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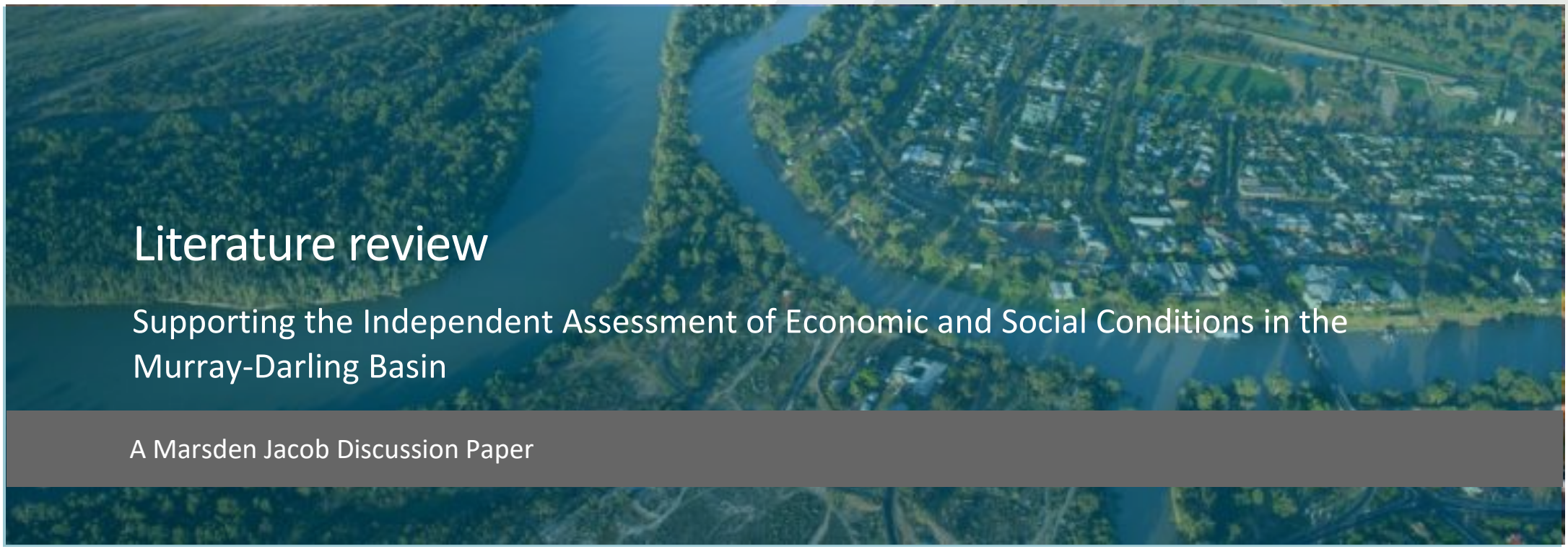

Literature review

Supporting the Independent Assessment of Economic and Social Conditions in the Murray-Darling Basin

A Marsden Jacob Discussion Paper

Prepared for Social and Economic Assessment Panel

August 2019

This investigation has been commissioned by the Panel for the Independent Assessment of Social and Economic Conditions in the Murray-Darling Basin. The Panel has made this document available for public scrutiny as part of its commitment to transparency. The views in this report do not necessarily represent the views of the Panel. This is part of a series of literature reviews and research investigations that will help inform the Panel's eventual findings and recommendations.

Acknowledgements

Marsden Jacob would like to acknowledge and thank all the people we engaged with during this project for their contributions. The report is better for their input. All final recommendations and views in this report are attributable to Marsden Jacob unless otherwise stated.

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About Us

Established in 1996, Marsden Jacob Associates has grown to be Australia's leading dedicated natural resource economics, policy and strategy advisory. We employ talented economists and policy advisors who specialise in solving practical, real world problems relating to water, energy, environment, natural resources, agriculture, earth resources, public policy and transport. We work with a wide range of cross-disciplinary partner firms to deliver best project outcomes for our clients.

Acronyms and abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
BOM	Bureau of Meteorology
COAG	Council of Australian Governments
GL	Gigalitre
GS	General Security
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
ML	Megalitre
NRM	Natural Resource Management
NSW	New South Wales
QLD	Queensland
SA	South Australia
Vic	Victoria
VWAP	Volume Weighted Average Price
WESA	Water for the Environment Special Account

Glossary

Environmental flows	The streamflow required to maintain appropriate environmental conditions in a waterway or water body.
Environmental water(ing)	Water that is available or preserved, to achieve environmental outcomes, including ecosystem function, biodiversity, water quality and water resource health.
Volume-weighted average price	VWAP is the ratio of the value traded to total volume traded over a particular time horizon.
Water allocation	The specific volume of water allocated to water access entitlements in a given water year or allocated as specified within a water resource plan.
Water (access) entitlement	A perpetual or ongoing entitlement to exclusive access to a share of water from a specified consumptive pool as defined in the relevant water plan.
Willingness to pay	The maximum amount someone is willing to pay for a good or service.

Summary

At the request of the Minister for Water, The Hon David Littleproud, MDBA has convened an Independent Panel to assess economic and social conditions in the Murray-Darling Basin ('the Basin'). The Panel's independent assessment is a critical opportunity to shape understanding of current economic and social conditions in the Basin, longer-term approaches for monitoring these conditions, and future Basin policy.

The Panel is looking at how things like drought, demographic change, commodity prices and Basin water reform are contributing to social and economic conditions across the Basin.

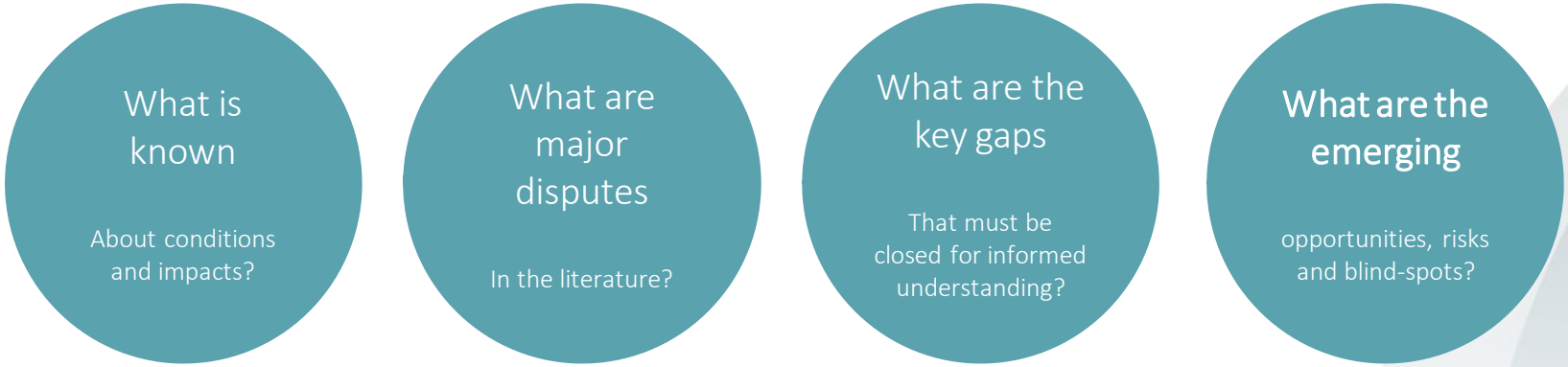
Consistent with best-practice approaches, the Panel is taking a whole-of-community approach that is supported by multiple lines of evidence. The Panel's approach recognises that Basin communities are complex. Communities are constantly evolving in response to, and anticipation of, perceived and actual opportunities and risks. Basin communities' lived experiences are central to understanding current social and economic conditions, and how communities are planning their futures. This complexity means that multiple lines of inquiry need to be used to develop robust evidence-based understandings of Basin communities.

To support the Panel, Marsden Jacob Associates (Marsden Jacob) was engaged to deliver a rapid literature review of economic assessments of Basin communities, and Basin water reforms. To deliver a focussed assessment, our literature review has concentrated on issues around economic and social impacts of Basin water reforms over the past decade, and in communities of most interest to the Panel.

Communities of most interest to the Panel are those groups of people whose lives and livelihoods are most connected to water and Basin water reform. For the Panel this includes irrigators, recreational and commercial river users, Indigenous and nations groups and nation communities of the Murray-Darling Basin. It includes businesses operating in local economies that are deeply connected to the rivers, and groups of people who have clear local, cultural and other connections to the Basin's rivers and water management.

Four focus areas

This Marsden Jacob discussion paper focuses on the four key questions that we were asked to explore in detail. Our headline findings are discussed below.



What is known about economic and social conditions and effects of Basin water reforms to date

Many aspects of social and economic conditions of Basin communities are well documented. MDBA, State Governments and ABS publish comprehensive profiles of Basin communities [1-4]. These profiles cover statistics and information on how communities are changing over time on measures like population, age, employment, agricultural production and water availability. Some contain local peoples' perspectives about their towns and trends over time, and measures of community social capital and wellbeing.

ABARES, ABS and others [5-7], publish comprehensive analyses of irrigated agricultural production, dryland production, farm performance and water use for Basin regions. Recent reviews, including three recent reviews by the Productivity Commission [8-10], have looked at how social and economic conditions are changing in regional and rural Australian and Basin communities, and how national water reforms have impacted on communities.

Collectively, this body of work shows things that many people would expect intuitively, and some things people may not expect. These include:

- **Agricultural production and water use:** The economic value of agricultural production and irrigated production in the Basin has been steady over the past decade of water reforms. Figure 1 at the end of this Summary shows this graphically. After a 20% reduction in the consumptive pool since 2006-07, the value of irrigated production in 2018, measured in $2018, is around 12% higher in real terms than in 2000-01 ($2018). The value of dryland agricultural production in the Basin has grown by around 22% in real terms over the same time. This result highlights that there is not a linear relationship between water use and the value of agricultural production in the Basin.
- **Farm performance and rates of return** in the Basin from 2005-18 have been mixed. Performance and rates of return have mainly been driven by factors other than Basin water reform, including commodity prices, input costs, and farm scale and setup (Section 3).
- **Factors other than water reform are shaping most communities in the Basin. In most cases, water reforms over the last decade have not impacted the trajectory of communities**. We discuss the evidence on this in Section 3.9. Multiple lines of evidence show that factors unrelated to water reform, such as population size, are normally the key drivers of economic activity and social wellbeing, not exposure to water reform [11, 12].

This evidence does not mean that water reform in the Basin has no effect on economic activity and wellbeing of people living in the Basin, the sectors they work in and the communities they live in. It does. Rather, what the evidence does suggest is that, overall, the impact of water reforms on regional communities and economies has less impact on economic activity and overall wellbeing of most individuals and communities than other things [11].

We highlight in this discussion paper evidence from multiple studies showing that population size is one of the key determinants of economic structure and growth, as well as population growth. Figure 2 at the end of this Summary shows this pattern using an example of 60 Basin communities, taken from the MDBA southern Basin community profile series. The bubble size in Figure 2 shows the population in 1996. The horizontal axis measures the percentage population change in the decade between 1996 and 2006. The vertical axis measures the percentage population change in the decade between 2006 and 2016, when Basin reforms and environmental water recovery have peaked.

Broadly speaking, Figure 2 shows that in the last decade most Basin communities have followed the same trajectory that they were on before 2006, a trajectory that pre-dates Basin water reforms:

(1) **towns in the Basin that in 1996 had populations over around 14,000 have grown and have increasingly diverse and service-driven economies.** These regional centres were growing before 2006 and have grown and become more diversified over the past decade of water reforms. The top right quadrant in Figure 2 shows towns that had growing populations before 2006 that continued to grow after 2016. The bubble size shows the population in 1996. Many of the towns in the top right quadrant are

regional centres that had populations over 14,000 in 1996. These communities are on a sustained growth trajectory. Their service driven economies are less sensitive to Basin water reform because they rely less on (irrigated) agriculture.

(2) **towns in the Basin with populations of between around 8,000-14,000 in 1996 are mixed economies**, often coupled to agricultural value chains. A town like Leeton is an example. Since 1996 these towns have been seeing mixed outcomes. Some are growing, others are shrinking. Often these changes reflect changes in value chain structure, for example consolidation of agricultural supply and processing services and other services in larger regional centres.

(3) **towns in the Basin with populations of less than around 8,000 people in 1996 are often declining, and have been declining over decades.** Towns that have declined in population over 1996-2006 and 2006-16 are located in the bottom left quadrant of Figure 2. There's a lot of evidence showing that this pattern of decline in smaller towns is happening across most of regional and rural Australia, not just in the Basin [9]. Australians are moving from smaller towns to larger regional towns and metro cities. They are doing this because larger centres offer things they want, and larger communities are more economically diverse. The migration out of smaller towns is often younger people in the 18-40 year range. They are often families with kids. This out migration is driven by multiple things. Basin water reforms are typically not one of the main reasons for migration.

We summarise what is known about the economic impacts of Basin water reforms to date in Sections 3.1 to 3.12. These sections draw together evidence from the literature to show over the last 10-15 years evidence suggests overall:

- **key water access entitlement and planning framework water reforms** have had net positive social and economic impacts in the Basin (Section 3.1)
- **on-farm and off-farm irrigation infrastructure investments linked to water reform in Basin have acted as economic stimulus for Basin communities** during their construction stage (Section 3.2)
- **on-farm irrigation infrastructure investments linked to water reform are delivering technical and economic on-farm efficiency, and are having positive outcomes for many participating irrigators.** The type, size and sustainability of these gains differ significantly across farms and regions (Section 3.3).
- **off-farm irrigation investment is delivering mixed outcomes. Evidence showing that off-farm irrigation efficiency is delivering net benefits is thin.** Simply stated, there is no good publicly available evidence that shows off-farm investments are delivering better overall productivity and profitability outcomes for irrigators and irrigation infrastructure operators (IIOs). We note this was a key finding of the recent Productivity Commission Basin Plan review (Section 3.4).
- **Buybacks have facilitated on-farm adjustment, and increased water use efficiency. Most of the evidence around buybacks is dated, and pre-drought.** Several studies looked at the impacts of buybacks for irrigators and regional communities in the years

following the peak buyback (2007-2012). These studies focussed on the southern Basin. Collectively, the studies suggest irrigators participating in buybacks reported neutral or positive outcomes. Importantly, evidence also shows that irrigators located in irrigation schemes selling water retained delivery shares and continued paying for their delivery rights. Irrigators selling water did so to accelerate changes that they were likely to have made anyway – restructuring debt, investing on farm, and retiring from farming.

These consultations mainly happened before the current drought. This means we have a more limited understanding of how farmers who sold water during buybacks are performing now (Section 3.5).

- **On-farm and off-farm irrigation infrastructure investment, and to a lesser extent buybacks, are potentially creating risks for irrigators and their communities. People are potentially not as aware of the risks as they need to be.** This is an important part of the developing evidence base around the impacts of Basin water reforms. There is growing consensus that on-farm and off-farm infrastructure investments are potentially creating hidden risks for irrigators. In particular, longer term costs associated with running, maintaining and renewing infrastructure funded by water recovery may offset or exceed the benefits of these investments in some regions and for some sectors [8, 11, 13, 14]. There is also growing appreciation that irrigators and irrigation communities are generally not aware of these risks (Section 3.6).
- **Environmental water recovery is leading to higher permanent and temporary water market prices and increasing risks, particularly during dry and very dry years.** There is also evidence that irrigators who sold water entitlements to the Government or who are producing commodities with lower marginal value product of water / 'profit per drop' (such as rice and dairy) are at a competitive disadvantage in the water market compared to irrigators who received on-farm and / or off-farm irrigation infrastructure upgrades (Section 3.7).
- **Water market reforms have had overall positive social and economic effects in the Basin.** There is general consensus that water market reforms and reducing barriers to trade have provided incentives for more efficient water use and infrastructure investment. Water trading has allowed water to move to higher value uses and has become a vital business management tool for irrigators, giving them flexibility to respond to changing climatic and market conditions [8, 10, 11, 15, 16] (Section 3.8).
- **There is little evidence that targeted structural adjustment assistance programs linked to Basin water reforms have effectively improved economic and social outcomes for Basin communities, or made them more resilient.** The Productivity Commission concluded that the structural adjustment assistance has had little lasting impact in communities where the investment occurred. In part this could be attributable to the small size of funds spent. It is also not clear that structural adjustment has been allocated to communities that are most vulnerable to Basin water reforms (Section 3.10).
- **There is little evidence of beneficial economic and / or social impacts of environmental watering for Indigenous groups** (Section 3.11).

- **There is little evidence of beneficial economic impacts of environmental watering for amenity, recreation and tourism in Basin communities** (Section 3.12). Several studies show there is not a proportional relationship between Basin water availability and regional tourism expenditure.

Major disputes

In this paper we define major disputes as points of disagreement that could lead to material differences in economic and social impacts and outcomes for Basin communities. Major disputes can be backward and forward looking. We focus on disputes that have forward looking implications for future reforms, and future economic and social impacts in Basin communities.

In our assessment, within the scope of our literature review, there are at least three key areas of dispute about the social and economic effects of Basin water reforms. We summarise these below.

The role of Government in addressing community adjustment issues attributable to Basin water reforms

In our assessment, there is underlying foundational dispute about the role of Government in Basin water reform in the literature, and what the 'right' level and type of government intervention should be. This underlying dispute is important, and has real world implications because it underpins many of the ongoing tensions about how economic and social impacts of Basin water reform are assessed, and how Basin water reforms should proceed. We discuss this in Section 4.1.

- **Role of Government view 1:** One view is that Australian, State and Local Governments have existing arrangements in place that support regional growth and transition. These arrangements include preferential tax arrangements, regional service delivery objectives, and regional investment programs. Social security, training and job services provided by Governments give support to regional communities. This existing portfolio of investment and support means additional initiatives for regions and industries should be limited, temporary, and only used in extreme circumstances [9]. It also means water reform should occur when it is in the net national interest, and using existing market approaches where they are available.
- **Role of Government view 2:** The dominant alternative view is that the Government's role in Basin water reforms is to make regional communities more viable. Any water reform that breaches strict conditions for socioeconomic neutrality for regional communities, or creates any negative third party impacts within regional communities is not acceptable. It is acceptable for Governments to invest taxpayer money in regional sectors and communities in ways that are not cost-effective for the Australian taxpayer. Any water reform must demonstrate that it contributes to increasing viability of proponent businesses and irrigation districts in regional Australia, irrespective of the trajectory of the businesses and districts. This is because the investments address

real distributional concerns of regional communities, and the role of Government should be to make regional communities more viable.

The potential economic impacts of Basin water reforms, past and future

There are disputes around the potential economic impacts of Basin water reforms, particularly around how water recovery will impact on regional production levels, production mixes, jobs, and communities. We discuss this in Section 4.2.

Commissioned economic evaluations underpin this debate. Commissioned economic evaluations have used different economic tools, assumptions, and datasets in their work. In our assessment, and the assessment of others, most of the disputes about economic impacts are occurring because some of the key economic evaluations that have been relied upon to shape Basin water reform have significant limitations. When compared to evaluations that do not have these limitations, the evaluations with limitations are creating divisions in understanding.

We summarise some of the more important limitations of some of the economic impact evaluations in Section 4.2. Importantly, we discuss in Section 4.2 that some commissioned economic evaluations by MDBA in 2016 for the Northern Basin review [17] and 2018 for the Southern Basin [18] and by regional interest groups [19] have notable limitations. The limitations in this work mean that these studies overstate the negative impacts of Basin water reforms, and understate positive impacts.

What regional water availability and prices will look like in the future, particularly during dry and very dry conditions

Recent evaluations have looked at how issues like return flows [20] and system losses [21] are impacting regional water availability, and may impact regional water availability in the future. Due to scope and timing reasons we have not included these evaluations in our literature review.

We have focussed our review on economic assessments of water markets, water availability and water market prices in the future. There are emerging disputes around what water availability and water market prices will look like in the future, particularly in dry and very dry conditions. This emerging dispute focuses on the southern interconnected MDB. We discuss this in Section 4.3.

Our view is that divergences in assessments of regional water availability through trade and prices in the future will largely stem from differences in assumptions around the operation of trade constraints, regional water availability including carryover, and regional water demand. The differences in underlying modelling approaches, and assumptions around land use and regional water demand are being updated. This means we expect to see water trade modelling results converging over the next 18 months.

Importantly, we discuss in this literature review that the water trade models covered in this report have historically not been very good at predicting future market prices. Efforts to improve the predictive ability of the models currently underway may change this. The low

forecasting accuracy of existing trade models should be kept in mind when looking at water market simulation modelling results from current studies, and predictions of future water availability and prices, particularly under dry and very dry conditions.

Combined, the above points tell us is that water market models and assessments of regional water resource availability and prices should be seen as rough approximations of potential future states, subject to assumptions being met. More importantly, models should be used to transparently understand the impacts of trade restrictions on regional water availability and prices, and groundwater availability for use. Reporting of modelling should be transparent about the assumptions used, and why other potentially realistic trade constraint and water availability scenarios have not been modelled.

What are the key gaps in the literature and understanding

In this report we define key gaps in understanding as gaps that could lead to material differences in economic and social impacts and outcomes for Basin communities. We focus on gaps in economic understanding that have forward looking implications for future reforms, and economic and social impacts in Basin communities. The key gaps we identified in this review are:

- **Whether water reforms in the Basin to date, and future Basin water reforms, are in the national interest.** There is an overarching gap around whether past and future Basin water reforms, are in the national interest, and in the best interests of key communities identified by the Independent Panel. This overarching gap in understanding originates from research holes in key areas that would allow us to clearly demonstrate water reforms are delivering net beneficial outcomes. This includes lack of understanding around the size and sustainability of productivity gains being impacted by on-farm and off-farm investments, whether infrastructure investments are making farms, IIOs and communities more or less resilient, the impact of infrastructure on IIO financial sustainability and pricing (and how they will respond) and the impact of water recovery and infrastructure investment on water prices (Section 5.1).
- **What the longer term on- and off-farm productivity impacts of infrastructure investments are.** On-farm productivity gains to increase irrigated production are a key benefit claim for on-farm and off-farm infrastructure modernisation, and one of the main ways irrigation infrastructure investment has been justified in investment cases supporting Basin water reforms. Productivity gains have to occur to offset lower future production given water has been transferred to the Government.

  Our literature review's summary of Irrigator surveys found that some irrigators believe irrigation infrastructure has helped improve on-farm productivity. What these irrigator surveys have not told us is how much productivity has increased by, and whether the overall productivity gains outweigh the costs of achieving them. In short, despite the fundamental importance of understanding on-farm productivity gains from infrastructure investment, beyond anecdotal and selective case study evidence, there is little to no real

documented empirical evidence about how much net economic value is being created through productivity change in the Basin (Section 5.2).

- **What the long-term impacts of irrigation infrastructure investments on IIOs, their financial sustainability, footprint and prices, and implications for irrigators and communities are.** We discuss in this literature review evidence that, in some cases, off-farm irrigation infrastructure may be creating medium to long term challenges for the financial sustainability of IIOs. We also discuss that these financial sustainability issues could have pricing implications for irrigators, and that many irrigators are probably unaware of the potential future price impacts.

  The magnitude and timing of future higher costs for IIOs and irrigators are currently unknown. To our knowledge there is little public information available about future price paths beyond the five year regulated period. This is a key gap in understanding that has potential material implications for irrigators and irrigation communities (Section 5.4).

- **Long-term impact of water reform on Basin water market prices.** We discuss in this literature review that, historically, existing water market models have not proved to be accurate at predicting water future market prices for dry and very dry conditions, even for average allocation prices just 12 months out. Modifications happening to these models now may improve their predictive ability. More importantly, transparent reporting of underlying model assumptions, and limitations of models will provide more understanding and confidence in these models, and lower gaps in understanding (Section 5.5).
- **Structural adjustment, recreation, tourism and Indigenous economic benefits.** There are key gaps in the literature around how Basin water reforms have impacted economic outcomes for Indigenous communities, recreation, and regional tourism. Closing these gaps would give more insight into the impacts of Basin water reforms for these groups (Section 5.6).
- **Whether reforms are going to make regional irrigators and Basin communities more resilient and viable.** Given the evidence base discussed in this literature review and the gaps bullet pointed above, our view is that there is currently insufficient evidence to say whether Basin water reforms, past and planned, are making regional irrigators and communities more resilient and viable. This is a key gap in understanding.

What the literature and literature gaps tell us about lagged effects of past reforms and known reforms still to be implemented

Our literature review and evaluation highlights that:

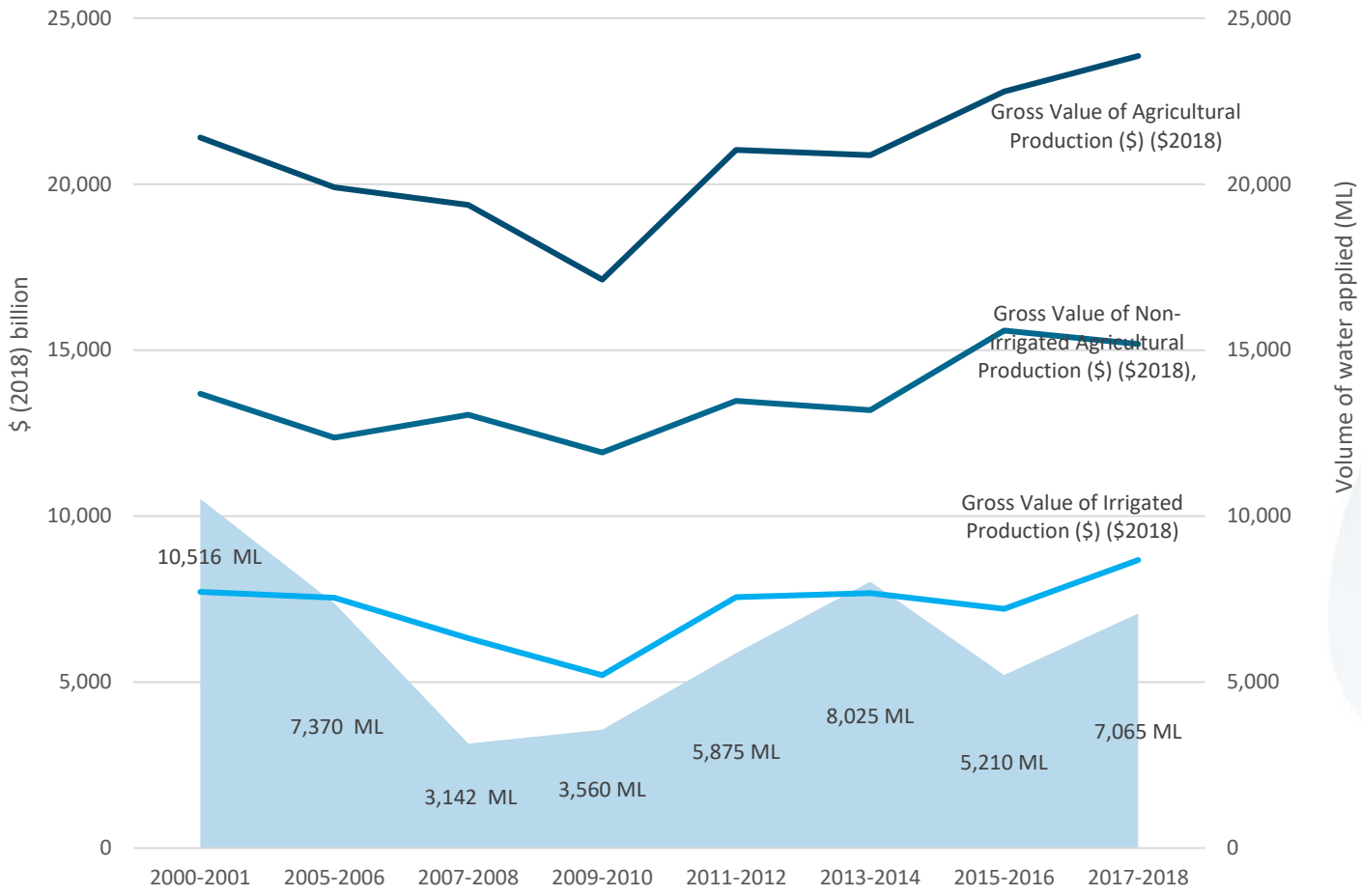
- **Under current policy settings, future water recovery will probably cost more than budgeted.** The Commonwealth Government's $1.5 billion allocation through the Water for the Environment Special Account (WESA) for efficiency measures that contribute to the

additional 450 GL of water recovery (upwater) is a key future reform. The history of Basin reform shows that this environmental water recovery will probably cost more than what the Commonwealth has budgeted. Added to this, across the Basin, most of the easier, more cost-effective and lower risk options for recovery have been exhausted [22]. There is opposition to further on-farm water efficiency measures [23] and Victoria has said it will not pursue further on-farm measures because of the perceived negative economic impact of these [22]. Any future investments need to satisfy strict socioeconomic neutrality tests. All this suggests future water recovery will cost more than budgeted.

- **The future economic impacts of water reform will be different to what much of the commissioned economic modelling suggests.** This is true for lagged impacts of past reforms and future reforms that are yet to be implemented. Our literature review highlights that the impacts of Basin water reforms, and environmental water recovery in particular, are complex. None of the commissioned economic evaluations discussed in our literature review accurately captures all of this complexity. What our review does highlight with confidence is that:
  - The lagged impacts of Basin water reform are unlikely to be as negative as some of the key commissioned economic studies have suggested. This is because many of the commissioned economic analyses use assumptions and approaches that overstate negative impacts, and understate or ignore positive impacts and transfers.
  - The on-farm productivity benefits of past (and potentially future) on-farm and off-farm infrastructure investments are likely to be smaller than anticipated by commissioned economic modelling in many cases. This outcome unfortunately will continue the long history of optimism bias in water infrastructure projects in Australia. The Productivity Commission documents this history in its recent national water reform review [8].
  - The price impacts of infrastructure modernisation, reflected in infrastructure charges and water market prices, will probably be greater than what has been factored into most commissioned economic analyses. Irrigators may be unaware of how these potential price increases will place pressure on farm viability.
  - Water reforms have in many cases accelerated farming and structural changes that would have occurred anyway, but not with the same speed or regional intensity.
- **Effects of infrastructure upgrades are just beginning to reveal themselves. It will take time for these to pass through regional communities. Lagged impacts will be more mixed for irrigators and communities than communities anticipate.** We discussed in this paper that infrastructure upgrades were promoted as being neutral or slightly positive in their effects. The reality is that the what, how, and where of infrastructure upgrades in the Basin is having a large effect on the underlying competitiveness of farm businesses now and going forward. The overall impacts will be more mixed than neutral or slightly positive.

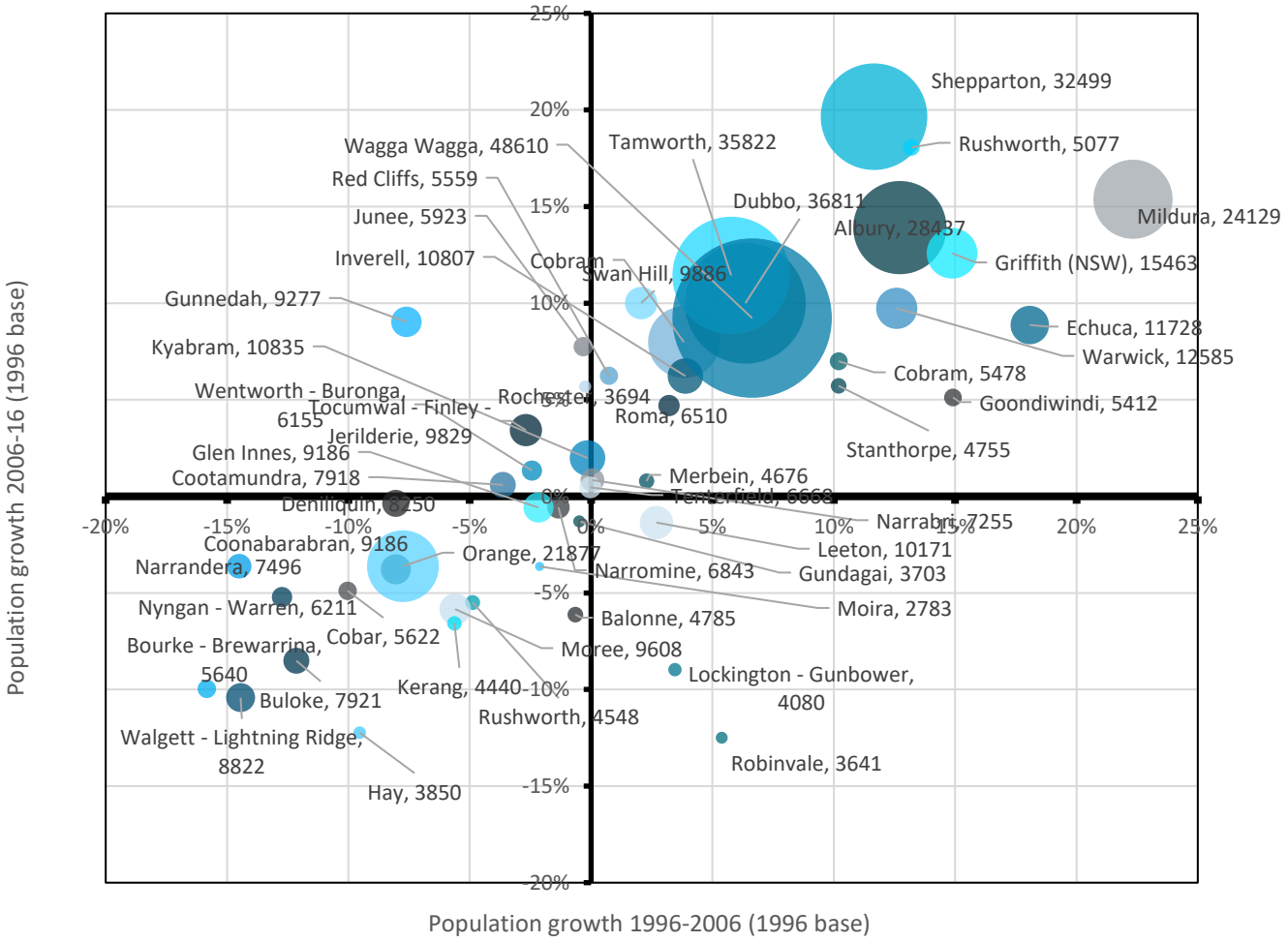
- **Water prices will increase with additional recovery. Regional water availability will shift. Irrigators need to price these changes into their future.** It is clear that removing more water from the consumptive pool will increase water prices, particularly during dry and very dry periods. Water will reallocate through trade to where it returns the highest profit per drop. How water will reallocate and how this will impact on prices will depend on the speed of water recovery, where recovery occurs, the type of water rights that are recovered, and how inter-valley constraints are managed, particularly in the southern MDB.
- **Irrigators need to be willing to pay for future price increases and accept the risks.** The impacts of water reforms to date, and the potential lagged impacts discussed above show that irrigators need to be made aware of future risks of irrigation infrastructure upgrades on water prices and infrastructure charges. We are aware that many irrigators and people living in irrigation communities are not aware of what these future price impacts look like. One of the reasons irrigators and irrigation communities are not aware of the potential implications for future infrastructure charges is because this information on the lagged impacts of gifted assets is not available beyond the current regulatory price period, where the lagged impact of gifting is only reflected in differences in operating costs.
- **All water recovery options should be on the table, because they can deliver better outcomes for Basin irrigators, IIOs, and communities.** We discuss in Section 4.1 that Basin State signatories to the 2004 NWI agreed to a specific Government role in Basin water reforms that involved considering all available options for water recovery. These options included (but were not limited to) investment in more efficient water infrastructure; purchase of water on the market, by tender or other market based mechanisms; investment in more efficient water management practices, including measurement; and investment in behavioural change. Our view is that the evidence base in this literature review suggests that all of these options should be on the table, and all of these options should remain on the table for water recovery going forward. This is because the evidence base suggests combining on-farm, off-farm and buybacks can probably deliver better long-run outcomes for irrigators, IIOs and communities than options that preclude one or more of these options.
- **There are potentially better ways to support regional adjustment than infrastructure subsidies.** We finish the literature review with what is probably one of the more controversial points for the Panel. A key lesson from the literature review for lagged effects and known reforms to be implemented is that there are clearly potentially better ways to support regional adjustment to water reforms than on-farm and off-farm infrastructure subsidies alone. By considering options for regional adjustment beyond irrigation infrastructure the Panel may identify better ways to make regional communities more resilient and viable.

Figure 1: Gross value of agricultural production, irrigated production and volume of water applied (ML), Murray-Darling Basin, 2001-18



Source: Marsden Jacob analysis of ABS data.

Figure 2: Population change 60 Basin regions, 1996-2016 (bubble size shows 1996 population, bubble label shows region and population in 2016)



Source: Marsden Jacob analysis of ABS data.

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1. Introduction

At the request of the Minister for Water, The Hon David Littleproud, MDBA has convened an Independent Panel to assess economic and social conditions in the Murray-Darling Basin ('the Basin'). The Panel's assessment will support longer-term efforts to monitor and understand economic and social conditions in the Basin, and inform future Basin water policy.

MDBA engaged Marsden Jacob to deliver a rapid literature review to support the Independent Assessment of Economic and social Conditions in the Murray-Darling Basin. We have prepared this report over a period of 10 days, by drawing on Marsden Jacob's two decades of direct experience from advising on and supporting delivery of Basin water reforms, and completing a literature review of more than 30 directly relevant papers and reports.

This Marsden Jacob discussion paper focuses on the key questions we were asked:

- **What is known currently about economic, social and environmental effects of Basin water reforms** to date, lagged effects of past reforms and changes that are still to emerge?
- **Where there are major disputes in the literature,** and why are these occurring?
- **What are the gaps in knowledge, and the strengths and weaknesses of approaches** to fill those gaps?
- Given the above, **what are the known reforms / changes still to be implemented, and what are their potential** impacts on communities?

To deliver a focussed assessment for the Panel, in this discussion paper we:

- **Identify the scope of Basin water reforms** that we have focussed on for this discussion paper.

- **Focus on the literature and issues surrounding economic and social impacts of Basin water reforms in communities of most interest to the Panel.** This includes more recent literature and literature on priority Basin communities. The Panel defines Basin communities inclusively [24], and places a priority on understanding groups of people whose life and livelihoods are most connected to and impacted by water, and Basin water reform. For the Panel this includes irrigators, recreational and commercial river users, Indigenous and nations groups and nation communities of the Murray-Darling Basin. It includes businesses operating in local economies deeply connected to the rivers, and groups of people who have clear local, cultural and other connections to the Basin's rivers and water management.
- **Focus our economic and social literature review on** seven (7) important questions developed by the Panel to make their engagement, analysis and assessment transparent, tangible and meaningful for Basin communities and other key stakeholders. In particular, our literature review focuses on Panel question 4: How have water reforms and changes impacted Basin communities to date, and what future impacts are likely?
- **Go beyond what is available in current published literature to identify gaps**, based on Marsden Jacob's long involvement in advising on and supporting water reforms in the Murray-Darling Basin, and understanding of issues likely to emerge in the future resulting from current water reform policy settings.

Table 1: Seven key questions for the Panel to investigate and answer

#	
1	What are the visions and hopes of Basin people for themselves and their communities?
2	What have been the economic and social experiences of Basin communities, relative to other rural and regional communities in Australia, and what have been the main underlying drivers of these experiences?
3	What are expected to be the most significant drivers of future change, opportunities, and risks for Basin communities?
4	How have water reforms and changes impacted Basin communities to date, and what future impacts are likely?
5	Under what scenarios could the current reliance on irrigation cease to be financially viable for some regions, communities or commodities in the long term, and what could be done to manage the impacts of these possible changes?
6	What strategies have the greatest potential to enhance the resilience, adaptability and wellbeing of Basin communities?
7	What are the responsibilities and distinctive contributions of governments, businesses, non-profit groups, and individuals in enabling action to promote prosperous and sustainable Basin communities?

2. Basin water reforms we have focussed on

Water reforms in the Basin stem from the 1994 COAG Water Reform Framework. The 2004 National Water Initiative extended the Water Reform Framework, responding to overallocation and addressing issues emerging from the early stages of the Millennium Drought [8].

Basin water reforms over the last 25 years have aimed to address challenges largely created by State and Commonwealth governments' focus on expanding irrigated agriculture and available water use up until the 1980s. In many ways, Basin water reforms since 1994 aim to address earlier government failure, overallocation, and over-investment in the Basin.

Figure 3 provides a snapshot of some of the key Basin water reforms since 2007-08, mapped against overallocation water recovery in the Basin through buybacks and infrastructure investments. In agreement with MDBA we have focussed our literature review on Basin water reforms since 2012. The 2017 Productivity Commission review of national water reform [8] and the 2014 former National Water Commission national reform assessments [11] provide comprehensive summaries of national water reform and impacts in the Basin before 2012.

The 2004 Inter-governmental agreement on a National Water Initiative [25] committed all Australian Governments to, among other things, prepare water resource plans, achieve sustainable water use in over-allocated water systems, water property right reform, expanding trade in water rights, and improving pricing for water storage and delivery.

Table 2 includes more detail on these water reform areas. The water reform areas in Table 2 are the areas we have focussed on in this literature review.

The Australian Government has committed more than $13 billion to implement the Murray–Darling Basin Plan (Basin Plan) and associated activities in the Basin. Around $8 billion of this investment is being made available for on-farm and off-farm irrigation investments to achieve water efficiency improvements. Table 3 shows progress and expenditure against the recovery targets and expenditure as at December 2018.

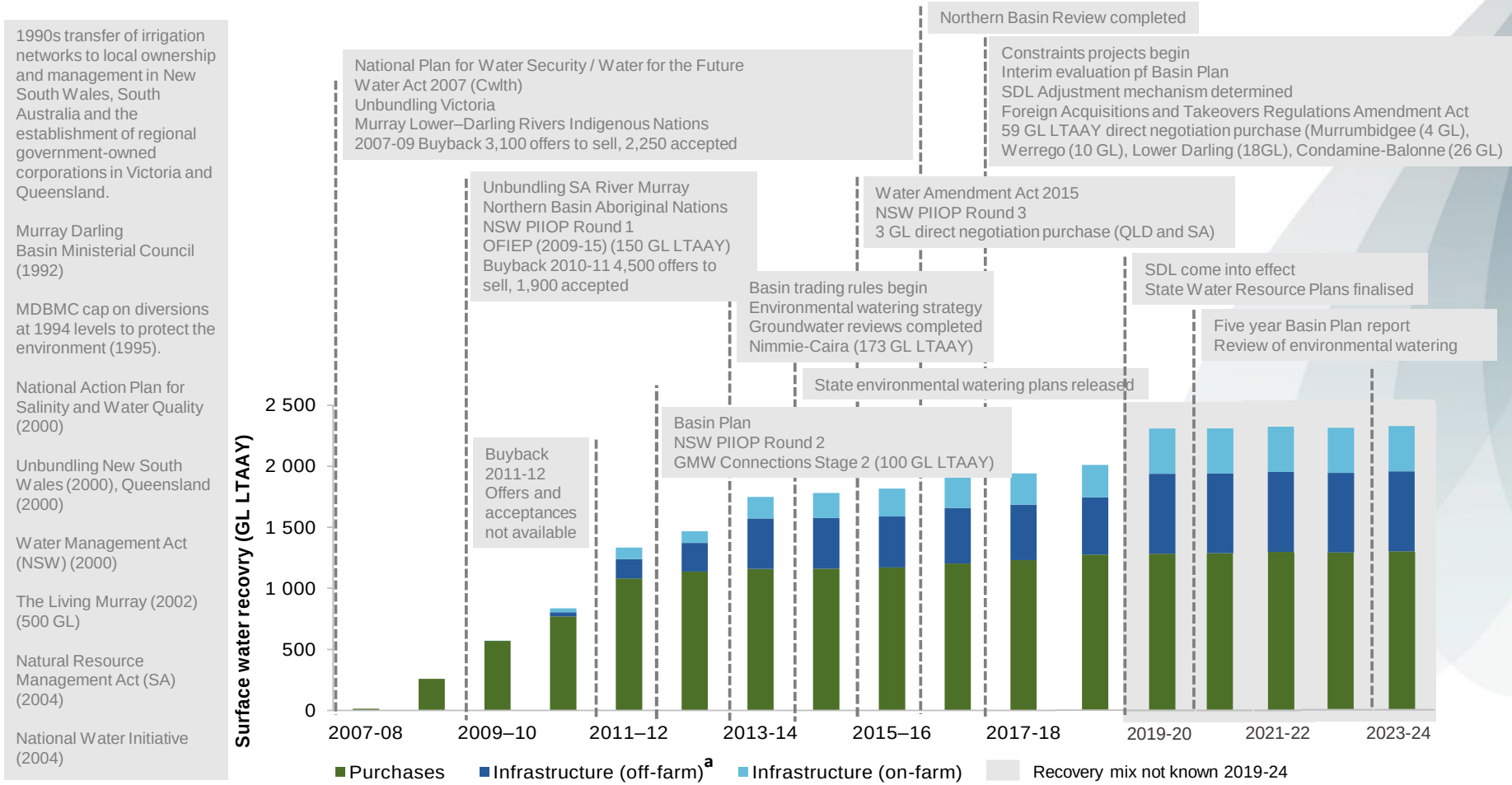
Total water recovery to date is around 2100 GL LTAAY (Figure 3). Total expenditure on infrastructure and purchases is around $6 billion. Measured in $2018, the average cost of recovering water by purchase has been $2,300 ML. The average cost of recovering water through infrastructure investment has been $5,385 ML.

Table 2: National Water Initiative Basin reforms [25]

Element	Objectives and actions
Water Access Entitlements and Planning Framework	The Parties agree that, once initiated, their water access entitlements and planning frameworks will: • Have clear and nationally-compatible statutory characteristics for water access entitlements Implement transparent statutory-based water planning • Ensure water planning is characterised by planning processes in which there is adequate opportunity for productive, environmental and other public benefit considerations to be identified and considered in an open and transparent way • Provide a statutory basis for environmental and other public benefit outcomes in surface and groundwater systems to protect water sources and their dependent ecosystems, and improved environmental management provisions • Complete the return of all currently overallocated or overused systems to environmentally-sustainable levels of extraction • Clearly assign the risks arising from future changes to the consumptive pool • Recognise Indigenous needs in relation to water access and management Actions Substantially complete plans to address any existing overallocation for all river systems and groundwater resources in accordance with commitments under the 1994 COAG water reform framework by 2005. Establish water property rights including a water access entitlement, separate from land. The entitlement is a perpetual or open-ended share of the consumptive pool of a specified water resource, as determined by the relevant water plan.
Water trading	The States and Territories agree that their water market and trading arrangements will: • Facilitate the operation of efficient water markets and the opportunities for trading, within and between States and Territories, where water systems are physically shared or hydrologic connections and water supply considerations will permit water trading • Minimise transaction costs on water trades, including through good information flows in the market and compatible entitlement, registry, regulatory and other arrangements across jurisdictions • Recognise and protect the needs of the environment; and • Provide appropriate protection of third-party interests.

Element	Objectives and actions
	Actions The States and Territories agree to establish by 2007 compatible institutional and regulatory arrangements that facilitate intra and interstate trade, and manage differences in entitlement reliability, supply losses, supply source constraints, trading between systems, and cap requirements. Recognising the need to manage the impacts of assets potentially stranded by trade out of serviced areas, the Parties agree to ensure that support mechanisms used for this purpose, such as access and exit fees and retail tagging, do not become an institutional barrier to trade Basin States agree to reduce barriers to trade in the Southern Murray-Darling Basin by taking the necessary legislative and other actions to permit open trade and ensure competitive neutrality (with interstate trade commencing 2005)
Best Practice Water Pricing and Institutional Arrangements	Give effect to the principles of user-pays and achieve pricing transparency in respect to water storage and delivery in irrigation systems and cost recovery for water planning and management. Actions Implement upper bound pricing for water storage and delivery. Upper bound pricing is the definition of full cost recovery under the National Water Initiative. It involves recovering all of the costs of providing water services, including a market-reflective return on the capital used to provide them and the full recovery of that capital.
Community Partnerships and Adjustment	Parties agree that the outcome is to engage water users and other stakeholders in achieving the objectives of this Agreement by: improving certainty and building confidence in reform processes; transparency in decision making; and ensuring sound information is available to all sectors at key decision points. Actions The Parties agree to address significant adjustment issues affecting water access entitlement holders and communities that may arise from reductions in water availability as a result of implementing the reforms proposed in this Agreement (s97).

Figure 3: Basin water reform timeline 2007-24



Source: Marsden Jacob, adapted from [10]

Table 3: Australian government yearly actual administrated expenditure and water recovery listed by program, to September 30, 2017, expressed in long-term average annual yield [26]

Period	RTB (AUD million)	Infrastructure (AUD million)	RTB (GL)	Infrastructure (GL)	RTB AUD/ML	Infrastructure AUD/ML
Total (nominal)	2,494	3,504	1,237	703	2,016	4,984
Total ($2018)	2,853	3,786			2,307	5,385
2007–08	33.1	86.0	14	0	2,299	NA
2008–09	371.7	55.8	243	0	1,533	NA
2009–10	780.2	189.1	311	1	2,511	233,457
2010–11	357.7	221.2	201	66	1,776	3,327
2011–12	540.9	528.6	311	208	1,740	2,547
2012–13	112.9	520.5	56	78	2,012	6,707
2013–14	55.9	492.4	21	233	2,607	2,116
2014–15	60.8	557.1	5	29	12,383	19,344
2015–16	40.0	262.6	9	28	4,689	9,416
2016–17	23.7	522.5	34	58	700	9,012
2017–18	116.9	42.8	26	2	4,453	NA
2018–19 (up to 1/12/18)	0	25.0	6	0	NA	NA

3. What is known currently about economic and social effects of Basin water reforms and changes to date

We summarise what is known currently about Basin water reforms and changes to date in this section. We do this by grouping our discussion around the National Water Initiative Basin water reforms shown in Table 2.

Many aspects of social and economic conditions of Basin communities are well documented. MDBA, State Governments and ABS publish comprehensive profiles of Basin communities [1-4]. These profiles cover statistics and information on how communities are changing over time in measures like population, age, employment, agricultural production and water availability. Some contain local people's perspectives about their towns and trends over time, and measures of community social capital and wellbeing.

ABARES, ABS and others [5-7], publish comprehensive analyses of irrigated agricultural production, dryland production, farm performance and water use for Basin regions. Recent reviews, including three recent reviews by the Productivity Commission [8-10], have looked at how the social and economic conditions are changing in regional and rural Australian and Basin communities, and how national water reforms have impacted communities.

We start this Chapter by providing an overview of agricultural production and water use in the Basin since 2000-01. The economic value of agricultural production and irrigated production in the Basin has been steady over the past decade of water reforms. Figure 4 shows this graphically. After a 20% reduction in the consumptive pool since 2006-07, the value of irrigated production in 2018, measured in $2018, is around 12% higher in real terms than in 2000-01 ($2018). Over the same time period, the value of dryland agricultural production in the Basin has grown by around 22% in real terms.

Figure 4 shows that the relationship between water availability for irrigation and irrigated production value has not been proportional in the Basin over the last decade. For example in:

- **2015-16** the gross value of irrigated production in the Basin totalled $7.2 billion (measured in $2018) from 5,000 ML of water applied

- **2005-06** the gross value of irrigated production in the Basin totalled $7.5 billion (measured in $2018) from 7,400 ML of water applied.
- **2000-01** the gross value of irrigated production in the Basin totalled $7.7 billion (measured in $2018) from 10,500 ML of water applied.

There are many reasons why the relationship between water use and the value of irrigated production are not proportional. These reasons include the role that water reforms have played in the Basin over the past decade, but this is only one of many reasons. We discuss some of the other reasons later in this literature review.

Figure 5 shows rates of return for irrigated horticulture, dairy, rice and cotton farming in the Basin over 2005-18[1]. Returns have been mixed, mainly for factors other than Basin water reform. ABARES identifies [5]:

- **Rates of return during the drought years** (2006–09) were mainly caused by drought, particularly in the southern Basin. Drought years were generally followed by higher rates of return in the years after.
- **Cotton farms rates of return were above 3% from 2007-15** reflecting better terms of trade and water availability, particularly in the Northern Basin during 2011-14 (Figure 8). ABARES farm survey data shows rates of return are higher for farms operating on larger areas of more than 1,500 hectares. Poorer performing farms tended to be mainly dryland with only a small area of irrigated cotton.
- **Dairy rates of returns peaked in 2011–14** before declining in 2014–15. Declines are mainly attributable to lower milk prices, reductions in total milk production and higher input costs. ABARES farm survey data shows some dairy farms have performed better than others over the last decade. Farms with larger herds generally outperform smaller dairy herds, on average. Farms with poorer performance were often those scaling back milk production and switching to other irrigated or dryland activities.
- **Horticulture farm rates of return have** generally risen since 2010-11. ABARES farm survey results show that although returns for irrigated horticulture farms have improved, improvements have differed markedly. Citrus rates of return are stronger than grapes and pome. Horticulture farms with negative returns are often smaller farms focussing on single enterprises, mainly wine grape and citrus.
- **Rice farm returns** reflect water availability and allocations. Returns peaked in 2013-14 when around 8,000 ML of water was used on irrigation farms across the Basin (Figure 4). Falling allocations, and increasing allocation prices (Figure 6) resulted in smaller rice

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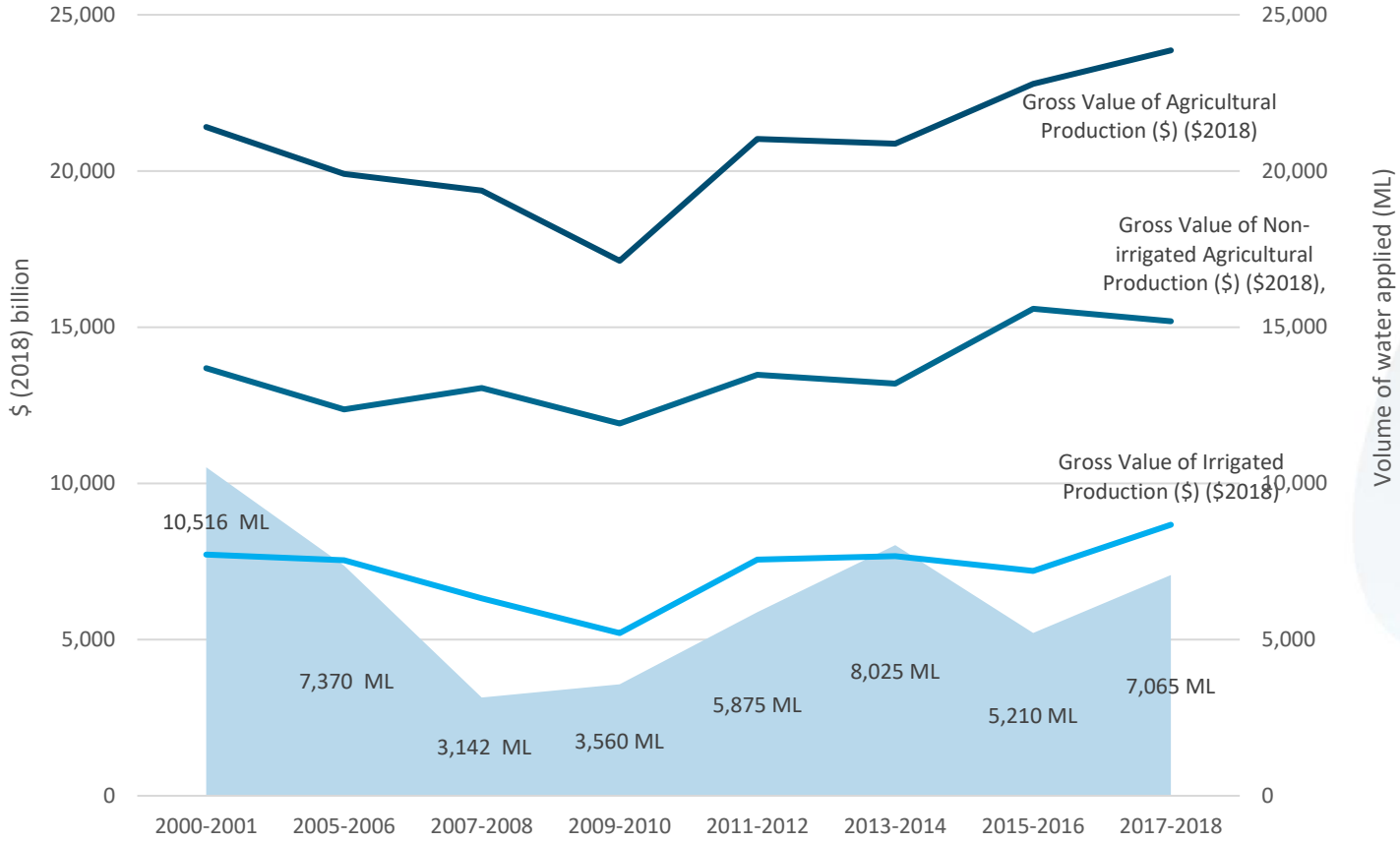
[1] Farm rates of return are measured by the profit generated by a farm divided by the farm capital used to generate the profit [5] This means the rates of return for different irrigated farm types are directly comparable.

D. Ashton, "Irrigated agriculture in the Murray-Darling Basin," ed. Canberra: ABARES, 2018..

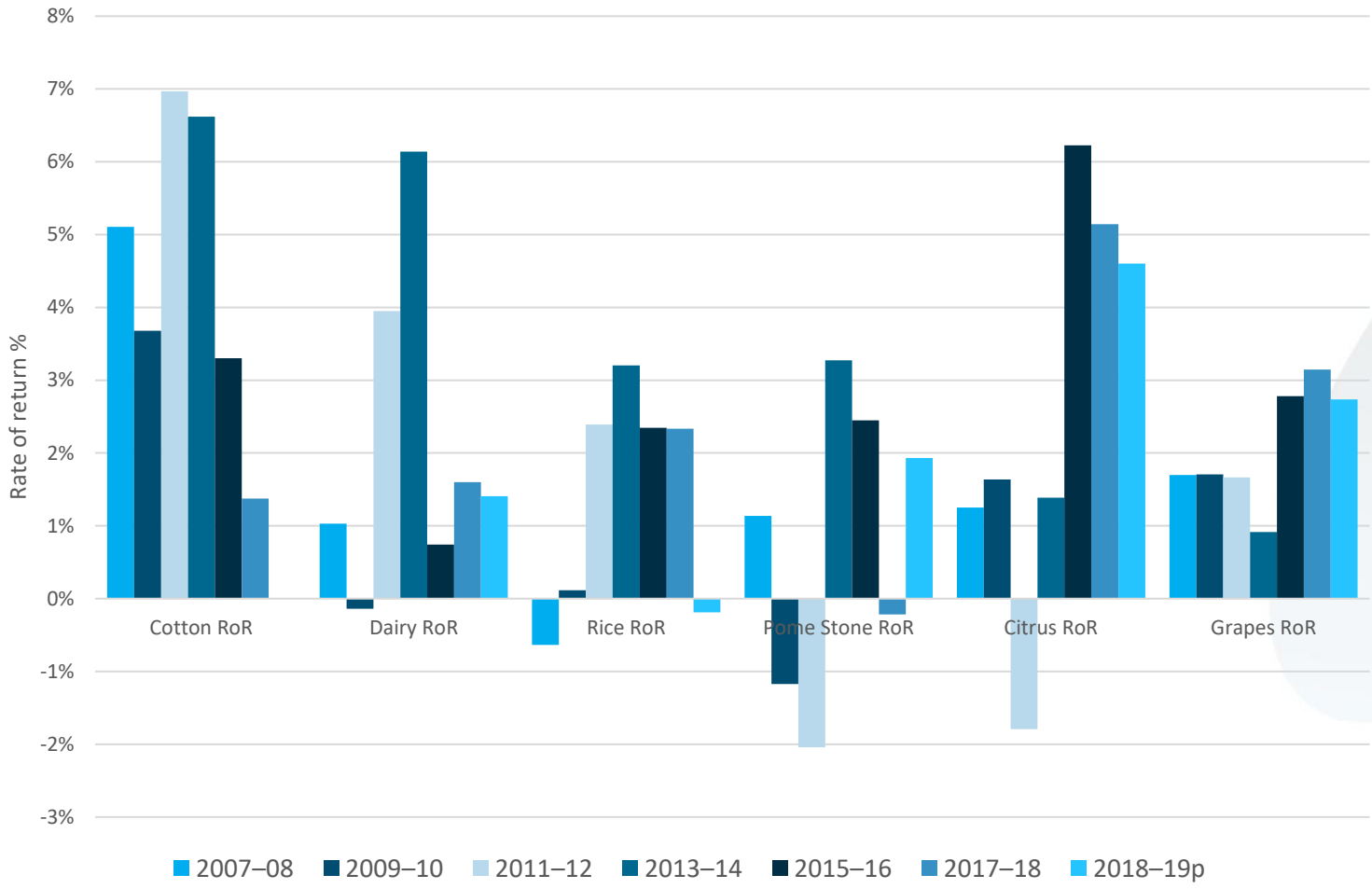
crops. ABARES survey data suggests better performing rice farms generally have a wider mix of irrigated and dryland crops, and more flexible farm setup.

Figure 4: Gross value of agricultural production, irrigated production and volume of water applied (ML), Murray-Darling Basin, 2001-18



Source: ABS cat, 4610.0.55.008

Figure 5: Rate of return, irrigated farming Murray-Darling Basin 2005-18



Source: ABARES, personal correspondence, 2019

3.1 Overall, available evidence suggests key water access entitlement and planning framework water reforms have had net positive economic and social effects in the Basin (NWI reform areas: Water Access Entitlements and Planning Framework).

The overarching conclusion from recent reviews of the NWI is that the introduction of NWI-consistent water entitlement and planning frameworks has created secure property rights, and established clear processes for water allocation between consumptive and environmental uses [8, 11, 15]. These reforms have established clear caps and security on consumptive and environmental use.

There is overall agreement that these reforms have generated significant, and overall net positive, financial benefits [8, 11, 15]. In particular, water entitlement reforms meant water entitlements are valued business assets that can be loaned against as collateral.

Water sharing plans have been subject to ongoing debate about the allocation of resources between competing uses. Overall however, they are believed to have encouraged public confidence in planning decisions, and confidence in resource allocations [8, 11, 15].

3.2 Overall, the significant construction investments into Basin regions to restore the balance have acted as regional economic stimulus for Basin communities (NWI reform areas: Water Access Entitlements and Planning Framework).

Infrastructure and water efficiency investments have created regional economic stimulus during the construction stage. This means jobs, salaries and local business profits for Basin communities.

Available estimates for the southern Basin of the economic impacts of construction suggest around 40-50% infrastructure construction expenditure remains in local economies as 'first round' local value added (that is, excludes dynamic flow on-effects through the economy) [27]. The remaining half of goods and services are sourced from outside the investment area. Using this rule of thumb implies that first round impacts of current infrastructure investment (Table 3) has resulted in $1.8-2 billion of regional economic stimulus during the construction stage.

There are likely to be marked differences in the size of the construction stimulus across Basin regions. This will primarily be due to the type of infrastructure investment undertaken and the extent of local sourcing.

3.3 Overall, on-farm infrastructure investments are delivering technical and economic on-farm efficiency, and are having positive outcomes for many irrigators (NWI reform areas: Water Access Entitlements and Planning Framework).

On-farm investments have included reconfiguration of irrigation layouts, border check irrigation, new precision infrastructure, laser levelling, piping, and drip or spray systems to improve in-field application systems [28].

There is a general consensus that on-farm infrastructure investments are likely to have created productivity gains through on-farm efficiencies for many farms [8, 13, 27-29]. The type and size of these productivity gains vary by region, sector, the type of on-farm upgrades and the sequence in which they have occurred. Estimated on-farm productivity impacts will also depend on the underlying assumptions and approach used to estimate the productivity impact. We discuss both of these points further in the next section.

Current available evidence suggests the on-farm productivity gains from on-farm infrastructure investments are typically small, and mainly driven by labour savings rather than crop productivity enhancements [27, 30]. The productivity impacts of on-farm irrigation are typically small in the first 10 years in part due to delays in optimising management of irrigation systems [30].

Available survey evidence shows irrigators receiving irrigation upgrades have done different things to increase farm productivity and profitability. Evidence from irrigator surveys shows irrigators who have received on-farm infrastructure grants are more likely to be increasing irrigated area, and less likely to be reducing production, compared to other irrigators, and were no more likely than other irrigators to be reducing employment on the farm [29, 31]. Irrigators who have transferred entitlements to access on-farm irrigation grants report overall positive impacts for their farms on a range of measures (Figure 11).

There is some evidence that irrigators who have received on-farm water infrastructure grants are performing better than farms who have not received grants, and that this effect was more pronounced once the time lag between receiving a grant and experiencing benefits from the investment is taken into account. Irrigators who had invested in modernising on-farm infrastructure were significantly more likely to report they were planning to expand their farm business or change their enterprise mix [28]. However these results are based on small samples that may not be representative. We discuss implications of this later.

There is also evidence that on-farm infrastructure investments may be creating risks and potential downside for irrigators. We discuss this more in Section 3.6.

3.4 Overall, evidence of off-farm infrastructure investment are delivering mixed outcomes. Supporting evidence is thin (NWI reform areas: Water Access Entitlements and Planning Framework).

Off-farm programs seek to reduce water losses from irrigation networks. Under the Commonwealth's programs more than 900 kilometres of irrigation network delivery channels have been upgraded [28]. Off-farm programs preceded on-farm programs in GMW. In other systems off-farm and on-farm programs proceeded in parallel.

Evidence on the benefits of off-farm infrastructure investment is limited. It is also mixed. ABARES [28] reports selected case studies where off-farm irrigation investments have improved water supply reliability for irrigation customers, improved automation, quality and flow rates, and reduced some operating and maintenance costs, particularly through reduced labour requirements.

In contrast, the recent review by the Productivity Commission reported no clear evidence that off-farm investments were delivering productivity outcomes for irrigators or IIOs. The Commission did however identify evidence showing off-farm projects are typically more expensive per ML and complex than on-farm works [10].

What the evidence to date suggests is that there can be productivity gains to the community from off-farm infrastructure upgrades. But the impacts are mixed. While upgrades reduce water utility labour force requirements, they also create future depreciation and maintenance liabilities that need to be funded. We discuss these issues further in Section 3.6.

3.5 Overall, buybacks have facilitated on-farm adjustment, and increased water use efficiency (NWI reform areas: Water Access Entitlements and Planning Framework).

Buybacks have meant water entitlement holders, mainly irrigators, sold water to the Commonwealth at, or slightly above, prevailing market rates. Around one in five Basin irrigators sold water entitlements to the government between 2007 and 2015 [13].

Evidence from irrigator surveys shows that irrigators who participated in buybacks overall found it a positive or neutral outcome for their businesses [29, 32] (Figure 10). Selling water to the Commonwealth allowed irrigators to achieve farming objectives and manage better during drought.

The regional economic impact of buybacks is a point of debate that we discuss in the next Section. What is clear is that around 70% of irrigators who sold water to the Commonwealth continued farming on their land. The other 30% exited farming, either selling their farm or passing it to the next family farming generation. Effectively all irrigators selling water remained in their local communities [29, 32].

Cheesman and Wheeler [32] identified that, in the period 2008 to 2011, 60% of those who sold entitlements to the government in the Basin remained irrigating, while 10% remained in farming but switched to dryland farming, and 30% exited farming altogether. In the

2015 Regional Wellbeing Survey sample, of the 168 people living in the Basin who reported having sold entitlements to the government since 2008, 67% had remained in irrigated farming, 20% were now dryland farmers, and 13% had left farming [29].

Evidence suggests many irrigators who sold water to the Commonwealth before 2011 sold 'surplus' water that was not being used in production, and was not being traded. Other irrigators who had sold entitlements were more likely to be planning to exit farming, downsize their farm business, and seek additional off-farm work, compared to those who had not sold entitlements [29]. These results suggest that buyback helped irrigators who were planning on reducing their farming activity anyway, often as part of succession planning.

Evidence from the RWS survey shows that irrigators selling entitlements used the proceed of funds to: (1) improve irrigation efficiency on their farm business (67% of those who sold compared to 54% who had not) (2) decrease the area of land they irrigated (42% compared to 31%) and (3) increase the area of dryland farming (32% compared to 22%). They also reduced the number of workers on their farm (34% compared to 24%) [29].

A commonly raised concern is that water entitlement trade will result in unused or stranded irrigation assets. Best available evidence shows this is not the case. Wheeler and Cheesman (2013) found that 94% of partial entitlement sellers (in an irrigation district) to the RTB program retained their delivery rights, while 83% of those who sold all their water kept their delivery rights. The key point is that irrigators who choose not to terminate delivery rights do so because of they expect to buy either water allocations or water entitlements in the future, or they wish to ensure that their farm can be resold as an irrigation property [26].

Few studies have looked at the delayed impacts of selling water entitlements on irrigators and their communities. The few studies that have looked at this issue have found at best very weak evidence of delayed negative impacts from selling water entitlements on net farm income. What the best available evidence shows is that reductions in farm production are being offset by irrigators using their proceeds from sales to reduce farm and other debt, to restructure and invest on farm [33]. Importantly, these evaluations of buyback occurred before the current period of drought and low water availability.

Selling water entitlements has created risks and potential downside for irrigators. We discuss this in Section 3.7.

3.6 Overall, on-farm and off-farm irrigation infrastructure investment, and to a lesser extent buybacks, are potentially creating opportunity and risk for irrigators and their communities. People are potentially not as aware of the risks as they are the opportunities (NWI reform areas: Water Access Entitlements and Planning Framework and Community Partnerships and Adjustment).

The main risks identified from recovering water through irrigation include (1) potentially higher IIO operating and asset renewal costs (2) potentially less water coming into IIO as a result of competitive advantages going to other regions from new irrigation infrastructure development and (3) potentially smaller footprint (and hence revenues). These risks are passed to irrigators through delivery charges and termination fees.

The ACCC Water Monitoring Report series shows that the largest price increases often occur in IIO schemes that have modernised. This is particularly true for pressurised systems where energy and upgrade costs reportedly increased infrastructure operators' charges [34]. Marsden Jacob have previously identified in work for the ACCC in 2015, how infrastructure modernisation can materially impact on future delivery charges, and energy costs for irrigators [35].

More than $2 billion has been invested by December 2018 in off-farm irrigation infrastructure [10]. IIOs are 'gifted' this off-farm infrastructure in return for water savings. Gifting means that the infrastructure is excluded from the regulatory asset base (RAB) for the duration of that asset life. However, the recipient of the assets pay the operational and maintenance costs of the asset. They also pay tax on the asset as the assets are accounted for in the statutory asset base (SAT) from the time of receipt.

An IIOs RAB is the basis for most of the costs incurred by the IIO operator, and the basis for pricing delivery and other charges for irrigators. When infrastructure is excluded from the RAB, the IIO does not charge irrigators for the depreciation of the irrigation infrastructure, or the financing cost of the infrastructure. This can encourage over-investment in irrigation infrastructure. It also results in an unfunded liability because, at some point, gifted irrigation infrastructure will need to be renewed. When this happens, the full cost of the irrigation infrastructure renewal will, in principle, get passed on to irrigators through additional charges.

There is growing consensus that the price impact for irrigators could involve material price increases in some IIOs, and that the cost implications of gifted investments will be felt through price rises in the future [8, 11, 13, 14]. There is also growing appreciation that irrigators are generally not aware of how gifted assets may impact on future IIO prices, to the extent that once gifted assets are brought into the RAB, future price increases are large. This risks the financial viability of irrigators, creates asset stranding risks, and creates risks for irrigation communities.

Goulburn Murray Water is one example. The Goulburn Murray Water Review [14] concluded that the "Connections Project, while providing enormous opportunities to improve the efficiency of the GMID, also presents major financial challenges in the short, medium

and long term. This is particularly as the project will reduce GMID's footprint (and hence revenues) and because the 'gifted' assets will eventually need to be replaced" (pp1).

As part of the Review, the Panel engaged Marsden Jacob Associates to develop a 50-year financial model of GMW. We used the GMW model to evaluate the business' long term financial sustainability for its main business lines. Our modelling identified the necessary savings required to achieve long term financial sustainability in the overall GMW business, and the gravity irrigation business in particular.

Our work for the Panel showed the GMW gravity irrigation business is financially unsustainable assuming constant prices in real terms. We showed that to be financially sustainable with the new infrastructure it has taken on, the GMW gravity irrigation business would need to increase prices significantly in real term to achieve operating and other cost savings, or both.

Murray Irrigation is another example. Murray Irrigation has forecast that delivery charges would need to rise by at least 30% in real terms over the next decade if the current footprint is maintained. These price increases are due in part to the $280 million in Round 2 and 3 Private Irrigators Infrastructure Operators Program (PIIOP) investments[2].

We discuss in the next section that there has been substantial debate about the ongoing viability of off-farm investments, and whether these investments will create long run beneficial or detrimental impacts for IIOs, irrigators and regional communities. What is clear however, is that irrigation infrastructure subsidisation is currently hiding the real ongoing cost of irrigation upgrades from irrigators [8]. Eventually this real cost will be priced into irrigation charges. It is not clear that irrigators are aware of the potential longer term price impacts of 'gifted' infrastructure.

3.7 Overall, environmental water recovery is leading to higher permanent and temporary water market prices and increasing risks, especially during dry and very dry years (NWI reform areas: Water Access Entitlements and Planning Framework).

There is consensus that environmental water recovery and water reforms have put upward pressure on permanent and temporary market prices [16, 27, 31, 36, 37]. There are several reasons for this.

First, State and Commonwealth environmental water recovery has taken around 20% of available water out of the consumptive pool (albeit with the right to trade this water back into the pool subject to trading protocols[3] to meet environmental needs). Even if this

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[2] https://www.abc.net.au/news/rural/2015-08-17/murray-irrigation-financial-problems-1708/6701980
[3] http://www.environment.gov.au/water/cewo/publications/water-trading-framework http://www.vewh.vic.gov.au/watering-program/trading

water was 'surplus' the water would not have been surplus during dry periods, and would be unlikely to have remained surplus as water markets matured in the southern MDB. Increasing overall scarcity of water will drive up prices.

Second, irrigation infrastructure projects that achieve entitlement transfer can result in higher water market prices than buybacks. There are several reasons for this, most neatly summarised in [31]:

- **The volume of water used by participants can fall by less than the volume transferred to the Commonwealth. Water use can even increase.** As a result, participants in WUE programs with entitlement transfer must either buy more or sell less water, which drives up water prices [16]
- **The average value of water increases.** When irrigators can achieve 'more profit per drop' because of water use efficiency investments and infrastructure investment that is sunk, then they will irrigate more often compared to if they didn't upgrade. This is because it remains profitable to do so when irrigators can achieve more profit per drop. The end result is that instead of selling water into the market, water is retained for irrigation, or purchased by irrigators. This drives up allocation and entitlement prices. The case study below taken from [31] is an example of this.
- **Irrigation infrastructure has encouraged irrigators to move into production of crops with higher marginal value product of water** [31]. A higher marginal value of water means irrigators get more profit per drop. This means they will pay more for water in allocation and entitlement markets. Since the peak of the Millennium drought in 2008, the southern Murray-Darling Basin (sMDB) has seen large increases in nut and cotton plantings, which is known to be driving up prices [16, 36, 37].

There is clear evidence that irrigators who sold water entitlements to the Government are more likely to report challenges relating to water costs than irrigators who transferred entitlements through upgrades [29]. This result suggests that irrigators selling through buyback have been comparatively disadvantaged compared to irrigators receiving upgrades. In part this is because irrigators selling in buybacks were compensated at market rates, whereas irrigators transferring entitlement received premiums on market rates.

Case studies of increasing water demand because WUE programs support higher MVP of water [31]

"A farmer in the Loddon valley with drip and gravity irrigation systems undertook improvements including upgrading the gravity system, changing paddock and bay size configurations, upgrading supply channels, land re-lasered, and installation of drainage lines and two reuse systems. It provided substantial labour savings, but a key benefit was that it enabled a more flexible cropping regime. Previously the area was only used for winter crops because water and labour efficiency was not adequate for more frequent watering of summer maize or other summer crops.

"Cropping farmers in northern Victoria made upgrades including channel remodelling, outlet size increases, lasering and remodelling of bays, and one kilometre of channel was decommissioned. Previously due to the labour and water use required they were reluctant to do much summer cropping. Now they are more comfortable with a higher proportion of summer crops. Post upgrade, the farm is now double cropping following canola with soya beans, whereas previously it would mostly have been winter cereals."

3.8 Available evidence suggests water market reforms overall have had positive economic and social effects in the Basin (NWI reform areas: Water trade reforms).

There is general consensus that the capacity to trade water has provided incentives for more efficient water use and infrastructure investment. Water trading has allowed water to move to higher value uses and has become a vital business management tool for irrigators, giving them flexibility to respond to changing climatic and market conditions [8, 10, 11, 15, 16].

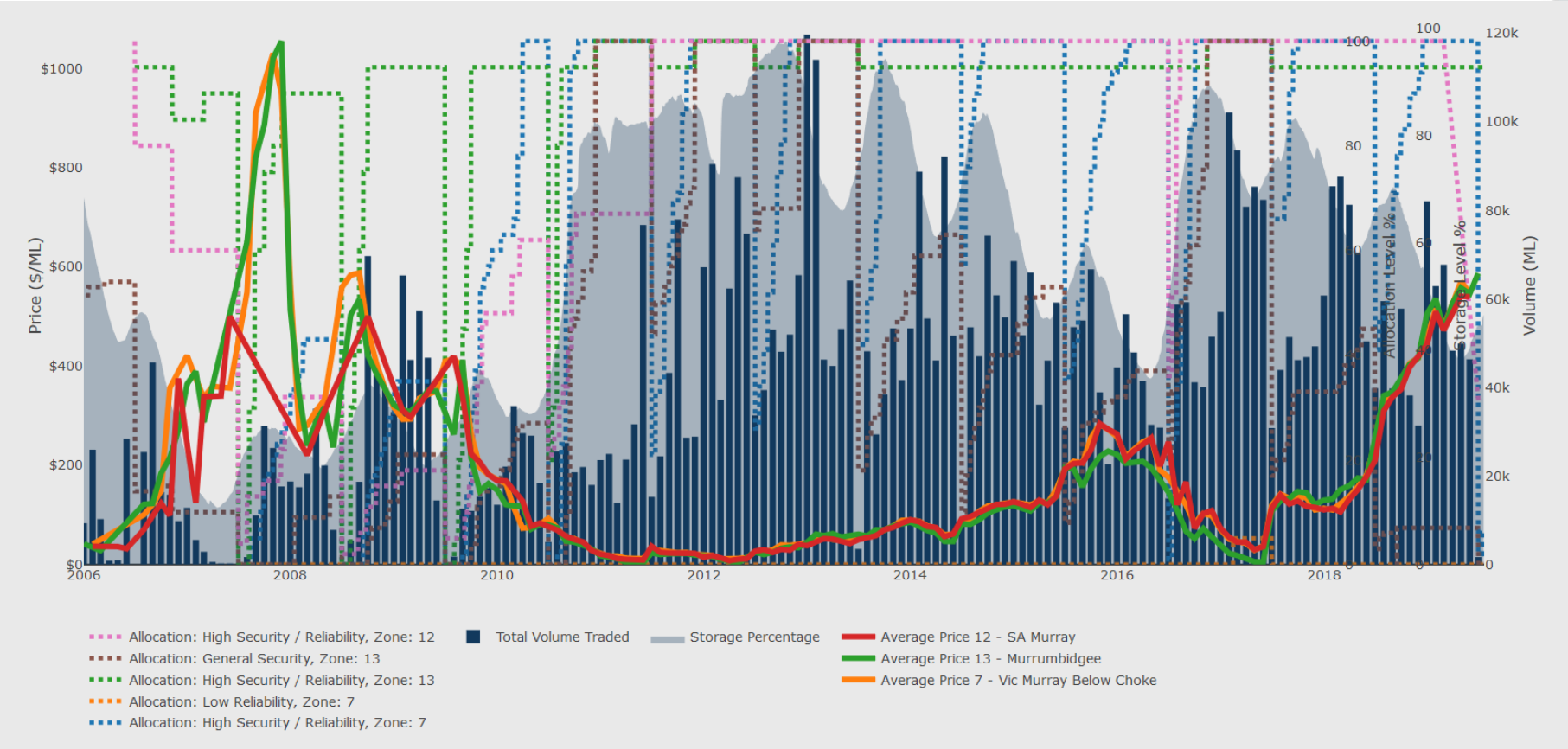
Secure water rights separated from land, together with clear and effective caps on use, have underpinned trading and the establishment of MDB water markets. The value of entitlements, their legal backing and developed markets for those entitlements, has allowed financial institutions to accept them as collateral for loans. Based on a 2013 survey of New South Wales irrigators, around 20 per cent of New South Wales' irrigators have used water entitlements to secure finance. There is widespread agreement that these arrangements have produced significant financial and non-financial benefits [8].

Based on data from Marsden Jacob's water market information platform Waterflow™, trade in allocations have grown from around 450 GL in 2007 to 1,500 GL in 2017-18 in the southern Murray Darling Basin (Figure 7) and from 11 GL to 70 GL In the Northern Basin (where trade is more constrained) (Figure 8).

Separation of water from land, water markets, changing trading arrangements and things like carryover arrangements have provided water users with greater flexibility, and more scope to manage business risks, including climate risk. Markets have allowed water to move to more productive and efficient uses, have encouraged more efficient water use, and have provided farmers with incomes in years they have chosen not to produce [8, 11]. During drought, available evidence shows that many producers have chosen to sell water allocations. This has helped them cope with drought and manage debt, while purchasers were able to maintain production and keep permanent plantings alive [11].

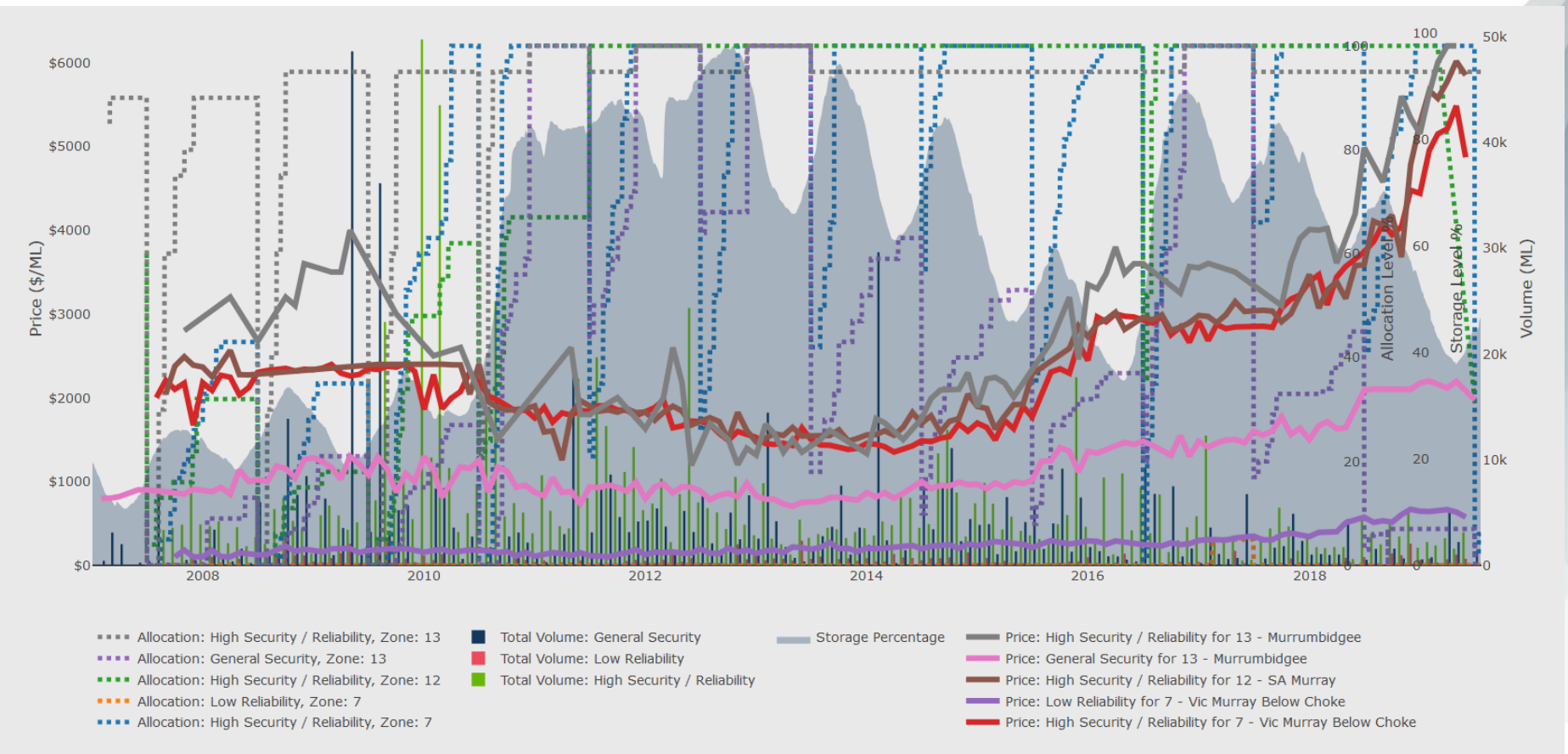
Studies that have estimated the benefits of water trading show that producers are much better off with markets than without them. One estimate is that water trading in the southern MDB increased Australia's gross domestic product by $220 million in 2008-09 (in 2008-09 dollars) (a drought year) [8].

Figure 6: Allocations, temporary prices, and storages for SA Murray, Murrumbidgee and Vic Murray Below Choke 2006-19



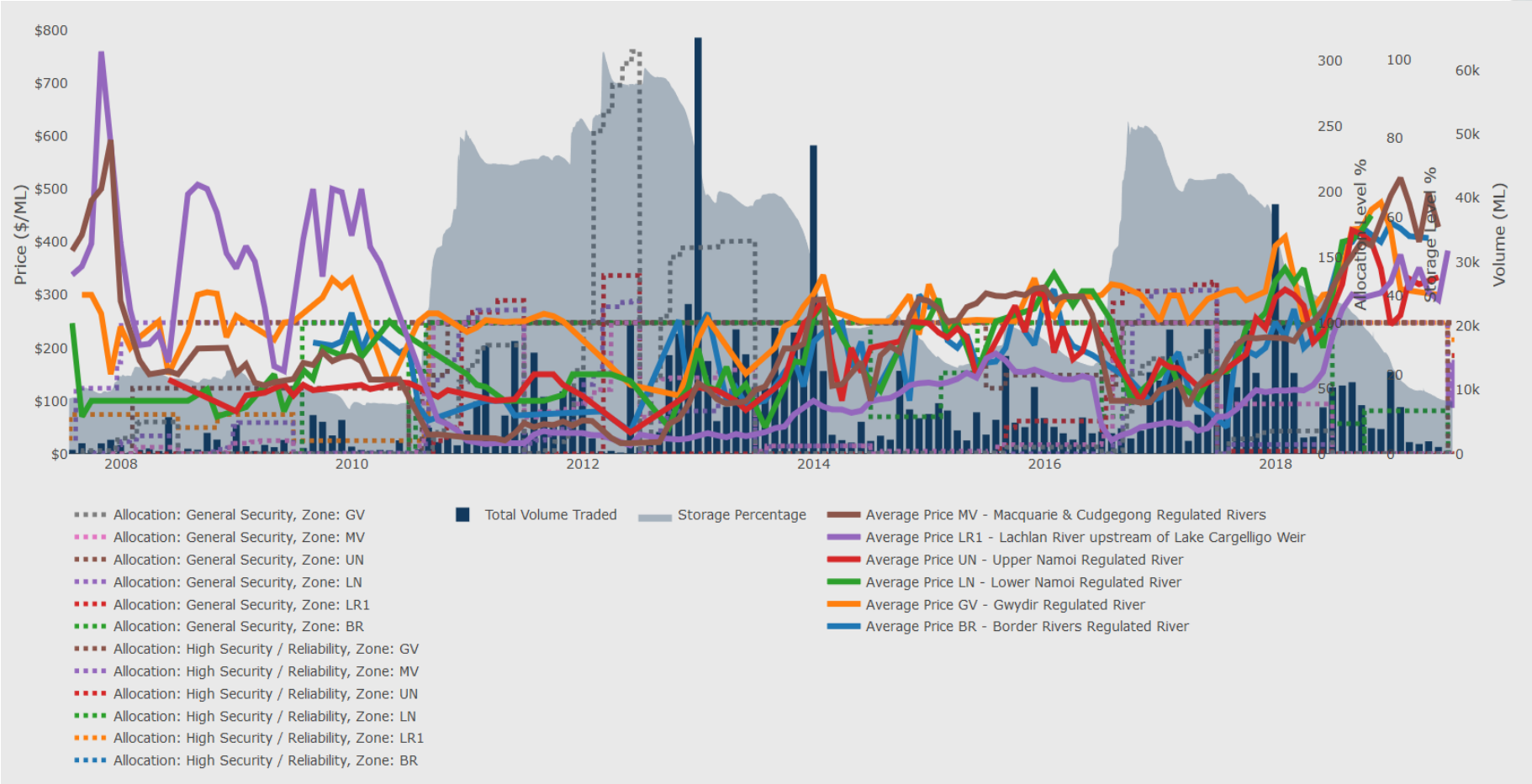
Source: www.waterflow.io

Figure 7: Allocations, entitlement prices, and storages for SA Murray, Murrumbidgee and Vic Murray Below Choke 2006-19



Source: www.waterflow.io

Figure 8: Allocations, allocation prices, and storages for select northern Basin regions 2006-19



Source: www.waterflow.io

3.9 Overall, available evidence shows that factors other than water reform are changing communities more than water reforms in most cases (NWI reform areas: Community Partnerships and Adjustment).

While there is debate in media around socioeconomic impacts of water reforms, evidence based studies show factors other than water reforms are shaping communities. The available evidence shows that factors unrelated to water reform, such as population size, are typically the key drivers of economic and social wellbeing, not exposure to water reform [11, 12].

Figure 9 shows an example of how factors like population size are more likely to determine economic and social outcomes. Figure 9 shows what's happening to population growth in 60 Basin regions where there have been infrastructure and buybacks. The graph shows (1) population change for towns in these regions from 1996-2006 (2) population change from 2006-16 and (3) the population (bubble size). The extent of buyback in the region the community is located in is colour coded. Communities in regions where buybacks accounted for 100-80% of all water recovery are in Red; 80-60% buyback are orange; 60-40% buyback are yellow; 40-20% buyback are blue; and 20-0% are green.

Figure 9 shows a couple of things for these 60 communities:

- There is a pattern of growth and decline: Larger communities (bigger bubbles) are growing. Larger communities generally grew over both periods (1996-2006 and 2006-16) (top right hand quadrant). Smaller communities (smaller bubbles) aren't growing as much as large communities. Many smaller communities shrunk over both periods (bottom left hand quadrant). There's a lot of evidence showing this pattern of growth and decline is happening across most of regional and rural Australia [9]. Australians are moving from smaller towns to larger regional towns and metro cities. They are doing this because larger centres offer things they want, and larger communities are more economically diverse. From other work we've done for State governments, we know the migration in the MDB is mainly younger people in the 18-40 year range. They often are families with kids.
- Some communities where buybacks dominated are growing and some are shrinking, just like communities where infrastructure dominated. In short, there is no good clear evidence that buyback has systematically depopulated communities. On the flip side, you can see in the graph that for many communities where infrastructure investment dominated water recovery, their populations have shrunk.
- Population growth is generally higher for 2006-16 than 1996-2006 for most communities, irrespective of whether buyback or infrastructure dominated. That means many of these communities have grown faster (or shrunk less slowly) over the 2006-16 (i.e. during water recovery and the peak of Basin water reforms) than the previous decade before water recovery.

These evaluations do not suggest that water reform has no effect on the wellbeing of individuals or communities. What they do suggest is that the effects of water reform are not readily observed at an aggregate level. Any effect is confounded by the influence of other factors that have a greater effect on the overall wellbeing of individuals and communities [11].

Despite these general trends, there is also clear evidence that some smaller irrigation dependent communities are more impacted than larger communities by water reforms. Communities are particularly impacted when the town depends on a single large business (generally a commercial farm) that decides to sell all water. These communities are also more impacted by fast rather than gradual recovery [10].

3.10 There is little evidence that structural adjustment assistance supporting Basin water reforms have been effective in improving economic and social outcomes for Basin communities (NWI reform areas: Community Partnerships and Adjustment).

The NWI agreed that Parties would address significant adjustment issues affecting water access entitlement holders and communities that may arise from reductions in water availability as a result of implementing NWI water reforms (Table 2).

The Productivity Commission reviewed the performance of structural adjustment assistance by the Commonwealth in the Basin in 2018 [10]. The Commission reports around $65 million has been invested in communities through the Strengthening Basin Communities program for urban water saving initiatives. The Murray-Darling Basin Regional Economic Diversification Program (MDBREDP) has committed $72.65 million to assist Basin communities to increase economic diversification and adjust to a water constrained environment (Queensland: $15 million, NSW $32.5 million, Victoria $25 million).

The Productivity Commission concluded that the structural adjustment assistance has had little lasting impact in communities where the investment occurred. In part this could be attributable to the small size of funds spent. It is also not clear that structural adjustment has been allocated to communities that are most vulnerable to Basin water reforms.

The $641.6 million Building Better Regions Fund (BBRF) supports the Australian Government's commitment to create jobs, drive economic growth and build stronger regional communities into the future. We do not have details on how this fund is being allocated in the Basin.

3.11 There is little evidence on beneficial economic impacts of environmental watering for Indigenous groups (NWI reform areas: Water Access Entitlements and Planning Framework and Community Partnerships and Adjustment).

The NWI committed signatories to recognise Indigenous needs in relation to water access and management and to introduce policies to meet these needs through water planning and entitlement reform. Basin States have made progress against these commitments.

The 2017 Productivity Commission review of national water reforms recognised that NWI does not explicitly require provision of water to Indigenous communities for commercial purposes to support economic development [8].

Water reform in the Basin have given some Indigenous groups better access to water for economic purposes:

- In New South Wales, Indigenous people can seek access to an Aboriginal Community Development Licence. Water from these licences can be used for economic activity. The licences have a maximum of 500ML per year per water source. Restricted trade is allowed (for example, permanently to other Aboriginal groups or individuals, or temporarily without this restriction).
- In Victoria the Government has allocated $5 million to develop a roadmap for Aboriginal access to water for economic development, working in partnership with Traditional Owners and Aboriginal Victorians [8].
- In May 2018, the Australian Government committed $40 million for direct investment in cultural and economic water entitlements in the Basin [10].

There are currently no evaluations that we are aware of that have looked at the economic impact of water reforms, including cultural and economic water entitlement purchases, in the Basin on Indigenous groups. We discuss this further in our gaps section of this report.

3.12 There is little evidence on beneficial economic impacts of environmental watering for recreators and tourism (NWI reform areas: Water Access Entitlements and Planning Framework and Community Partnerships and Adjustment).

Environmental watering is expected to deliver recreational, community liveability and tourism benefits [38]. To date there is limited evidence of these benefits in the Basin, particularly economic impacts of increased tourism. We discuss this more in our gaps section of the report.

The lack of evidence around the economic benefits of environmental flows for tourism have been attributed to several things [26, 38, 39] including:

- There may be lags between environmental flows and improved environmental outcomes that lead to increased tourism
- The high variability of basin inflows means a lot of environmental condition is independent of Basin environmental watering activities
- The data supporting analysis of the relationships between environmental flow and tourism is often poor.

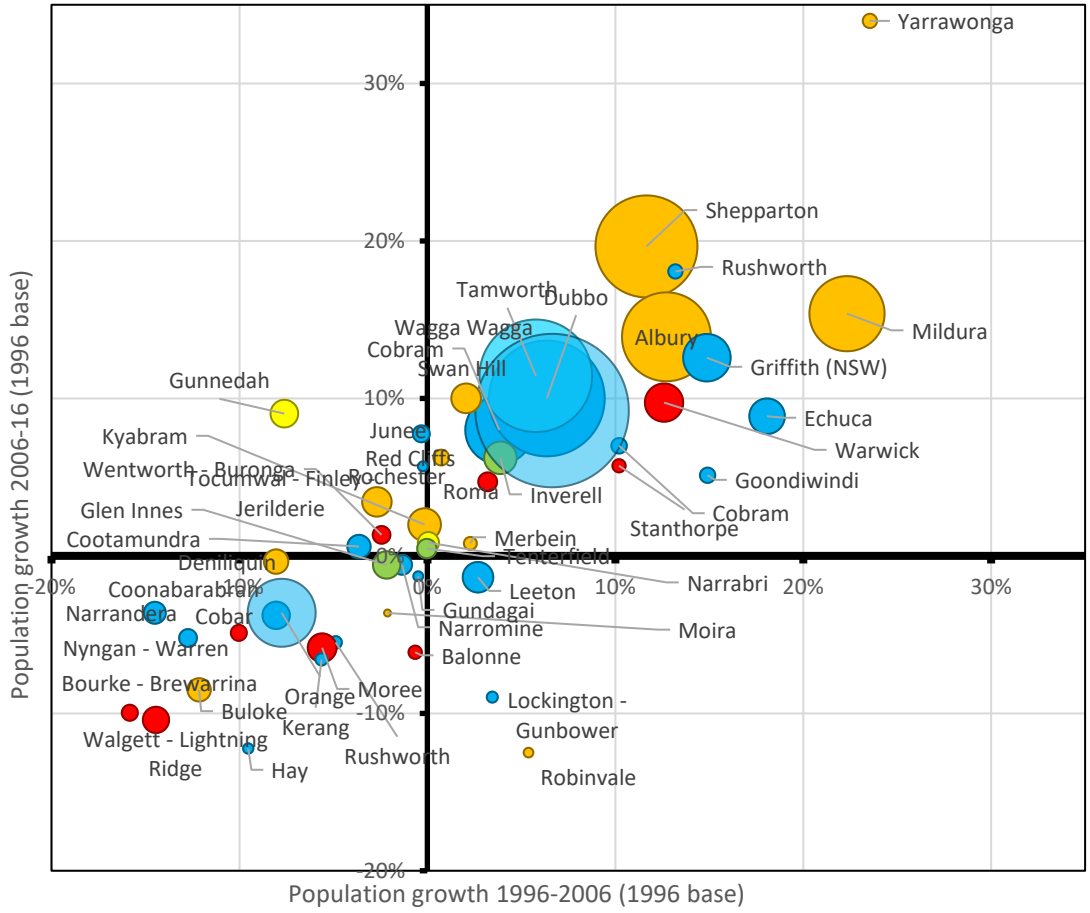
Marsden Jacob's analysis for the MDBA of the relationship between recreational boating activity levels and water availability at major recreational boating sites in the Basin in 2012 showed that there is no clear statistical relationship between peak season water availability and recreational boating activity at most of the main sites based on available data [39]. In SA, there appears to be a weak statistically significant relationship between peak season water availability and recreational boating expenditure.

These findings are consistent with the conclusions of several earlier reports that reported no statistically significant relationship between Basin water availability and tourism levels, and found that those very significant changes in Basin water availability that occurred during the drought did not translate into an equivalent decline in tourism activity in the Basin [39].

Analyses of the relationship between recreational and commercial fishing activity and water availability are uncertain [40]. In 2012, Deloitte estimated recreational fishing in the Basin produced around $914 million in expenditure and commercial fishing produced $8.1 million in revenue per annum. Most of this activity is located in the southern Basin.

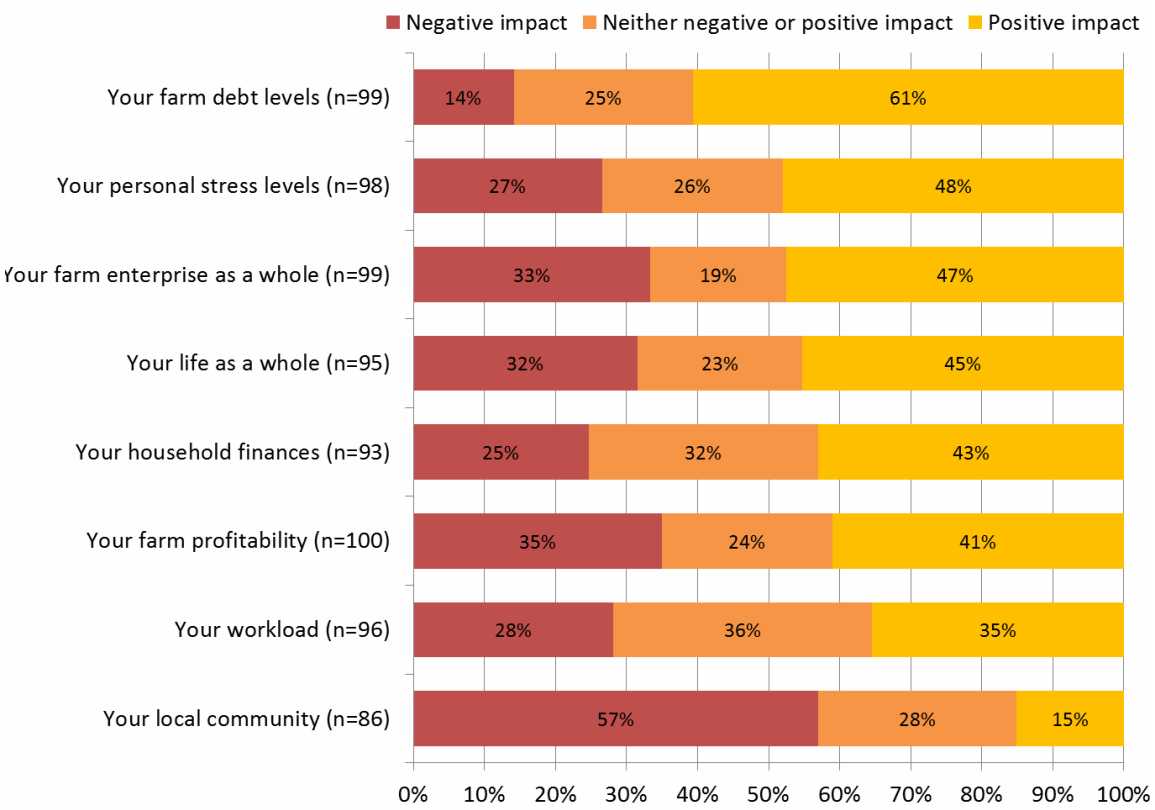
Deloitte found that, assuming the environmental flows are managed with native fish as an objective along with the other ecological, economic and social objectives of the Plan (i.e. the ecological needs of native fish are taken into account), modest impacts on the Basin's fisheries can be expected – in the order of consumer surplus of $9.1 million per annum for recreational fishing and an increase in producer surplus of $254,000 per annum for commercial fishing. Deloitte concluded most impacts would be in the Murray, Murrumbidgee, Goulburn-Broken and Condamine-Balonne.

Figure 9: Population change 60 Basin regions (bubble size shows 1996 population, bubble label shows region and population in 2016)



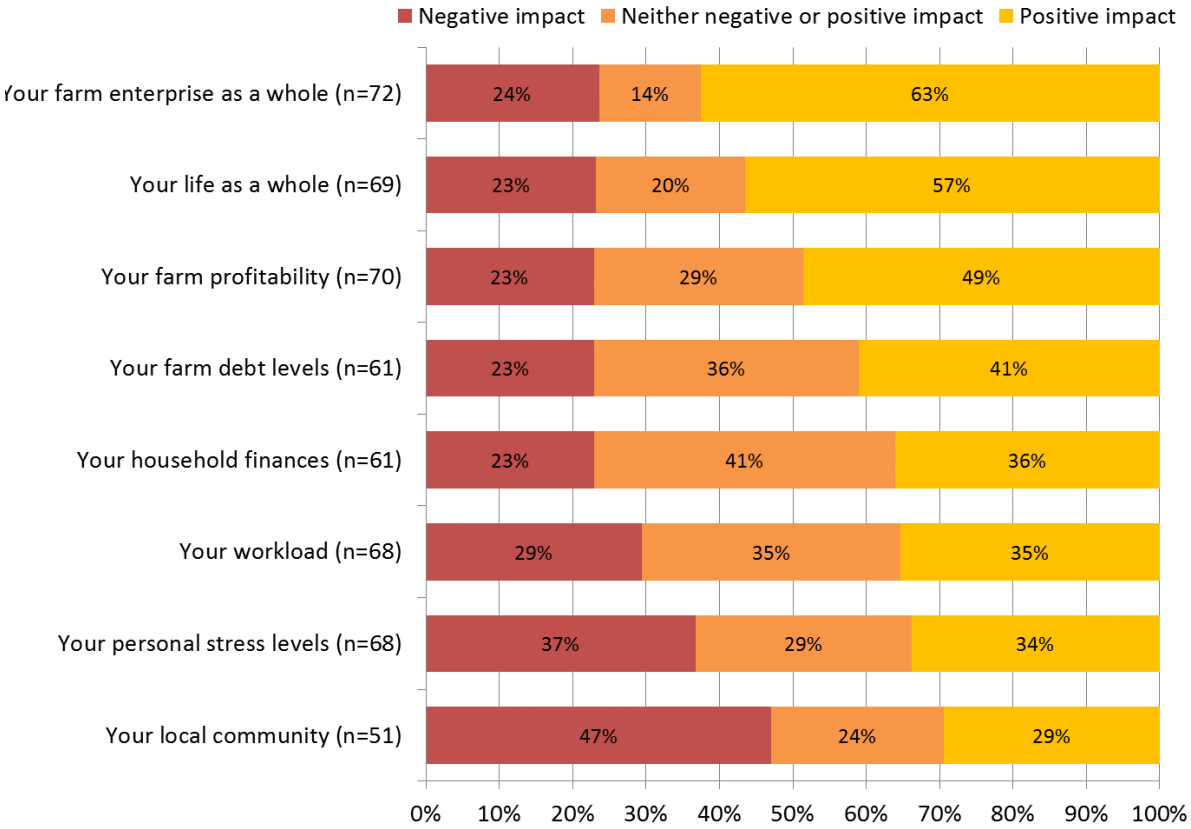
Source: Marsden Jacob analysis of ABS data.

Figure 10: Outcomes of water entitlement sale, experienced by those who sold and remained an irrigator (note: small sample sizes mean that these results may not be representative).



Source: [29]

Figure 11: Outcomes of water entitlement transfer, experienced by those who transferred entitlements in order to access on-farm irrigation infrastructure grants. (note: small sample sizes mean that these results may not be representative).



Source: [29]

4. Where there are major disputes in the literature, and why these are occurring

We define major disputes as points of disagreement that could lead to material differences in economic and social impacts and outcomes for Basin communities. Major disputes can be backward and forward looking. We focus on disputes that have forward looking implications for future reforms, and future economic and social impacts in Basin communities.

Our discussion of major disputes extends on our discussion from the previous section about what is currently known about economic and social effects of Basin water reforms and changes to date.

4.1 The role of Government in funding Basin reforms and addressing significant community adjustment issues arising from reduced water availability.

There is a foundational dispute about the role of Government in Basin water reform, and what the 'right' level and type of government intervention should be. This foundational dispute is important, and has real world implications. It underpins many of the ongoing tensions about how economic and social impacts of Basin water reform are assessed, and how Basin water reforms should proceed.

The foundational differences in the literature about what Governments should do include:

- The Government role in managing risks that irrigators face because of water reform. For example, should Government compensate irrigators for increasing water prices and irrigation infrastructure costs? Should the Government support irrigators who have not participated in buybacks or infrastructure upgrades, given the Government has increased their risk too, and potentially put them at a competitive disadvantage to irrigators who have participated?

- The extent to which Governments should address community structural adjustment issues. For example, should all communities impacted by Basin water reforms be supported, or just communities where the impact has been fast and quick (e.g. communities where a single large commercial holder has sold their full entitlement and exited irrigated production)? What is the best way to support these communities? Is it the Government's role to invest in communities that are showing a long-term trend in population decline, or should the Government's available funds be allocated to some communities over others?
- Do we help irrigators first, or should we be helping the communities first?

The Basin State signatories to the 2004 NWI agreed to a specific Government role in Basin water reforms. NWI signatories agreed that:

- Water recovery in the Basin would be based primarily on cost-effectiveness, with a view to managing socio-economic impacts (s79 ii b). In other words, the role of Government is to support prudent and efficient investment in the national net best interest, while managing social and economic impacts, either directly or indirectly through the Commonwealth and State welfare systems.
- Water recovery by Government would consider all available options including (but not limited to) consideration of all available options for water recovery, including investment in more efficient water infrastructure; purchase of water on the market, by tender or other market based mechanisms; investment in more efficient water management practices, including measurement; and investment in behavioural change to reduce urban water consumption.
- Governments would address "significant adjustment issues affecting water access entitlement holders and communities that may arise from reductions in water availability as a result of implementing the NWI reforms. Government adjustment support would be considered on a case by case basis, taking into account matters including the scale of the changes sought and the speed with which they are to be implemented (including consideration of previous changes in water availability" (s97).

The NWI agreed Government role is markedly different from the December 2018 socioeconomic neutrality criteria agreed for efficiency measures[4]. The differences in objectives between the 2018 Government role set out in the socioeconomic agreement and the NWI agreement highlights the current foundational dispute about the role of Government. The December 2018 agreement does not include cost-effective delivery as a primary role of Government. The agreement says any future water recovery investments:

- Should not reduce the overall productive capacity of the relevant region and should not impact negatively on regional jobs
- Should not have negative third party impacts on the irrigation system, water market or regional communities

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[4] https://www.mdba.gov.au/media/mr/murray-darling-basin-ministers-meet-melbourne

- Must contribute to the current and future viability of proponent businesses and irrigation districts.

4.2 The potential economic impacts of Basin water reforms.

There are disputes around the potential economic impacts of Basin water reforms, particularly around how water recovery will impact on regional production levels, production mixes, jobs, and communities.

Commissioned economic evaluations underpin this debate. Commissioned economic evaluations have used different economic tools, assumptions, and datasets in their work. In our assessment, and the assessment of others, most of the disputes about economic impacts are occurring because some of the key economic evaluations that have been relied upon to shape Basin water reform have significant limitations. When compared to evaluations that do not have these limitations, the evaluations with limitations are creating divisions in understanding. We summarise some of the more important limitations of some of the economic impact evaluations below.

Importantly, commissioned economic evaluations by MDBA in 2016 for the Northern Basin review [17] and 2018 for the Southern Basin [18] and by regional interest groups [19] have notable limitations. The limitations in this work mean that these studies overstate the negative impacts of Basin water reforms, and understate positive impacts. We discuss the implications of using flawed economic impact analysis for understanding the lagged impacts of Basin water reforms later in this report.

Key economic analyses of Basin water reforms were evaluated by academic economists for the SA MDB Royal Commission [41]. The SA MDB Royal Commission submission includes summaries of around 20 studies of Basin water reform economics and detailed evaluations of around seven key economic impact evaluations from the last five years.

The SA MDB Royal Commission submission identifies that the major debates around economic impacts of Basin water reforms are occurring because some commissioned economic studies use assumptions that do not align with the realities and dynamics of farm and regional economics while others do. We agree with this overall assessment. We also note that the SA MDB Royal Commission report reviews several Marsden Jacob studies, and identifies these as examples of best practice economic impact evaluation.

Key limitations in studies that will result in material overstatement of negative impacts of Basin water reforms include that:

- **Some studies assume there is a proportional relationship between less farm water use and the (value of) farm irrigated production.** The studies commissioned by MDBA for the Northern [17] and Southern Basin [18] and for regional and industry groups [19] assumed there is a proportional relationship. The assumption that the relationship between water use and the value of irrigated and volume of irrigated production is proportional ignores the substantial amount of evidence that shows this is not the case [41].

Figure 4 in this report is a simple example showing the relationship between water input and irrigated production output is not proportional. It shows the gross value of irrigated production in the Basin in 2015-16 from 5,000ML of water applied was almost the same as the value of irrigated production in 2000-01 with 10,000ML applied, measured in real terms.

- **Some studies assume a proportional relationship between reduction in farm production and regional employment and economic activity.** Recent studies commissioned by MDBA for the Northern [17] and Southern Basin [18] and for regional and industry groups [19] make this assumption. The work in the Southern Basin [18] recognises this assumption is unrealistic and that it is a key limitation of its work, but adopts the modelling approach anyway.
- **Assuming that falling employment means a decrease in the value of regional production or falling incomes and rising unemployment.** The Productivity Commission's 2017 evaluation of transitioning regional Australian economies shows that falling employment in many agricultural regions in Australia, including regions in the Murray-Darling Basin, does not result in a decrease in the value or quantity of production or a fall in incomes [9].

  Recent studies commissioned by MDBA for the Northern [17] and Southern Basin [18] and industry groups make this assumption. They overstate the negative impacts of water reforms as a result.
- **Productivity and other changes in farms and regional communities over time are not reflected in the models.** Few economic models of water reform impacts have accounted for productivity change over time, and other changes that will impact on farm and regional economic performance, such as changing farmers' terms of trade.

  There have been substantial structural adjustment and productivity changes in relative farm competitiveness in the Basin over the past decade [42]. These changes are likely to persist in the future. Models that do not account for these changes over time are likely to over-estimate the negative impacts of water reforms.
- **They do not allow for factor movement.** Factor movement is an economic term for saying that people, water, capital and land can all change use and location. For example, people change jobs or move towns to take up new jobs, farms change the crops they produce, and water moves across trading zones through markets.

  Good economic studies evaluating the economic impacts of Basin water reforms make reasonable and evidence based assumptions about factor mobility, and they make their factor movement assumptions clear. The SA Royal Commission review identifies Marsden Jacob's Murrumbidgee economic impact study as a best-practice study that makes realistic assumptions about factor movement, and makes assumptions clear [27].

Commissioned economic impact studies that assume factors cannot move have overstated the negative impacts of water reforms and recovery. This is because these studies effectively assume that the resources (people, capital, land, water) have no alternative productive use. This assumption does not match with reality.

- **They ignore important parts of the economy or stimulus.** For example, some economic studies have ignored that buybacks create a positive economic stimulus in local economies. This stimulus happens when irrigators receive money for selling water and they stay in the community and spend these funds. Other studies ignore other changes that are occurring in communities because of reasons other than Basin water reforms.

  As we discuss in Section 3.5 there is very clear evidence that irrigators who sold water to the Commonwealth remained in their communities and spent buyback money in their communities, either on-farm or off-farm. Recent studies used to justify the SDL reduction in the Basin Plan ignored this economic stimulus. This means they understated the positive impacts of buybacks on communities.

- **They are based on data that is not representative.** This is discussed well and in detail in [41]. There are three main areas where commissioned economic impact studies have not used representative evidence:

  (1) **Cherry picking communities.** Some economic studies of Basin water reforms have focussed on "specific ill-affected communities" for modelling the relationship between water, production and regional communities [17]. This evidence was then used to model potential impacts of water recovery in other regions. This is very poor economic impact evaluation practice. The approach assumes the relationships between water, production and jobs that hold for worst impacted communities hold for all communities. Unpublished work that Marsden Jacob Associates has undertaken for State Governments clearly shows that this is not the case – the impacts of water reforms can be very different across communities.

  (2) **Relying on incomplete samples**. Some irrigator surveys and consultations have relied on samples that are probably not representative of irrigators or irrigation communities [23, 29]. This can be because sample sizes are too small, or because studies have not used recruitment approaches that can help get unbiased sample respondents. There is a material risk that the findings of studies that do not use representative samples are not an accurate reflection of irrigator and community views, preferences and outcomes. When water reform policy is based on unrepresentative evidence we end up with biased policy.

- **They suffer from model misspecification.** Some studies have used estimation techniques that do not meet basic standards for good model design. For example, modelling in the Northern and Southern Basin has specification problems with its estimation techniques that mean the statistical models used to estimate relationships between water use and regional productivity and employment are biased. This estimation bias means the work probably overstates the negative impacts of Basin water reforms.

4.3 What regional water availability and prices will look like in the future, particularly during dry and very dry conditions.

Recent evaluations have looked at how issues like return flows [20] and system losses [21] are impacting regional water availability, and may impact regional water availability in the future. Due to scope and timing reasons we have not included these evaluations or debates about these evaluations in our literature review.

We have focussed on debates around economic assessments of water markets, regional water availability and water market prices in the future. We think the debates around how water markets impact regional water availability and future water market prices will become more pronounced through the ACCC inquiry into irrigation water trading in the southern MDB.

In the public domain, the emerging dispute is being played out between ABARES and the consulting firm Aither. ABARES water trade modelling from March 2018 [16] suggests that water availability and market impacts will be less pronounced than recent work by Aither commissioned by the Victorian Government [43].

- ABARES water trade model simulations of 2019-20 water allocation prices for dry, normal and wet scenarios. They observed storage volumes were good in Victoria in 2017 (at the time of writing). Under a dry scenario they conclude water availability would fall in 2019-20 but remain above levels observed during the (2007 to 2009). Under this scenario they estimated an average annual water price of $475 ML is estimated (for the Murray trading zones).
- Aither concludes that horticulture demand in the connected Murray could result in there being effectively no 'headroom' water available for competing sectors (such as dairy) under an extreme dry scenario. For the lower Murray they assume no water allocations can be traded into connected zones, that there is no groundwater available in the lower Murray region (on the grounds that groundwater in the lower Murray region is not good enough quality to be used for irrigated agriculture), that no carryover will be available, and that the Mulwala Canal Escapes Agreement would not be used. Aither notes this presents as a worst case scenario.

  Aither concludes that observed prices would be "expected to increase up to the short-run willingness to pay of the lowest value permanent horticultural enterprises in the connected Murray." While there is uncertainty about the willingness to pay for water across different industries and individual enterprises within each industry, it is reasonable to assume that allocation prices higher than $450 to $550 per ML (mid-season 2018- 19 southern Murray-Darling Basin allocation market prices) may be observed.

However, we see that differing views on water market prices are converging, as are underlying assumptions in water market models being used. In our assessment, this means future debates around regional water availability and market prices will likely be based on differences in assumptions in models around areas planted, maturity and water demand, trade constraints, carryover capacity, and groundwater use. Here we note:

- ABARES is currently updating their water trade model to better reflect underlying demand for water from sectors including horticulture and cotton. This work will address limitations in data around new horticulture plantings below the Barmah Choke. ABARES is also looking to better incorporate groundwater sources, particularly in the Murrumbidgee, Lower Murray and Northern Victoria regions, in their modelling. There is also opportunity to refine calculation of carryover figures, and IVT rule operation.
- Differences in price and regional resource availability between modelling are converging in recent work. ABARES August market update forecasts average Southern MDB allocation prices of around $650 ML for 2019-20 under very dry conditions, and $530 ML under dry conditions. Aither's 2019-20 water market report released in August suggests prices will be around $425 under a dry scenario and $590 under a very dry scenario. Aither notes this assumes unrestricted inter-regional trade, which is unlikely due to IVT limits. IVT limits will mean Lower Murray will trade at above the forecast prices and Goulburn and Upper Murray will trade below the levels.
- The historical accuracy of ABARES or Aither's water trade models has been generally low, particularly for dry and very dry scenarios. Aither has been transparent about the low predictive accuracy of their water trade price modelling, and how they are working to improve the accuracy of their models (see Section 6.2.3 of their report).

Combined, what the above points mean for us is that water market models, and assessments of regional water resource availability and prices, should be seen as rough approximations of potential future states, subject to assumptions being met. More importantly, models should be used to transparently understand the impacts of trade restrictions on regional water availability and prices. Reporting of modelling should be transparent about the assumptions used, and why other realistic scenarios have not been modelled where these exist.

5. What are the key gaps in the literature and understanding

We define key gaps in understanding as gaps that could lead to material differences in economic and social impacts and outcomes for Basin communities. We focus on gaps in economic understanding that have forward looking implications for future reforms, and economic and social impacts in Basin communities.

Our discussion of key gaps extends on our discussion from the previous sections about what is currently known about economic and social effects of Basin water reforms and changes to date, and the major areas of dispute.

5.1 Whether water reforms in the Basin to date, and future Basin water reforms, are in the national interest.

There is an overarching gap around whether past and future Basin water reforms are in the national interest, and in the best interests of key communities identified by the Independent Panel.

This overarching gap in understanding results from research holes in key areas that would allow us to clearly demonstrate that water reforms are delivering net beneficial outcomes. This includes lack of understanding around the size and sustainability of productivity gains being impacts of on-farm and off-farm investments, whether infrastructure investments are making farms, IIOs and communities more or less resilient, the impact of infrastructure on IIO financial sustainability and pricing (and how they will respond)and the impact of water recovery and infrastructure investment (Jevons paradox) on water prices. We discuss these gaps in more detail below.

The Productivity Commission's national water reform and Basin reviews [8, 10] summarised the overarching gap well when they concluded the net benefits of Basin water reforms, and irrigation infrastructure projects have not been comprehensively assessed. They said (Section 3.4 under the heading 'The additional cost has not been clearly justified'):

- The available evidence indicates that infrastructure modernisation has probably provided some benefits for some irrigators. It has also probably had some positive flow-on effects for regional communities through economic stimulus.
- But the size of these benefits (for irrigators and regional communities) are not clear. No comprehensive benefit-cost analysis has been undertaken to confirm that the public benefits of these measures have exceeded the costs to taxpayers.
- Available evidence indicates a number of private benefits for irrigators. Available evidence does not substantiate that infrastructure projects have delivered public benefits that have helped sustain regional communities, or that any benefits outweigh costs to Australians and regional communities.
- There is evidence that infrastructure works can provide a stimulus effect, depending on the share of expenditure that is spent locally. The evidence is that productivity impacts other than those that support labour savings are negligible. This implies potentially negligible flow on effects for regional communities where key farm input services are being used. It also implies potentially less farm labour service requirements.
- If the benefits of infrastructure modernisation are primarily private (and those benefits exceed the costs of works), it raises the question of why those investments were funded by Governments rather than by irrigators or irrigation infrastructure operators.

5.2 What the longer term on-farm and off-farm productivity impacts of infrastructure investments are.

On-farm productivity gains to increase irrigated production are a key benefit claim for on-farm and off-farm infrastructure modernisation, and one of the main ways irrigation infrastructure investment has been justified in investment cases. Productivity gains have to occur to offset lower future production given water has been transferred to the Government.

The evidence set out in Section 3.3 of this paper based on irrigator surveys shows that some irrigators believe irrigation infrastructure has helped improve on-farm productivity. What these irrigator surveys have not told us is how much productivity has increased by, and whether the overall productivity gains outweigh the costs of achieving them. In short, despite the fundamental importance of understanding on-farm productivity gains from infrastructure investment, there is little to no real documented empirical evidence about how much net economic value is being created through productivity change in the Basin.

The nature of the actual on-farm productivity effects need to be better understood as they are likely to significantly differ across farm systems and be important drivers of relative regional performance. These gaps need to be considered in at least three ways:

- **Gaps in understanding off-farm infrastructure driving on-farm productivity changes**. For example, the NVIRP Stage 1 and 2 business cases were heavily predicated on off-farm delivery improvements driving large on-farm productivity gains. From working in GMW we know the real productivity gains have turned out to be nowhere near the levels assumed in the business case.

For example commissioned work that we have cited assumed a productivity gain of around 15 percent for dairy in NVIRP. These estimates have since been revised downwards to be in the order of 5 percent for dairy in the GMID. Importantly, this is still a claimed productivity increase, not an actual observed productivity increase, and in our view is still probably an overstatement of benefit. A further complication for the GMID is that the water savings meant to accrue to irrigators from off farm investments under the original design of the program will not be delivered until at least 2023.

- **Gaps in understanding on-farm infrastructure driving on-farm productivity changes**. Ernst & Young's 2018 analysis of efficiency measures in the Murray-Darling Basin [12] concludes that irrigation infrastructure investment would need to create productivity gains of at least 16 percent for rice and horticulture to break even (Section 5.6). EY concludes if short-term[5] production does not increase (as a result of irrigators either not being able to retain water savings, on-farm productivity not improving, or water being sold in dry years) then the investment will deliver net losses.

  However there is no evidence that these levels of productivity gains are actually being achieved on farms that have received on-farm irrigation investment. This means we cannot be clear if infrastructure is delivering beneficial outcomes for irrigators.

- **Gaps in understanding regional productivity differences.** The level of off-farm to on-farm investment in infrastructure varies significantly between irrigation districts in the southern connected system. We have a gap in understanding of how these differences are contributing to on-farm productivity outcomes, if at all. Whole farm system analysis is needed to close this understanding gap.

  For example, there has been relatively significantly more off-farm investment in the GMID and relatively significantly more on-farm investment in the Murrumbidgee. Further, the GMID has a higher proportion of farm systems less suited to achieving on-farm productivity through off-farm upgrades compared to the Murrumbidgee that that has a higher proportion of farms more suited to achieving on-farm productivity gains from on farm investments. There is a gap in understanding productivity gains across different systems.

5.3 Future impacts of WRP changes.

The Productivity Commission has noted [10] that in "some WRP Areas, significant rule changes may be needed to meet Basin water reform and Basin Plan requirements. Stakeholders are justifiably concerned that if WRPs are rushed to meet the accreditation deadline, changes could affect the reliability of their entitlements or not sufficiently protect environmental water. They are concerned that there is not enough time left to properly examine and test the proposed changes before they become laws."

[5] EY does not define what they mean by 'short-term', but it appears to be 10-years based on pp101 of their report

There is currently little to no publicly available evidence about the potential economic impacts of proposed rule changes. Evidence in this area is particularly important in NSW [10] where Rule changes could impact on irrigators, IIOs and communities.

5.4 Long-term impacts of irrigation infrastructure investments on IIOs, their financial sustainability, footprint and prices, and implications for irrigators and communities.

We discussed in Sections 3.3, 3.4, and 3.6 evidence that, in some cases, off-farm irrigation infrastructure may be creating a medium to long term challenges for the financial sustainability of IIOs. We also discussed that these financial sustainability issues could have pricing implications for irrigators, and that many irrigators are probably unaware of the potential future price impacts. Reduced delivery volume and increased infrastructure cost may require irrigation infrastructure operators to spread a higher fixed cost over a smaller number of remaining irrigators and / or a smaller volume of delivery shares, increasing charges for those users [10]. Impacts on termination fees will be passed through at 10 times the current delivery share price if current arrangements continue.

The magnitude and timing of future higher costs for IIOs and irrigators are currently not known, and there is very little public information available about future price paths beyond the five year regulated period. This is a key gap in understanding that has potentially material implications for irrigators and irrigation communities.

Underlying shifts in water and energy prices could have a significant impact on the profitability of upgraded farms and IIOs. Analyses have identified that the design of any future on-farm WUE programs that require entitlement transfer should be aware of the increased potential for inefficient investment and perverse outcomes, including stranded assets [31].

5.5 Long-term impact of water reform on Basin water market prices.

We discussed in Section 3.7 evidence that, in some cases, on-farm and off-farm irrigation infrastructure is increasing allocation and entitlement prices, and that some of these price increases will be sustained in the future. We also discussed that many irrigators, and their communities, are not aware of how sustained price increases could impact on farm viability and profitability.

We discussed in Section 4.3 that there is an emerging and important disagreement around how Basin water reforms will impact on allocation and entitlement prices in the future, particularly during periods of low water availability. We also discussed that water recovery via irrigation infrastructure investment probably leads to higher water market prices than equivalent volumes recovered by buyback. We noted that the truth probably lies somewhere in between what is being presented in the current available literature.

There are gaps in understanding to be closed, in part with modelling, to gain a more complete picture of water demand, availability, and constraints. These include better understanding and closing gaps in understanding around:

- Water market price impacts in the Northern Basin. Currently the discussion on water market price impacts is focussed on the southern Basin.
- How better constraints management can deliver better outcomes for irrigation that will keep downward pressure on water market prices above and below the choke. Murray Irrigation's 2018 temporary agreement with WaterNSW allows water orders to the Lower Murray to bypass the Barmah Choke by using the Mulwala Canal (which has an offtake capacity of 10 GL a day). This relieves the pressure on the Murray River during heavy demand and provides the river operator with a greater range of strategic options to run the river.
- How groundwater may be used in the future, and the extent to which this decreases demand on water markets in the southern MDB.
- Updating current modelling to better estimate changes in future demand from growth in horticulture, and additional environmental water recovery, including the means by which this occurs.

5.6 Structural adjustment, recreation, tourism and Indigenous economic benefits

We discussed in Sections 3.10 - 3.12 that there are key gaps in the literature around how Basin water reforms have impacted economic outcomes for Indigenous communities, recreation, and regional tourism. Closing these gaps would give more insight into the impacts of Basin water reforms for these groups.

5.7 Whether reforms are going to make regional irrigators and Basin communities more resilient and viable.

Given the evidence base discussed in Chapter 3 and the gaps discussed above, our view is that there is insufficient evidence at this time to say whether Basin water reforms, past and planned, are making regional irrigators and communities more resilient and viable. This is a key gap in understanding. What is clear is that:

- Irrigation infrastructure investment is probably having mixed impacts on farm resilience and viability. This is because different types of upgrades have occurred in different regions. Different regions have different industry concentrations and different industries perform differently depending on the type of infrastructure upgrades. Irrigation infrastructure investments have probably delivered some productivity improvements for some irrigators, and in some IIOs. The investments will also result in higher water market prices (including potentially higher prices than if the same volume was recovered by buyback), and higher delivery charges and termination

fees as assets are rolled into the RAB. To the extent that irrigators are not aware of how these price impacts will impact on their financial viability, this creates risk, including stranded asset risks.

- All farm adjustment and community analysis needs to be considered against a counterfactual of continuous change. The inevitable trajectory of farming systems that wish to remain competitive is increasing efficiency in the use of resources (labour, land, machinery, water and so forth) – this is a reality for farming businesses that compete against one another for resources and operate in national and international markets.

  This inevitably means that the number of farms engaged in irrigation, the number of people they employ and the dependence of rural communities on irrigation will decline in relative terms. These are simple economic realities that are not the consequence of water reform or the Basin Plan per se. Rather, water reforms have reduced some of the road-blocks to greater efficiency and broad forward aspects of this adjustment process. In the absence of these initiatives there would be more impediments and fewer signals driving farmers to improve their productivity and inevitably more long terms risks to the competitiveness of irrigation farming.

- The extent to which smaller irrigation communities can be more resilient to the inevitabilities of increasing farm productivity depend on the capacity of individual and businesses to find and develop new service opportunities. This is a mix of entrepreneurialism and leadership. Arguably, a way forward in the same manner of farm preparedness is to address gaps in knowledge and skills to plan and prepare these businesses and communities for risks and opportunities.

6. What does all this tell us about lagged effects of past reforms and known reforms to be implemented?

In this section, we build on the evidence base and discussion in the previous three chapters to develop some key messages about the future and lagged impacts. We focus on points in economic understanding that have forward looking implications for future reforms, and economic and social impacts in Basin communities. Some of the key remaining Basin water reforms are mapped out in Figure 3.

6.1 Future water recovery will probably cost more than budgeted.

The Commonwealth Government's $1.5 billion allocation through the Environment Special Account (WESA) for efficiency measures that contribute to the additional 450 GL of water recovery (upwater) is a key future reform.

The history of Basin reform shows that this environmental water recovery will probably cost more than what the Commonwealth has budgeted. The Productivity Commission estimates that (assuming current entitlement prices hold) recovering 450 GL at a market multiple of 1.75 would cost about $2.2 billion. This will exceed the funding available in the WESA for water recovery by about $660 million.

Across the Basin, most of the easier, more cost-effective and lower risk options for recovery have been exhausted [22]. There is opposition to further on-farm water efficiency measures [23] and Victoria has said it will not pursue further on-farm measures because of their perceived negative economic impact [22].

However, off-farm water recovery has been more expensive than on-farm recovery in the Basin, on average [10]. Compounding this, the socioeconomic neutrality conditions agreed to for the 450 GL of recovery impose constraints on choice of investments that will also

drive up the costs of any further environmental water recovery. It will also limit adjustment options for irrigators and irrigator communities by unnecessarily taking options for water recovery off the table.

There is one case where future water recovery may not cost more than budgeted. If enough progress has not been made on up-water and down-water by 2024, then there may be pressure on Parliament to get both through buyback.

6.2 Economic impacts will be different to what much of the commissioned economic modelling suggests.

We have shown in this literature review that the impacts of Basin water reforms, and environmental water recovery in particular, are complex. None of the commissioned economic evaluations discussed in this literature review accurately captures all of this complexity. This is because economic models are simplifications of complex systems. Because the future is not known with certainty, models cannot reflect all things.

What is hopefully clear from this literature review is that:

- The negative impacts of Basin water reform are unlikely to be as negative as some of the key commissioned economic studies have suggested. We discuss the reasons for this in Section 4.2. Simply stated, key economic studies that have been relied on for Basin water reform decisions are constructed in ways that overstate the negative economic impacts of environmental water recovery, and understate the positive impacts
- The on-farm productivity benefits of past (and potentially future) on-farm and off-farm infrastructure investments are likely to be smaller than anticipated by commissioned economic modelling in many cases. This outcome unfortunately will continue the long history of optimism bias in water infrastructure projects in Australia. The Productivity Commission documents this history in its recent national water reform review [8].
- The price impacts of infrastructure modernisation, reflected in infrastructure charges and water market prices, will probably be greater than what has been factored into most commissioned economic analyses. Irrigators may be unaware of how these potential price increases will place pressure on farm viability.

The other challenge with socio economic analysis is the tendency to predict a static outcome – or 'new equilibrium'. That there is a defined future form of irrigated farming and communities that will settle and can be predicted. The new reality is that the future form of farms and communities will be dynamic and fluid. There is no new steady state. This has significant implications for irrigation dependent communities.

6.3 Effects of infrastructure upgrades are just beginning to reveal themselves. It will take time for these to pass through regional communities. Lagged impacts will be mixed for irrigators and communities.

We have discussed in this paper that infrastructure upgrades were promoted as being neutral or slightly positive in their effects. The reality is that the what, how, and where of infrastructure upgrades in the Basin is having a large effect on the underlying competitiveness of farm businesses now and going forward. We have discussed in this literature review that these effects have begun to reveal themselves, particularly through things like water markets. These competitiveness impacts will continue to reveal themselves in the coming years.

We have discussed in this paper how off- and on-farm infrastructure investments have been rolled out differently across districts. The differences in how infrastructure has been rolled out will have lagged impacts for regions and regional communities.

For example, the NVIRP connections project was meant to significantly reduce the footprint of the GMID, thereby lowering future water charges and driving substantial on-farm productivity gains. Neither of these outcomes have occurred. This has created:

- A footprint of gifted capital that will soon require increasing costs of maintenance and renewal. This large bow wave of significant increases in water charges is prospective unless substantial resetting of cost recovery arrangements and investment occurs. We note that the Victorian government's delivery charge review [44] makes good recommendations for how water reform policy innovations like seasonal delivery charges, limited term contracts and delivery share markets could help address lagged irrigation infrastructure financial viability and pricing risks.
- Relatively less competitive farm businesses in some specific sectors. For example, dairy farm systems have a range of underlying factors (limits to herd management and milk harvesting and the increased complexity of management of large herds) that limit the capacity of those farms to capture labour saving and economies of scale from on-farm water infrastructure upgrades. The lagged impacts of these competitive disadvantages compared to other sectors are now being seen.

In comparison, in the Murrumbidgee off-farm infrastructure was implemented more incrementally and in a more fit for purpose manner. As a result, the irrigation infrastructure upgrades are better aligned to on-farm labour savings (e.g. through things like borderless check irrigation).

These changes are resulting in substantial improvements in broadacre irrigated cropping economies of scale and scope in MIA. These gains have meant that the area under renewed irrigation infrastructure has expanded. Farmers in the Murrumbidgee have capitalised on the relatively higher prices paid for infrastructure versus buyback. They have 'banked' the productivity gain and purchased water to offset the savings exchanged for the upgrade and expand their area under crop.

All other things constant, the lagged impacts across these two regions will probably include:

- A relative decline in the competitive position of the GMID and MI relative to the MIA over the next decade
- A net trade of water from those not upgrading infrastructure to those that have upgraded infrastructure (irrespective of the system)
- A net trade of water from the Murray to the Murrumbidgee system

These outcomes will emerge slowly through indirect economic effects in the agricultural value chain and regional communities. The changes were predicted to some extent by economists, but they were not explained to affected communities as opportunities and risks. The lagged effects will create substantial emerging third party impacts within some and across some communities. The impacts will be deep and lasting and will lead to different drought outcomes in the future to those of the past.

In the foreseeable future there is a structural adjustment lag still to wash through local economies. In the same manner as drought, these changes do not fully play out during drought but rather carry on for many years afterwards. These adjustments facilitated by the water market, will be driven by geographical differences in how water has been recovered by the Basin Plan.

6.4 Water prices will increase with additional recovery. Irrigators need to price this into their future.

Removing more water from the consumptive pool will increase water prices, particularly during dry and very dry periods.

We have discussed in this literature review that there is a gap in knowledge around what the price impacts will look like, and the timeframe that price impacts will happen. In part this will depend on the speed of water recovery, where recovery occurs, the type of entitlements that are recovered, and how deliverability constraints are managed, particularly in the southern MDB.

Work commissioned by the Victorian Government has estimated that a further 450 GL of water recovery through on-farm WUE programs with entitlement transfer could result in allocation prices rising by around $13 ML during normal years in northern Victoria. During dry years allocation prices would increase more, by around $18 ML [45].

6.5 Irrigators need to be willing to pay for future price increases and accept the risks.

The impacts of water reforms to date, and the potential lagged impacts discussed above shows that irrigators need to be made aware of future risks of irrigation infrastructure upgrades on water prices and infrastructure charges. We are aware that many irrigators and people living in irrigation communities are not aware of what these future price impacts look like.

One of the reasons irrigators and irrigation communities are not aware of the potential implications for future infrastructure charges is because this information on the lagged impacts of gifted assets is not available beyond the current regulatory price period, where the lagged impact of gifting is only reflected in differences in operating costs.

Our view is that IIOs should be communicating best case, worst case and likely case price paths for the next 10 years at least, and preferably 20 years. Without this price information, irrigators are being made to make choices and take on risk without having the information they need to make informed decisions. This means we are risking stranded assets and overcapitalisation.

6.6 All water recovery options should be on the table, because they can deliver better outcomes for Basin irrigators, IIOs, and communities.

We discussed in Section 4.1 that Basin State signatories to the 2004 NWI agreed to a specific Government role in Basin water reforms that involved considering all available options for water recovery. These options included (but were not limited to) investment in more efficient water infrastructure; purchase of water on the market, by tender or other market based mechanisms; investment in more efficient water management practices, including measurement; and investment in behavioural change.

Our view is that the evidence base in this literature review suggests that all of these options should be on the table, and all of these options should remain on the table for water recovery going forward. This is because the evidence base suggests combining on-farm, off-farm and buybacks can probably deliver better long-run outcomes for irrigators, IIOs and communities than options that preclude one or more of these options.

Currently, up-water recovery options have been constrained, based on incomplete evidence. Victoria will not allow up-water recovery through on-farm investment, in some cases. South Australia agreed to a provision that bars voluntary buybacks of irrigation water licences to boost environmental flows unless a “robust” assessment of socio-economic factors demonstrates it would have a neutral or positive impact on socio-economic factors. Because Victoria and NSW will review all water recovery investments before they go to the Commonwealth, we see this as code from Victoria and NSW that buybacks are off the table.

6.7 Risk and uncertainty is the new norm. Focus on preparedness.

Intervening in farm production decisions in the ways we have discussed in this literature review tends to have some foreseen and many unforeseen outcomes. These outcomes can have undesirable flow on consequences that are counterproductive and misalign with other objectives of water reform.

There is a growing recognition in the literature that the Basin Plan has increased risk and uncertainty for irrigators and community. We have discussed much of this literature in this review. The increased risk and uncertainty means that future shocks in the Basin, such as an extended drought, will have differing place-based impacts than those previously experienced.

These outcomes will be difficult to predict. In a world of increased uncertainty the most appropriate responses are:

- Don’t predict but instead prepare for a range of plausible scenarios.
- Enable those best placed to manage the risks to be able to do so.

This starts with the farm business and improving preparedness. Here, the learnings of the WA drought Pilot and the insights of the Australian Farm Institute are instructive. The most useful approach to beginning the journey of farm preparedness is to improve farm planning literacy and management skills. Improving farm planning literacy and management involves empowering farmers to develop the skills and make their own farm plans. Arguably, this planning, literacy and management could be extended to local community businesses servicing those farms.

While there are gaps in farm planning skills and literacy there are also gaps in information about the likely response of input costs going forward, this includes

- Limited sophistication in understanding some of the new dynamic driving water markets.
- Likely price trajectories over the longer term for water infrastructure.
- Likely future water reliability and regional water availability as water saving investments mature.

6.8 There are potentially better ways to support regional adjustment than infrastructure subsidies.

We have kept what is probably one of the more controversial points for the Panel until the end of this literature review. A key lesson from the literature review for lagged effects and known reforms to be implemented is that there are clearly potentially better ways to support regional adjustment to water reforms than on-farm and off-farm infrastructure subsidies alone.

There is an opportunity to learn from the past and to get better outcomes from what remains of Basin water reform, and supporting structural adjustment policy and investment. For example compared to irrigation infrastructure investment, economic modelling demonstrates that investments in health and / or education services could lead to 3-4 times more permanent jobs being created in regional communities than spending the same on irrigation infrastructure [41].

An important lesson out of the literature and analysis is that the tail should not wag the dog. Ultimately, the form and shape of local off-farm communities dependent on irrigated agriculture will be a mirror of the form and shape of the farm businesses that remain and thrive. It is important that policies and interventions are not focussed on farm businesses alone in order to achieve a predetermined outcome for local off-farm communities. There are substantial risks of using single instruments, such as infrastructure investment, to achieve multiple policy objectives. A broader and deeper suite of policy levers need to be used to deliver best outcomes for regional communities.

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