WENTWORTH GROUP
OF CONCERNED SCIENTISTS

SUBMISSION TO THE MURRAY-DARLING BASIN ROYAL COMMISSION

21 May 2018

Wentworth Group of Concerned Scientists

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Summary

The Wentworth Group commends the South Australian Government for establishing the Murray-Darling Basin Royal Commission and we welcome the opportunity to make a submission.

A healthy Murray-Darling Basin is important for the whole of Australia. It is vital for the 3 million people who depend on the Basin's water resources, it underpins the agriculture industry which generates $20 billion each year, and it supports a rich diversity of water-dependent ecosystems of national and international significance. The Basin is one interconnected system requiring collective actions to sustain the environment, communities and economy of the system as a whole.

In recent decades, the mismanagement of water in the Murray-Darling Basin has affected the health of the river and the livelihoods of people who depend upon it. Over-allocation of water resources during the Millennium drought resulted in high salinity and toxic water quality, the collapse of the Coorong and Lower Lakes in South Australia, the closure of the Murray mouth and need for dredging, and widespread degradation of wetlands, floodplain forests, native fish and waterbirds across the Basin. These challenges are likely to become more frequent as climate change continues to impact the Basin, particularly in the south where the latest projections show reduced river flows are likely to have significant impacts on water availability. Rising salt loads, soil degradation and increasing global demand for food will further challenge the management of water resources in the Basin.

National water reforms since 2004 have set a new agenda for managing water resources in the Murray-Darling Basin. The historic National Water Initiative in 2004, championed by the then leader of the National party John Anderson, was described by many at the time, including the Wentworth Group, as one of the most significant agreements in the nation's history.

On Australia Day in 2007, the then Prime Minister, the Hon John Howard, announced a $10 billion national plan for water security to "once and for all" address over-allocation of water in the Murray-Darling Basin. In that same year the then Minister for Environment and Water, the Hon Malcolm Turnbull, introduced the Commonwealth Water Act 2007, which, among other things, set the foundations for the Murray-Darling Basin Plan.

The Murray-Darling Basin Plan was agreed by Parliament in 2012 to return 2,750 GL of water from consumptive use to the river system by 2019, with a program to recover an additional 450 GL of water by 2024, bringing the total to 3,200 GL. This volume fell substantially short of the Murray-Darling Basin Authority's best estimate that between 3,856 GL (high uncertainty) and 6,983 GL (low uncertainty) was required for a healthy river. The Basin Plan also allowed for significant increases in groundwater extractions, and did not take into account the likely future impact of climate change nor the role of the sea in closing the Murray mouth.

Five years in, the Wentworth Group reviewed progress towards the environmental, social and economic objectives of the Basin Plan. Overall, the review found there has been significant progress since 2004, but this progress has slowed to a trickle since the Basin Plan was adopted in 2012. Since then, systematic weakening of 2004 reforms and undermining of the Basin Plan have left Australia's most productive river basin at risk. Serious management failures have

eroded the public trust in governments to successfully implement reforms. Without major changes in implementation, it is almost certain that the Basin Plan will fail.

In addressing the Commission's Terms of Reference and Issues Papers 1 and 2, we believe there are four underlying problems inhibiting progress:

1. Deliberate misuse and neglect of scientific evidence in decision-making to justify a pre-determined political outcome;
2. Secretive agreements on Basin Plan implementation between Commonwealth and state government agencies, and allegations of water theft in the northern Basin, which have resulted in a complete erosion of public trust in water reform;
3. Failure of the Commonwealth to intervene, as required by Parts 8 and 10 of the Water Act, when states fail to fulfil their duties; and
4. Failure to manage for climate variability and climate change, eroding the security of water entitlements and placing livelihoods and ecosystems at risk.

Our submission seeks to provide evidence for these problems and the consequences for the long-term health of the river system.

With nearly $5 billion in allocated Commonwealth funds remaining, it is possible to put Australia on a path towards restoring the health of the Murray-Darling Basin. This is an enormous sum of money for an environmental program in Australia, and the Commonwealth, on behalf of taxpayers and the public good, has a responsibility to ensure the investments produce the outcomes that are expected of them.

There will be no winners if the Basin Plan fails. We believe the following broad recommendations are required, in addition to specific recommendations for key issues, to restore integrity to the water reform process, and in doing so, help to fulfil the Australian Government's 2007 commitment to "ensure the viability of the basin's water dependent industries, to ensure healthy and vibrant communities and to ensure the sustainability of the basin's natural environment:"[1]

1. Rebuild trust through transparency;
2. Ensure continued application of science in decision-making;
3. Enable fair representation of communities and other stakeholders in decision-making, for example, through a more balanced MDBA board;
4. Fulfil the mandate given by Parliament for the Commonwealth to use its compliance and regulatory powers under the Water Act to manage resources in the national interest; and
5. Prepare for a future with less water in a changing climate.

A healthy and productive Murray-Darling Basin

Benefits of a healthy and productive Murray-Darling Basin

A healthy Murray-Darling Basin is vital for the wellbeing and livelihoods of over 3 million people who depend on the Basin's water resources, and of great importance to the whole of Australia and globally. A healthy Murray-Darling Basin means:

1. Water for drinking and for growing food and fibre, with flows to discharge salt to the sea, sediment and excess nutrients out of the Basin;
2. Economic benefits from recreation, fishing, tourism and education;
3. Reduced risk of algal blooms, hypoxic blackwater events, acidification, salinisation and erosion which pose significant health risks and impacts farming, fishing and tourism;
4. Improved soil fertility and enhanced pastures in floodplain grazing landscapes as a result of the natural wetting cycles;
5. Improved water security for farmers during dry periods, improved capacity of wetlands to buffer floods and refuge for animals during droughts;
6. Cultural and economic benefits for Indigenous people;
7. Resilience to climate extremes with greater capacity to adapt to a changing climate in the future; and
8. Conservation of assets of national and international significance, by providing habitat, food webs, migration pathways and breeding opportunities for native fish, waterbirds and other native wildlife that rely on water in the Basin.

Water reform in the Murray-Darling Basin

Sustainable management of freshwater resources across the whole interconnected Basin is key to protecting and restoring the health of the ecosystems that provide these benefits. Australia is the driest inhabited continent in the world and annual water availability in the Murray-Darling Basin is highly variable (Figure 1). A century of water resource development has created strong competition over water use. Through past mistakes, many rivers have become over-allocated or overused,[2] causing a marked decline in the basin's environmental health. Without sufficient quality and quantity of flow, there has been a reduction in the areas of healthy wetland, native fish numbers have declined, salinity levels have risen and algal blooms have increased in frequency, especially during periods of low rainfall and river flow as have occurred in the past. Agricultural development encroaching into flow corridors has further fragmented river channels from their floodplains, resulting in degradation of floodplain habitat, reduced capacity for water filtration and increased blackwater risks.

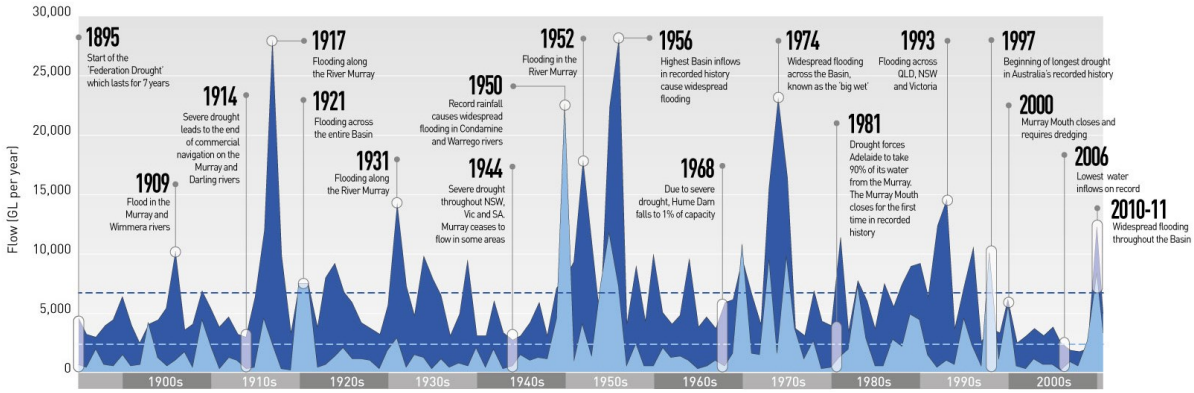

Figure 1. Historical river flows in the Murray-Darling Basin from 1895 to 2011 with major events highlighted. Annual flows are shown for the Southern Basin on the Murray River at Euston (dark blue) and for the Northern Basin on the Darling River at Burke (light blue), with averages shown as dotted lines. Source: MDBA, 2017.[3]

For over a century, successive governments have grappled with the challenge of managing water resources in the Basin. Water management through the mid-20th century was driven by the post-war nation-building agenda, through large public investments in large dams and water infrastructure to support hydro-electricity and the expansion of irrigation into the dry inland plains. By 1988, 84 large dams and weirs had been built for regulating the river for water supply, river navigation, flood mitigation and hydro-electricity, including Australia's largest engineering project, the Snowy Mountains Hydro-Electric Scheme.[4] Thousands of small dams were constructed on farms for private use, and levees and channels were built to transport water to farms. This infrastructure provided for the rapid expansion of irrigated agriculture. Water use more than doubled in the period between the 1950s and the 1970s, and continued to grow steadily through the 1990s (Figure 2). By 1998, about one third of the annual inflow into the Basin was extracted for irrigation each year, an amount that was approaching the average annual natural flow to the sea (Figure 2).[4]

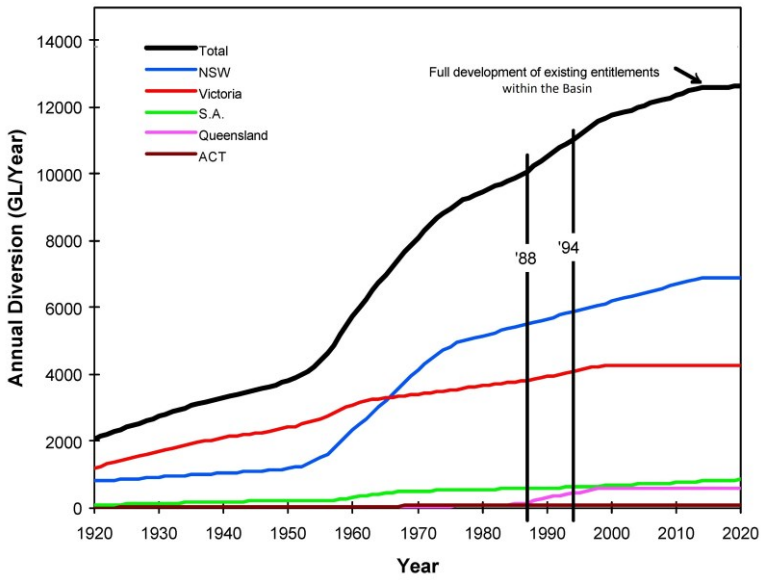

Figure 2. Annual diversions in the Murray-Darling Basin. Average annual inflows are approximately 32,500GL/y. Source: MDB Ministerial Council, 1995[5]

The 20th century approach to water management proved adequate during the period of expansion and growth, but in drier years it failed to support communities, industries and ecosystems that depended on a healthy river system:

1. During the 1960s and 1970s, dryland salinity began to emerge, prompting investigations into salinity across the Basin. By 1987 it was estimated that 96,000 hectares of the Basin's irrigated land were salt-affected (about 1%) and 560,000 hectares (about one third) had water tables within two metres of the land surface.[6]
2. The impacts of increased diversions resulted in the Murray mouth closing for the first time on record in 1981, and dredging commenced to flush salt stored in surface water, groundwater and sediments to the sea.
3. In 1991, a 1,200km blue-green algae bloom formed in the warm, shallow waters of the Darling River, posing risks to livestock and human health.
4. An audit of water use by the Murray-Darling Basin Commission in 1995 revealed that median annual flows through the Murray mouth were only 21-28% of what they would have been in natural conditions.[7] It also found that drought conditions in the lower Murray as a result of over-extraction now occurred in 60% of years compared to 5% under natural conditions.
5. The Millennium drought (1999 to mid-2010) was the most significant in recorded history. It caused widespread degradation of the environment across the Basin, hyper-salinisation of the South Coorong, high alkalinity levels in the Lower Lakes region in South Australia, and the closure of the Murray mouth. By the end of the decade, only 2 of the 23 valleys of the Basin remained in moderate to good health (Figure 3).[8] The impacts of the Millennium drought had flow-on effects for communities and regional economies. One in every five jobs in agriculture across the Basin were lost from 2001 to 2011.[9]

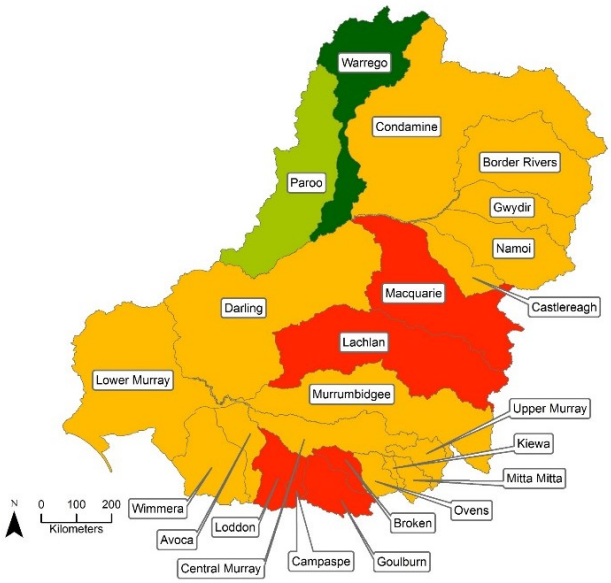

Figure 3. Ecosystem health as reported in the Sustainable Rivers Audit 2, showing valleys in good (dark green), moderate (light green), poor (yellow) and very poor (red) health (2008 - 10).

In the past two decades, governments have responded to these challenges by setting a new agenda for managing water in the Murray-Darling Basin. They have embarked on a series of water reforms aimed at securing water supply for people and their livelihoods, and protecting and restoring the health of Australia's rivers, wetlands, estuaries and groundwater systems, in a way that also creates economic opportunities and prosperity for communities in the Basin.

The historic *National Water Initiative* in 2004 was described by many at the time, including the Wentworth Group, as one of the most significant agreements in our nation's history. Its foundation rested on the creation of more wealth using less water, by securing property rights for water users and promoting trade of water to higher value uses, in exchange for restoring over-allocated rivers to sustainable levels of extraction.

On Australia Day in 2007, Prime Minister John Howard announced a ten billion dollar *National Plan for Water Security* to "once and for all" address the over-allocation of water in the Murray-Darling Basin.[10] In that same year, the then Minister for Environment and Water, Malcolm Turnbull introduced the *Water Act 2007* which set a legislative framework for water planning and management through what amounted to a $13 billion public investment package. In introducing the Water Bill 2007 to Parliament, Minister Turnbull announced "for the first time, the governance of the basin will reflect the hydrology of the basin—one interconnected system managed for the first time in our history in the national interest." He went on to say "we need these reforms to ensure the viability of our water-dependent industries, to ensure healthy and vibrant communities and to ensure the sustainability of the basin's natural environment".

The *Water Act 2007* set the foundations for the Murray-Darling Basin Plan which was the key policy for returning a sustainable balance to the Basin. The *Water Act 2007* also established the Commonwealth Environmental Water Holder tasked with managing the portfolio of environmental water, of what will amount to up to a quarter of entitlements in the Basin.[11] The *National Water Initiative*, the *Water Act 2007* and the Basin Plan are nationally significant reforms aimed at bringing Australia's most productive river basin back into a more sustainable balance. Notably, the Commonwealth drew in large part on its constitutional authority to legislate to implement treaties as the basis for the Water Act. In particular, the Act draws on the *Ramsar Convention on Wetlands* as well as the *Convention on Biological Diversity* for its mandate.

The Murray-Darling Basin Plan

The purpose of the Murray-Darling Basin Plan is to provide for the integrated management of the Basin's water resources by ensuring "the return to environmentally sustainable levels of extraction for water resources that are allocated or overused" (*Water Act 2007* Part 3 (d) (i)). This helps give effect to a key component of the Water Act "to protect, restore and provide for the ecological values and ecosystem services of the Murray-Darling Basin" (Part 3 (d) (ii)).

The Murray-Darling Basin Authority was required to prepare a Basin Plan following the provisions in section 20 of the Water Act which provides for the purposes summarised below:

1. Give effect to relevant international agreements, including the Ramsar Convention on Wetlands (shown in Figure 4);

2. Establish and enforce environmentally sustainable limits on the quantities of surface water and groundwater that may be taken (including by interception activities);
3. Basin-wide environmental objectives for water-dependent ecosystems, and water quality and salinity objectives;
4. Use and management of water resources in a way that optimises economic, social and environmental outcomes;
5. Water to reach its most productive use through the development of an efficient water trading regime across the Murray-Darling Basin;
6. Requirements that a water resource plan must meet if it is to be accredited or adopted; and
7. Improved water security for all uses of water resources.[12]

In 2012, the Basin Plan was adopted by the Commonwealth Parliament with agreement from state governments. The sustainable diversion limits set (SDLs) in the Basin Plan were insufficient to sustain a healthy river system, one that conserved the values stated by the governments (see Key Issue 1). Yet we acknowledge the decision of the Australian Parliament to opt for a lesser degree of river health, and in so doing support the commitment by the Prime Minister and COAG to deliver the Basin Plan "on time and in full."[13, 14] In offering this support, we recognise the inadequacies of the Plan and in this submission seek to express our concerns and recommendations about how the Plan can be improved to meet its objectives.

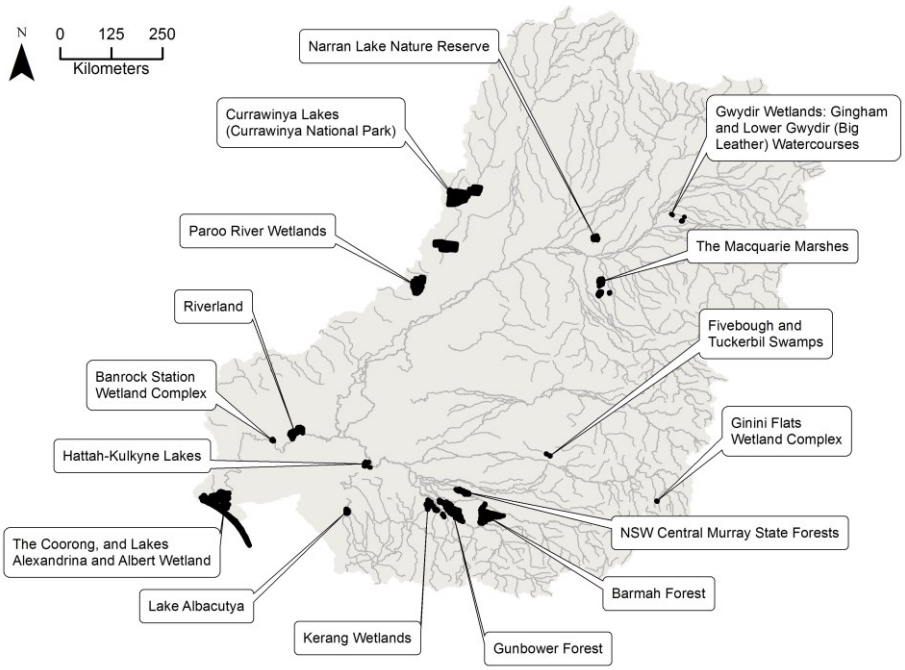

Figure 4. Location of the sixteen Ramsar wetlands in the Murray-Darling Basin.

Key issue 1: Establishing an environmentally sustainable level of take

This section addresses the Royal Commission's terms of reference 3 and 12 and Issues paper focus area 28 (a): Process used to determine the "Environmentally Sustainable Level of Take.

Water requirements for a healthy river system

Section 4 of the Water Act 2007 defines the environmentally sustainable level of take (ESLT) for a water resource as "the level at which water can be taken from that water resource which, if exceeded, would compromise:

- key environmental assets of the water resource; or
- key ecosystem functions of the water resource; or
- the productive base of the water resource; or
- key environmental outcomes for the water resource."

Validity of the Basin Plan's approach

The process-based approach represented by the Murray-Darling Basin Authority's use of 18 hydrologic indicator sites to set Basin Plan parameters has little fidelity with the text, subsequent resolutions and guidelines of the *Convention on Biological Diversity* and *Ramsar Convention on Wetlands* for biodiversity conservation. Two examples highlight this disjunction. There are around 5.7 million hectares of wetlands in the Murray-Darling Basin,[15] and under the Ramsar Convention, Australia's has promised their "wise use" in a manner that maintains their "ecological character" in the context of "sustainable development."[16] The two conventions emphasise conservation of a representative areas of ecosystems, threatened species and waterbird population, among other values. The Basin Plan does not show how it conserves these values, especially since much of this biodiversity is located in the mid or upper reaches of the basin's rivers, and has specific hydrological requirements that are, at best, left to state water resource plans to consider.[17] Basing the Basin Plan on meeting indirect hydrological indicators assumes that meeting required water flows at the monitored sites in the lower reaches of the rivers would see adequate conservation of wetlands and other target biodiversity throughout the Basin. This is unlikely.

Analysis by Pittock and others has raised the question of whether or not the Basin Plan and the Water Act are at risk of being constitutionally invalid under section 51(xxix) of the Commonwealth Constitution. Their assessment asks if deficiencies in implementing the terms of the Ramsar Convention and provisions that negatively impact on Ramsar designated wetlands are substantially inconsistent with the terms of the Ramsar Convention.[16]

A further concern is whether the places conserved through the Murray-Darling Basin Authority's use of 18 hydrologic indicator sites at the lower reaches of the rivers provides a sound approach for conserving freshwater biodiversity with a changing climate. Other wetland areas may be of importance for conservation under such conditions,[18] as the following examples illustrate. Gaining river reaches where fresh groundwater discharges into river

channels in mid-Basin locations could be important refugia for aquatic biodiversity. The few remaining free-flowing rivers in the Basin provide important habitat for migratory fauna and unregulated flows that may trigger breeding. Currently degraded wetland areas may be located in parts of the landscape that are more resilient in a changing climate and should be priorities for conservation. None of these wetlands have been identified or are prioritised for conservation directly in the Basin Plan. Again, at best, they left for subsidiary state water resource plans to consider.

The adopted Basin Plan approach

The 18 hydrologic indicator sites identified by the Murray-Darling Basin Authority were representative of a subset of 2,442 key environmental assets and 88 sites for key ecosystem functions.[19] If the flow targets for these hydrologic indicator sites are met with low uncertainty, the assumption is there is a "high likelihood that the ecological outcomes will be met."[20]

Evidence produced by the Murray-Darling Basin Authority in 2010 suggested that achieving an ESLT would require the recovery of between 3,856 GL ± 20% (high uncertainty) and 6,983 GL ± 10% (low uncertainty) of surface water from an annual consumptive use of 13,623 GL.[19] The method used to estimate the ESLT was based on maintaining 60% to 80% of without-development flows at end-of-system locations.

In recommending this volume, the Authority determined that it would "provide the flow needs for all water-dependent ecosystems across the Basin."[19] Without the release of any new independently reviewed scientific information, the Guide still represents the best publicly available science to establish what is needed to restore the Basin to health.

In 2012, the Authority's Board rejected this advice and instead put to the Australian Parliament a Basin Plan for a water recovery target of 2,750 GL (by 2019), with a program to remove constraints and recover an additional 450 GL of water (by 2024), bringing the total to 3,200 GL. The hydrological models used to inform the Basin Plan in 2012 were more complex than the models used to inform Guide, however the water recovery scenarios selected (2,400GL, 2,800GL, and 3,200GL) were lower than the bottom end of the range proposed in the Guide.

As a consequence, modelling results showed that a 2,800 GL water recovery target would only achieve 11 of the 18 flow indicators for the southern Basin (61%), a 3,200GL target would only achieve 13 of the 18 indicators (72%) and a 3,200GL target with relaxed constraints would achieve 17 of the 18 indicators[21] (94%; Table 1). There was no published scenario that achieved all flow indicators, nor was there any reason given as to why only some indicators were achieved and others not. In other words, on the evidence provided by the government's own Authority suggested that the reduction amount grossly underestimated the environment water requirements needed in all but the relaxed constraints scenario.[22]

Table 1. Achievement of 'actively managed' river channel and floodplain environmental flow indicators achieved on the River Murray for the baseline and Basin Plan scenarios.[21]

Scenario	Baseline	BP-2800	BP-2800-RC	BP-3200	BP-3200-RC
Number of flow indicators achieved	0/18 (0%)	11/18 (61%)	11/18 (61%)	13/18 (72%)	17/18 (94%)

The Basin Plan also allowed for a further increase in the sustainable diversion limit through projects which offset water recovery, and an increase in groundwater extractions across the Basin by 949 GL provided the impacts on river flows could be managed.[23] The Basin Plan did not take sufficient account of the risks to river health from climate change,[22] despite the Water Act requirement to develop the Basin Plan on the basis of best available scientific knowledge (s21 (4)(b)).

Modelling underpinning the Basin Plan has been secretive and contested,[22] and this has undermined the opportunity for the community and governments to compare options and make an informed decision about the level of conservation. It is not possible to assess the ecological outcomes from the information available in the modelling reports accompanying the Basin Plan. Subsequently it is impossible to assess the ecological implications for Ramsar sites, wetlands listed on the Directory of Important Wetlands of Australia as well as Commonwealth, State or Territory listed threatened species and/or ecological communities. Without the information to assess this, it is impossible to determine whether the draft Basin Plan complies with the Water Act.

Unwinding of water recovery targets since 2012

A series of policy changes since 2012 are now threatening to further undermine the possibility of achieving an ESLT and satisfying the objectives of the Basin Plan:

- In 2014, the Commonwealth Government announced a policy shift from water purchase to irrigation efficiency upgrades[24] and in 2015 the Australian Parliament amended the Water Act by placing a 1,500GL cap on water purchase.
- In 2017, the Australian Government proposed to amend the Basin Plan by increasing surface water extraction limits for irrigation by 70 GL in the Northern Basin and increasing groundwater extraction limits by 160 GL. This would have undermined the objectives of the Basin Plan, resulting in even less water available for the environment and a reduced likelihood of achieving environmental outcomes in the Basin.[25] The amendment was disallowed by the Senate in February 2018, however a future amendment to the Basin Plan in the northern Basin has not been ruled out.[26]
- In December 2017, the Australian Government amended the Basin Plan by increasing water extraction limits by 605 GL on the basis of 36 projects which offset water recovery. The Murray-Darling Basin Authority has never published evidence to demonstrate that the revised water recovery target satisfied the definition of an environmentally sustainable level of take, nor published key model assumptions upon which their assessment was based. Our assessment showed that the majority of

projects were not of sufficient quality to deliver Basin Plan outcomes equivalent to 605GL of water (see Key Issue 3).

- The December 2017 adjustment of sustainable diversion limits reflected the fact that almost no progress has been made on recovering the additional 450 GL of water towards the 3,200 GL target.
- Projects proposed by state governments to address constraints are not consistent with the MDBA's targets to achieve 17 of the 18 flow targets in the River Murray (Table 3). In one case, flow constraints have worsened in the Goulburn River since 2012. Failure to remove constraints to allow flows within the Bureau of Meteorology's minor flood level will compromise the ability achieve the Water Act objective of inundating an additional 35,000ha of floodplains along the River Murray (s86AA (2) (f)).

As a result of these changes, the worse-case scenario is a surface water recovery target of 2,136GL, or two thirds of the 3,200GL target (Figure 5), with continued impediments to river flows on floodplains. The Authority has not published figures describing the overall impact of these combined reductions on key environmental assets and functions including Ramsar sites, nor the volume of water available at the end of the river system. However, we have identified broad implications of reduced water recovery targets for the Basin as a whole with respect to river flows, salt export and floodplain wetlands:

- Reduced water quality to water users, particularly salinity and blackwater risk, and less water available for flushing of salt and nutrients out to sea;
- Reduced end-of-system flows could compromise key environmental objectives for the River Murray including the Ramsar-listed Riverland and the Coorong, Lower Lakes and Murray Mouth;
- Reduced inundation across the large majority of floodplains and wetlands that are not served by environmental works and measures; and[27, 28]
- Running the river system on tighter water volumes reduces the capacity of the Basin to cope with stresses of the inevitable of drought as well as increases vulnerability to climatic and other changes.

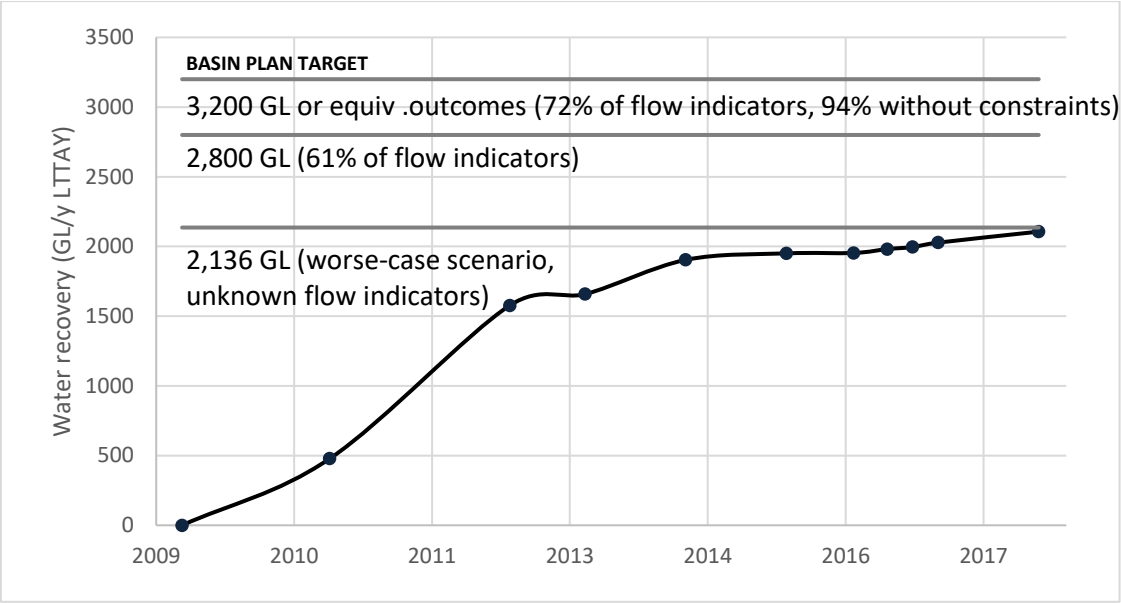

Figure 5. Progress of water recovery since 2009 towards the Basin Plan target of 3,200GL or equivalent. Under the SDL adjustment amendment and the Northern Basin Review, the revised surface water recovery targets of 2,136GL would fail to satisfy flow indicators representing key assets and functions across the Basin, as determined by the MDBA in 2012.[29]

Optimising social, economic and environmental outcomes

A review of key socio-economic indicators in the Basin commissioned by the Wentworth Group in 2017 showed that national water reforms since 2004 have brought a range of direct and indirect benefits to the irrigation industry (see Appendix 3 of Attachment 1 - Socio-economic changes in the Basin). The review found that water reform has improved water trade which has provided greater flexibility for irrigators to manage risks and adapt with less water. Water is now moving to higher value uses, assisted by permanent and temporary water trade. The Basin's economy as a whole has grown since 2002 and has been maintained in the five years since the Basin Plan has been in place.

However, the review found a number of regional communities have been adversely affected by water reform and there has been inadequate support for these communities. Adverse effects of water recovery in some smaller communities occurred from water entitlements leaving production, resulting in downsizing or closure of businesses, fewer employment opportunities and reduced revenue streams for supply chain and other supporting services. Adverse effects of water reform may have also occurred as a consequence of the policy to invest in high efficiency, high value enterprises, leading to the rationalisation of farms (e.g. automation, out-sourcing and consolidation) and reduced labour costs.

The review showed that the impacts of water recovery have compounded other pressures facing rural and regional Australia. For example, advances in technology (e.g. round cotton balers, 'Roundup Ready' crops that require less spraying) in the irrigation industry reduced the total demand for seasonal workers reduced by 75% or about 5,000 jobs from 1999 to 2013.[30]

Our conclusion is that water reforms have failed to provide adequate support for communities most adversely impacted by the Basin Plan. Under the current reforms, only those with water to sell will receive financial compensation, and only irrigators will benefit from infrastructure improvements. Less than one per cent of the $13 billion has been made available to assist communities to adapt to a future with less water. Well-coordinated irrigation groups have used this failure to lobby governments to halt water recovery, at the expense of Basin communities and river health. Instead of advocating for the support of impacted communities, the MDBA has continued to recommend lowering the water recovery target to mitigate impacts on a small number of communities.

The Authority has used evidence selectively to justify a reduction in water recovery targets. For example, socio-economic analyses undertaken as part of the Northern Basin Review focused on short-term impacts of water recovery on irrigated area and jobs,[31] ignoring the many benefits of water reforms to the irrigation industry since 2004 (e.g. water quality improvement, infrastructure modernisation, cash flow during drought).[9] Further, the Authority's assessments failed to adequately incorporate into their final recommendation the benefits of a healthy river for communities including Indigenous groups, and industries including tourism, fisheries and floodplain grazing, despite advice from the statutory Northern Basin Advisory Committee that these values "need to be considered as part of triple bottom line assessment.[31]

Recommendations for Key Issue 1

The Basin can't have viable regional communities without a healthy river. An optimal social, economic and environmental reform requires first securing the water resources in the national interest, then assisting those who are likely to be most impacted to adapt to these changes.

In the next revision on the Basin Plan, the Murray-Darling Basin Authority should revise SDLs using hydrological models and recent gauged data, with view of defining an ESLT which satisfies all key environmental flow indicators at least to a level of high uncertainty. The indicators should be met under conditions of river flow variability associated with both historic observations and in relation to climate change scenarios for a range of plausible environmental watering demands. In undertaking this revision, the Authority should make all evidence including models publicly available and report on likely specific outcomes for all key assets and functions including Ramsar sites and threatened biodiversity.

The Commonwealth Government should provide a regional development package that puts communities at the centre of reform. The package would assist communities most affected by water recovery to restructure their economies to adapt to a future with less water. One approach is to use strategic purchase to recover water for the environment while releasing funds for regional development. Assigning for example, 10% of the remaining $5.1 billion would release up to $500 million for regional development initiatives.

Key issue 2: Progress on implementing the Murray-Darling Basin

In 2017, five years after the Murray-Darling Basin Plan was adopted by Parliament, the Wentworth Group undertook a comprehensive review of progress of water reform in the Murray-Darling Basin. The 300-page review (Attachment 1) documented progress towards the environmental, social and economic objectives in the Basin Plan and identified actions needed to deliver the Basin Plan in full. Overall, the review identified that progress has been made in many aspects of water reform across the Murray-Darling Basin. Unprecedented volumes of water have been recovered for the environment, environmental outcomes are being realised where this water is used, and significant investment has been made in modernising irrigation infrastructure. There has also been considerable improvements in the governance of water markets, which has led to irrigation water resources moving to higher value uses.

Notwithstanding these important achievements, strong political pressure has been placed on governments to halt water purchase and unwind water recovery targets. Only one quarter of the water recovered so far (530 GL) has been acquired since the Basin Plan was adopted, while the cost of water recovery has doubled. While no overall improvement in the condition of river systems has been observed yet, there have been local improvements in salinity, water quality, and the condition of freshwater species in river reaches receiving additional water.[32] The Ramsar-listed Coorong is still in poor condition due to inadequate freshwater flow, however the condition of the Lower Lakes, also an internationally recognised environmental asset, has improved through the combination of the return of wetter conditions since the millennium drought and the delivery of environmental flows.[33]

As a result of this review, we identified five major risks to the implementation of the Basin Plan "in full and on time" (see Review for detail):[34]

1. Secrecy and allegations of water theft have caused an erosion of public trust in governments to implement reforms;
2. Stalling of progress on water recovery towards the target of 3,200 GL or equivalent outcomes;
3. Risk that environmental flows could fail to reach target locations because they are being undermined by state water management rules and constrained by development on floodplains;
4. Inadequate support for regional communities most affected by water reform; and
5. Present and future challenges of managing water in a variable and changing climate.

Recommendations for Key Issue 2

We identified five actions needed to deliver the Basin Plan 'on time and in full' as committed by COAG in December 2016.[13]

1. **Rebuild trust with greater transparency, by:**
    - **Improving metering and compliance** by Commonwealth, state and territory governments agreeing to comprehensive measurement of consumptive water use and water interception, including groundwater, across the whole Basin to a standard suitable for compliance action.

- **Improving accountability** with professional water accounting standards and independent auditing against standards, accompanied by annual audits of expenditure of public funds and annual reviews of the Basin Plan's progress by an independent auditor.
- **Reinstating a basin-wide river monitoring program** to measure and report regularly on the overall condition of the 23 river systems across the Basin as well as targeted programs reporting on progress towards specific Basin Plan objectives against what would have occurred without the Basin Plan.
- **Strengthening the capacity of the Murray-Darling Basin Authority to fulfil duties as a regulator.**

2. **Guarantee recovery of the full 3,200 GL or genuinely equivalent outcomes, by:**
   - **Securing the remaining 1,093 GL or equivalent**, including the 450 GL to enhance the Basin's health, through a combination of strategic water purchase, water efficiency programs and on-farm investment, but only where such recovery results in measurable additional water to the river system. Water recovered must account for the reduction in runoff and groundwater recharge that would have otherwise benefitted the environment.
   - **Ensuring environmental outcomes are equivalent or better** as a result of any adjustment to the sustainable diversion limit by agreeing to the conditions in Table 2. Rivers need water, and 'complementary measures' such as carp herpes virus, are not a substitute for real water.
   - **Making sure water recovered for the environment is protected in the river and not being undermined** by changes to state water resource plans (see Table 12 in Appendix 1), river management and operating rules, changes to baselines or model assumptions, and other land use changes that affect water availability in the catchments (e.g. farm dams, plantations, floodplain harvesting).[2]
3. **Ensure that water recovered achieves measurable improvements to the river system, by:**
   - **Removing constraints (physical and policy)** that restrict the use or passage of environmental water to target floodplains and wetlands, by re-configuring infrastructure and enforcing planning restrictions in designated floodways, and where appropriate, compensating for any third party impacts.
   - **Ensuring sufficient water reaches the Lower Lakes, Coorong and Murray Mouth** to export salt from the Basin, reduce water quality risks, and deliver freshwater to maintain the ecological character of the Ramsar wetlands (including a suggested amendment to s86AA (2)(c) of the Water Act 2007, on dredging the Murray mouth).
   - **Aligning the Basin Plan targets, the Basin-wide environmental watering strategy, and water resource plans**, at the catchment level as part of the accreditation process to achieve outcomes.
4. **A regional development package that puts communities at the centre of reform, by:**
   - **Assisting communities most affected by water recovery to restructure their economies to adapt to a future with less water.** Assigning for example, 10% of the

remaining $5.1 billion would release up to $500 million for regional development initiatives.

- **Linking public funding directly to the Basin Plan**, by the Commonwealth working directly with community leaders, local government, regional development boards and natural resource management agencies to recover the water in a manner that optimises regional development opportunities for those communities.

5. **Prepare for the prospect of a future with less water, by:**
    - **Improving scientific understanding of the potential future stresses** caused by extreme weather events (e.g. more frequent and more severe drought and higher evaporation from rising temperature) and long-term changes in climate including water availability, supported by a climate change adaptation program for environmental assets, industries and public infrastructure.
    - **Expanding the mandate of the Basin Plan** to integrate water planning with broader natural resource management to improve the overall environmental condition of the Basin.
    - **Investing in knowledge and capacity** to enhance agricultural productivity, sustainable production and food and water security, and protect the natural resource base in a variable and changing climate (see p73 of the Review,[34] including the possible development of field experiment stations similar to that in Loxton in South Australia).
    - **Ensuring water reform** remains a permanent item on the COAG agenda, and recognising the long-term nature of national water reform via the establishment of an independent expert body to undertake regular reviews of progress.

Key issue 3: Adjusting the Sustainable Diversion Limits

This section addresses Terms of Reference 3, 5, and 6. It also corresponds with 28 (b) and (c) of Issues paper 1 related to the 36 supply measure projects and the recovery of 450GL for enhanced environmental outcomes.

The Murray-Darling Basin Plan is an agreement to recover 3,200 GL of environmental water or equivalent outcomes to help restore the health of the Murray-Darling Basin. Under Chapter 7 of the Basin Plan, this volume may be reduced if state governments can demonstrate alternative ways of delivering similar outcomes for the environment, as part of a process known as the Sustainable Diversion Limit (SDL) adjustment. The SDL adjustment process also allows for the easing or removal of constraints to environmental water delivery and the addition of 450 GL per year of environmental water above the 2,750 GL target to deliver a combined water recovery target of 3,200 GL (Basin Plan s7.09 (e)).

To ensure that the SDL adjustment mechanism is implemented in a way that is consistent with the Basin Plan and Water Act, the following four components should be delivered in full:

1. **Supply measures:** All supply measure projects should meet all the relevant conditions of approval required by the Basin Plan and other government agreements (Table 2);

2. **Constraints measures**: All constraints proposals should be consistent with targets set by the Murray-Darling Basin Authority in its Constraints Management Strategy[35] (Table 3);
3. **Efficiency measures:** The full 450GL of real water savings should be recovered within statutory requirements, accounting for the impact of efficiency measures on return flows; and
4. **Pre-requisite policy measures:** All pre-requisite policy measures proposed by Basin states should be consistent with model assumptions, based on publicly available information from the MDBA.

Supply measures

New South Wales, Victoria and South Australia have brought forward a package of 36 projects to be considered for a reduction in the water recovery target under the SDL adjustment process. This package includes engineering works, changes in river operations, evaporative savings, and enhancements to ease or remove constraints to the delivery of environmental water. The Murray-Darling Basin Authority has estimated the outcomes that could be achieved by this package is equivalent of up to 605GL of environmental water.

The Wentworth Group has identified twelve conditions (Table 2) that we believe are required to ensure that supply measures will deliver "equivalent environmental outcomes with a lower volume of held environmental water than would otherwise be required" (the requirement of section 7.09 in Basin Plan). Eleven of these conditions are sourced from the Basin Plan itself, or policies that have been agreed by Basin governments or adopted by the Authority (see references in Table 2). One further condition (Condition 8) was a recommendation from an independent stocktake of SDL projects commissioned by the Authority in 2015. This condition applies to projects that generate water savings (e.g. evaporative or operational loss savings), and is designed to ensure that these savings will be available for environmental use and not diverted for consumptive use.

These twelve conditions are safeguards against obvious risks and avoidable failures, such as the failure to secure landholder approval which has hampered operation of the $80 million Koondrook-Perricoota "The Living Murray Project" since it was operationalised in 2014. The conditions are also necessary to give the public confidence that $1.3 billion of taxpayers' money spent on projects will deliver the expected outcomes without unacceptable risks to communities and the environment (e.g. salinity, blackwater, unforeseen collateral damage), including the Coorong and Lower Lakes.

Table 2. Conditions to ensure supply measures projects are consistent with the Basin Plan.

Condition of Approval	Statutory Reference
1. Works-based projects must align with Basin Plan targets.	Basin-wide environmental watering strategy [36]
2. All works-based projects must be assessed using a scientifically robust method.	Basin Plan S6.05
3. Any adjustment of the sustainable diversion limit must ensure that there is no change in flow indicators.	Basin Plan S6.07
4. Sustainable diversion limit must not change by more than ±5% overall.	Basin Plan s7.19
5. Environmental risks must be mitigated to acceptable levels.	Phase 1 Assessment Guidelines for Constraint and Supply Proposals, Overarching Evaluation Criteria #4.
6. Long-term governance arrangements must be secured.	Phase 1 Assessment Guidelines for Constraint and Supply Proposals, Overarching Evaluation Criteria #3.
7. Environmental water must be able to reach works projects and the broader floodplain in the future.	Basin-wide environmental watering strategy [36]
8. Any water savings from rules-based projects will be converted into a water entitlement.	Recommended in the SDL Adjustment Stocktake report commissioned by MDBA "Converting savings to licence entitlements is required to achieve a supply contribution" [37]
9. Projects must deliver value for money.	*Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin*, and Phase 1 Assessment Guidelines for Constraint & Supply Proposals, Overarching Evaluation Criteria #2
10. Projects must be monitored to ensure outcomes are delivered.	Basin-wide environmental watering strategy [36]
11. Projects are consistent with the Constraints Management Strategy, including that constraint levels as at 2012 must be used as a benchmark to compare changes.	Constraints Management Strategy, Phase 2 Assessment Guidelines for Supply & Constraint Measure Business Cases #3.2.2
12. Pre-requisite policies proposed by states for managing environmental water must be configured in the model used to calculate an adjustment.	Basin Plan s7.15 (1) (ii)

Our assessment of supply measure projects[38] showed that:

1. Only one project, the South Australian Murray Key Focus Area, meets the necessary conditions for approval. Approval of this project for SDL adjustment is however, contingent on upstream constraints proposals meeting targets in the Constraints Management Strategy, which they currently do not.
2. Eleven other projects (representing in the order of 150-270 GL water savings) require additional information before a proper assessment can be undertaken. With such information it might be possible for some or all of the projects to satisfy the 12 conditions for approval. However, all projects would need to ensure there is no significant change in environmental flows reaching the Lower Lakes and Coorong (Condition 3).
3. The remaining twenty five projects (representing in the order of 316-436 GL) do not satisfy these conditions and should not be approved in their current form. This includes The Living Murray works which, although they are able to be considered for an SDL adjustment, they are not likely to result in equivalent environmental outcomes because of the environmental risks identified.

One of the primary reasons for the lack of trust in governments is the lack of transparency in government decision making. State Governments and the MDBA have consistently refused to make project business cases available to the public or the Australian Parliament - including information on the cost of individual projects. When the MDBA assessments of supply measure projects was released, only through a Senate order for production of documents, it confirmed the MDBA had serious concerns about many of the projects despite recommending to the Minister an adjustment on the basis of these projects. For example:

- the Menindee Lakes Supply Measure Proposal (NSW) "may lead to the loss of over 8,000 ha of golden perch nursery habitat in Lake Cawndilla for over 65% of time", and "over 15,000 ha of golden perch nursery habitat in Lake Menindee for over 20% of the time." This is the only system remaining in the entire Basin that provides nursery habitat to sustain mass golden perch recruitment events.[39]
- The majority of ecological targets for the SDL offsets in the Lower Murray (NSW) "are not supported by evidence" and the proposal seeks "an above natural flow through this system."[39]
- Lindsay Island (Stage 2) Floodplain Management Project (VIC) has "the potential that ecological risks have been underestimated due to a lack of available information."[39]
- The Business Case for Improved flow management works at the Murrumbidgee River – Yanko Creek Offtake (NSW) "contains no detail as to when upstream flood runners and tributaries may engage from the increased Yanco weir pool. This represents potential significant unknown third party impacts that represent a significant risk for the project." [39] This risk could be exacerbated by a separate proposal to discharge saline water from effluent creeks into the Yanco creek system, posing a "significant risk to salinity and water quality."

There can be no trust in governments under such circumstances.

In April 2018, the Wentworth Group put forward to the Government a set of legislative amendments to the Basin Plan and Water Act to ensure, *inter alia*, that the 2024 reconciliation process is transparent and supply measure projects will be modified in line with the Basin Plan objectives. In a response to the Wentworth Group on the 8 May 2018, Commonwealth Minister for Agriculture and Water Resources, Hon David Littleproud wrote "[I] appreciate that the legislative amendments and conditions that you propose are intended to ensure the integrity of the package of notified supply measures" yet he also states "I consider that the legislative amendments, including the 12 conditions for supply measure projects, proposed in your letters are neither necessary nor warranted." This statement is not supported by evidence provided in the MDBA's assessment that project assessment criteria was not rigorously applied. For example, the MDBA's assessment of the Lindsay Island (Stage 2) floodplain management project stated that "Information provided for ongoing operations and maintenance resourcing does not currently meet the phase 2 business case criteria and until this issue is resolved, there will be a significant risk for this project." Such failures serve to justify the need for stronger measures to improve transparency and robust process for ensuring states deliver the agreed outcomes under the SDL adjustment process by 2024.

Recommendations for Key Issue 3a

We recommend that the 36 supply measure projects are modified in line with the twelve conditions. Attachment 2 describes the conditions necessary for each project, based on our 2017 assessment of projects and updated with information from the Murray-Darling Basin Authority's own assessments of supply measure projects[39] made publicly available on 22 March 2018.

To facilitate these changes, the Wentworth Group has recommended legislative amendments to the Basin Plan 2012 and Water Act 2007 (Attachments 3a and 3b) to ensure that the conditions would be met as part of funding approval, and if any project cannot meet the 12 conditions, the project should be withdrawn as a notified measure prior to the mandatory reconciliation process in 2024 (Basin Plan section 7.11).

The legislative amendments to the Basin Plan and Water Act we have proposed (Attachment 3a and 3b) would also provide for greater transparency with respect to information about SDL projects including their operation, third-party impacts, costs and long term governance arrangements. The amendments would also provide for greater transparency in the hydrological modelling during the 2024 reconciliation process by requiring that the Murray-Darling Basin Authority publishes evidence to demonstrate that model assumptions reflect actual management practices. This would help to avoid unrealistic model assumptions which could allow the Authority to justify a lower water recovery target. For example, flow rates downstream of Yarrawonga were modelled with an aspirational target of 50,000ML/d when only 30,000ML/d was proposed by states (Table 3).

Constraints measures

The level of constraint relaxation being proposed by Victoria and New South Wales is not sufficient to satisfy the aims of the Constraint Management Strategy to achieve 80,000ML/d at the South Australian border or the Water Act objectives (s86AA (2) (f) and (h)) reflected in the enhanced environmental outcomes in Schedule 5 of the Basin Plan (Table 3). Constraints need to be relaxed to enable 75% of wetlands and flood dependent vegetation in South Australia to be inundated, compared to just 40% with the river system constraints that were in place in 2012.[21] This would satisfy 94% of flow indicators in the River Murray compared with 72% of indicators with the constraints in 2012[21] (Table 1).

Of the six nominated constraints proposals submitted for assessment under the sustainable diversion limit adjustment mechanism, only two are consistent with the Constraints Management Strategy (River Murray from Hume to Yarrawonga, and River Murray in South Australia). Further, the benefits of these two projects would depend on whether upstream constraints can be addressed in line with the MDBA's targets (Table 3).

Table 3. Removing physical constraints to permit delivery of water to floodplains and wetlands in the southern Murray-Darling Basin. Constraints highlighted in red are proposed levels that will fail to meet the Murray-Darling Basin Authority's target as specified in the Constraints Management Strategy.

Region	**Location**	**Pre-Basin Plan:** Constraint in 2012[35] (ML/d)	**MDBA Target:** In MDBA Constraints Management Strategy (ML/d)	**Proposed by States:** In business case [40] (ML/d)
Murray	Hume to Yarrawonga	25,000	40,000	40,000
	Downstream of Yarrawonga	40,000 (but effectively 22,000* due to upstream constraint of 25,000)	40,000 (50,000 for reaching disconnected wetlands and ephemeral creeks) [41]	30,000
Darling	Weir 32/Increase Menindee outlet capacity	9,300	18,000	14,000
	Darling anabranch	Water flows into anabranch over 9,300ML/d	Regulator added and closed above 9,300ML/d when environmental water is supplied from Menindee	n/a
Murrumbidgee	Gundagai	30,000	50,000	40,000 at Wagga (~30,000 at Gundagai)
	Balranald	9,000	13,000	9,000
Goulburn	Seymour	12,000	15,000	n/a
	McCoys Bridge	20,000	40,000	20,000
Total flow at South Australian border		66,000 **(assuming 26,000 from Goulburn)	111,000 **assuming Menindee allowed 18,000	73,000**

* 10,600 ML/d in regulated periods in summer and in other periods Hume to Yarrawonga constraint of 25,000 ML/d was in place meaning that flows downstream of Yarrawonga were effectively restricted to 22,000 ML/d.
** This number assumes perfect co-ordination of flows between the Murray, Darling, Goulburn and Murrumbidgee Rivers, something which is highly unlikely. The 111,000ML/d target is most likely to achieve the outcomes in schedule 5 of the Basin Plan (i.e. 80,0000 ML/d).

In one case, the proposed constraint levels put forward by the Victorian Government and supported by the MDBA actually represent a return to what could be delivered prior to the Basin Plan, reflecting the fact that constraints in these areas have not improved since the Basin Plan came into effect in 2012. In this example, the Goulburn River constraints project proposed the delivery of regulated flows up to 20,000 ML/d, the same flow rate identified by the Murray-Darling Basin Authority in 2012, whereas the Victorian Government was required to achieve a flow rate of 40,000ML/d.

With the current constraint proposals, we estimate that it will only be possible to deliver 52,600ML/d of environmental water to South Australia, and this will inundate only 32% of the wetlands and floodplain vegetation along the River Murray. This represents a reduction of 47,000ha in the area of wetlands and floodplain vegetation that would be able to receive environmental water compared to the Murray-Darling Basin Authority's target. If we assume

perfect coordination of flows in the Murray, Darling, Goulburn and Murrumbidgee Rivers, which is difficult in reality, it will be possible to deliver 73,000ML/d to inundate 59% of the floodplain.

We are pleased that as part of the recent Senate vote on the SDL adjustment amendment, the Commonwealth Minister for Agriculture and Water Resources the Hon David Littleproud and Shadow Minister for Environment and Water the Hon Tony Burke agreed to full implementation of constraint relaxation in the Southern System by 2024 to ensure the capacity of river managers to achieve flows of 80,000 ML per day at the South Australian border.[35] However we are disappointed that these targets were not legislated, particularly given the history of behaviour of state governments in the recent past.

Recommendations for Key Issue 3b

All constraints measures are essential to the successful implementation of the Murray-Darling Basin Plan. The following constraints proposals need to be modified in line with the targets in the Constraints Management Strategy[35] (Table 3), and sufficient funding needs to be made available:

- Murray River downstream of Yarrawonga;
- Darling River (Weir 32/Increase Menindee outlet capacity);
- Murrumbidgee River at Gundagai and Balranald; and
- Goulburn River at McCoys Bridge.

Constraint levels as at 2012 should be used as the benchmark to compare changes to ensure real improvements in river flow corridors since the Basin Plan was introduced.

Efficiency measures

Recovering the full 450GL is essential for achieving the outcomes in the Water Act and Schedule 5 of the Basin Plan, including "providing opportunities for environmental watering of an additional 35,000 ha of floodplain in South Australia, New South Wales and Victoria, improving the health of forests and fish and bird habitat, improving the connection to the river, and replenishing groundwater."

Basin governments have listed water use efficiency projects to contribute to recovering 450GL of water to enhance the health of the Basin's environment while achieving neutral or improved socio-economic outcomes. A 2018 report by Ernst & Young for the Murray-Darling Basin Ministerial Council has concluded that it is possible to deliver the 450GL of water with neutral or positive socio-economic impacts.[42] However, there has been no specific projects agreed nor any reported recovery of this water to date, and the Ernst & Young report identified a "significant risk in achieving the recovery of the 450GL within the statutory budget", given the volatility of water prices and anticipated increase in future water prices.

Recommendations for Key Issue 3c

The full 450GL of real water savings should be guaranteed to be recovered, within statutory requirements, accounting for the impact of efficiency measures on return flows, and ensuring appropriate monitoring and auditing be undertaken.

Pre-requisite policy measures

When setting the Sustainable Diversion Limit, the Murray-Darling Basin Authority assumed that specific policy measures would be implemented to allow the maximum environmental benefit to arise from use of water recovered under the Basin Plan. These measures included crediting return flows for downstream environmental use and calling environmental water from storages (e.g. Hume Dam; see Basin Plan s7.15 (b) (ii), including shepherding arrangements).

In their SDL adjustment determination, the Murray-Darling Basin Authority provided no details about how the states proposed to implement the pre-requisite policy measures.[43] Full transparency is required to ensure that pre-requisite policy measures brought forward by States are consistent with the SDL adjustment benchmark model (i.e. the hydrological model of the Basin that was used to estimate the unadjusted SDLs, with some modifications as per Basin Plan Schedule 6.02). Unless these measures are implemented in full and in a way that is consistent with the modelled assumptions, more water will be required to meet environmental outcomes of the Basin Plan, leaving less for consumptive users.

Recommendations for Key Issue 3d

In determining the reconciliation adjustment, the Murray-Darling Basin Authority should provide evidence to demonstrate that the pre-requisite policy measures configured in the SDL adjustment Benchmark model are consistent with those implemented by Basin states. This should include hydrological monitoring or auditing as appropriate.

Key issue 4: Reviews of surface water and groundwater SDLs

This section addresses Terms of Reference 3, and also 28 (e) of the issues paper related to the northern Basin review.

The Murray-Darling Basin Plan provides for the Murray-Darling Basin Authority to conduct research and investigations to inform amendments to the Basin Plan, including changes to Sustainable Diversion Limits (SDLs; s6.06 (1)). Following reviews of SDLs in the northern Basin and groundwater diversion limits in 3 zones in the Basin, a legislative amendment was tabled in the Senate on 4 November 2017. The proposed changes to the Basin Plan included a 70GL increase in SDLs in the northern Basin (from 390GL to 320GL recovery), and an increase of 160GL to SDLs in three groundwater areas. The Senate voted to disallow the amendment on the 14 February 2018, however a future amendment has not been ruled out.[44]

The Wentworth Group did not support this amendment in its tabled form, because:

1. **The Authority ignored recommendations from its own advisory committee to mitigate impacts of water recovery on communities, and instead lowered environmental standards.** In reviewing SDLs in the northern Basin, the Authority ignored recommendations of the statutory Northern Basin Advisory Committee to mitigate adverse impacts of water recovery on communities. The only option presented to communities was an amendment which lowered environmental targets in an attempt to avoid assumed socio-economic impacts, affecting key environmental assets including the Ramsar-listed Macquarie Marshes, and the Condamine-Balonne floodplain where the proposed flow targets were no longer consistent with Water Act and Basin Plan objectives.
2. **Environmental outcomes were likely to be worse than modelled because necessary policy measures were not guaranteed in legislation.** The Authority's recommendation to increase surface and groundwater limits was contingent on policy measures which were not guaranteed under the amendment (e.g. coordinating environmental watering, recovering water strategically, effective compliance). Governments did not demonstrate that they were willing and capable of implementing these measures to a standard consistent with model assumptions.
3. **States did not demonstrate they were capable of managing risks of increased groundwater extractions.** Risks resulting from increasing the SDLs are likely to be significant in the Eastern Porous Rock and Goulburn-Murray SDL units where groundwater is well connected to surface water, and in the Western Porous Rock units where four large mines have been proposed.

The amendment also failed to address the further issue that water management rules in the Northern Basin do not adequately protect important flow events (e.g. environmental flows, low flows) from being diverted by irrigators. Environmental water recovered in the northern Basin under the Basin Plan can be legally diverted by irrigators in valleys including the Barwon-Darling and the Balonne. This includes important low flow events which would otherwise have supplied the river, downstream communities and businesses with water during droughts (e.g. Wilcannia, Broken Hill, Lower Darling).[45]

Recommendations for Key Issue 4

We propose six recommendations aimed at ensuring that future reviews of the Sustainable Diversion Limits fulfil their intended purpose and result in amendments that are consistent with the Water Act and the Basin Plan's objectives:

1. Any review of SDLs should include a comparison of actual gauged data at hydrological indicator sites against the expected flow targets at those sites, given the known inaccuracies of hydrological models.
2. The Parliament should not consider any changes to the sustainable diversion limits until statutory event-based protection of flows (including environmental flows and low flows) is in place, and capable of being audited and enforced. Non-statutory based measures are not sufficient: statutory measures are necessary (e.g. via Water Resource Plans reviewed regularly), with interim protection prior to 2019.

3. The Murray-Darling Basin Authority should consider structural adjustment measures to mitigate impacts of water recovery on smaller communities as part of future water recovery in the Northern Basin, and as part of any review of sustainable diversion limits.
4. There should be no change to surface and groundwater sustainable diversion limits until statutory measures are in place which guarantee Basin governments will implement specific water management measures in a way that is consistent with assumptions in the hydrological model (e.g. in the case of the Northern Basin Review, measures include coordination of environmental flows; strategic recovery of water entitlements; and effective compliance).
5. Prior to any change in the sustainable diversion limits for groundwater, Victoria and New South Wales Governments must demonstrate that they are capable of implementing water management rules which will enable risks of groundwater extractions to be managed to acceptable levels.
6. Monitoring, compliance and enforcement regimes should be implemented and properly resourced at both State and Commonwealth levels.

Key Issue 5: Fulfilling the Commonwealth's mandate to manage water resources

This section addresses Terms of Reference 9 relating to enforcement and compliance powers under the Act.

The Murray-Darling Basin is one integrated natural system managed by multiple governments, yet the Constitution vests powers over water to states. Revelations of possible water theft and meter tampering in New South Wales have exposed a need for the Commonwealth to fulfil the mandate prescribed to them by Parliament under the Water Act, not only in compliance but in reviewing, auditing and implementing all aspects of the Basin Plan. An investigation by the New South Wales Ombudsman in November 2017 stated that "these failures potentially affected the integrity and reputation … and undermined public confidence in the water regulation system."[46]

Institutional changes since the Basin Plan was enacted have further reduced national oversight over water reforms with little accountability of governments to their commitments. The COAG Standing Council on Environment and Water, the peak body for coordinated government action on water reform, was disbanded in 2013 without replacement, and the Sustainable Rivers Audit was abandoned in 2012. The independent review body, the National Water Commission, was abolished in 2014 and responsibilities were split amongst government agencies, leaving the "potential for diminished commitment to the [National Water Initiative] reform agenda" according to the Commonwealth Government's 2016 State of the Environment Report.[47] This Report also found that "progress has slowed in areas such as development of comprehensive water plans, improvements in sustainable water use, standardisation and nationalisation of water markets, and broader adoption of water accounting."[47] The erosion of the national capacity to monitor water reform has made for a difficult policy environment for implementing and progressing reforms in the Murray-Darling Basin.

The Water Act prescribes some regulatory and compliance powers to the MDBA (e.g. Part 8 and 10), but the Authority is yet to fully exercise its capacity as a regulator. For example, the Murray-Darling Basin Authority recommended a 605GL reduction of water recovery targets based on 36 SDL adjustment projects, despite their own criticisms of many of the projects raised in reports which only became public following a Senate order for production of documents. As implementation continues, sustainable diversion limits come into effect and water resource plans proceed through accreditation, it is vital to the success of the Basin Plan that the Murray-Darling Basin Authority exercises greater authority as a regulator to ensure states fulfil all obligations to implement the Basin Plan, as required in the Water Act 2007.

Recommendations for Key Issue 5

- Ensure the composition of Authority members is balanced across social interests (e.g. local government, other regional community representatives), environmental interests (e.g. environmental scientists and non-government organisations) and economic interests (e.g. tourism, floodplain graziers and other water users) who are not currently well represented on the board.
- The Commonwealth Government should have a stronger powers over surface and groundwater, including financial incentives, regulatory measures, and ultimately powers to override state interests where this obstructs the national interest (e.g. constraints relaxation). The Commonwealth should apply greater scrutiny in the release of public funds to ensure states deliver the promised outcomes (e.g. tranche payments, payment on delivery of outcomes).[48]
- The Murray-Darling Basin Authority should have greater capacity as a regulator, for example, through adequate resourcing and by introducing experienced regulators and compliance officers within the agency.
- MDBA needs unfettered access to the Ministerial Council. Currently, submissions to the Ministerial Council are channelled through the Basin Officials Committee on which the MDBA has no direct representation.

Key Issue 6: Managing the Coorong, Lower Lakes & Murray mouth

This section addresses Terms of Reference 5 of the Royal Commission.

Rivers die from the bottom up, and many great river systems of the world have suffered from over extraction of water allowing “end of system” deltas and estuaries to degrade. The sea and lakes endure significant environmental damage as a consequence of the demand for irrigation water when it exceeds the hydrological and ecological limits for maintaining a healthy end of system (e.g. the Colorado in USA). Whilst the Basin Plan provides for increased flows to the Lower Lakes, Coorong and Murray mouth (CLLMM), this volume is not sufficient for a healthy end of system and there remains an ongoing and potentially ever-increasing threat to its environmental, social and economic health.

Vital to a healthy river and estuary system is the export of salt, hence the Basin Plan objective to have an average annual discharge of 2 million tons of salt into the Southern Ocean (s.9.09 (3)). Lower sections of the Murray-Darling Basin are underlain by reservoirs of marine salt, a legacy of deposition of marine sediments during the Cainozoic Era (last 66 million years), mainly from sediments deposited during Oligocene and Miocene periods, but also from later Pliocene and Quaternary marine incursions over the last 10 million years. Clearance of vegetation for agriculture since European settlement facilitated and progressively exacerbated the export of salt from ground waters into rivers and soils. The geologic legacy of stored salt constitutes a major factor in managing the Murray-Darling Basin given its influence on water quality not just in the CLLMM but upstream in South Australia, Victoria and New South Wales. In response to this legacy, salt interception schemes have been constructed along the river system to manage salt loads, however there is an expectation that salt loads will continue to rise over the next century in response to past land clearing activities.[49]

Marine and freshwater environments of the Lower Lakes and Coorong have interacted over several thousand years, reflecting the complex interplay of marine forces (waves, tides and wind) with river flows. The Lower Lakes and Coorong form an estuarine system that evolved in the last 10,000 years during the Holocene. As sea level rose towards its present position around 6,000-7,000 years ago, sands from the continental shelf were pushed landwards to form the Sir Richard and Younghusband Peninsulas. Today, these two sand barriers, connected at the Murray Mouth, block off the Coorong lagoons (north and south) and Lake Alexandrina. Several geologic and geomorphologic studies have documented the development of this open-ocean and estuarine sedimentary record.[50, 51]

Prior to construction of the barrages on Lake Alexandrina in the late 1930s, there is historic evidence that waters of the Lower Lakes were periodically impacted by salt waters from the sea, particularly during drought episodes with low fresh water inflows to the lakes. These episodes are part of the characteristic El Nino-La Nina cycle of droughts and flooding rains across southeast Australia.[52] During this time the Murray mouth appears to have mostly remained open under the influence of an efficient tidal exchange and reduced river flows.

In order to assist agriculture, maintain lake level heights for boats, and provide for water for settlements bordering the Lower Lakes, five barrages were constructed on Lake Alexandrina just prior to World War II. The aim was to reduce the impact of salt water incursions and thus keep freshwater levels stable. As a consequence, the area of the tidal prism (approximately 100km^2) was reduced by around 90%. This was at a time of progressive increase in water extraction in the Murray-Darling Basin for irrigation (Figure 2). The reduction in freshwater inflows combined with weaker tidal exchange from the construction of the barrages meant the sea began to dominate over river flows in shaping the evolution of the Murray mouth. These processes, combined with wind action, have led to the build up of sand in the mouth, including Bird Island. All this has been well documented in the academic literature since the early 1980s, especially the work of Bourman and Harvey (1983).[53]

Drought conditions induced by a major El Nino event in the early 1980s saw the closure of the Murray mouth for the first time in living memory. This required dredging the entrance of wave-deposited sand. A return to dry El Nino conditions of very low river flows and more sand accumulation during the Millennium drought again saw the Murray mouth close and dredges

return. Flood flows excavated a channel in 2010, only for the Murray mouth to close a few months later as a result of wave deposition. Figure 6 documents this history from 2002 to 2017 highlighting the relationship between sand volumes driven shoreward by wave processes compared to river flows at the barrages. A report commissioned by the South Australian Government in 2017 showed the rate of sand inflow from the sea is around 2,250m^3 per day necessitating the use of two dredges to sustain an open mouth.[54]

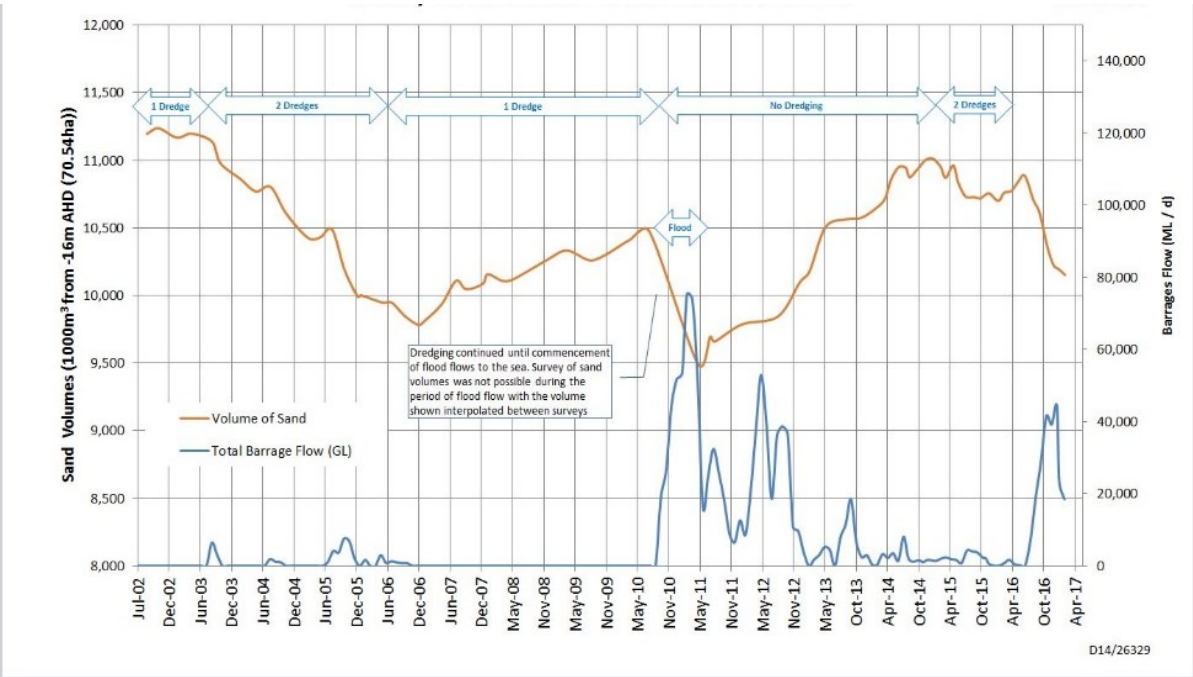

Figure 6. Barrage flow, sand volumes and dredging of the Murray mouth between 2002 and 2017. Supplied by South Australian Department of Environment and Natural Resources.

Very low freshwater inflows into the Lower Lakes during the Millennium Drought, with little or no flow over the barrages, combined with high evaporation rates affecting the Lower Lakes (of the order of 600GL to 800GL per year), allowed lake levels to fall below AHD (c. mean sea level). Figure 7 shows levels in Lake Alexandrina dropping below the normal range of plus 0.4 to 0.75m AHD to as much as -1.4m AHD in 2008 - 09 (Figure 7). The impact on water quality at this time was dramatic. A spike in salinity is apparent in Figure 7 indicating seepage through the barrages given the higher levels of marine waters on the seaward side. These waters contained larvae of sea worms which allowed worm tubes to grow as mounds on the lake floor and on turtles in areas of high alkalinity levels. A contrast occurred in other areas; adjoining the lake shores and local creeks, acid sulfate soils were exposed contributing to very low pH levels. This contrast in water chemistry, if sustained, or repeated in future droughts, could have long-lasting impacts on ecosystems subject to Ramsar Convention obligations. It should be noted that Goolwa town water supplies no longer utilise lake waters.

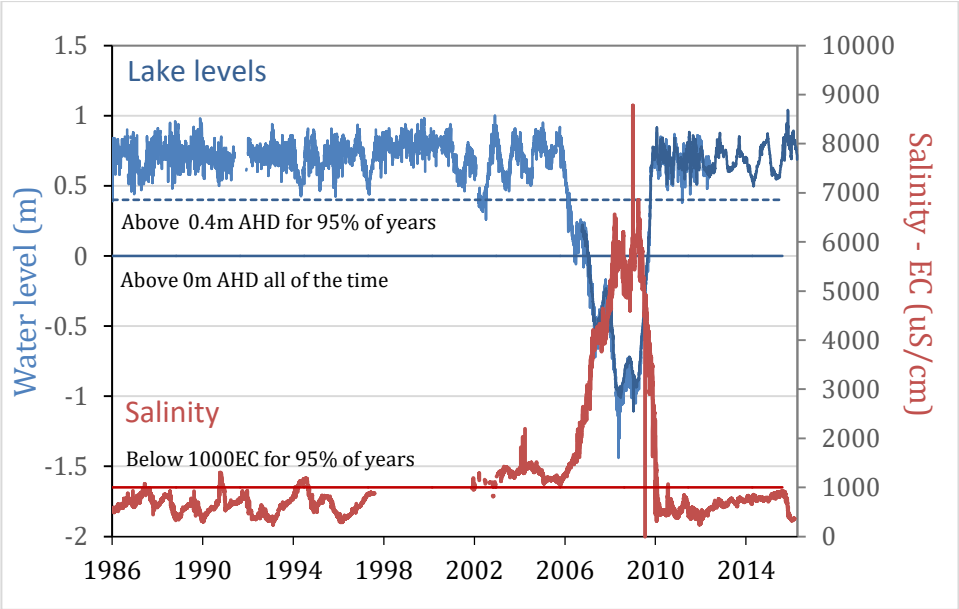

Figure 7. Daily water levels (blue) and salinity levels (red) for Lake Alexandrina from 1986 to 2015 measured at Milang.[55] Basin Plan targets are shown for water levels (s8.06 (e)) and salinity (s9.14 (5) (c)).

Figure 8. The Goolwa Channel during the Millennium drought in 2009.

Our analysis of historic river flow, available tidal energy and rates of sand ingress show that meeting Basin Plan objectives to ensure that the "mouth of the River Murray is open without the need for dredging in at least 95% of years" is impossible (Basin Plan Sch 5 (2) (c) and repeated as a non-binding clause as s86AA (2) (c) in the Water Act 2007).[34]

Since at least 2002, dredging has been needed to keep the Murray mouth open except during major flood events. Dredge spoil is placed in areas adjacent to the Murray mouth that can be subjected to wave and wind processes resulting in future ingress of sand that can choke the mouth.

Why the discrepancy between the objectives of the Basin Plan (and Water Act) and observed mouth openness? Modelling underpinning the Basin Plan failed to incorporate information and knowledge (both published and unpublished) related to the influence of marine processes affecting the mouth since barrage construction. Consequently, the percent of time the mouth will close was grossly underestimated. Our review of published data suggests that over a year, around 7,300GL of additional water would be needed to achieve this outcome. As a consequence, the 3,200GL environmental water recovery target will make only a marginal difference to the openness of the mouth. Governments will have no choice, even with an additional 3,200GL of water, to continue to spend $6m or more per year on dredging to keep the mouth open. The exception will be during major floods with discharges at the barrages of more than 20,000ML/day.

In order to keep the Coorong and Lower Lakes healthy, and also meet the Ramsar obligations, sufficient water must flow past Wellington into the shallow Lake Alexandrina to meet Basin Plan targets for water levels behind the barrages to stay above 0m at all times and 0.4m in 95% of years.[34] We estimate that if less than 2GL/day is conveyed into Lake Alexandrina (about 700GL/y long-term average), as was the case during the Millennium Drought, then evaporation and other losses will lead to lake levels falling below the Basin Plan targets. The result will be deterioration of water quality and habitat condition in the Coorong and Lower Lakes. There is a risk of acidification and other adverse impacts (including social and economic) if water levels drop below the target range again for sustained periods. To achieve minimum desired flows at the barrages into the Coorong, and through the dredged mouth to export salt, flow of the order of at least 4GL/day at Wellington is needed. Neither the Basin Plan nor the Murray Darling Basin Agreement specify minimum flow requirements for discharge into the Lower Lakes.

This analysis excludes the longer term impact of climate change. In Key Issue 7 we examine issues associated with a drier catchment as outlined in Appendix 4 of Attachment 1, on water inflows into the Coorong, Lower Lakes and Murray mouth. Moreover, there is the added potential impact of sea level rise and sand sequestration into the mouth from eroding coastal beaches and dunes that demands attention.

Recommendations for Key Issue 6

Given this knowledge and the likely future impacts of climate change, it would be prudent for the South Australian Government to undertake a full investigation into the long-term management of the Coorong, Lower Lakes and Murray mouth. This might include for example:

1. Whether inflows into the Lower Lakes during dry periods are sufficient to meet water level targets and reduce the water quality risks;
2. If the management of upstream constraints will allow for flows of sufficient volume and timing to reach the end of the system as per the Constraints Management Strategy;

3. A process for reaching agreement between responsible government agencies on priorities for the Lower Lakes, Coorong and Murray mouth, taking into consideration the need to protect the Coorong and Lakes Alexandrina and Albert Ramsar Wetland and export salt through the mouth;
4. Whether the objective for salt export will be achieved following adjustment to the sustainable diversion limits;
5. Consideration of an ongoing dredging program because of the power of the sea to bring sand into the mouth;
6. Review of the placement of dredge spoil to reduce the return of sand to the Murray mouth;
7. Adaptation strategies to cope with adverse impacts of long-term changes in climate including water availability and sea level rise on the Lower Lakes and Coorong. This should involve a state and Commonwealth process to assemble better knowledge, consult the community, define future management options and adopt a strategy for management of the region with climate change; and
8. A recommendation to the Commonwealth Government to either remove the non-binding clause 86AA (2) (c) from the Water Act 2007, or just remove the words "without the need for dredging" from the clause. As written, the clause creates the illusion that water recovered under the Basin Plan will be sufficient to maintain the river mouth.

Key Issue 7: Climate variability and climate change in the Basin

This section addresses Terms of Reference 12 of the Royal Commission.

An issue facing the implementation of the Basin Plan is how to move beyond consideration of what is termed the "long-term **average** sustainable diversion limit" to embrace the reality of Basin climate variability as experienced in the historical past, as well as climate change projections on potential flow regimes in the future. In order for the Plan to ensure water is recovered in volumes that meet environmental requirements and social and economic needs at times of variable flow, it is imperative that future iterations of the Basin Plan incorporate a scientific understanding of variability under changing climatic conditions.

In our 2017 review of water reform in the Murray-Darling Basin,[34] we provided an up-to-date assessment of how climate change is affecting the Basin (see Appendix 4 in Attachment 1, by climate scientist Dr Penny Whetton). This assessment goes beyond an understanding of past wet and dry years, and looks at what the "new climate era" might look like. In this context we discuss both the resilience of natural systems to change, along with the need to embrace adaptation pathways.

Natural variability

For purposes of the Basin Plan, the long-term sustainable diversion limit is a modelled average based on the historical record (114 years). Figure 1 highlights the historic "shifts" in climatic conditions from flood- to drought-dominated periods across the 20th century. Under current water sharing arrangements, the environment bears a greater burden of reduced flows in dry

periods. As water becomes scarcer, environmental water is reduced by about four times as much as reductions in surface water extractions by irrigators.[56] This is illustrated in the Murrumbidgee River during the last drought where water sharing rules of a diminishing inflows (green line) resulted in negligible outflows into the River Murray between 1994 and 2005 (red line) while irrigation diversions remained above 1,500 GL (yellow line; Figure 9). Planned environmental water is particularly vulnerable because it is not well protected and consists of 70-80% of the water available. CSIRO (2008) concluded "this policy represents a significant risk to the environment".[57]

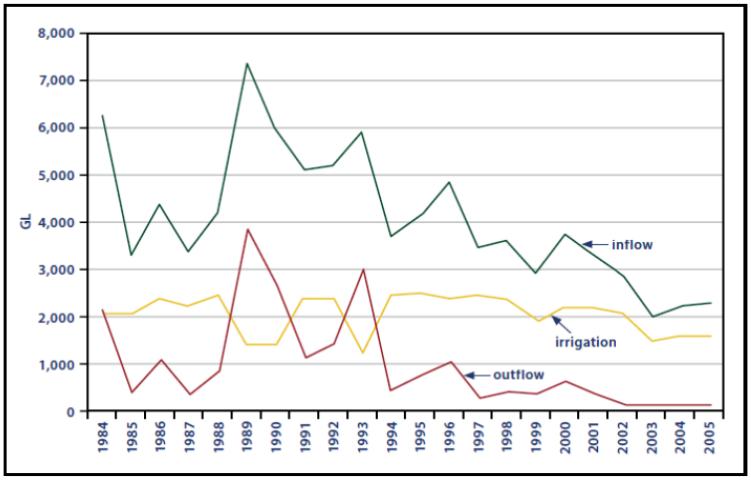

Figure 9. Murrumbidgee River inflow, outflow and water used for irrigation from 1984 – 2005.[58]

Further, some river management rules fail to adequately protect small but ecologically significant flows from extraction during dry periods. For example, current water management rules in the Barwon-Darling River allow irrigators to pump low flows "beyond the threshold of concern identified for most environmental flow requirement events."[59] The consequences include increased dry spells, increased risk of algal bloom, restricted fish movement, spikes in salinity and reduced water for communities downstream.

In future reviews of the Basin Plan, water management rules need to be reviewed to ensure that environmental flow requirements can be met under drought and flood conditions. Gauged river data should be used in addition to modelled data, given the tendency for models to overestimate flow volumes in the low flow range.[59] Future iterations of the Basin Plan should consider whether the current water sharing arrangements between the environment and consumptive use is appropriate, or whether different SDLs should be required for dry, median and wet scenarios.

Climate change in the Basin

The Basin Plan and its implementation does not properly address climate change. Several reports besides that of the Wentworth Group's review[34] have made this point (e.g. Pittock, Williams and Grafton, 2015[60]). Modelling research by various researchers have built on global and regional climate models to provide a basis for thinking about the implications of changes in temperature, evaporation, precipitation, soil moisture, soil/slope stability and runoff. These studies point to higher temperatures (already the Basin area has warmed by around 1 degree since 1910), more hot days and fewer cold days (less snow), and a trend to lower rainfall

especially across the southern parts of the Basin in winter.[61, 62] Daily extreme rainfall is projected to increase even if average rainfall declines, with implications for erosion and flooding. Whetton (2017) has applied the climate analogue approach representing substantially different climatic conditions for existing sites as those conditions 'move' under contrasting scenarios (Figure 10).[63]

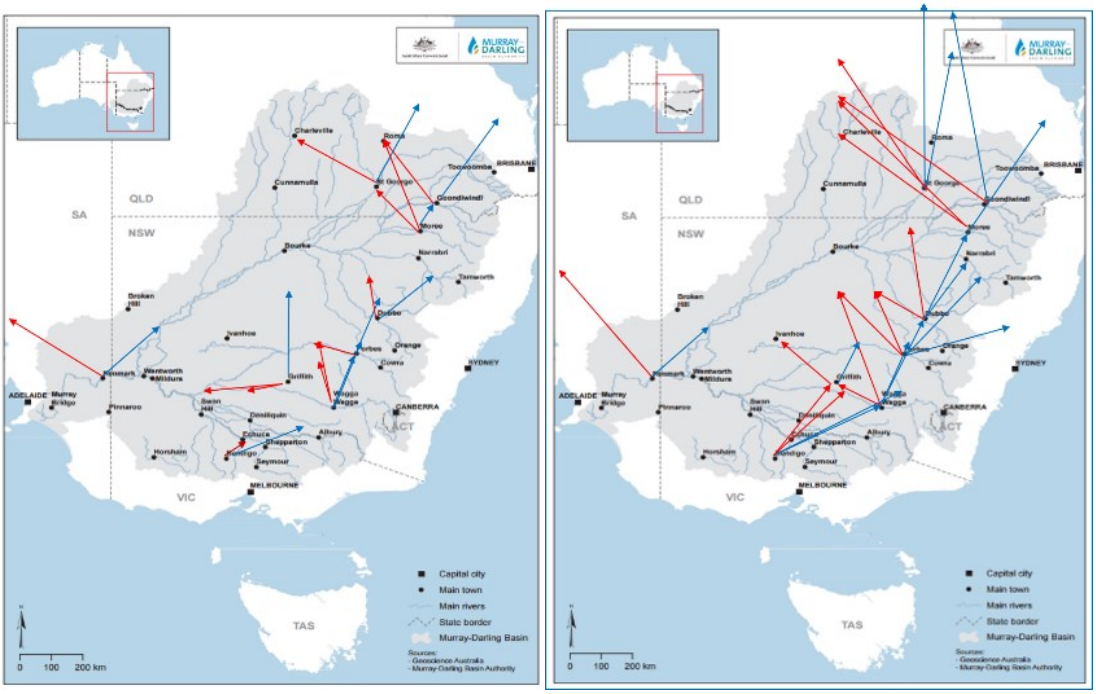

Figure 10. Map depiction of the climate analogues. Left panel 2030 and right panel 2050. Red arrows hottest and driest case, and blue arrow coolest and wettest case.

What is needed is a more sophisticated approach to wet and dry climate scenarios as used initially in the 2008 CSIRO Sustainable Yields Report.[64] Whetton assessed these scenarios as still valid and representative of the latest science, the next step is to incorporate these into future Basin planning. Our recommendation is that water allocation scenarios need to be developed around climate change projections highlighting on the one hand ecological resilience against known natural coping strategies, and on the other where there may be tipping points that require application of the adaptation pathways approach. This work could be facilitated by the development of a network of experimental stations as discussed in our Review report.[34]

A number of 'no and low regrets' approaches to conservation of freshwater biodiversity and adaptation to climate change have been identified,[18, 65] notably the following complementary measures:

1. Environmental flows
2. Environmental works & measures
3. Thermal pollution control
4. Freshwater habitat connectivity
5. Restoration of riparian vegetation
6. Conservation of more resilient landscapes (including remaining free-flowing rivers)

7. Conservation of gaining reaches
8. Geomorphic restoration
9. Management of exotic species

Through the Basin Plan and associated programs, governments have focussed on only the first two, environmental flows and works and measures. Environmental works and measures floodplain engineering projects have been extensively criticised due to their negative environmental impacts, expense and risk of governance failure.[27] The governments have not addressed the other seven options through the Plan processes. The 2007 water reforms have narrowed the scope of Basin management institutions to focus on water quantity and quality, arguably excluding joint programs to undertake a number of these non-volumetric water management and natural resources management activities that would greatly enhance the benefits of Basin Plan interventions now as well as contributing to climate change adaptation in the future.

Implications of climate change at the end of system

Failure to incorporate climate change into the Basin Plan is quite apparent in any consideration of the management of the CLLMM. On-going sea level rise and increasing basin temperatures could be seen as part of the new climate era affecting specific issues such as marine inundation on the one hand and rates of evaporation from the shallow waters of the Lower Lakes and Coorong on the other. But the implications go much deeper if the Basin Plan is to adequately meet its objectives (for example s. 5.02 (2) (a); and s. 8.06 (3) (e)). The Southern Ocean is an active driver of change to the CLLMM impacting on sea level, wave energy, sand transport from and to offshore sand bars, beach and foredune erosion, tidal regime, and sand sequestration into the Murray mouth flood-tide delta complex. River discharge at the Murray mouth over time must be seen in the context of these dynamic oceanic forces. Sea level rise at the mouth may be estimated from relevant regional sea level rise projections.[63] These projections relate to different RCP's. They provide an indication of the need to understand that sea level will continue to rise into the future even beyond 2100.

The key point is what rising sea levels will mean for the mouth. First, it is highly likely for sand to move alongshore and be sequestered in the flood tide delta of the mouth if combined tidal and river discharge remains insufficient to flush the mouth in the long term. (Cowell and Short, 2006, Report to SA Government). Second, rising sea levels will eventually reach a point when tides on the seaward side of the barrages exceeds or intersects the 0.4 to 0.75 range of water levels in the Lower Lakes. And third, depending on sand accumulation in the flood tide delta and impact on tidal range attenuation due to frictional effects, marine flows into the North and South Coorong will be altered. By how much is uncertain because of complex morphodynamics feedback processes.

All these factors should be incorporated into a Plan which recognises the 'near-term,' that is the period when management of the CLLMM can be undertaken with barrages still in place; and the 'long-term' which involves consideration of a tipping point when the barrages could be removed. In the near term, dredging must be used to maintain an entrance most of the time (we estimate in 95% of years) to allow salt and other pollutants to be discharged as per the existing Basin Plan. However, increased evaporation and reduced river flows will progressively threatened the integrity of ecological systems of the CLLMM especially during prolonged

droughts. Ramsar obligations will need to be met as these conditions become more prevalent.[16] However, the dramatic shift to a more open estuary state for the CLLMM without barrages will be a massive ecological and social challenge. It may require large scale engineering works to 'train' the Murray mouth similar to that of Gippsland Lakes. Ecological and water quality conditions would change as water levels of the Lower Lakes adjust to rising sea levels of the Southern Ocean. These works could be paid for by using the training walls/breakwaters as a location for wave power generation; this area is part of a broad region of the Southern Ocean defined by CSIRO of potential wave power generation.[66]

Recommendations for Key Issue 7

A robust way to rebalance the climate change risk is to periodically re-assess sustainable diversion limits under climate change projections and use the results as the basis for new sharing arrangements.[67] This approach enables environmental objectives and targets to be assessed within the envelope of projected water availability. A first step is to select the appropriate climate scenarios and prepare future flow projections. New modelling may be required as CSIRO Sustainable Yields projections do not extend beyond 2030. A further step is the requirement to assess climate change implications and appropriate tipping points for the management of the CLLMM which will create major ecological and social challenges. Consideration should be given to the establishment of experimental stations to assist in the adaptive management of natural and economic resources of the Basin under pressures from climate change.

Reading list

★= Key document

1a. Policy and legislative changes, in chronological order since 2004

Intergovernmental Agreement on a National Water Initiative (2004)
http://www.agriculture.gov.au/water/policy/nwi

★COAG Communique – 25 June 2004
http://ncp.ncc.gov.au/docs/Council%20of%20Australian%20Governments%20Meeting%20-%2025%20June%202004.pdf

★A National Plan for Water Security 2007
Prime Minister John Howard (see press release pages 30 – 41)
http://parlinfo.aph.gov.au/parlInfo/download/media/pressrel/K81M6/upload_binary/k81m68.pdf;fileType=application%2Fpdf#search=%22media/pressrel/K81M6%22

Water Bill 2007 Second Reading Speech
Minister for Environment and Water Resources Mr Malcolm Turnbull MP
http://parlinfo.aph.gov.au/parlInfo/genpdf/chamber/hansardr/2007-08-08/0016/hansard_frag.pdf;fileType=application%2Fpdf

★Water Act 2007
https://www.legislation.gov.au/Series/C2007A00137

Guide to the proposed Murray-Darling Basin Plan 2010
https://www.mdba.gov.au/publications/archived-information/basin-plan-archives/guide-proposed-basin-plan

★Basin Plan 2012
https://www.legislation.gov.au/Details/F2017C00078

Intergovernmental Agreement on Implementing Water Reform in the Murray Darling Basin (2013, revised 2017)
https://www.coag.gov.au/about-coag/agreements/intergovernmental-agreement-implementing-water-reform-murray-darling-basin

★Constraints Management Strategy, 2014
https://www.mdba.gov.au/publications/mdba-reports/constraints-management-strategy

Basin-wide environmental watering strategy, 2015
https://www.mdba.gov.au/publications/mdba-reports/basin-wide-environmental-watering-strategy-2014

1b. Policy and legislative changes, in chronological order since 2012 (including proposed changes)

★Murray–Darling Basin joint program arrangements - Current activities and implications of possible future funding scenarios 2013 (related to the Audit Program, the Sustainable Rivers

Audit, Climate Change Research and the Native Fish Strategy) Report available as a link on the archived website:
http://webarchive.nla.gov.au/gov/20140114071709/http://mdba.gov.au/about-mdba/governance/joint-programs

Water recovery strategy for the Murray-Darling Basin, 2014
http://webarchive.nla.gov.au/gov/20160107191400/http://www.environment.gov.au/water/publications/water-recovery-strategy-murray-darling-basin

★Water Act Amendment Bill 2015
https://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=r5468

★National Water Commission (Abolition) Bill 2015
https://www.aph.gov.au/Parliamentary_Business/Bills_LEGislation/Bills_Search_Results/Result?bId=s974

Water Legislation Amendment (Sustainable Diversion Limit Adjustment) Bill 2016
https://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=s1043

★Media Release: Murray–Darling Basin Plan legislative amendment tabled by Senator Anne Ruston, 2017
http://www.anneruston.com.au/media_release_murray_darling_basin_plan_legislative_amendment_tabled

★MDBA Recommendation to adjust the Sustainable Diversion Limits, 2017
https://www.mdba.gov.au/basin-plan-roll-out/proposed-adjustment-sustainable-diversion-limits

COAG Communique 9 December 2016
https://www.coag.gov.au/meeting-outcomes/coag-meeting-communiqu%C3%A9-9-december-2016

2. Wentworth Group publications

Blueprint for a National Water Plan 2003
http://wentworthgroup.org/2003/07/blueprint-for-a-national-water-plan/2003/

Sustainable Diversions in the Murray-Darling Basin 2010
http://wentworthgroup.org/2010/06/sustainable-diversions-in-the-murray-darling-basin/2010/

★Statement on the 2011 Draft Murray-Darling Basin Plan
http://wentworthgroup.org/2012/01/statement-on-the-2011-draft-murray-darling-basin-plan/2012/

Wentworth Group Evaluation of the Proposed Basin Plan 2012
http://wentworthgroup.org/2012/08/wentworth-group-evaluation-of-the-proposed-basin-plan/2012/

Senate Inquiry into Management of the Murray-Darling Basin system, 2012
http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;db=COMMITTEES;id=committees%2Fcommsen%2F4fa6f79d-0cf1-412a-bcb5-79c38e745ae2%2F0005;query=Id%3A%22committees%2Fcommsen%2F4fa6f79d-0cf1-412a-bcb5-79c38e745ae2%2F0000%22

Analysis of Groundwater in the 2011 Draft Murray-Darling Basin Plan, 2012
http://wentworthgroup.org/2012/04/analysis-of-groundwater-in-the-2011-draft-murray-darling-basin-plan/2012/

Wentworth Group Evaluation of 3200Gl Modelling with Relaxed Constraints, 2012
http://wentworthgroup.org/2012/10/wentworth-group-evaluation-of-3200gl-modeling-with-relaxed-constraints/2012/

★Statement on the Future of Australia's Water Reform, 2014
http://wentworthgroup.org/2014/10/statement-on-the-future-of-australias-water-reform/2014/

★Review of Water Reform in the Murray-Darling Basin, 2017
http://wentworthgroup.org/2017/11/review-of-water-reform-in-the-murray-darling-basin/2017/

★Submission to MDBA on SDL Adjustment Draft Determination
http://wentworthgroup.org/2017/11/submission-to-murray-darling-basin-authority-on-sdl-adjustment-draft-determination/2017/

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https://www.mdba.gov.au/publications/mdba-reports/proposed-environmentally-sustainable-level-take-surface-water-murray

MDBA (2012a) Hydrological Modelling to inform the proposed Basin Plan. Methods and Results, MDBA publication no: 17/12, Canberra
https://www.mdba.gov.au/publications/mdba-reports/hydrologic-modelling-inform-proposed-basin-plan-methods-results

MDBA (2012b) Hydrologic modelling of the relaxation of operational constraints in the southern connected system: Methods and results, MDBA publication no: 76/12, Canberra
https://www.mdba.gov.au/publications/mdba-reports/hydrologic-modelling-relaxation-operational-constraints-southern-connected

NSW (2012) Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012 under the Water Management Act 2000
https://legislation.nsw.gov.au/#/view/regulation/2012/488/part1

4. Academic publications

Floodplain engineering projects (related to SDL adjustment supply measures)

- Pittock, J., C. M. Finlayson and J. Howitt (2012). "Beguiling and risky: 'environmental works and measures' for wetland conservation under a changing climate." Hydrobiologia 708(1): 111-131.

  https://www.dropbox.com/s/nblmqug1bb78nqd/Pittock%20et%20al%202013%20Beguiling%20EWM%20MDB%20paper%20Hydrobiologia%202013.pdf?dl=0

- Wallace, T., D. Baldwin, R. Stoffels, G. Rees, D. Nielsen, C. Johns, C. Campbell and C. Sharpe (2011). 'Natural' versus 'Artificial' watering of floodplains and wetlands. Final Report prepared for the Murray-Darling Basin Authority by The Murray-Darling Freshwater Research Centre: 28.

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Infrastructure efficiency upgrades

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  https://www.researchgate.net/publication/282636368_The_Murray-Darling_Basin_Plan_fails_to_deal_adequately_with_climate_change

Ramsar Convention

- Pittock, J., M. Finlayson, A. Gardner and C. McKay (2010). "Changing character: the Ramsar Convention on Wetlands and climate change in the Murray-Darling Basin, Australia." Environmental and planning law journal 27: 401-425.
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