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Basin Plan Socio-economic impacts NSW Murray Valley

Stage One

Murray Group

2 June 2017

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Contents

1 Murray Valley irrigation challenges

1.1 NSW Murray Valley

The NSW Murray Valley is a highly productive farming region within the Murray Darling Basin. Irrigated production focusses on annual summer crops such as rice, and on winter cereals. There is also extensive irrigated pasture for dairy and livestock, with more limited production of high value horticulture such as nut crops and wine-growing.

In an average to wet season, about 1,600GL of water has traditionally been used within the region, the large majority being sourced from NSW General Security entitlements. Murray Irrigation is by far the largest grouping whose usage can be above 1,000GL, (diversions of 1,900GL in 1991/92) with other shared schemes using a further 250GL. Individual private diverters are a small proportion of the total usage at around 60GL/yr. The environmental water holders now command around 450GL/yr of entitlements, dominated by NSW General Security Entitlements.

The NSW Murray region experienced severe impacts from the extended drought from 2002-2009, farm-business restructuring and a reduction in the volume of water allocated to production as a result of the Murray-Darling Basin Plan. Taken together these have resulted in a reduction in the level of irrigated production in the region. That in turn has led to impacts on social issues such as jobs and the viability of smaller towns. The community is concerned about the effect of the impacts to-date and on proposals to further extend the purchase of water for the environment. This study was commissioned by the Murray Group to review the trends and changes over time and to assess how far those changes can be attributed to the different factors.

The study builds on significant previous modelling and analysis completed by RMCG on the impact of the Basin Plan on irrigated production across northern Victoria, undertaken for the GMID Water Leadership Forum.[1] That report identified a substantial impact from the introduction of the Basin Plan to date and flagged the adverse socio-economic implications of the proposal to seek a further 450GL through the Upwater program.

1.2 The Murray Group

The Murray Group consists of members from four major regional irrigation groupings:

- Murray Irrigation Ltd
- Murray Valley Private Diverters[2]
- Southern Riverina Irrigators
- West Corurgan Irrigation

While retaining the independence of each organisation, regular meetings promote communication and collaboration on specific issues relating to water availability and water security in the Murray Valley. The aim of this study is to develop robust and convincing evidence to support the Murray Group's continuing role in the national water debate to protect and enhance the interests of the Murray Valley regional community.

[1] RMCG (2016), *Basin Plan - GMID socio-economic impact assessment*
[2] Murray Valley Private Diverters represents the interests of a range of irrigators within the valley including a number of members of the Wakool Landholder Association, Wakool System Advisory Committee, Bullatale Creek Landholders Group, Bullatale Creek Trust, the Lower Edward R. Pumpers and Landholders, and the Colligen/ Niemur Landholders, Merran Creek Trust, Wakool River Association, Colligen Creek Landholders, Eagle Creek Pumping Syndicate (Inc), Bringan Irrigation Trust and Edward River Pumpers

1.3 Study scope and objectives

The study is being implemented as four sequential stages:

1. Analysis of the impacts on irrigation production within the valley
2. Analysis of broader and flow-on impacts for the regional economy, ie impacts on service sectors and downstream processing, riparian regions, additional industry impacts
3. Analysis of the implications for the business viability of Murray Irrigation Limited

This report covers the first part of the study and so the scope is to assess the impact of the Basin Plan on irrigated production within the valley. The project covers:

- Irrigated production in the NSW Murray Valley, stretching from Yarrawonga to the Wakool junction
- Irrigators serviced by Murray Irrigation Limited, other smaller irrigation trusts and private diverters
- All irrigated sectors, ie: rice, other irrigated crops such as winter crops, cotton, dairy and horticulture

The study focuses on the level of water use availability and levels of production by sector. It has two main parts:

- Impact of the Basin Plan and other factors to-date. This includes:
  - An analysis of historical trends in production over time across the region and identification of drivers for change in production by sector since 2001
  - An assessment of how the dynamic equilibrium across the southern connected basin now results in different water use by sector dependent on the climate scenario
  - An assessment of the significance of the Basin Plan on levels of production since 2010, both by reducing the total volume of the consumptive pool and through impacts on prices in the water market
- Looking forward. This assesses the projected impact of possible future policies such as an extension of the water recovery program to include 450GL of Upwater.

1.4 Methodological issues

The Basin Plan established Sustainable Diversion Limits (SDLs) that determine the size of the allowable consumptive pool. The Plan involves transferring some 2,750GL from production to the environment, with 2,289GL being recovered from the southern connected basin. This study reviews longer-term trends and wider factors to determine what impact that transfer has had on the productive capacity of the region.

Assessing the relative significance of different factors on productive capacity involves a rigorous and explicit analytical framework. This study is based on a number of key methodological assumptions:

- The level of water use across the SCB varies by season depending on the climate scenario as this determines the total water available for consumptive use.
- Water trading is now effective across the southern connected basin. The price in the market for annual allocation in all three states is driven largely by the announced level of NSW General Security allocation in any season
- The water market then leads to a sharing of the available resource in any season between sectors, dependent on the price of the water and the sector's willingness to pay to achieve a desired level of security given the relative return available from production
- Transferring water from productive irrigation to the environment impacts both on the individual irrigator and third parties:
  - A reduction in the size of the consumptive pool has led to a reduction in the total size of irrigated production - despite enhanced levels of productivity per ML used.

- The reduction in the size of the consumptive pool as a result of the Basin Plan has also led to an increase in the price of water in the market. This issue is particularly acute within irrigation communities with shared supply infrastructure.
- Many of the irrigators who sold water during the 2002-2009 drought period did so to repay debt and refinance business operations. Many of them are therefore now exposed to greater risk as they are reliant on accessing the annual water market where they are often exposed to higher prices
- Most irrigators purchase high value business inputs from the local community. For example, the dairy sector spends an average of $3,000/ha/yr on buying services, whereas a dryland property will only spend $600/ha/yr. So a 150ha, 300 cow dairy that sells 900ML, and becomes a small-scale cropping enterprise, will reduce its annual spend in the local community by $400,000.
- Irrigated sectors generate products that support high value processing sectors- and the processing generally occurs within the irrigation area. This is true of rice, milk, horticulture as well as cotton and several irrigated summer grain & legume crops.
- Most NSW Murray and Murrumbidgee irrigated sectors depend on large-scale irrigation corporations to manage the delivery of water to the individual property. A significant reduction in the scale of water in use in an irrigation area or sub-area (district) can undermine the viability of those corporations. This is particularly the case when the water-use reduction is based on a market-based solution, not developed as part of a strategic or targeted approach to reducing water-use.
- All sectors (irrigators, processing, transport and so on) then support a wider social and economic framework of towns, services and businesses - whether in retail, accommodation or schools, health clinics or council services.

Any assessment of the impact of the Basin Plan has to assess the full spectrum of these impacts at a regional scale taking account of all players not just at the level of the individual farm enterprise.

The study also reviews future reforms:

- There is a possibility that the 650GL of SDL offsets will not be met, and there will be more buyback/farm efficiency initiatives needed to meet the agreed 2,750GL target.
- The proposed 450GL Upwater initiative has a requirement for there to be no net socio-economic impact. Under the current neutrality test, if farmers apply voluntarily agree to take part in the on-farm efficiency initiatives then the recovery-method passes the test.

This study addresses each of these issues.

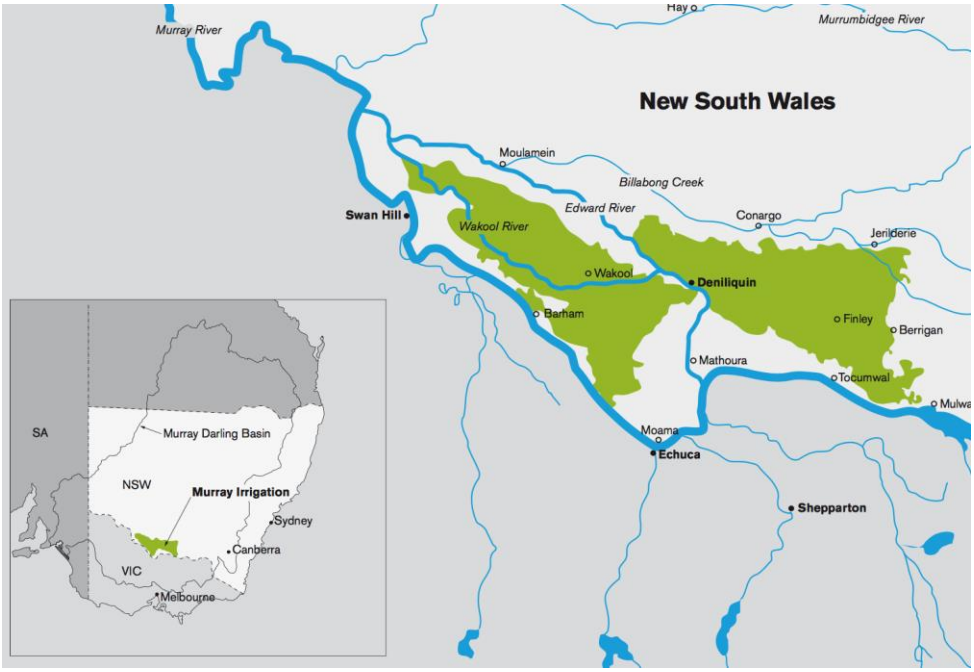
2 Southern Catchment story

2.1 NSW Murray is part of the southern connected basin

The NSW Murray region is located within the 'southern connected basin' of the Murray Darling Basin region. There are many different agricultural industries suited to the climate and soils of the broader southern connected basin region including horticulture, rice production and pasture (particularly for dairy production). Irrigated production is constrained by the limited supply of water as there is only enough water to irrigate a fraction of the irrigable land within this broader area. Apart from a small number of nominated Irrigation *Areas*, the large NSW irrigation Areas and Districts were initially dominated by 'Districts'. Within irrigation and water supply districts the focus was on securing water for households and livestock.

The focus in most water supply systems was on maximising the number of properties with access to stock water. As a result, only a proportion of the total farm area serviced by Irrigation-district supply schemes were irrigated - even in seasons of plentiful irrigation water availability. The Murray irrigation Areas and Districts constructed between 1932 and 1965 comprise 3,300km of channels servicing 2,390 landholdings over 740,000ha between the Murray River and the Billabong Creek. The scheme originally supplied 1,200GL in a season of 100% announced allocation and usage. Even at this 100% level of availability the total irrigation water supplied averaged less than 2ML/Ha. This is well below summer crop demand of 10ML/Ha, or even winter crop/winter pasture demand of 3-5ML/ha. As a result, for most of the 2,390 landholdings, irrigation water in the NSW Murray Areas and Districts was usually applied to significantly less than half the property area.

Figure 2-1: Southern NSW highlighting the Murray Irrigation Ltd area of operations[3]



Prior to 1985, there was little connectivity between irrigation regions within and between states. Water was allocated to specific parcels of land, which limited the development of irrigated agriculture to certain regional areas, and, by default, to certain agricultural industries. In addition, specific limitations were placed on land-use in some regions, e.g. to prohibit permanent plantings within Murray Irrigation, and to limit the area each land owner was permitted to plant for rice production each year. Water trading between farms or locations

[3] Source Murray Irrigation Ltd annual report

was not permitted. Each regional area, even within larger Irrigation *Area and Districts* acted independently. Therefore, irrigation activity within the NSW Murray *Areas and Districts* was disconnected from the rest of the southern connected basin.

This disaggregated irrigation framework continued until the level of development led to irrigators with highly developed farms seeking to expand production by simply securing more water. In addition, the new higher levels of water demand and the level of water use was deemed by a number of key environmental agencies to be in excess of what the environment could sustain. Two developments drove change in irrigation activity: one was the progressive introduction of water trading from the early 1980s and the other was the imposition of a 'cap' on total diversions in mid 1995, based on the 1993/4 levels of diversion. Water trading has expanded so that the SCB is now effectively a single integrated market in most years. Individual irrigators, sectors and regions across the SCB compete for the ability to own and use water entitlements and allocations.

2.2 A changing water regime

Water management across the MDB has seen ongoing change since before Federation, when the Chaffey brothers were sponsored by the Victorian and South Australian Governments to develop large-scale irrigation in Mildura and Renmark in the late 19th century.

This section confirms some of the key elements of that changing water management regime:

- Significant growth in diversions for irrigation up until 1995
- Development of sectors (particularly rice-growing) that could absorb the rapidly growing supply of irrigation-water available
- A series of water reform policies implemented to establish a sustainable balance between environmental flows and production, including:
  - The Cap on diversions in 1995
  - The Establishment of the NSW Murray Irrigation Corporations (based in Deniliquin and Dareton NSW) as private large-scale diverters with a single bulk-licence and defined conveyance allowances.
  - The NSW Water Act and the Water Sharing Plans, which for the first time, prescribed water to be set aside for Environmental benefits.
  - The Living Murray (2002) - the first significant water recovery initiative seeking to recover 450GL over 5 years, for environmental needs
  - The Water for Rivers program established in 2003 to recover water for the Snowy River and the Murray (70GL)
  - The National Water Initiative (NWI) in 2003
  - The Basin Plan, conceived in November 2007 by the Prime Minister John Howard and adopted by the Federal and State Parliaments in 2012, and
  - The final iteration of the MDB Plan, sustainable diversion limits (SDLs) to apply from 2019.

The other critical policy reform over this period was the staged introduction of inter-state water-trading and the progressive introduction of individual rights for the carryover of unused allocation volumes. In the NSW Murray Valley this involved a number of steps:[4]

- 1985-7: Introduction of temporary water trading recognising the growing demand (first raised by Tullakool landowners as early as 1938)

[4] NSW DPI office of Water (2012), *Water reform in the NSW Murray-Darling Basin – summary of regional water reform and environmental water recovery in NSW 1996-2011.*

- 1988: Phasing out of area-licences along the Murray for licensed diverters (pumpers) and the progressive introduction of water meters and volumetric allocations for these users.
- 1988: Phasing out of individual NSW farm-business licensed rice areas. i.e. the limits on maximum allowable areas of rice grown were lifted. Rice growing commences outside irrigation Areas and Districts
- 1991: Introduction of permanent water-entitlement trading between land-owners, but only within Irrigation Areas and Districts
- 1993/1997: First E-water allocation account created when NSW and Victoria established a rules-based water account of up to 150,000ML/yr for the Barmah-Milawa forest. This was formalised as the Barmah-Millewa Environmental Water Allocation and is now incorporated into the 2004 Water Sharing Plan for the *NSW Murray and Lower Darling Regulated Rivers*
- 1995: Privatisation of Murray Irrigation Ltd (MIL) and creation of Bulk Entitlements for Irrigation Areas and Districts, including a specific conveyance allowance. The M&A for the new company limits the transfer of entitlements from each property within and outside of MIL
- 1995: First held E-water account (30,000ML) created from NSW Murray Irrigation Limited water savings, and vested in NSW Murray Wetland Working Group.
- 1998: Pilot program for annual and permanent inter-state water trading.
- 2002-2012: Water-for-Rivers established to secure water recovery of more than 300GL for Snowy River and 70GL for Murray River E-flows commences.
- 2001: NSW Water Act replaces 1912 act.
- 2004: NSW Murray and Murrumbidgee Water Sharing Plans Gazetted – formalises the unbundling of Water Rights from land. NSW introduces Carry-over for all GS water holders (50% maximum in NSW Murray)
- 2007-09: ACCC moves to remove all restrictions on right to sell or purchase allocation from former NSW Irrigation areas and districts. Introduction of water as an independent asset, able to be owned without irrigable farmland. Delivery shares (tied to irrigable farm land) introduced to replace former fixed charges for water, and termination-fees confirmed to recognise the diminished capacity of infrastructure providers to deal with stranded assets.

The outcome has been to promote the development of a highly effective trading market both within the NSW Murray and inter-state that creates high levels of competition for the right to use the available allocations in any system in any season, although there are still some physical restrictions on water movement around the Barmah choke and out of the Murrumbidgee and Goulburn River systems into the main-stem of the Murray.

2.3 Framework - concepts and assumptions.

This report is based on a strong analytical framework under-pinned by robust and comprehensive data. It also relies on a number of critical assumptions that establish the rationale for the analysis and conclusions reached.

2.3.1 Climate variability - water allocation availability and price

A key part of the analysis is the recognition of the high variability between seasons in the volume of water that is available for consumptive use. Many studies and policy positions rely on looking at average allocations across seasons, defined in terms of Long-term Annual Average Yield (LTAAY). This approach does not take account of the variability in the volume of available water between seasons and the dynamic this drives in terms of water use by sector and the impact on market price.

As a result, this study clearly identifies the water available to be used in different seasons and under different climate scenarios, as outlined below. Importantly this study uses the water availability experienced between 1996 and 2016 as the basis for projections as to future water availability (and price). This includes the prolonged drought period, and related water shortages experienced between 2002 and 2009.

Table 2-1: Likely water use and price under different seasonal conditions - SCB (source RMCG)

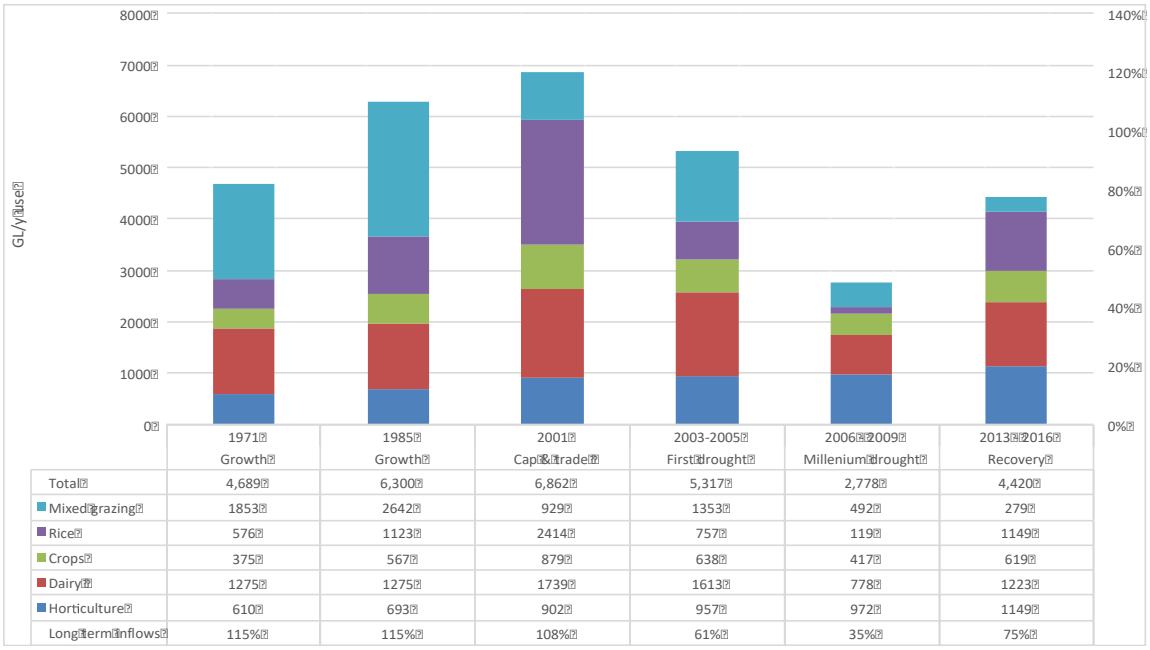
Scenario	Allocation level	Frequency (over 20 yrs)	Total water used (GL)*	Price ($/ML)
Wet	Victorian Low security water available	3	5,800	50
Medium – wet	95% NSW General Security	5	5,200	80
Average	55% NSW General Security	5	4,500	130
Medium - dry	20% NSW General Security	5	3,700	225
Drought	80% NSW and 50% Vic high security only	2	2,300	575

* includes 500GL groundwater

2.3.2 History and drivers of water use

The history of irrigated agriculture across the southern connected basin (SCB) falls into a number of broad time periods.

Figure 2-2: Water use by sector over time - Southern Connected Basin- key products only



- **1970 - 1985: Dams and growth:** This was an early development phase, with growth in supply and use supported by the construction of storages and the issuing of new entitlements. There was unconstrained growth in all sectors with little effective competition for that water. The initial aim of using the new storages to drought-proof south east Australia was abandoned in favour of a focus on irrigated crops that would use water in all years. The Victorian dairy and NSW rice industries emerged to replace mixed farmers (irrigated cereals and annual pasture for meat & wool producing livestock) as the major water-users during this period.

- **1986 - 2001: Cap and trade:** This period saw the removal of limits on water use for some crop-types in NSW, the widespread introduction of water trading and the imposition of the Cap on total diversions (limiting maximum allocations). These factors created competition for the available water and drove water use to higher values.
- **2003 - 2010: Drought and buyback:** This was an eight year period of shocks with severe drought, combined with the buyback of entitlements and the impact of adverse commodity price cycles. It had two phases: a dry period from 2002 to 2006 and then a drought of record from 2007 to 2010. In NSW, NSW Water Sharing Plans were suspended for some years, 50% of water allocated in the 2006/7 year had to be clawed back by Government mid-season to avoid allocation-failure. For the first time since opening the scheme in 1932, some areas of Murray irrigation were not supplied during the 2006/7 water year.
- **2012 - 2016: Recovery:** This period has seen a staged recovery from the drought years with some restoration of production volumes but at a lower overall level than previously, due to a continuing period of lower spring-inflows, increased volumes of private carry-over of unused balances and the buyback of water for environmental initiatives.

2.4 A dynamic equilibrium

The variability of rainfall across the SCB between years means that the level of allocation between seasons is also highly variable. The market price for the allocation in any season varies to reflect its relative scarcity. A 'dynamic equilibrium' has therefore become established between different sectors that access differing proportions of the water available in any season, determined by their willingness to pay and their ability to manage with differing levels of water security:

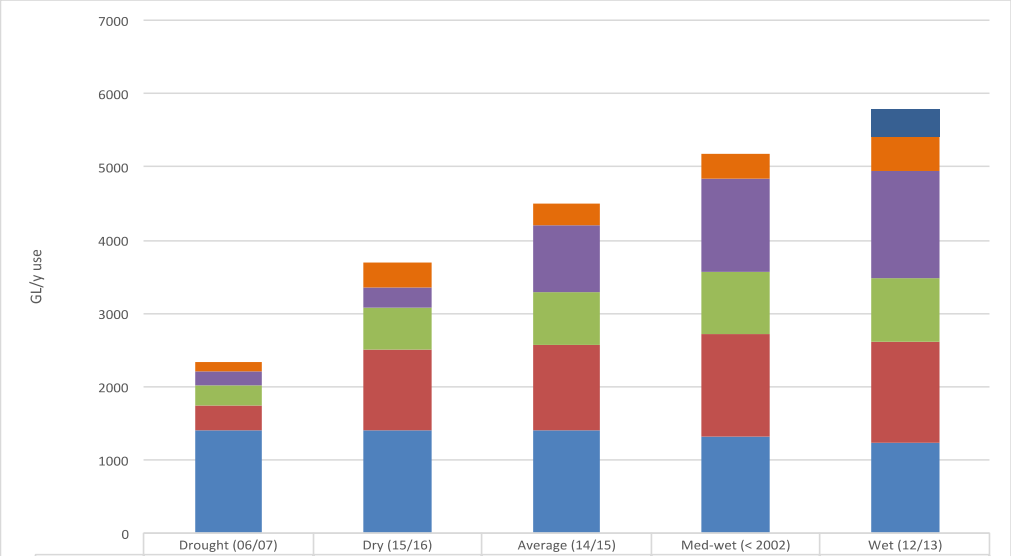
- **Horticulture:** has high willingness-to-pay to access water but requires guaranteed water in each season because of its permanent plantings. It will buy water in most years but the total area planted and the total water commanded by horticulture will be constrained to the total volume of allocation available in a drought year
- **Dairy:** buys water in most years from lower return sectors. It is able to manage with a medium high degree of security as it can substitute bought-in feed for water when prices rise. However, this flexibility is limited and the overall level of production will be constrained to the net volume that is available in “Medium” and “Medium-dry” years after horticultural demand is satisfied. Only in drought scenarios will the dairy sector sell to horticulture
- **Annual crops- particularly rice:** a variety of different annual crops (rice, cotton etc.) are able to manage with a lower level of water security as they can vary the area planted each season to match the available water. They will maximise production in average or wet seasons. In drier seasons they will sell their allocation rather than plant crops themselves. Although more expensive to grow than other summer crops, cotton generates a higher return per Ha than most irrigated annual crops. Cotton also requires a medium security water product as many growers enter into future-year supply contracts. Most NSW Murray summer crop irrigators are also mixed farmers, with the capacity to boost production by irrigating both winter cereals and pastures for livestock.
- **Mixed:** these are opportunistic water holdings for lifestyle or dryland properties and were once the cornerstone of irrigation districts. The sector will sell allocations in most years but use that water when allocations are high and prices low, to produce feed or hay for sale or for their own use. The sector has low willingness-to-pay but high flexibility. Many in this sector are supported by off-farm income and represent last generation ‘legacy’ properties.
- **Carryover:** all sectors will carryover allocation in wet years to boost security in the following seasons. Following the experience of the severe drought years, the practice of carrying over water is now part of planning for most irrigation businesses. This has effectively taken some water out of annual irrigation. Even in drought years volumes carried-over into the future season seem to remain constant.

This dynamic equilibrium drives the distribution of available water between sectors depending on the climate scenario. Figure 2-4 below makes projections for probable future sharing of water between sectors under those different climate scenarios. The five climate scenarios are based on the series of recent seasons that fall neatly into the different categories but with the drought scenario based on the 2006/07 season. In each case, the values represent the volumes used, but subtracting the volume of entitlements now held by the Commonwealth.

Under this model, horticulture shows stable demand irrespective of climate, dairy demonstrates greater vulnerability to drought but a major presence, while annual crops, especially rice, are highly variable between years in response to the level of allocation and the price on the water market. Under very wet scenarios all sectors carry-over allocation to increase the security of supply for following seasons.

This analytical framework informs the modelling for this study. It also explains why any reduction in available water impacts across a range of sectors.

Figure 2-3: Water use between sectors by climate scenario - SCB (RMCG)



	Drought (06/07)	Dry (15/16)	Average (14/15)	Med-wet (< 2002)	Wet (12/13)
Total	2,328	3,700	4,507	5,186	5,800
Carryover					400
Mixed grazing	116	352	316	346	460
Rice	186	279	901	1,268	1,468
Crops	279	558	721	864	864
Dairy	349	1,113	1,172	1,383	1,383
Horticulture	1,397	1,397	1,397	1,325	1,225

This suggests that there are, in effect, three main different water use patterns in the SCB:

- **A very high security water use pattern**: this is for permanent plantings that need water every year. This applies predominantly to the horticultural sector. The volume that is available in drought/dry years will define the total size that the horticultural sector can grow to across the SCB, when the market price will be around $575/ML. This is estimated at around 1,400GL once other sectors maintain a minimum presence.
- **A medium to high security water use pattern**: with a likely net total volume of around 1,100GL after the very high security need has been met, and a price of up to $225/ML. This is used mainly by the dairy sector. The volume available in a dry sequence defines the scale of the dairy sector.
- **A low security water use pattern:** with a large volume of up to 2,500GL, generally at a price of less than $100/ML, but only available in half of the years, ie. in wet conditions. This is accessed by annual cropping sectors.

This creates an effective hierarchy of users, with lower-value sectors preferentially selling their allocations to other sectors with higher willingness to pay for water. However, this does not lead to a single irrigated monoculture across the SCB as the variability of inflows between years limits the growth of higher value sectors to the volumes available in drier seasons, as they have a high reliance on the relative security of that water. This then provides an opportunity for other sectors to utilise the additional allocation available in wetter scenarios. That creates the proposed dynamic equilibrium with the mix of sectors that have differing ability to take advantage of differing levels of security for their water requirements.

3 Murray Valley

3.1 NSW Murray Entitlements

The NSW Murray Valley is a highly productive farming region within the Murray Darling Basin. Irrigated production focusses on annual summer crops such as rice, and on winter cereals. There is also extensive irrigated pasture for dairy and livestock, with more limited production of high value horticulture such as citrus, nut crops and wine-growing.

A significant volume of water entitlement is held in the valley, mostly in the form of General Security entitlement. The Murray General Security Entitlements were originally issued as volumetric *water rights* secured through annual base-flows and the water held in Hume Dam. Water rights were issued within the defined gravity-supplied areas and irrigators were usually limited by licenced area, and maximum pump-size not by a volumetric allocation. The number of water entitlements or rights on issue to each irrigator in the NSW Murray increased during the 1960s and 1970s because of a number of civil works constructed to secure more water storage. These works included increasing the capacity of Hume Dam (completed 1961), the construction of Dartmouth Dam (1979) and the inclusion of almost 500GL net annually into the Murray system from the Snowy Scheme (1974). The importance of these extra works, combined with a period of above-average annual rainfall from 1950-1999 led to significant irrigation development and increases in irrigation production throughout the NSW Murray Valley.

NSW Murray irrigators share storages (Hume, Dartmouth, Mulwala and Snowy Hydro Murray Storages) and stream-flows with Victorians for most key tributaries- with the notable exceptions of the Murrumbidgee (NSW) and the Goulburn (Vic), the Ovens (Vic), the Loddon (Vic) and the Broken River (Vic). The sharing of flows and even storage-space has proved problematic during some periods with Victorians often seeking to utilise NSW Dam storage space during periods when Victoria has more water stored. NSW irrigators with General Security Entitlements believe that several of the NSW Government initiatives and even the development of the NSW Murray and Lower Darling Water Sharing Plan (2004) have led to water reductions that have been disproportionately borne by a reduction in security and yield for NSW General Security Entitlement holders. The total volume held in the NSW Murray compares with the other major irrigation valleys in the SCB.

Table 3-1: High Security and General Security Entitlements held in southern connected basin (ML)

	NSW Murray	NSW M'bidgee	Vic Murray	Vic Goulburn	SA Class 3A	Totals
High Sec (NSW)	187,595	358,511			544,018	1,090,124
HRWS (Vic)			1,186,000	892,000		2,078,000
Gen Sec (NSW)	1,672,367	1,891,890				3,564,257
LRWS (Vic)			289,000	396,412		685,412

In an average to wet season, almost 1,800 GL of water is used within the region, the large majority being sourced from NSW Murray General Security entitlements.

3.2 NSW Murray water users and entitlements

There is a mix of different water user groups and types along the full length of the NSW Murray:

- 500 licensed private diverters. Smaller, single property, pumped supplies have existed for more than 100 years along the NSW Murray. Typically this group use a small proportion of their available water allocation and often hold the full 50% allowable carry-over at the end of the season.

- Murray Irrigation Ltd is by far the largest grouping, with licence volumes of 845GL General Security, excluding Government accounts. Annual diversions in the past have exceeded 1,200GL. Murray Irrigation supplies over 1,100 farm businesses owning 2,300 landholdings over 724,000 hectares. Traditionally, irrigated production has been dominated by rice, winter cereals and irrigated pasture
- Other smaller groups and trusts including: West Corurgan Private Irrigation District, The Moira Trust, Cadell Trust, Eagle Creek Pumping Syndicate, The Bringan Irrigation Trust, The Merran Creek Trust and a number of others.
- 451GL of the total General Security is now held as environmental entitlement, with 351GL held by the Commonwealth Environmental Water Holder. 451GL represents 27% of the total entitlement.
- This study excludes Western Murray Irrigation as it is based downstream from the Wakool junction.

Table 3-2: General Security entitlement holdings - NSW Murray study area

NSW Murray Water-user	Entitlement type	Volume (GL)
Murray Irrigation Ltd	General Security	845
Other NSW Murray users	General Security	376
Environmental entitlements	General Security	451
Total		1,672

The total water portfolio of the greater NSW southern Murray region also includes:

- 187GL: NSW High Security
- 300GL: Supplementary water use and trade into the region
- 300GL: conveyance allowance for Murray Irrigation Ltd
- The valley also has access to groundwater systems with:
  - A deep aquifer of around 60,000ML usage
  - Shallow groundwater aquifer of around 3,000ML

3.3 Groundwater in the region

Despite quality, cost and yield issues, some groundwater is used in the NSW Murray Valley, mainly within the Murray Irrigation area of operations - all to the East of Wakool. The total annual volumes used are typically low and as most properties with bores also have access to surface water, groundwater use falls dramatically in wetter seasons when surface water is available at a cost less than the combined energy-cost of bore-pumping and annual bore equipment maintenance.

Licensed volumes: Roughly 5-10% of the average MIL usage, around 60,000ML of Lower Murray NSW deep aquifer water and approximately 3,000ML ML shallow aquifer water, mainly within the Murray Irrigation Ltd area of operations.

Shallow aquifer not significant: Shallow aquifer licence water use is not considered significant in the region: the water extractions are typically very low yielding, and subject to failure (both yield and quality) during dry periods. (Note: although there is over 65,000ML of shallow aquifer licences in the NSW Murray, utilisation has historically been poorly monitored, and is likely to be very low)

Water Quality: Water quality of deep groundwater to the west of a line between Moulamein and Moama is of very high EC, and even in the well regarded, and highly extracted, regions around Deniliquin (MIL footprint) the high EC of bore water (c2000-4000Ec) often requires significant shandying with river or channel water to avoid crop-damage and yield losses.

Cost to extract: State charges for bore licences and per ML extractions are low, however capital, energy and maintenance costs are generally high (c $120/ML depending on water depth), relative to surface water, in most years. This leads to irrigators banking groundwater underuse, for use in dryer seasons in accord with flexible-use provisions in the NSW Lower Murray Groundwater sharing plans.

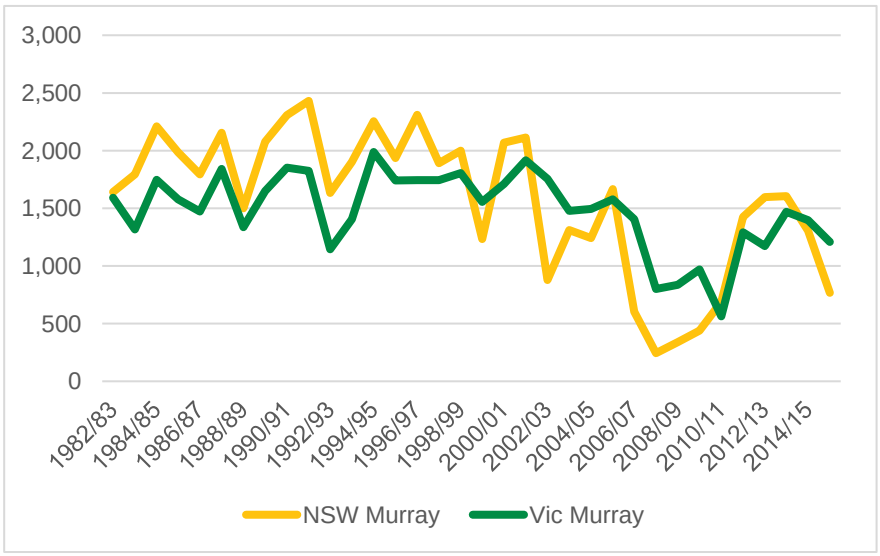
Trade in groundwater: Trade in groundwater is possible under the NSW Lower Murray Groundwater sharing Plan and significant trading does occur. In some other irrigation areas (eg the Lower Lachlan) the rapidly growing number of horticultural users create strong demand and often purchase ground-water annually or even permanently from existing groundwater owners. Only deep groundwater can be traded between users in the NSW Murray, and as the water quality of deep groundwater is highly variable, very few high value horticultural crops have been developed as groundwater-dependent orchards in the NSW Murray Region. In addition, the recognition of a 'hot spot' (and the threat of a hot-spot declaration) characterised by falling ground-water levels as a result of identified over-extraction, in the key groundwater-use area near Deniliquin, has further limited trade of groundwater into the area near Deniliquin.

3.4 NSW Murray diversions over time

Water use in the NSW Murray region has always varied significantly between seasons. This reflects the allocation philosophy which has sought to maximise irrigated production in each season at the risk of greater variability between seasons. In this regard it differs from the approach in Victoria which has been to promote consistent security between years at the potential expense of yield. This is shown in Figure 3-1 below where:

- The difference in allocation philosophy is demonstrated in the greater variability of diversions in NSW when compared with Victoria. NSW delivers a higher yielding General Security product but with higher risk of low allocation.
- In wetter sequences, the Victorian emphasis on security means that Victorian Murray storages have traditionally filled and then spilled into the NSW air-space in the shared-storage. The NSW proportion of total deliveries has declined over time as these internal spills have decreased as seasons have become drier.
- The allocations announced to NSW General Security users prior to the introduction of the cap on extractions were invariably between 85% and 140%. Both the allocation level and usage have been much lower more recently following the droughts, the introduction of the Water Sharing Plan limit on allocations to 100% and the introduction of 50% carry-over in the NSW Murray.

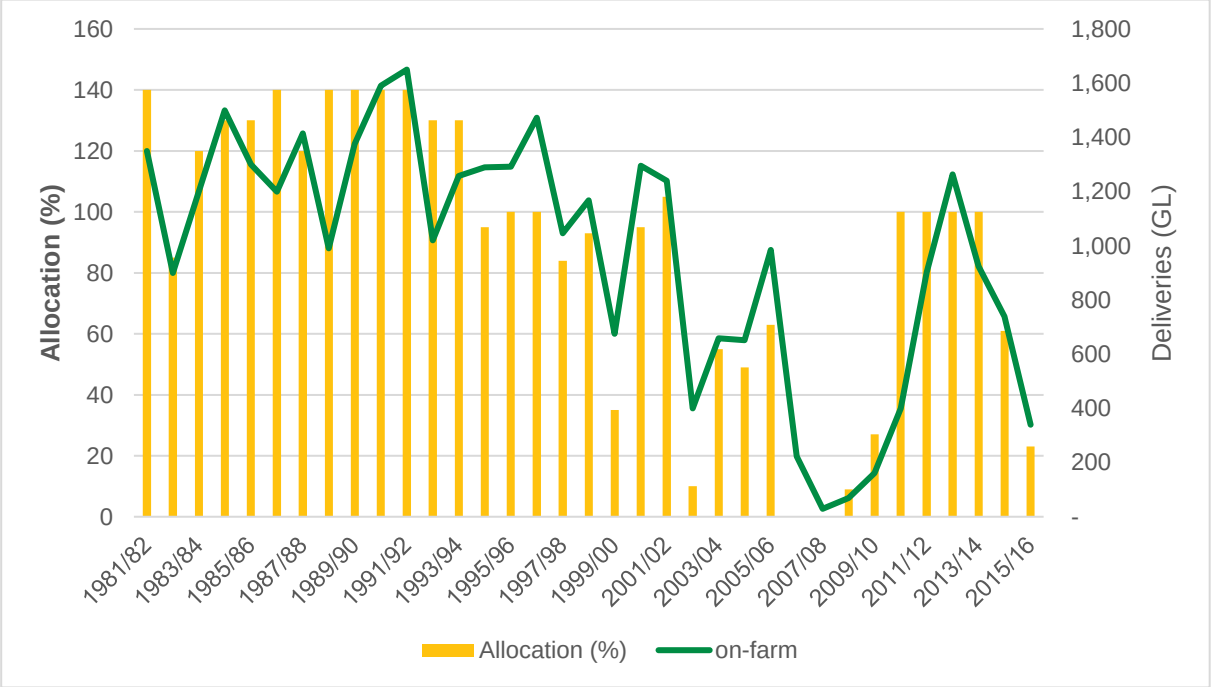
Figure 3-1: NSW and Victorian Murray Diversions 1983 - 2016 (GL)



3.5 Changes in use over time

The graph below shows the changes in deliveries and allocations over the years. This shows the change from a relatively uniform scenario prior to 2001/02, in a wetter climate sequence, to a highly variable scenario since then. It also shows the impact of policy changes in the late 1990s to introduce the cap on extractions and limit allocations to 100%.

Figure 3-2: General Security allocations (%) and use in Murray Irrigation (GL)



Murray Irrigation Limited has changed from a system that delivered, on average, 1,350GL/yr prior to the millennium drought to a system that delivers on average around 750GL/yr. So, in practice, the average level of deliveries has almost halved. The variability between years also appears more extreme.

3.5.1 Likelihood of different scenarios

Section 2.4 confirmed the analytical framework and the importance of assessing current and projected water use against five different climate scenarios rather than by reference to an 'average' climate and water use year. Those five scenarios and their respective reference years are as follows, with recent seasons shown as indicative examples of each scenario:

- Wet (as in 2012/13)
- Medium wet (as in 2013/14)
- Average (as in 2014/15)
- Medium dry (as in 2015/16)
- Very dry/drought (as in 2006/07)

The central judgment is as to the probability of each of these scenarios occurring in the future. The challenge is to decide what past data to refer to in making these projections. The table below gives the likely frequency of the five climate scenarios over a twenty year sequence based on a number of different data sets and projections. The table also identifies recent years that provide examples of each of the scenarios and the outcomes for allocation policy in the NSW Murray:

- LTCE: based on the frequency over the last 100 years - this shows only one drought year and seven very wet years in a twenty year sequence. That would be an optimistic outcome but shows the evidence for previous growth projections
- The last 20 years: a new norm based on the frequency of the scenarios since 1996 - this shows more drought years and fewer wet seasons
- Wet sequence: based on the ten year period from 1996/97 to 2005/06 - this shows a more stable sequence, with most years at an average allocation and no drought years
- Dry sequence: based on the ten year period from 2006/07 to 2015/16 - this shows a more extreme series of outcomes, with both drought and flood evident and fewer average seasons
- Recent: based on the highly variable experience of the last four seasons, 2012/13 to 2015/16 - this shows an equal frequency of each of four of the five scenarios.

Figure 3-3: Frequency of climate scenarios over a twenty year sequence

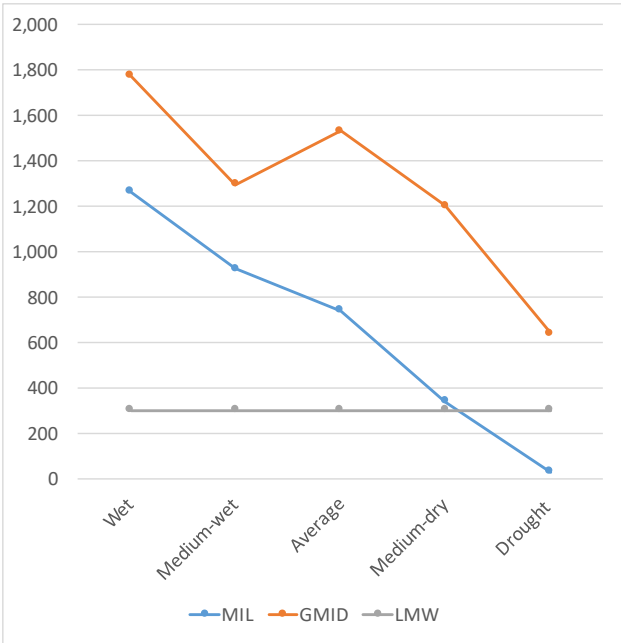
Scenario	Example	Allocation	LTCE	20 yrs	Wet	Dry	Recent
Wet	2012/13	Low security	7	5	4	6	5
Medium-wet	2013/14	95% General security	4	4	6	2	5
Average	2014/15	55% General security	4	5	8	2	5
Medium-dry	2015/16	20% General security	4	3	2	4	5
Drought	2006/07	80% High security	1	3		6	

There is clearly no single 'correct' projection. This study is based on an expectation that future seasons will be closer to the recent years since 2006, with greater variability and so greater frequency of extreme weather events. That makes for a challenging planning horizon.

3.5.2 MIL compared to dairy or horticulture regions

The graph below shows the level of water use within Murray Irrigation under the five projected climate scenarios and is compared with a largely horticultural region, Lower Murray Water (LMW), and a predominantly dairy region, the Victorian GMID. The values are based on each of the four last seasons, which are good examples of the different scenarios and also the drought year in 2006/07.

Figure 3-4: Water use under different scenarios (GL) for three different water corporations



The figure shows the direct and immediate correlation between climate and the level of water use for the region. It also shows how exposed Murray Irrigation is to risk from future drought years due to the high proportion of General Security entitlement held in the district. By contrast, Lower Murray Water, with its focus on high value horticulture is less exposed to variation between seasons. The GMID holds a larger percentage of higher security entitlement and so for any given allocation will retain a larger volume in use.

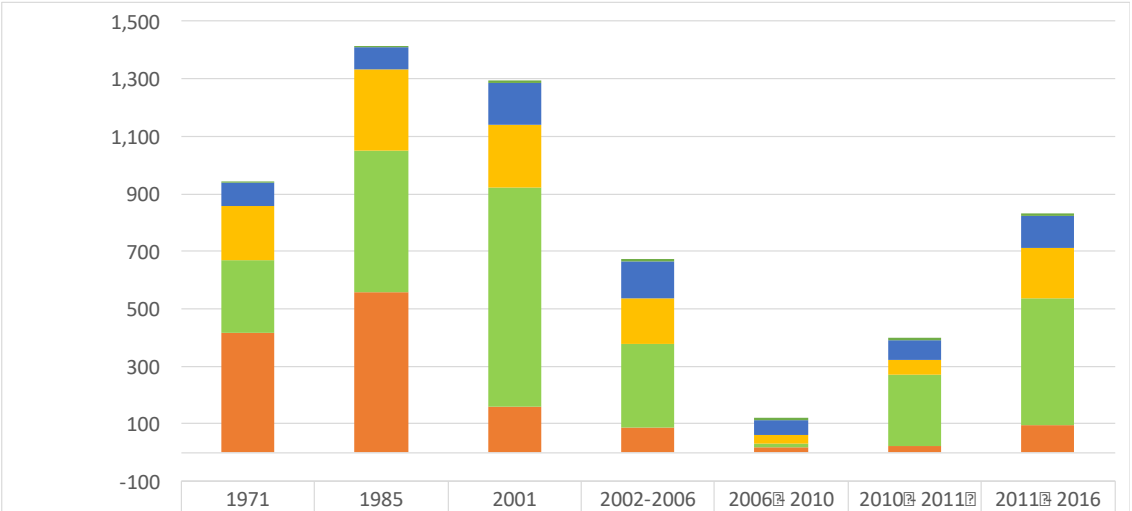
3.6 Irrigated enterprise use within Murray Irrigation

The following section reviews trends in water use by sector within Murray Irrigation over the last forty years. The data is presented by reference to a number of time periods to demonstrate the impacts of changing policy options and climate scenarios:

- Growth: 1971 to 1985: a period of expansion with investment in new dams and promotion of growth in irrigation
- Controls: 1986 to 2001: the introduction of controls on the total volume of diversions, and water trading to drive use to higher values
- Drought: a series of drought years
  - The first drought from 2002 to 2006
  - The later more severe drought from 2006 to 2010
- Buyback and flood: a period from 2010 to 2012 with flooding rains at the same time as the major drive for buyback
- Recovery: a period from 2011/12 to 2016 with a more stable policy and climate environment

The relative water use by sector is shown in the figure below segmented by these time periods.

Figure 3-5: Relative water use by sector Murray Irrigation - 1971 to 2016 (GL)



	1971	1985	2001	2002-2006	2006 to 2010	2010 to 2011	2011 to 2016
Total	943	1,414	1,295	674	121	400	833
Horticulture	5	5	10	10	10	10	10
Dairy	80	75	146	128	50	70	114
Crops	188	283	220	156	30	50	174
Rice	253	494	762	293	12	250	442
Mixed grazing	416	556	157	87	19	20	94

From this it can be seen that:

- Irrigated pastures for non-dairy grazing sectors have declined over time, in particular since the introduction of the cap on diversions and water trading created incentives to move water to higher

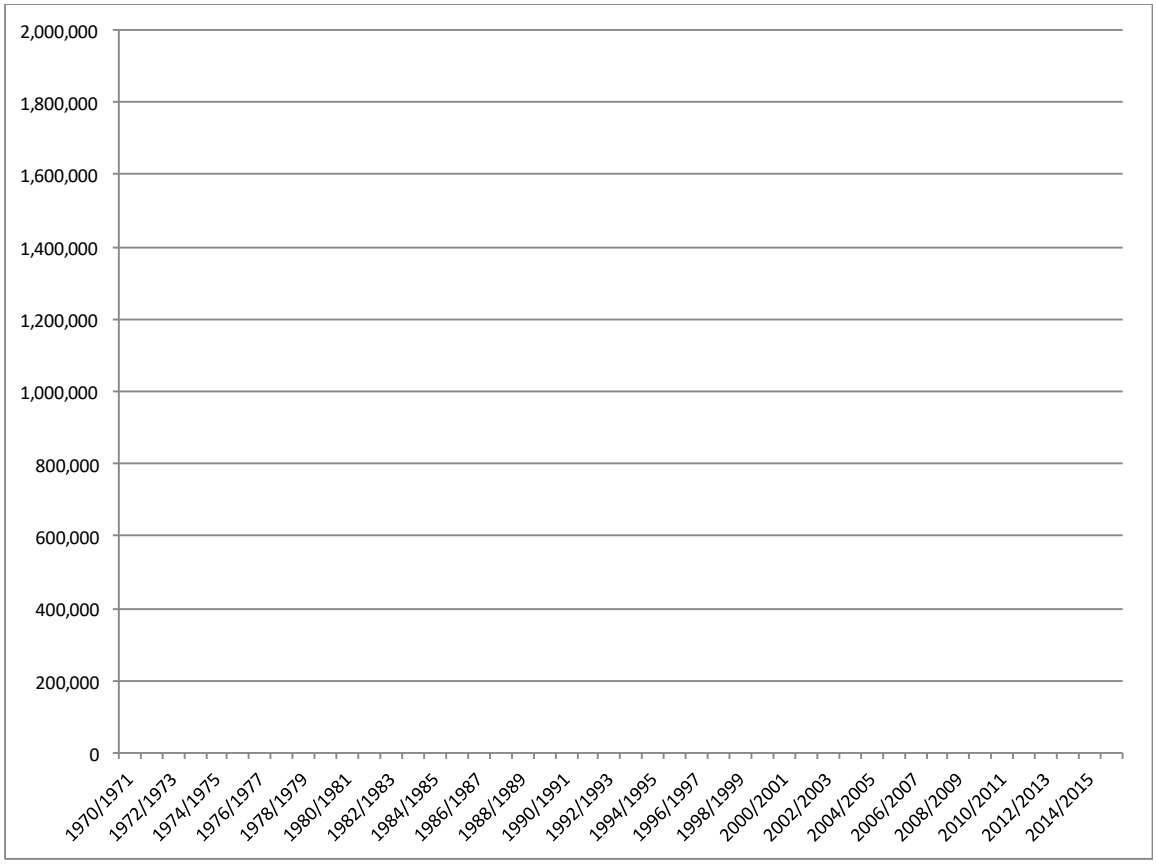
value uses. This was particularly evident in the sheep wool sector which collapsed after the fall in the wool price in 1989. This then saw a transfer from irrigation of autumn pastures to summer crops

- The rice sector grew very substantially over the period to 2001, mainly at the expense of the grazing sector. Since 2002, the scale of use has reflected the availability of water allocations
- There is little dairy within Murray Irrigation but it uses a large proportion of available water in drought years
- There is very little horticulture within the study area, as there was a regulatory ban on any permanent plantings in Murray Irrigation until the 1990s.

3.7 Rice industry

The rice sector and other annual crops vary the area planted in any season in response to the level of announced allocation early in the season, and the price of water in the temporary market. Industry regulation, not water availability, controlled the growth in the rice industry up until the year 2000.

Figure 3-6: NSW Riverina rice production (tonnes): 1970/71 – 2014/15[5]



An analysis of the level of water use and rice production over the last twenty years shows a number of clear phases:

- A period of steady overall growth over thirty years from 1970 to 2001, with total production rising from 200kt to 1,800kt, but with some annual variation to reflect the level of allocation in any season
- A profound collapse in the level of production from 2002/03 to 2009/10 as the drought hit, water use was reduced and water prices rose in the market (with an exception in 2005/06 with fully-utilised carry-over from a late season increase in allocation the year before)

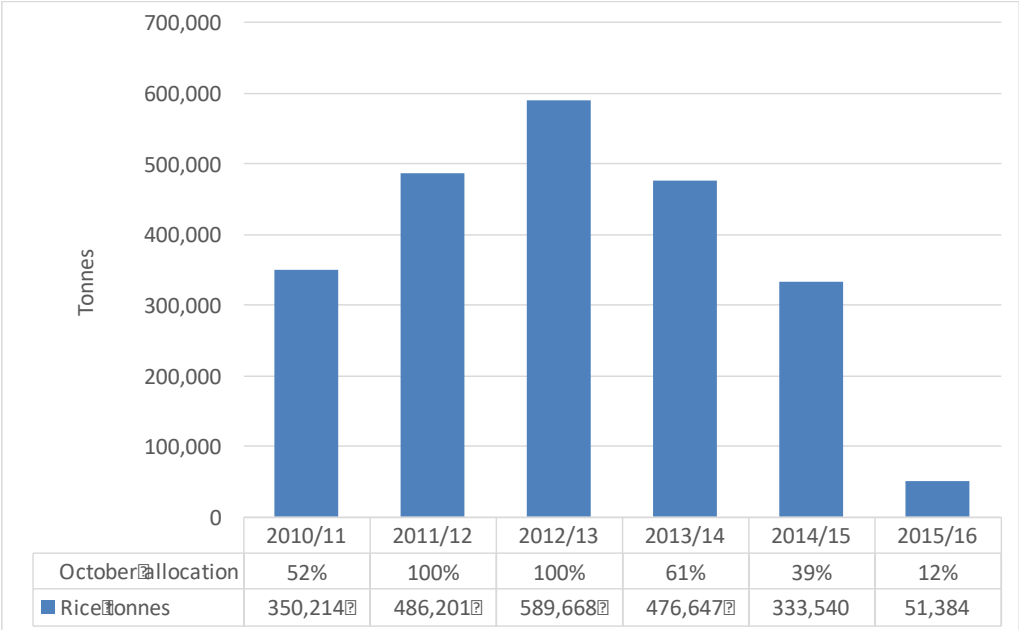
[5] Ricegrowers Association of Australia

- Recovery over the last four years, but to a lower level of production than before the drought and with greater variation in response to the level of allocation.

The timing and level of announced allocation has an impact on the area of rice sown. Historically, the level of water use for rice production was directly correlated with water availability, with decisions on the level of rice production based on allocation announcements in October/November. There is evidence that the level of rice production now collapses when announced allocations early in the season are below 30% because the price of water makes the sale of the allocation more attractive than production.

For example, in 2015/16, only 51,384 tonnes of paddy-rice was grown in the Murray Valley following an opening allocation for General Security in October of 12%, despite 152GL being available in carry-over. It is argued that rice growers are unlikely to plant a summer rice crop when the price of water is trading for $280/ML as it was on the Murray Water Exchange in October 2015.

Figure 3-7: Rice production NSW Murray and General Security October allocation[6]



The effect can also be seen in a comparison between the relative water use by rice and other irrigated crops in Murray Irrigation between seasons (Table 3-3).

Table 3-3: Relative water use (ML) by crop type in MIL[7]

Sector	2012/13		2014/15		2015/16	
GS allocation	100%		39%		12%	
Rice	686,412	56%	333,170	47%	38,319	12%
Pasture	308,811	25%	191,444	27%	129,776	41%
Cereals	188,426	15%	123,085	17%	103,075	33%
Other	52,659	4%	66,351	9%	45,606	14%
Total	**1,236,308**		**714,050**		**316,776**	

There was a significant drop in total water use across MIL by 56% between 2014/15 and 2015/16, but the water use by rice dropped by 88%, whereas other sectors maintained a far more stable level of production.

[6] Data from SunRice and MIL Water Exchange
[7] MIL (2016), Annual Compliance Report 2015/16, Table 18

In seasons with low initial allocations, therefore, a number of factors now come into play:

- A dry spring means that mixed farming properties will tend to add an extra watering onto an existing winter crop to optimise the return on a prior investment - rather than sacrifice that return in order to save the water for summer crops
- That dry spring is also likely to lead to a lower announced allocation in October when planting decisions are taken for summer crops
- Lower allocations drive higher prices in the temporary water market reducing the margin available to rice growers from production as against sale of the allocation
- The introduction of carry-over has reduced the size of the November allocation volumes in all but the wettest years, even though the volume is available (to individuals) in carryover accounts
- Historically, the rice sector has been able to depend on a significant volume of allocation being made available from high security entitlements in the Murray and Murrumbidgee. This volume has reduced over time as new high-value orchards are planted and utilise the available water, or expanded water trading transfers the water to other locations.
- Development of other higher value summer crops, such as cotton and corn, provide competition for an increasingly scarce resource.

Irrigators with a small balance after watering winter cereals are more inclined to sell the balance or carry-over into a following season rather than launch into a summer rice cropping program, particularly when the price on the water market is raised.

3.8 Dairy production

The dairy sector is significant in the NSW Murray region and produces around 280ML of milk a year, which represents around 12% of the total milk production in the wider Murray Dairy region of southern NSW and northern Victoria. The sector makes use of around 114GL of water in an average year. This represents some 15% of total deliveries within MIL of around 750GL.

Table 3-4: Milk production NSW Murray Dairy (ML) 2013/14[8]

District	ML
Berrigan	175
Conargo	24
Corowa	4
Deniliquin	24
Wakool	55
Total NSW Murray	**282**
Total Murray Dairy	2,288
NSW Murray %	12%

Dairy farms in southern NSW tend to be larger than in Victoria due to the scale of available irrigated properties. Most dairy farmers seek to maintain the level of production between seasons. The industry has some flexibility to respond to variations in the level of allocation between seasons by substituting bought-in feed for home-grown pasture, but this adds to the costs of the business. In more extreme climate scenarios dairy farmers can sell-off stock or pay for agistment elsewhere, although this reduces income as well as increasing costs. In wet seasons the sector can expand by bringing additional pasture into production to save the costs of bought-in feed. The dairy sector therefore shows a similar overall story over time as for the rice sector, but with a reduced amplitude of variance.

[8] Murray Dairy: Annual Report 2013/14, page 10

3.9 Cotton industry returns

The cotton industry is now well established in Southern NSW, with current season production estimated at around 60,000ha, and growth over the next two seasons projected to increase that figure to 75,000ha/yr.[9] The expansion since 2002 has mainly been along the Murrumbidgee river, with only 3,000ha located within the Murray Valley. The sector could therefore command 600-750GL of annual water use across the wider Riverina (at 8-10ML/ha). Most of this water would come from General Security users in the NSW Murray and Murrumbidgee valleys, currently growing other summer crops such as rice.

Although cotton production requires significant investment in high quality irrigation layouts, cotton gross margins are consistently higher than rice production (c $350/ML v $200/ML). As a result, much of the irrigation water to support the growth in cotton areas in NSW has come from, and will continue to come from current rice producers.

Like rice growing, cotton production will be impacted by trade-out of the valley in drought years. However, the variability in the level of cotton production will be less extreme than it is for rice, due to forward contract commitments and the higher margins available.

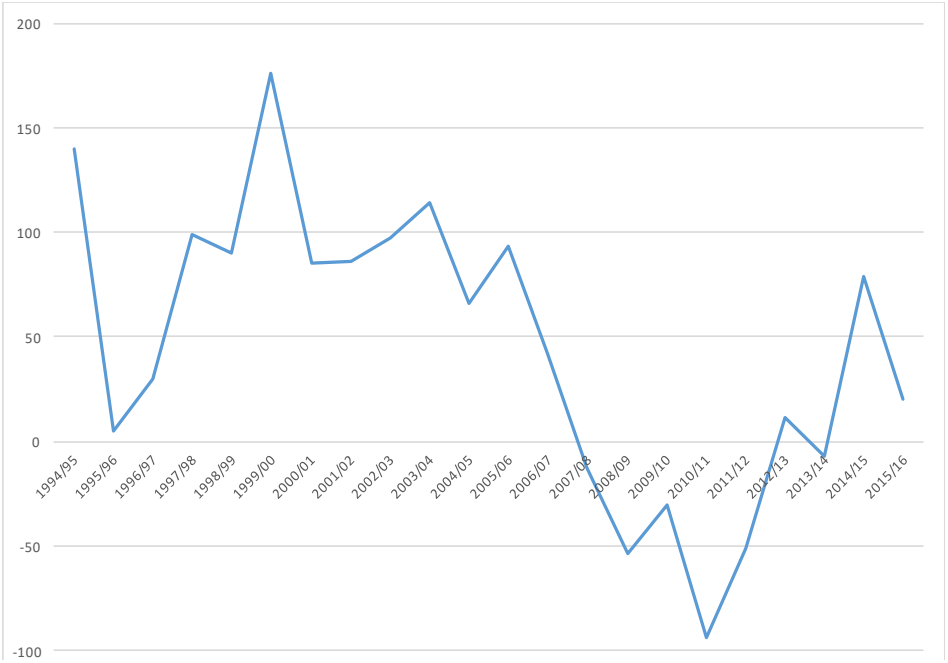
3.10 Water use and trade in Murray Irrigation

It is also useful to review the history of water use and trading in the NSW Murray over time:

- Before the introduction of trade and carry-over, there was significant underuse of NSW Murray High Security and General Security allocations outside Murray Irrigation. By contrast there was generally high levels of demand within the irrigation districts.
- As a result, there was a general reallocation of the surplus from outside MIL to within Murray Irrigation in the following year's allocation. This is demonstrated in the five year period before the introduction of the Cap, when Murray Irrigation consistently used more than 100% of entitlement while users in the remainder of the NSW Murray used an estimated 45%
- There was also significant access to supplementary, off-allocation flows of up to 300ML/year
- With the introduction of water trading, sleeper licences were activated, and irrigators within Murray Irrigation then accessed the same surplus through water trading in most years. Trading also activated local underuse of water within the districts
- The introduction of carry-over has seen a rebalancing between total yield and security, with many irrigators holding steady volumes in carry-over accounts. It has also seen some irrigators in NSW Murray 'park' their unused allocation on water accounts in Victoria, as the state has a more generous carry-over policy. Because of volumetric trade restrictions on trade to Victoria from NSW, some of this water has been routed via South Australia, with the risk that this trade has been incorrectly recorded as trade to SA.
- As the market has matured, horticulture has expanded and dairy has become more water-constrained. As a result, Murray Irrigation is now a net importer in average to wet years but a net exporter in dry years to higher value sectors. Increased horticultural developments outside the Murray Irrigation footprint may increase the pressure on the market in future even in average years.
- However, despite this overall trend, Murray Irrigation Limited itself, is generally a net importer of water, with a net trade balance of imports over exports of 100GL in June 2015 (Murray Irrigation, Talking Water: 10 June 2015). This is confirmed in the following figure sourced from end of year trading data from the Murray Irrigation Water Exchange.

[9] Kieran O'Keeffe, Cotton Info - *pers comm*

Figure 3-8: Relative net water trading position of Murray Irrigation Water Exchange (GL)



Analysis of water trading data for Murray Irrigation and the NSW Murray Valley is complex due to the range of categories involved. Historically Murray Irrigation used to hold around 1,200GL of General Security entitlements out of the total in NSW Murray of 1,72GL. The environment now holds 451GL and MIL 845GL. However, there is also a volume of entitlement that is now held unattached to land in the districts that was previously recorded as entitlement held within MIL - commonly referred to as Water Access Licences (or WALs). The owners of this water may still operate irrigated properties within MIL but have paid a termination fee to disassociate the entitlement from a works licence at a specific property. Therefore if they choose to use the water within MIL then they have to transfer the water back into the district - increasing the apparent volume imported into the district (at zero cost). Equally, if that water is sold out of the NSW Murray then it is not recorded as an export from Murray Irrigation.

3.11 Carryover and the role of carryover

The NSW rules regarding carryover are set out in the *Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources (2003)*. Access to carryover is based on the quantum of water entitlement held. There are two constraints:

- **% carryover:** The maximum carryover from one irrigation season to the next is:
  - Class C, General Security – 50% of water entitlements
  - Class A and B, High Security – generally no access to carryover
- **Maximum Volume:** The maximum volume of annual allocation plus carryover able to be received is:
  - Class C, General Security - 110% of water entitlements
  - Class A and B, High Security - 100% of water entitlements

The carryover rules in Victoria allow a larger volume to be carried forward in the Murray, Goulburn and Campaspe water systems, with a lower likelihood of 'losing' access to this carry-over water. The key elements are:

- **% carryover:** up to 100% of entitlement volume may be carried forward
- **Maximum volume:** an irrigator may store water above the 100% of entitlement volume but that extra value is stored in a 'spillable water account' that is at risk of being spilt if inflows occur that provide for

new allocations. An irrigator can use or trade that water only after the the Resource Manager makes a declaration of a "low risk of spill".

Carryover practice appears to be being driven by a number of factors:

- **Insurance:** Individual irrigators are holding a fairly steady volume of carryover as an insurance policy to reduce risks of low allocations early in the next season. This increases the security of the product but reduces the overall yield that is used for irrigation in any given season.
- **Wet years:** there is high carryover in years when seasonal conditions make it difficult to use the water – either through very wet seasonal conditions, or late allocation announcements, eg as in 2010/11, 2011/12 and 2016/17.
- **2-year planning horizon:** growers are increasingly working within a two year timeframe. A decision on the level of carryover for the following year is based on a judgment as to the likely announced allocation for that year - more will be carried over if projections suggest a lower allocation. This is more influential for Victorian water users seeking to establish an early-season availability-guarantee in the following season. If SunRice repeats the 2016 offer to contract premium prices to growers committing to grow & deliver key varieties in in the following season, more water will be carried over with the NSW Murray to underpin these rice-contracts.

3.12 Drivers of change in the NSW Murray

A set of factors and drivers have led to changes in the level of diversions within the NSW Murray over the last fifteen years, since the drought in 2002, when compared with the previous twenty years. These factors include:

- General Security allocations have been limited to 100%, since the introduction of the cap on extractions and the introduction of the Water Sharing Plans
- The introduction of carry-over has meant that NSW has carried over more water in wet years and increased the reliability, but has decreased the overall yield. Making the water "more reliable" means that water tends to go from being used for late-season irrigation in NSW into carryover accounts both in NSW and (through trade) in Victoria, as well as being lost through spills.
- The introduction of more active trading combined with carry-over has meant that change between sectors has occurred faster than previously. This has seen growth in horticulture outside the region at the expense of summer crops within the valley. This is particularly noticeable in the drier years, where a net loss from the region is occurring for the first time since the area commenced irrigation.
- The heightened frequency of net trade out of water has added to the impact of more than 451GL (27%) of all NSW Murray River General Security Entitlements now being held by State and Federal environmental agencies, and effectively no longer available for allocation to irrigators.[10]
- The experience of drier years has had two impacts on the region:
  - Victoria has spilled less water into the NSW half of Hume Dam so reducing the total volume available
  - MIL and the region use proportionally less of the water available in dry years compared with medium and wetter years

10 DPI NSW (2016), *NSW General Purpose Water account Murray & Lower Darling 2014/5*

4 Impact of the Basin plan on the region

4.1 Reduction in the consumptive pool at the basin level

The analysis of the impact of the Basin Plan on regional production is undertaken at two levels:

- A review of the quantum of changes and their impacts at the scale of the Southern Connected Basin
- An analysis and assessment at the scale of the NSW Murray Valley

4.2 The overall holdings in the SCB

The following table confirms the total water entitlements held by the Commonwealth Environmental Water Holder (CEWH) at the end of November 2016, across the SCB. The long-term annual average yield (LTAAY) represents the projected volume that the CEWH can expect to realise given the historic security of the different holdings over the long-term.

Table 4-1: Commonwealth water holdings in the SCB (ML) [11]

Entitlement	Volume	LTAAY	Security (%)
High	786,899	739,655	94%
General/Low	674,064	479,101	71%
Conveyance	34,790	31,724	91%
Supplementary	403,197	176,207	44%
TOTAL	**1,898,950**	**1,426,687**	**75%**

The holding comes from acquisitions through a number of routes:

- Buyback by direct commonwealth tender
- Investment in irrigation modernisation schemes, such as PIIOPs in NSW, or the NVIRP/connections project in Victoria
- Investment on-farm in water use efficiency projects both by the Commonwealth and the States

The total reduction is 1,426GL LTAAY or 1,899GL in entitlements. This is equivalent to a reduction of 19% of the total water available, or 21% of the surface water.

Given the mix of entitlements recovered, the change in the size of the consumptive pool is shown below, at the scale of the southern connected basin, under the different climate scenarios (where the total available includes 500GL of groundwater).

Table 4-2: Estimated reduction in consumptive pool due to Basin Plan (GL)

Scenario	Example year	Total available	Reduction
Wet	2012/13	5,800	1,404
Medium-wet	2013/14	5,200	1,217
Average	2014/15	4,500	1,070
Medium-dry	2015/16	3,700	845
Drought	2006/07	2,300	458

[11] http://www.environment.gov.au/water/cewo/about/water-holdings, as at 30 November 2016

4.3 Environmental holdings in the Murray Valley

The environment now holds over 600GL of water entitlements in the NSW Murray (Table 4-3), although the standard holding in most years represents around 500GL, as the 100GL of supplementary entitlement is not available in most years. The large majority of the holding is comprised of General Security entitlement.

Table 4-3: Environmental holdings in the NSW Murray (ML) [12]

Type of holding	CEWH	Other	Total	% of Water Plan
High Security	18,393	4,434	22,827	12%
General Security	353,387	97,967	451,354	27%
Conveyance	7,990	24,950	32,940	10%
Supplementary	211	100,000	100,211	40%
TOTAL	**379,981**	**227,351**	**607,332**	

The holding represents 12% of NSW Murray High Security Entitlement (excluding the Lower Darling) but 27% of the General Security entitlement within the Murray Valley. This is a higher relative proportion than the figure of 21% that applies at the wider scale of the southern connected basin (see Table 4-1 above).

The 451GL of General Security entitlement is comprised of three elements:

- Entitlement that was purchased from within MIL and is still held on MIL's General Security Licence
- Entitlement that was purchased from within MIL but has been transformed so is no longer recorded on MIL's General Security Licence (known as Water Access Licences or WALs)
- Entitlement that was purchased from other GS entitlement holders in the NSW Murray.

The following table reconciles the change in GS holdings in the NSW Murray between 2005 and 2015.

Table 4-4: General Security holdings 2005 and 2015

	2005	2015		
Entitlement holder	Irrigators	Irrigators	E-Water	Total
MIL 'on farm'	1,200	741		741
MIL 'Water only' account		127		127
E water within MIL			158	158
Total MIL Bulk licence:	**1,200**	**868**	**158**	**1,026**
NSW Murray WAL-only accounts	472	353		353
NSW E-water ex MIL now on WAL			174	174
NSW Murray E-Water WALs			119	119
Total River non-MIL WAL accounts	472	353	293	646
Total NSW Murray GS	**1,672**	**1,221**	**451**	**1,672**

[12] www.environment.gov.au/water/cewo/about/water-holdings, as at 30 November 2016, and NSW DPI (2016), *NSW General Purpose Water account Murray & Lower Darling 2014/5*

The significance of the analysis is to reinforce the scale of the impact on Murray Irrigation, as the environmental holdings comprise:

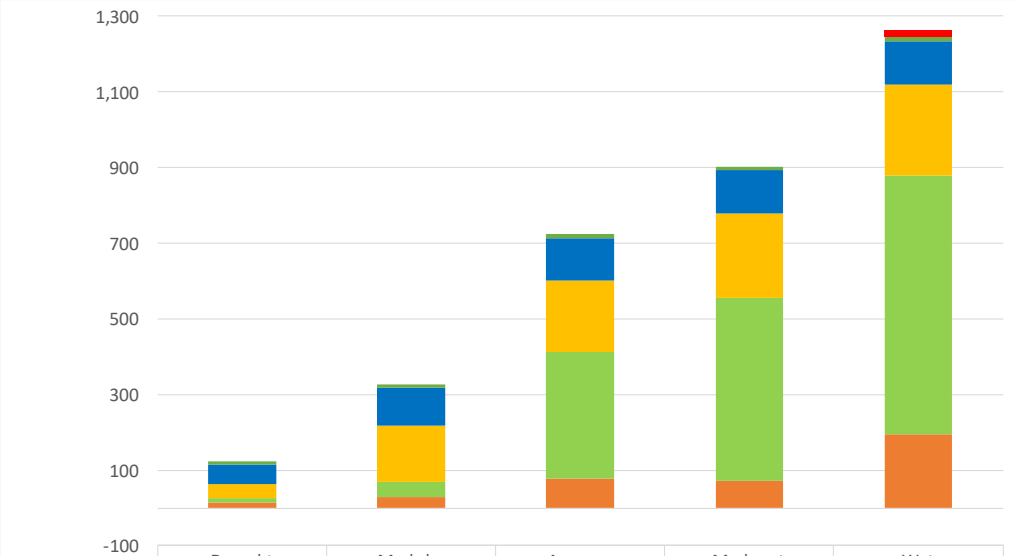
- 158GL still held within Murray Irrigation
- 174GL previously held within Murray Irrigation and now held on a Water Access Licence
- 332GL total - which represents 28% of the previous MIL General Security licence of 1,200GL

By contrast irrigators outside MIL have sold 119GL from their previous holding of 472GL, or a 25% reduction.

4.4 Likely enterprise use in the future

The likely future water use by sector type within Murray Irrigation is shown below for each of the five climate scenarios, taking account of the reduction in the consumptive pool. This has been calculated from the estimates of future water use by sector at the scale of the southern connected basin and apportioned to the Murray Valley by reference to historic trends and history of recent usage.

Figure 4-1: Likely future water use in the Murray Valley under different climate scenarios (GL)



	Drought	Med-dry	Average	Med-wet	Wet
Total	124	327	724	903	1263
Carryover					18
Horticulture	10	10	10	10	10
Dairy	50	100	114	115	115
Crops	36	149	189	223	240
Rice	14	38	333	484	686
Mixed grazing	14	30	78	71	194

From this it can be seen:

- The level of rice production is highly correlated with available allocations. However, there is an effective collapse in production once allocations are below 30%, as rice growers sell their allocation rather than grow rice when the temporary market price rises above $200/ML,
- Dairy production is steady between scenarios and becomes an increasingly important component of total use in dry and drought scenarios
- Cropping is an important water user to finish winter cereals etc in all but drought scenarios
- Grazing (non-dairy) is only a material water user as an opportunistic supply in wet scenarios

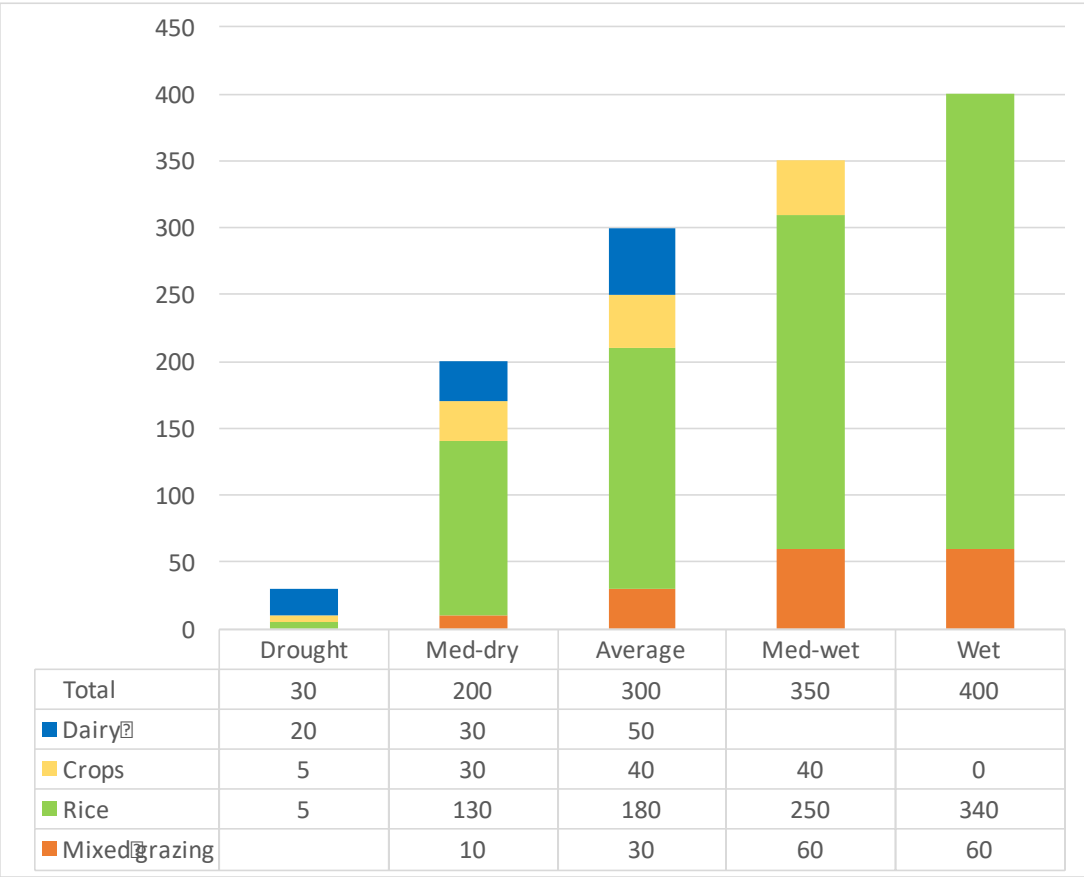
The impact on the NSW Murray region from the reduction in the size of the consumptive pool varies by climate scenario and is summarised below.

Table 4-5: Reduction under climate scenarios (GL)

	Drought	Med-dry	Average	Med-wet	Wet
Historic water use	151	540	1,038	1,254	1,663
Future water available	124	327	724	903	1,263
Reduction (vol)	27	213	314	351	400
Reduction (%)	18%	39%	30%	28%	24%

This shows a 30% reduction in water availability of around 300GL in an average climate season. The following chart then apportions this reduction in water use by sector across the NSW Murray Valley.

Figure 4-2: Reduction in water-use by sector across NSW Murray (GL)



	Drought	Med-dry	Average	Med-wet	Wet
Total	30	200	300	350	400
Dairy	20	30	50		
Crops	5	30	40	40	0
Rice	5	130	180	250	340
Mixed grazing		10	30	60	60

From this it can be seen that the largest impact is in the dry and average years when nearly 30% of the deliveries have been lost due to buyback and farm efficiency – this is a much higher % than the average 21% across the whole southern connected basin. The biggest impact is projected to fall on rice production as it is most reliant on General Security entitlement.

High value horticulture will be able to maintain production albeit at a higher input cost due to raised prices in the temporary allocation market. However, sectors and users reliant on General Security will be heavily hit with significant reductions in available water for irrigation.

Murray Irrigation now delivers on average around 750GL compared with 1,350GL prior to the Millennium drought. This reduction of 600GL can be attributed to a number of factors:

- There has been an overall reduction of ~ 300GL in the water available for use in the region from the transfer of entitlements to the environment - with the variation between years driven by the relative level of announced allocations
- The shift to a more cyclical pattern of rainfall has reduced the average deliveries by around 200GL. This climate shift has been compounded for NSW users as Victorian spills into NSW storage space, which were once a key element of NSW allocation security, have become much less frequent.
- The high up-take of carry-over as a tool for managing following season risk has the impact of reducing early-season allocation announcements in all but the wettest sequences
- The continued growth in horticulture outside the region has reduced allocation previously available from High Security entitlement in the Murray and Murrumbidgee, and has also provided stronger market demand in dry and drought seasons.

This not only reduces the average deliveries substantially but significantly increases the number of dry years when the deliveries are at very low levels - like the season in 2015/16.

4.5 Value of lost production

The previous section has identified that the Basin Plan has reduced the size of the consumptive pool by around 300GL in the average year. The following section estimates the consequential loss for the value of irrigated production. Rice production is the sector hardest hit. Here a value of $350/ML is taken as the gross value of production with a value of $150/ML as a conservative estimate of the gross margin (Table 4-6).

Table 4-6: Average production values for Reiziq rice

Variable	Metric	Value
Price	$/tonne	385
Yield	tonne/ha	10
Income	$/ha	3,850
Irrigation	ML/ha	11
Yield	t/ML	0.9
Yield	$/ML	350
Variable cost	$/ha	2,000
Gross margin	$/ha	1,850
Gross margin	$/ML	168

The following table (Table 4-7) takes the projected reduction in levels of production by sector and calculates the implications for lost production. This shows an annual loss of production across the NSW Murray Valley of $120M as a result of the reduction in the size of the consumptive pool.

Table 4-7: Reduction in value of production ($M/year)

Sector	Reduction (GL)	Yield ($/ML)	Value ($M)
Mixed grazing	30	100	$3
Rice	180	350	$63
Crops	40	300	$12
Dairy	50	850	$42
Total	**300**		**$120**

The gross value of production is taken as an appropriate metric rather than the gross margin as it is this production value that drives much of the regional economy as not only a value for the direct lost production but also as a proxy for the reduced input costs otherwise invested by the irrigated sectors in the local agricultural service sector.

4.6 Impact on water market price

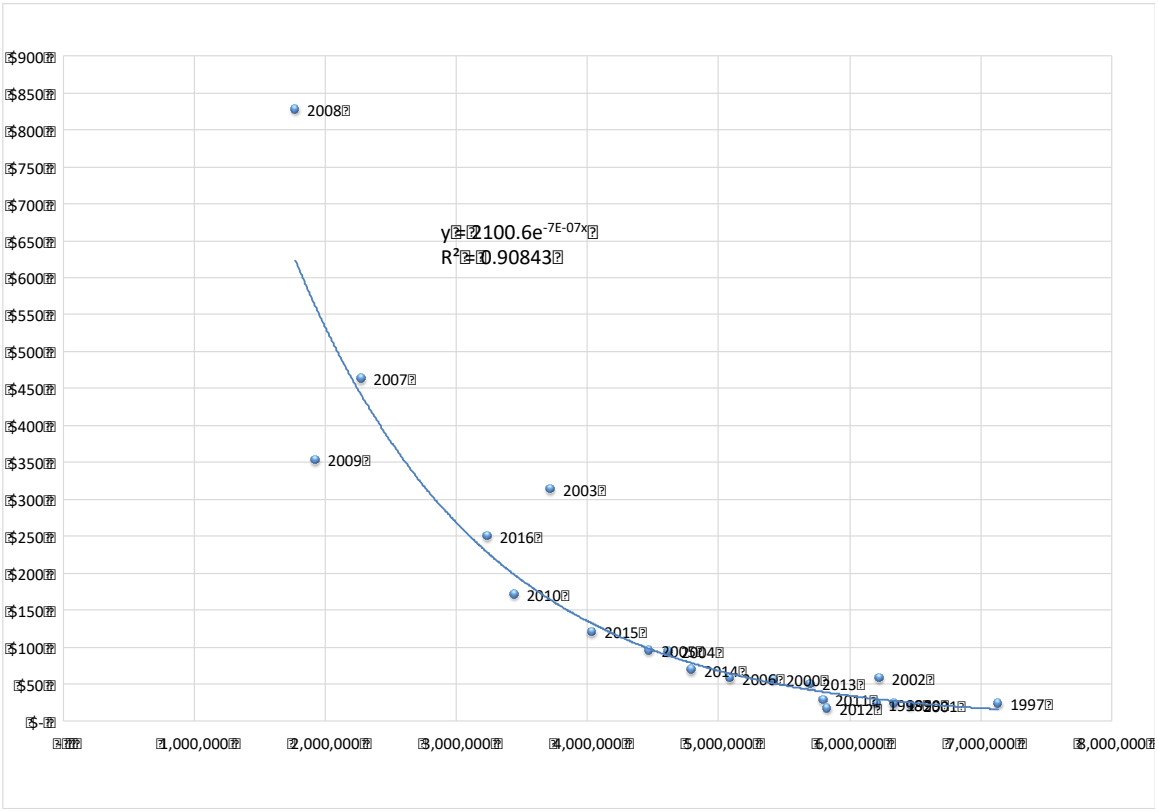
The purchase of environmental entitlements has reduced the size of the consumptive pool. That has led to a direct reduction in the level of irrigated production across the region. However the reduction in the consumptive pool volume has also had an effect on production indirectly through the impact on the price of water.

The analysis of water market data shows a strong inverse correlation between the level of total available water and the price in the temporary market. That is as you would expect - as increasing scarcity drives increased price - as a result this effect is particularly noticeable under dry or drought climatic scenarios.

The following graph plots:

- The total volume of announced allocations by season across the southern connected basin (i.e. for the Murray, Murrumbidgee and Goulburn systems), excluding carryover and access to groundwater - both of which will influence price
- The average price for 'allocation' on the Water Exchange run by Murray Irrigation Limited, with all values indexed to March 2016 prices

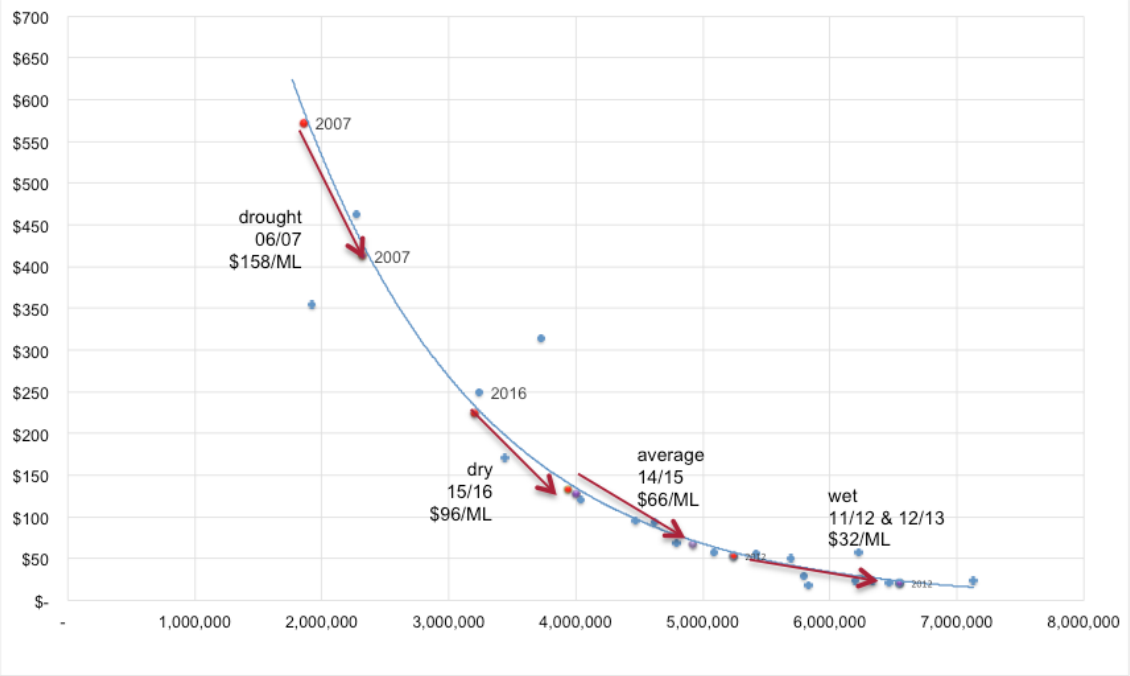
Figure 4-3: Plot of market price ($/ML) against volume of announced allocation



The graph demonstrates a statistically significant correlation between the two variables (R^2=0.908). The test is then to consider how far this correlation is affected by the Basin Plan. In practice the buyback program has involved withdrawing around 20% from the overall available consumptive pool at the scale of the SCB.

The following version of the same graph therefore provides comparative values for four points on the graph (representing the four different climatic scenarios), with or without a 20% increase in volume, to reflect the change that can be attributed to buyback.

Figure 4-4: Impact of 20% increase in volume on market price



This graph suggests that:

- In a drought scenario (as in 2006/07), increasing the volume of available water by 20% would have reduced the temporary market price from around $575/ML to $420/ML, ie by $155/ML
- In a dry scenario (as in 2015/16), increasing the available water by 20% would have reduced the temporary market price from $236/ML to $140/ML, ie by $96/ML
- In an average scenario (as in 2014/15), increasing the available water by 20% would have reduced the temporary market price from $150/ML to $80/ML, ie by $70/ML
- In a wet scenario (as in 2011/12 or 2012/13), increasing the available water by 20% would have reduced the temporary market price from $55/ML by only $32/ML.

The average climatic scenario is the standard reference point, so this analysis suggests that taking 20% out of the consumptive pool through buyback has led to an average increase in temporary 'allocation' market prices of $70/ML. This is close to a doubling of what would have been the market price.

Supporting evidence

There is supporting evidence for this analysis:

- Comparing 2002/03 with 2015/16: the percentage allocation against entitlement in the two years is the same but the available volume has reduced due to buyback and increased demand from horticulture. The result is a current temporary market price of $207/ML in comparison with a value of $84/ML in 2002/03, roughly a doubling in price
- Comparing 2014/15 with 2015/16: the total volume available in 2015/16 was around 1,000GL lower than it was the previous year. The average temporary market price was $250/ML in comparison with $120/ML in the previous year - again a doubling in price.

A summary of these changes by climate scenario is provided in the following table, which shows the price premium that can be attributed to the reduction in the scale of the consumptive pool and the increase in demand from the horticulture sector.

Table 4-8: Price impact of buyback (source RMCG)

Scenario	Similar season	Frequency (over 20 yrs)	Total Water Availability (GL)	Standard Price ($/ML)	Price premium ($/ML)
Wet	11/12	3	5,800	50	32
Medium – wet	12/13	5	5,200	80	45
Average	14/15	5	4,500	130	66
Medium - dry	15/16	5	3,700	225	96
Drought	06/07	2	2,300	575	158

This effect is significant for the Murray Valley because growers are highly sensitive to the impact of price. As we have seen in Section 3-7, rice-growers have to decide before November each season whether to launch into a summer rice cropping program or to sell their allocation on the temporary market. The trigger point for sale appears to be around a value of $180/ML. When the price is above $200/ML then the incentive is to sell rather than plant because the marginal return from rice is less than the return available from the market, particularly once the risks of the two options are compared.

The table above shows that reducing the size of the consumptive pool by 20% increase prices in average seasons from $130/ML to nearly $200/ML. That increases the number of years when rice-growers will sell rather than grow from 7 years out of twenty to more than 10 years out of twenty.

4.7 Off-setting impacts

The region has seen the injection of significant funds over the years from a number of sources:

- $100M in the green dowry which accompanied privatisation in 1995. This was used to fund significant works in the delivery system to reduce transmission losses between 1995 and 2010.
- $100M to fund on-farm works between 1995 and 2010 to promote greater water-use efficiency as part of the regional land and water management plans - particularly in the Finley and Wakool districts.

The Basin Plan itself has also seen significant investment in the region through a number of routes:

- Buyback has injected capital into debt laden farm enterprises as irrigated businesses attempt to restructure and recover after ten years of drought
- Infrastructure modernisation has injected capital into the region and generated 'new water' by reducing water previously lost in delivery systems through the PIIOPs scheme
- On-farm modernisation programs have provided farmers with incentives to upgrade farm infrastructure including irrigation systems in exchange for sharing the water savings generated.

These are real and tangible benefits, as are the improvements to river health and wider regional environmental values. However, the inputs need to be put in context:

- Buyback was largely used to retire debt as a short-term financing measure. However, those sellers who remained in irrigation are now at risk from exposure to temporary water market prices, which have

been driven higher by the reduction in the size of the consumptive pool. That merely exchanges a short-term financing problem for a medium-term input cost problem

- The two programs of investment in infrastructure to generate water savings have merely brought forward the timing of that investment, which would have been triggered in due course as the water market generated signals for efficient investment. However, in that case the water would have been retained for production while under the current schemes most of that saving has been withdrawn from production.
- The on-farm water use efficiency investment also has adverse effects on high value horticulture under drought scenarios. Prior to this program, horticultural producers could access a large buffer of available allocation in drought years, comprising the combined volumes from:
  - The water otherwise applied to lower value crops as well as
  - The water lost in distribution and application in that prior use

  So a low value enterprise selling water losses to the Government in exchange for system upgrade has reduced the size of the pool available to support high value horticulture in drought years. That will constrain the scale of production in all seasons, as total production of high value horticulture is limited to the area that can be irrigated with confidence in every season including drought years.
- A proportion of the growers who participated in the on-farm programs used the revenue from the scheme to purchase water at a lower market rate and so expand the scale of their production. Through this approach the on-farm schemes have been, in effect a form of buyback, and so have reduced the size of the consumptive pool.

5 Impact of future reduction in consumptive pool

This chapter estimates the implications of any further reduction in the size of the consumptive pool. There are two possible scenarios:

- **300GL shortfall from the SDL offset initiative:** the Basin Plan target of 2,750GL can be reduced by up to 650GL where projects can be identified that achieve an '*equivalent environmental outcome*' through works and measures and/or changes to operating rules. Victoria and NSW have submitted proposals for inclusion in the program. However, this 650GL target may not be reached. If the program only identifies savings of 350GL then the balance of 300GL would still need to be recovered - mainly through buyback.
- **450GL from the Upwater initiative:** Section 86AA of *the Water Act 2007* has the aim to increase *the volume of the Basin water resources that is available for environmental use by 3,200 gigalitres,* and to achieve this outcome by *increasing the volume of the Basin water resources that is available for environmental use by 450GL*. This volume would be recovered in addition to the 2,750GL target and so is commonly referred to as 'Upwater'. It would be recovered largely through expansion of the on-farm water use efficiency program.

In this chapter it is assumed that the 450GL of Upwater is recovered on top of the 300GL from the SDL offset shortfall, i.e. a total of 750GL to be recovered.

5.1 Revised water use figures and impacts

This analysis assesses the impact on production of a further reduction of 750GL in the consumptive pool, ie. where we fall 300GL short on the 650GL (due mainly to the constraints strategy) and implement the 450GL Upwater. This gives a total of 750GL in LTAAY or around 900GL in entitlements across the SCB. This represents another drop of 15% in total water entitlements or 17% of the surface water entitlements. The following table identifies the implications under the five standard climate scenarios.

Table 5-1: Further reduction from 750GL initiatives across the SCB (GL)

Scenario	Total available	Reduction
Wet	5,800	900
Medium-wet	5,200	800
Average	4,500	650
Medium-dry	3,700	513
Drought	2,300	325

5.2 Impact on Murray Irrigation

The suggested impact on Murray Irrigation is as follows.

Table 5-2: Projected water availability by climate scenario (GL)

	Drought	Med-dry	Average	Med-wet	Wet
Current	121	340	738	924	1263
Proposed	91	240	588	724	1013
Reduction	30	100	150	200	250

This represents a further reduction in deliveries of between 20% and 30%. The impact would again be most marked in the dry years.

The following provides an indication of the enterprise reduction in water use if this was to occur.

Table 5-3: Reduction in water use by sector from 750GL scenario

	Drought	Med-dry	Average	Med-wet	Wet
Mixed grazing	5	5	30	35	50
Rice	5	5	80	115	180
Crops	15	70	40	50	20
Dairy	5	20	0	0	0
Total	30	100	150	200	250

The rice and cropping industries would be most affected, with dairy only affected during Medium-dry or drought conditions.

5.3 Impact on MIL operations

Murray Irrigation now delivers on average around 750GL/yr compared with 1,350GL prior to the Millennium drought. The proposal to further reduce the size of the consumptive pool by a further 750Gl would mean that available allocations in Murray Irrigation in an average year would fall by a further 150GL. In a drought year Murray Irrigation would struggle to deliver 90GL in total.

This would challenge the viability of the irrigation corporation.

6 Summary

In summary, the Basin Plan within NSW Murray has seen:

- The transfer of 451GL of General Security entitlement to the environment. This represents some 28% of the General Security that was previously held within Murray Irrigation Ltd, and a further 25% of GS entitlement held elsewhere in the NSW Murray Valley.
- That reduction in the consumptive pool would otherwise have been available to generate irrigated production with a value of some $120M farm gate in an average season
- The main impact has been on annual cropping sectors, in particular rice, which has seen a reduction in production by nearly 30%
- A reduction in dairy production by around 21% and increased vulnerability in a drought situation with higher reliance on access to the temporary market
- Those regions that are predominantly horticulture such as SA, Sunraysia and Griffith have emerged largely untouched by the plan to date. In future drought seasons they will command a far higher proportion of the available water so putting greater pressure on all other sectors
- The reduction in the size of the consumptive pool has pushed up the average price in the allocation water market. This higher price makes irrigated production of annual summer crops less viable and increases the likelihood that water will be sold out of the area rather than used in production
- That loss of production impacts both on the irrigation sector and on the sectors who provide services to the irrigation sector
- The reduction in the volume of water used within the traditional irrigation districts may undermine the commercial viability of the irrigation businesses.
- Any further transfer of entitlement to the environment will further exacerbate these outcomes.
- Increasing the risk to the region is th unresolved issue of how the water purchased by government can be delivered physically and safely without third party impacts including major flooding of private property and
- Any reliability risks to remaining general security water entitlements with any adverse decisions in the Sustainable Diversion Adjustment Mechanism and Pre Requisite Policy Measures (rule changes)