Australia web site). Climate change will, on balance, support an increase in the spread of weeds and pests. The spread of weeds such as the Prickly Acacia, and the Rubber or Woody Vine, which both pose a national threat, is promoted by higher temperatures and the cane toad is mainly found in areas of higher temperature (see Allen Consulting Group report on Climate Change Risk and Vulnerability (20)) .

Despite the significant impact of weeds, weed related activities have not been priority investment areas in natural resource management regions (7). Similarly, control of feral animals and pests does not appear to be a priority in the Government's regional natural resource management process.

In November 2006, it was revealed the Howard Government had not renewed funding for the Australian Weeds Management Cooperative Research Centre, despite an eleven year successful track record. Australia now has no national body to coordinate weeds research or to disseminate critical information to farmers (25)

The Australian Bureau of Statistics (ABS) has suggested farmers spent more than $1.1 billion on weed prevention and management in 2004-05. According to the ABS, weed and pest management is the most common natural resource management issue for farmers, with 86% of farmers nominating that concern.

Some of the national problems associated with weeds and pests include:

- Difficulties in early detection and eradication of newly introduced weeds and pests;

- Absence of measure for dealing with 'sleeper' invasive plants and animals, that is, species that are already present in Australia, but which have not yet become weed and pest problems;

- Absence of preventative measures, current measure (apart from national border controls) are primarily reactive;

- Inconsistencies and mismatches between different jurisdictions and agency activities;

- Poor understanding of the impact of climate change on invasive weeds and animals and generally poor appreciation by the public of weed and pest problems.

Natural Resource Management Research and Development

In the face of Australia's significant natural resource problems the coordination and undertaking of research relevant to these pressing issues is not up to an adequate level. For example the Senate Committee report on 'Living with Salinity' (26) criticises the government over the abolition of the National Dryland Salinity Program, because of the valuable service it provided in coordinating salinity research.

There has been a loss of valuable natural resource management research institutions under the Howard Government, including the Coastal and the Reef and Rainforest Cooperative Research Centres.

There is no research body with a direct charter to investigate opportunities for large scale private investment in sustainable land use and management, particularly on degraded lands or in relation to alternative crops that are more adaptable to warmer climatic conditions. Nor is there any one research and development body of national scope charged with undertaking work on the impact of climate change on natural systems or on appropriate adaptation measures.

Labor's Approach

National Leadership

Labor is committed to national leadership in addressing Australia's land management challenges. That means taking action to avoid dangerous climate change, prioritising salinity prevention and remediation and exploring market based initiatives and stewardship payments.

It makes little sense for the Commonwealth to mount major natural resource management funding programs while other Commonwealth policies and programs could be having adverse impacts on Australia's water, biodiversity and lands. A Labor Government will consider asking the National Sustainability Commissioner to review relevant Commonwealth policies and programs to ensure that they are not having a detrimental effect on Australia's land and environment.

Labor will also review the Environment Protection and Biodiversity Conservation Act (EPBC Act) to ensure it is most effectively used to achieve desirable environmental outcomes.

Labor will end large scale land clearing and work with State and Territory Governments to establish a target to reverse the current decline in the quality and extent of native vegetation across Australia.

Labor's Approach to Environmental Stewardship Programs

Labor will consider introducing a national environmental stewardship and market based instrument program with matching funding from State and Territory Governments to assist in securing public environmental benefits.

Labor will consider supporting greater investment in interdisciplinary research and development related to sustainable agriculture and the development of tools and guidance for farmers to increase the uptake of sustainable agricultural practices.

A Labor government would work with the States and Territories to increase the uptake of sustainable practices and will consider setting a national target for the number of enterprises that have in place certified outcomes based environmental management plans.

Labor will consider providing funding assistance to regional natural resource management boards to increase capacity related to sustainable agricultural management.

Overgrazing and changed fire regimes in Australia’s rangelands pose particular threats to biodiversity. Labor will consider establishing a national program to encourage sustainable grazing and fire regimes in these lands.

Labor will encourage greater focus on Indigenous natural resource management in the regional funding delivery model, and will encourage Indigenous land stewardship programs.

Labor’s Approach to Weeds and Feral Animals

Labor will consider establishing a new and comprehensive national weeds and feral animals program which could include:

- an effective early warning and rapid response system for weeds and invasive pest animals;
- a weeds and feral animal risk assessment of relevant industries and government programs;
- national targets and standards for pest and weed management; and
- further research into the impact of climate change on weeds and pests.

Labor’s Approach to Natural Resource Management Research and Development

It was announced on 22 November 2006 that a Federal Labor Government will act in the long-term interests of drought-affected communities by establishing a new $20 million Enterprise Connect Centre for Climate Change and Agriculture in country Australia.

The Climate Change and Agriculture Enterprise Connect Centre will help Australia's hard working farmers to find and adapt new ideas and research, take up new technology and test new products and processes.

The Climate Change and Agriculture Enterprise Connect Centre will provide four key services:

- Advice on boosting productivity, efficiency and export value with on-call business advisers, technical experts and scientists;
- Access for agribusinesses to research labs, data processing systems and testing and prototyping facilities already operating in universities, TAFEs and other agencies;
- Labs equipped to provide sophisticated testing facilities for emerging agricultural industries with the capacity to test and prototype; and
- Critical benchmarking; to provide advice on improved business planning and innovation and growth strategies.

A Federal Labor Government will also help Australian farmers take advantage of innovative ideas for reducing greenhouse emissions, benefiting from emerging clean, green industries and markets; and dealing with the ongoing effects of climate change.

In the context of Labor's *Innovation Blueprint* a Labor Government will also consider establishing appropriate natural resource management research and development mechanisms to:

- Undertake and fund NRM research;
- Coordinate NRM research and development across Australia;
- Promote information sharing amongst relevant NRM research bodies;
- Communicate relevant R&D research results to NRM policy and decision makers.

A key focus for these mechanisms will be examining the impact of climate change on Australia's natural resources and developing adaptation strategies to cope with changed climatic conditions.

BIODIVERSITY

> *When the earth is spoiled, humanity and all living things are diminished. We have taken too much from the earth, and given back too little. It's time to say that enough is enough…I believe that with the right mix of political commitment and community support, that we can ensure that our country is simply the best in the world.*
> *(Bob Hawke, 20 July 1989)*

Labor's Record

Labor has a proud record of achievement in protecting our unique plants and animals and our natural wonders. Achievements of the Hawke/Keating Government included:

- Saving the Franklin River for future generations;
- Preventing uranium mining at Coronation Hill in Kakadu National Park and getting World Heritage listing for Kakadu;
- Extending the Tasmanian Wilderness World Heritage Area;
- Establishing the Daintree Rescue Package; and
- Signing and ratifying the UN Convention on Biodiversity and signing the UN Framework Convention on Climate Change.

Australia faces a dramatic challenge in protecting our biodiversity from the threat of climate change, large scale land clearing, weeds and pests and other threats. Biodiversity protection must be a priority issue for a national government.

Biodiversity Conservation

Australia is only one of 17 megadiverse countries on earth, containing 10 percent of the world's biodiversity, 80 per cent of which is native to Australia (23).

Australia's rich biodiversity is critical for maintaining the productivity of our rural land, the tourism industry and, importantly, our sense of what Australia is.

The Great Barrier Reef, our magnificent wetlands and national parks, the beautiful outback and our rugged coastline all have unique environments that have fostered a rich biodiversity and are an important part of our national character.

Policy makers have a significant responsibility to our children and grandchildren to protect our rich natural and cultural heritage.

Tragically, we are facing a biodiversity extinction crisis. The Australian Terrestrial Biodiversity Assessment of 2002 (15) documents the extensive loss of habitat and species over the last 200 years; the degradation of key ecosystems; and, the failures in current processes developed to conserve biodiversity.

Twenty per cent of our species are threatened with extinction by the end of this century and the number of terrestrial bird and animal species listed as extinct, endangered or vulnerable rose by 41 per cent from 1995 – 2005. Australia 'leads' the world in mammal extinctions.

Australia's biodiversity crisis has worsened since 1996 (3, 23). Australia ranks 16th out of 30 OECD countries for the amount of protected areas (WWF, 2006).

Over and above the high level of species and habitat decline in Australia due to land clearing, pests, and weeds, climate change is projected to have a dramatic impact on biodiversity.

Climate Change and Biodiversity

WWF has projected likely biodiversity and related impacts of various temperature rise scenarios (27). For example a 4 degree C increase will result in a 143 per cent increase in catastrophic wildfires. WWF has also estimated Australia could lose 74% of rainforest birds in north east Australia with a temperature rise of 3 degrees.

In 2001 the UN Intergovernmental Panel on Climate Change reported that Australia's biodiversity is highly vulnerable to global warming effects, in part because many Australian species have limited climatic zones in which they can survive (28). Examples of possible impacts include: loss of up to 50 per cent of upland tropical forests in the Wet Tropics area of Queensland; loss of many species in Alpine areas; changes in sea leave and rainfall patterns threatening significant areas of Kakadu and Macquarie Marshes (20).

Lack of National Leadership

Anecdotal evidence suggests that regional delivery has reduced the priority of biodiversity conservation in natural resource management plans and investment strategies. This argument is supported in a report by the National Biodiversity Alliance (29).

Many new key national biodiversity targets established by the Howard Government have not been met. A 2004 report by WWF and Humane Society International (30) found that many of the targets would not be met in the timeframe.

The Australian Conservation Foundation (3) has found that poor "*guidance at the national level (principally in the framework documents) and a lack of practical tools for benchmarking and tracking changes in biodiversity value also seem to impede regional delivery of conservation outcomes.*"

ACF also reported that from a "*national NGO perspective, it has proved extremely difficult to input into regional NRM planning*" and they conclude: "*it seems clear that the integration of biodiversity conservation into regional planning is largely inadequate at present.*"

The Australian Terrestrial Biodiversity Assessment 2002 (23) found that: 'Conservation is considered to be well integrated into production systems in only 1.5% of the IBRA bio-subregions' (IBRA- Interim Biogeographic Regionalisation for Australia).

There has also been a decline in Commonwealth Government funding for the National Reserve System Program which has reduced the rate of reservation of strategically significant lands (31).

WWF has stated that "insufficient and declining funding' for protected area acquisition has "significantly increased the risk" that the target for the national reserve system will not be met (30).

This is a matter of concern as opportunities to acquire suitable lands are decreasing (31) and climate change is increasing pressure on unprotected representative species and ecosystems.

Under the Howard Government, funding for biodiversity conservation has decreased under NHT2 (29). For example funding for the National Reserve System land acquisitions has collapsed under NHT2, falling from $20m under NHT1 to $2- 4m per annum, under NHT2 (20). The Australian Terrestrial Biodiversity Assessment (23) also states:

> "*Australia needs to significantly increase investment in biodiversity management if key biodiversity objectives are to be met.*
>
> *In many highly disturbed bioregions there has been much planning but limited resources or commitment to implement the plans.*"

Protected areas, in the form of national parks, nature reserves and landscape-wide initiatives on private lands are critical biodiversity conservation tools. Protected areas will increasingly plan an important role in giving plants and animals the best chance of surviving climate change. Protected areas also provide a critical foundation for Australia's $57 billion tourism industry (32).

Vegetation Clearance and Habitat Retention

Loss of vegetation and habitat is one of the most significant threats to species and ecosystems in eastern Australia (23). Land clearing is also one of the key factors in rising levels of salinity, particularly dryland salinity.

Despite State and Territory Government regulations, the lack of national leadership has ensured vegetation clearance is continuing at unacceptable rates and is undermining government and non-government efforts.

All levels of government as well as private landholders have roles to play in ensuring inappropriate vegetation clearing does not occur. Labor will ensure a national approach to vegetation clearance will be developed and implemented.

Private landholders have a key role to play in protecting biodiversity. The benefits of retaining native vegetation often accrue, all or in part, to the landholder. It is, therefore, appropriate landholders should bear some costs of retaining native vegetation.

Where public environmental benefits are involved and they are of national significance, the Commonwealth could examine the feasibility of establishing a financial mechanism for encouraging private landholders to support the delivery of national land management, water and biodiversity priorities. This could be for various facets of landholders' costs, such as subsidising rate payments or through stewardship payments.

There is a place for regulation in regard to habitat retention. Effective vegetation clearance controls have been established at State, Territory and local levels, although various issues related to implementation and enforcement, exist. Labor will work with the States and Territories and with local government on issues related to vegetation clearance controls.

Urban Biodiversity

Labor believes all Australian cities must be healthy places to live, with sustainable, well organised economic, environmental and transport structures.

As almost 80% of Australians live in urban areas, we need to be acutely aware of the impact of urban development on biodiversity.

Urban biodiversity gives the bulk of Australia's population an appreciation of Australia's natural heritage.

Urban areas often provide important refuges for Australian fauna, particularly birds. One Canberra garden for example has more terrestrial bird species passing through it than exist in the whole of the British Isles range of terrestrial species (33).

Open space is important in our cities and towns for biodiversity and the health and recreation of our citizens. State, Territory and Local Governments have made enormous contributions to establishing Australia's urban open space heritage and supporting the conservation of urban environments.

Over 40% of nationally listed threatened ecological communities occur in urban areas. Accelerating urbanisation in Australia is considered one of the greatest threats to biodiversity. This threat will increase without a more strategic approach to conservation planning in urban environments. (34).

Given the importance of our urban biodiversity and open space, Labor believes that there is a clear case for Federal involvement. It is in the national interest that the Commonwealth work with the States, Territories and Local Government to alleviate undesirable environmental impacts of urban development.

Labor's Approach

A Labor Government will make biodiversity conservation a national environmental priority. We will take action to avoid dangerous climate change, support the completion of a national system of land and marine protected areas covering public and private lands and Indigenous lands and sea country; and encourage corridors of conservation efforts to maximise the possibilities of plants and animals coping with climate change.

Labor will be rigorous in ensuring vegetation clearing proposals that significantly impact on high value natural areas are effectively considered under the EPBC Act.

Labor's policy will support the fact that national parks and other protected areas are the most cost effective way of protecting and enhancing biodiversity values (21).

Labor would consider establishing a National Biodiversity Program of funding and action. To develop this program, Labor will consider a complete review of the current 'National Objectives and Targets for Biodiversity Conservation, 2001 – 2005', with a view to developing a new set of national strategic priorities, objectives and targets, including detailed action plans.

An important base for priority setting for a National Biodiversity Program could be the development of new biodiversity conservation targets and the identification of biodiversity priority areas, as part of the proposed ' high value natural areas' in all of Australia's 85 bioregions. The targets and biodiversity priority areas would provide the Commonwealth criteria for biodiversity investment under the natural resource management program in national, regional and community investment streams.

Labor will review the EPBC Act to ensure it properly provides a legislative instrument for biodiversity protection.

Labor will consider amendments to the *Environment Protection and Biodiversity Conservation Act 1999* to include biodiversity 'hotspots' as a matter of national environmental significance.

Labor will honour Australia's obligation to contribute to the global effort to retain healthy environments.

Labor will work with State and Territory Governments to complete the National Reserve System. The 2002 Australian Terrestrial Biodiversity Assessment (23) has pointed out that many bioregions have little vegetation remaining or only scattered remnants and that "*the opportunity for developing a Comprehensive and Representative protected area system is rapidly diminishing*." As of 2002, 67 percent of Australia's regional ecosystems were represented in protected areas (23).

A Labor Government would consider providing sufficient funding related to National Reserve System land acquisition to enable the 80 per cent comprehensiveness target in the National Reserve System as agreed by all Governments under the 'Directions for the National Reserve System-A National Approach, to be achieved by 2010- 2015.

In collaboration with State and Territory Governments, Labor will urgently review the National Biodiversity and Climate Change Action Plan 2004 – 2007 with a view to developing a revised and more action orientated program with clear performance measures and provide funding for implementation of priority strategy actions.

Labor's National Reserve System acquisition program and biodiversity policy generally would be guided by the need to establish secure land corridors for the migration of species in the face of changing climatic conditions. Labor would also consider undertaking detailed studies into the most appropriate strategies for the proposed Eastern Australian Great Escarpment Corridor (27).

Labor will consider commissioning an urban biodiversity inquiry to:

- Identify urban biodiversity and open space needs in our capital cities and large regional cities and towns and the impact of urban development on bushland, biodiversity and prime agricultural lands.

- Recommend actions taken by both government and non-government agencies to protect and enhance urban biodiversity and open space and to protect bushland, bio-diversity and prime agricultural lands while maintaining urban development.

- Identify new requirements and identify possible roles for the Commonwealth Government in supporting State, Territory and Local Government and community groups to maintain and enhance urban biodiversity and open space and to protect bushland, bio-diversity and prime agricultural lands while maintaining urban development.

A SUSTAINABLE NORTHERN AUSTRALIA

Northern Australia contains many of this country's last frontiers, with vast tracts of wilderness including diverse rangelands, wetlands, wild rivers, rainforests, massive sand dune systems and fringing reefs of international significance, some of which are already World Heritage listed.

Key areas of environmental significance include Cape York, the Gulf Country, Arnhem Land and the Kimberleys.

Northern Australia is, however, facing increasing pressure from inappropriate and unsustainable development, creating a risk of repeating the mistakes made in the south.

About 65% of Australia's run-off is located in the tropical north. With the worsening drought in southern Australia, some people are considering water supplies and agricultural production in the North. These are important natural resource management issues which need to be considered within a sustainability framework.

Labor's policy to protect the North and encourage ecologically sustainable development will avoid inevitable and expensive repair bills later and sets the foundation for developing truly sustainable business, industry and tourism in a way that fits with the unique challenges and opportunities of the North.

The single most important thing a Federal Labor Government can do to protect our tropical North is to help protect Australia from dangerous climate change, ratifying the Kyoto Protocol and implement a national emissions trading regime.

If not addressed, climate change and associated impacts like rising sea levels will seriously damage our reefs and rainforests and cause havoc with the habitat of endangered species.

Scientists agree that a rise in water temperature of just 2 degrees will cause serious and irreparable damage to Australia's great natural wonders, including the Great Barrier Reef, Kakadu and the Wet Tropics Rainforests. This will be devastating for our environment and for regional economies, which derive significant income and jobs from nature based tourism.

Not all of our treasures are protected by national parks or World Heritage Areas. There are substantial areas of currently privately owned and managed land with significant conservation values.

Labor's Approach

The natural resource management options outlined in this paper could make a significant contribution to the conservation and sustainable management and use of Northern Australia.

To bring the northern aspect of these proposals together in an integrated way and to provide a framework for other proposals. Labor will consider establishing as a cooperative program with WA, NT and Queensland - a Northern Australian Sustainability Program.

The purpose of a Northern Australian Sustainability Program would be to ensure a focus on Northern Australia sustainability issues by dealing with priority needs in a consistent manner from the Kimberleys to Cape York.

Labor's proposed 'High Value Natural Areas' could provide the planning framework for the program.

Under the Northern Australian Sustainability Program, the Commonwealth would work with WA, NT and Queensland Governments and with indigenous people, private sector, research organisations and other interest groups to formulate a northern strategy and undertake priority actions.

Labor would also consider the following initiatives:

Buy back the Daintree – the Daintree Rescue Package

Labor will provide a focused environmental package, under its National Reserve System Program with an emphasis on rainforest buy backs to ensure all key Daintree rainforest lands are protected. Labor will also consider funding to continue conservation works to ensure the future of the Wet Tropics icon – the cassowary.

Cape York

Cape York is one of the nation's special and unique environments which includes open savannah lands, wetlands, wild rivers and rainforests. But development pressures are growing on the Cape with the population of the region expected to grow by 50 per cent by 2020.

A review in 2003 of the Cape York Natural Heritage Trust undertaken by the Queensland Conservation Council, the Australian Conservation Foundation, Cairns and Far North Environment Centre and the Wilderness Society revealed the Howard Government has abjectly failed to protect Cape York.

The Beattie Government has taken responsibility for protecting the Cape – but with Commonwealth leadership and resources, we can achieve a once in a lifetime opportunity to deliver a sustainable future on the Cape. Labor will examine the feasibility of the following programs to better protect Cape York:

■ Supporting a **Voluntary Acquisitions Program**. A Federal Labor Government under its national reserves system program will consider providing funding, together with the Queensland Government, to enable the buy back of high conservation value areas.

■ Pursuing **World Heritage Listing**. Labor will work in partnership with the Queensland Government to accelerate World Heritage Listing for appropriate areas of Cape York.

■ **Enhancing National Parks Management**. Labor will consider assisting the Queensland Government to better manage national parks by committing the NHT money the Howard Government promised but never delivered.

■ **Building on Indigenous expertise**. The Indigenous communities of Cape York have valuable local knowledge and expertise to bring to bear on local environmental challenges. Labor will consider providing funding to build partnerships with Indigenous communities and environmental experts to control invasive pests and weeds and to protect the local marine environment.

This could include recurrent funding for Land and Sea Management Centres, to support renewed efforts to remove weeds and invasive pests and ensure the protection of local marine environments. Indigenous communities could work in partnership with scientists and other environmental experts to link local Indigenous knowledge with our best environmental science.

REFERENCES

1. Keogh, Kim et al. Review of Arrangements for Regional Delivery of Natural Resource Management Programs. Report Prepared by the Ministerial Reference Group for Future NRM Programme Delivery. Final Report. March 2006.

2. Agriculture and Food Policy Reference Group. Creating our Future. Report by the Agriculture and Food Policy Reference Group. February 2006. (Corish Report).

3. Sources include: DEH 2001 State of the Environment Report (2006 report due in second half of 2006); Australian Bureau of Statistics. Measures of Australia's progress 2006. Australian Conservation Foundation Facts and Figures; David Lindenmayer- address to ANU Global Change Seminar June 2006; Wilderness Society. Land Clearing campaign; WWF web page; National Land and Water Resources Audit, 2000; Chartres, Colin and Williams, John. Can Australia Overcome its Water scarcity Problems? Journal of Developments in Sustainable Agriculture. 1 : 17-24 (2006). Climate Change Risk and Vulnerability. Report to the Australian Greenhouse Office by the Allen Consulting Group.

4. Australian Conservation Foundation. Getting on Track: Australia's Progress Towards the Ecologically Sustainable Management of our Rural Landscapes. July 2004

5. Dr Mal Washer MP, Chair of House of Representatives Standing Committee on Environment and Heritage. Tabling statement in the House of Representatives for: *Review of green office procurement audit—review of Audit report No. 22 2005-2006*. 4 September 2006.

6. National Water Commission. Progress on the National Water Initiative. July 2006. www.nwc.gov.au

7. The Senate. Environment, Communications, Information Technology and the Arts References Committee. Australia's national parks and Marine Protected Areas. (in progress). The Senate. Rural and Regional Affairs and transport. Water Policy Initiatives. (in progress)

See for example: Hassell & Associates Pty Ltd. Natural Heritage Trust Phase1 Final Evaluation. February 2005. ANAO Preliminary Inquires into the Natural Heritage Trust. May 1998.

8. NRM (NAP/NHT) Evaluations published to date:

- ITS Global. Evaluation of the National Investment Stream of the Natural Heritage Trust of Australia. Final Report. January 2006.
- Center for International Economics. Evaluation of the Australian Government Envirofund. Final Report to the Department of Environment and Heritage and Department of Agriculture, Fisheries and Forestry. December 2005.
- Walter Turnbull. Evaluation of Current Governance Arrangements to Support Regional Investment under the NHT and NAP. December 2005.
- ITS Global. Evaluation of the Bilateral Agreements for the Regional Component of the NHT of Australia. January 2006.
- Sinclair Knight Metz (SKM). Evaluation of the Salinity Outcomes of Regional Investment. April 2006.
- CSIRO. Evaluation of Invasive Species (Weeds) Outcomes of Regional Investment. November 2005.
- RM Consulting Group. Evaluation of Sustainable Agriculture Outcomes from Regional Investment. (NAP and NHT). March 2006.

- NRM Pty Ltd. Evaluation of the Biodiversity Outcomes of Regional Investment. January 2006.
- Coastal, estuarine and marine outcomes of regional investment;
- NRM evaluation still to be released (and not sighted):
- The impact of the national natural resource management facilitator network

9. Phillip Toyne and Rick Farley. A Decade of Landcare. Australia Institute. 2000.
10. Shahbaz Khan. 'Australia needs steady flow of cooperation on water management'. Canberra Times. 24 July 2006
11. Wentworth Group of Concerned Scientists. Blueprint for a National Water Plan. 2003.
12. Prime Minister media release. Transcript of address to CEDA. 17/7/07
13. Rural Water use and the Environment. The Role of market Mechanisms. Productivity Commission Discussion Draft. June 2006.
14. CSIRO Submission to Senate Rural and Regional Affairs References Committee Water Policy Initiatives Inquiry. December 2005. (Contacts Mike Young and Shahbaz Khan)
15. Jeremy Roberts. All-time low for flow into Murray. Weekend Australian. 12/8/06
16. Robin Pash. River System is flawed. Canberra Times. 16/6/06
17. Jon Breusch. 'McGauran hoses down water alert'. Australian Financial Review 16 June 2006.
18. Turnbull seeks answers on sustainable water for Australia's cities. Media release 22 March 2006.
19. Asa Wahlquist. Once it's wet, they'll leave. Weekend Australian. 8 July 2006.
20. John, M., Pannell, D.J. and Kingwell, R. (2005). Climate change and the economics of farm management in the face of land degradation: Dryland salinity in Western Australia. Paper presented at International Policy Forum on Greenhouse Gas Management, Victoria, British Columbia, April 28-29 2005.
21. The Allen Consulting Group. Climate Change Risk and Vulnerability. Report to the Australian Greenhouse Office. March 2005.
22. John Williams and Denis Saunders. 'Land use and ecosystems' in Goldie et al 'In Search of Sustainability' CSIRO. 2005.
23. Department of Agriculture, Fisheries and Forestry. Australian Government Response to the Agriculture and Food policy Reference Group Report, Creating our future: Agriculture and Food Policy for the next Generation. October 2006
24. Australian Conservation Foundation. Getting on Track: Australia's Progress Towards the Ecologically Sustainable Management of our Rural Resources. July 2004.
25. The Allen Consulting Group. Repairing the Country. Prepared for the Business Leaders Roundtable. August 2001.
26. Australian Terrestrial Biodiversity Assessment 2002 (15 A www.deh.gov.au/parks/nrs/**ibra**/)

27. World Wide Fund for Nature. Weeds and Pests: Eradicating the Invasive Threat. Position paper January 2003. World Wide fund for nature. Weed Proofing Australia. Making the *New National Weed Strategy* work. September 2005.

28. Beeby, Rosslyn. Govt axes two key research centres. Canberra Times. 14 November 2006