Background Report 7 Part A

Analysis of carryover options for Draft Strategy

Northern Region
Sustainable Water Strategy
Introduction

Enabling individuals to carry over part of their unused water from one season to the next effectively allows them to manage their own reserves – and their own risk.

The objective of amending existing carryover arrangements is to enhance water users’ capacity to manage their water availability with certainty between seasons. Rules should aim to best meet the needs of all entitlement-holders in this regard, while preventing potential third party impacts. Common rules for all entitlement-holders would provide a level playing field on the water market.

The Draft Northern Region Sustainable Water Strategy (Draft Strategy) proposes a two-stage process to review carryover rules to meet this objective.

This Background Report seeks to provide information and data to support the proposed two-staged approach to amending carryover arrangements. The three sections include information on:

- Section 1 – proposal for amending carryover rules
- Section 2 – use of carryover in 2006/07 and 2007/08
- Section 3 – initial analysis of environmental carryover options.
Section 1 – Proposal for amending existing carryover rules

What is carryover and why is it important?
Enabling individuals to carry over part of their unused water for use in the following season effectively allows them to manage their own reserves – and their own risk. Carryover allows individual entitlement-holders to make their own decisions on whether to use the water in the current year or save it for the following year. This gives them greater flexibility to use their water when it is of greatest value to them.

"During the current drought, irrigators have been given more control over their water resources by being allowed to use carryover. By using trade and carryover, individuals have the ability to set their own level of reliability."
- Submission to the Northern Region Sustainable Water Strategy Discussion Paper, 2008 (DP065)

Carryover is a particularly important tool in low allocation years:

1. It provides water at the beginning of the season when seasonal allocations may be low. This is critical for horticulturalists, whose crops must avoid stress at specific times (like fruit set and bud set) for a successful harvest.
2. It can provide certainty on the minimum volume of water available in that season. Together with trade, this gives individuals greater control over their own water supplies.

Carryover is important for environmental water managers because it allows them to store water for release early in the season when it is most needed (before allocations have increased sufficiently). Environmental water can be carried over to provide survival flows during droughts, or to opportunistically create wetland flooding.

In 2007/08, the carryover arrangements introduced as a drought contingency measure during the 2006/07 season were extended. Currently, Victorian entitlement-holders can carry over unused allocation under the following rules:

1. Entitlement-holders can carry over up to 30 per cent of the volume of their high-reliability water shares and up to 30 per cent of low-reliability water shares. Additional unused water will return to the reserve pool for re-allocation.
2. The volume of water available in the following season is limited to 100 per cent of entitlement (i.e. an individual’s carryover plus allocations cannot exceed 100 per cent).
3. Where an entitlement-holder has both high and low-reliability water shares linked to the same allocation bank account, water allocations carried over will be deemed to be recorded first against high-reliability water shares, then against low-reliability water shares.
4. Five per cent of the water carried over will be deducted to account for evaporation losses.

Individuals can carry over part of their own unused allocation or purchase water to carry over.

Specific issues

Changing the 30 per cent rule
By allowing entitlement-holders the freedom to choose how much water to carry over, increasing the 30 per cent rule would allow individuals maximum flexibility to manage their own risk.

The 30 per cent rule was initially intended to limit the impact of carryover on the system reserve pool and therefore, other entitlement-holders (third party impacts). Before the introduction of carryover, unused water was returned to the system reserve to be re-allocated to all entitlement-holders. Now that water can be carried over, the amount of unused water going to the system reserve could be reduced, resulting in potentially lower seasonal allocations. The 30 per cent rule effectively limits the potential magnitude of this impact.
As we are approaching full utilisation of water and the value of water increases, there will be less unused water at the end of a season. This will particularly be the case in dry years when most water will be used unless individuals choose to save it for carryover. This means that raising the 30 per cent limit to 50 per cent or even higher would have minimal impact.

Raising the limit to 50 per cent would allow individuals requiring greater certainty to ensure that a larger proportion of their water needs could be secured for the subsequent season. It would also bring Victorian irrigators more in line with current carryover arrangements for New South Wales and South Australian irrigators.

**Changing the 100 per cent rule**

Increasing the 100 per cent rule would reduce the risk to irrigators of returning their carryover water to the system reserve as allocations increase. This would provide greater certainty in their future water management decisions.

However, the 100 per cent rule also ensures that individuals cannot use more than the storage capacity to which they are entitled. In Victoria, it is assumed that storages have the capacity to hold 100 per cent of high-reliability water shares, sufficient reserve to ensure 100 per cent high-reliability allocations in the following season, and 100 per cent of low-reliability water shares. Hence, when the storages are full they are fully utilised to support entitlements. Allowing individuals to store allocations above the volume of their entitlements would mean other entitlement-holders may not receive full allocations against their entitlements (see Figure 1).

**Figure 1. Potential impacts of increasing the 100 per cent rule (conceptual only)**

- **a)** Storages at capacity can hold the full volume of high-reliability and low-reliability water shares, and next season’s reserve
- **b)** Allowing individuals to accumulate allocations above the volume of their entitlements could reduce storage capacity for low-reliability shares and next season’s reserve

Analysis has been undertaken to compare seasonal allocations with storage levels on both the Murray and Goulburn system. These plots show the historical maximum volume in the storages when 100 per cent allocations against low-reliability water shares are first announced. Hence, they can be used to test our assumption that storages are full when 100 per cent low-reliability allocations are announced.

On the Goulburn system (Lake Eildon) the analysis indicates there is approximately 390 GL of airspace in the storage after 100 per cent low-reliability allocations are reached.

On the Murray system (Victoria’s share of Hume plus Dartmouth) the analysis indicates there is approximately 200 GL of airspace in the storages after 100 per cent low-reliability allocations are reached.

When the storages are full, this additional water is currently used to provide reserves for future allocations against existing entitlements. Allowing individuals to occupy this storage capacity when the dam is full would undermine these future allocations.
If it were to be argued that this storage capacity could be used to raise the 100 per cent limit on carryover, there are existing and proposed rights to access that storage capacity that need to be taken into account:

- On the Murray system, the Barmah Environmental Water Allocation is able to accumulate up to 700 GL while the storages are not spilling.
- The environmental water reserve has extended use for six months on low-reliability water shares created as part of the sales deal.
- The Victorian Government’s response to the Food Bowl Modernisation Steering Committee Final Report proposed that any part of Melbourne’s 75 GL entitlement not used in any year will be held in a special reserve for allocation for urban use (regional and/or metropolitan) at the discretion of the Minister for Water in consultation with Melbourne Water, Goulburn-Murray Water and DSE.

Raising the 100 per cent limit could impact on these rights to access storage capacity. On the Murray it would mean that Barmah water would spill more frequently.

Reducing the risk to the individual of effectively losing carryover would allow individuals greater certainty in making decisions about when to carry water over into future seasons. How could this be achieved while still preventing the type of adverse third party impact described above?

Options include:

- introduce spill rules associated with relaxing the 100 per cent rule
- rent or allocate airspace, governed by spill rules
- seasonally adjust the 100 per cent limit
- record carryover against low-reliability entitlements before against high-reliability entitlements.

These options are explained in the following sections. It is proposed that these issues will be part of Stage 2 of the carryover review.

**Introducing spill rules**

One option would be to allow individuals to hold more water than the total volume of their entitlement in storage while the dam is not full, but have spill rules to ensure that carryover is lost once the dam fills.

The development of spill rules is problematic for several reasons:

a. Irrigators would lose water that they already hold in their account. This is much more severe than irrigators simply missing out on allocations (as occurs with the current arrangements). This could mean trying to take water away when it has already been used – putting individuals in ‘debt’ to the system reserve. Alternatively, it creates a disincentive for efficiency, where individuals may be encouraged to use more water to reduce the risk of having it taken away.

b. It is difficult to determine whose water is spilling in multi-storage systems (ie. storages where multiples states share a storage) where entitlements are not linked to a specific storage. Spill rules in these systems could well be overly punitive.

c. Carryover water would need to be treated separately to seasonal allocations with limitations on its tradability.

**Renting airspace**

The option of renting airspace has also been canvassed in preparing the Draft Strategy. This option is based on annual access to available airspace that individuals can use to carryover water. Individuals bear the risk of losing their carryover if the storage spills.

It is based on the assumption that airspace in storages is not owned by individual entitlement-holders, but by Goulburn-Murray Water as the managing authority to manage on behalf of the community of water share owners. Water shares have primacy in using storage capacity to support allocations against those entitlements, but while storage capacity is not being used for this purpose, it may be used opportunistically by individuals.
The scenario below has been drafted to illustrate how such an approach could currently be administered given existing accounting capabilities. These rules would co-exist with ordinary carryover rules available to entitlement holders.

**End of season 1**

1. The option of renting airspace to store carryover is only available when storages are less than 50 per cent full approaching the end of the season.

   *This is to mitigate the risk of individuals losing carryover, by making this product available only when the probability of spill in the following season is low. Alternatively there can be no limitation on its availability, with the onus all on individuals to judge the risk associated.*

2. In May during each season, Goulburn-Murray Water as the operator of the storages, would make a decision on the volume of airspace available for use in this manner.

   *Again the volume available would be judged to mitigate the risk of individuals losing carryover, with a low probability of spill in the following season.*

3. On May 15, Goulburn-Murray Water would conduct a pooled auction allowing individuals to bid for the amount they wish to carryover in this fashion and the price they are willing to pay. This could be conducted either:
   a. with a single clearing price set at the lowest successful bid within the volume available
   b. without a clearing price, but by accepting all the highest bids up to the volume available.

4. Successful bidders would enter into individual contracts with Goulburn-Murray Water to access that volume of storage capacity, conditional on spill rules governing the loss of water carried over in that airspace if the storage spills.

   *The price paid to access this airspace could be used by Goulburn-Murray Water to meet the costs of operating the storage, and could thus be deducted from the headworks charges of entitlement holders that currently fund storage operation costs.*

**Season 2**

5. The volume carried over in this manner (“airspace carryover”) is credited to the individual’s allocation bank account, and can be used or traded just like any other seasonal allocation. This volume will be noted, and can be debited from that account subject to spill rules when the storage spills.

**Spill rules**

6. When the storage spills (Eildon on the Goulburn system, Hume on the Murray system), then water will be proportionally deducted from all allocation bank accounts against which airspace carryover is recorded. Use or non-use of “airspace carryover” does not alter the risk of spill.

   *Note that as carryover cannot be differentiated from seasonal allocation, water will be deducted from these accounts regardless of whether it has been used or not or traded. For example, if the volume of spill is equal to half the sum of all “airspace carryover” then individuals will be deducted allocation from their account equal to half of their “airspace carryover”.*

   *“Airspace carryover” water will spill first (ahead of Barmah water and extended use carryover that has pre-existing claims to storage capacity).*

Various issues, benefits and costs have arisen from the above considerations, including:

- The risk to the individual of losing their carryover is significantly less than the risk if carried over against high reliability with 100 per cent limit (although only marginally less than risk if carried over against low-reliability with 100 per cent limit)
- risk is borne by individual that bids to carryover water in this manner
- spill rules involve taking water off individuals
- as carryover cannot currently be differentiated from seasonal allocation, this would mean taking water off individuals even though they may have used it and are no longer occupying the rented airspace. This could result in allocation bank accounts being debited into negative balances
- revenue raised from the sale of this access to airspace could be deducted from the headworks charges of entitlement holders that currently fund the operation of the storages
- this would add complexity to the Water Register, which would be required to record the volume of airspace rented by participating individuals to enable calculation of the volume of “airspace carryover”, traditional carryover against entitlements, and any water ineligible for carryover that is forfeited at the end of the season

Further detailed work needs to be undertaken within Stage 2 of the review process before the Government can consider altering the 100 per cent rule.

**Individual renting airspace**

Individuals can effectively rent airspace for carryover to or from other entitlement holders within the current carryover rules using temporary trade.

**An example:**

- Irrigators A & B both have 100 ML of high-reliability water share. At the end of season 1, irrigator A has 50 ML unused allocation while irrigator B has used all his water.
- Irrigator A wishes to carry over all his unused water, but can only carry over 30 ML under the current rules. He can enter into a contract with Irrigator B to carry over the additional 20 ML on his behalf to the effect that:
  - a. Irrigator A sells 20 ML to Irrigator B in June for a nominal fee
  - b. Irrigator B carries over the 20 ML and sells it back to Irrigator A on 1 July for an agreed greater fee.
  - c. If allocations exceed 80 per cent after 1 July, Irrigator A will make good the allocation that Irrigator B will not receive due to the encumbrance created by carrying over water on Irrigator A’s behalf.
- This could be done with a lower risk to Irrigator A by entering into a contract with the Irrigator B to carry over the water against a low-reliability entitlement.

Opportunities could be explored to raise awareness of these types of transactions.

**Introducing a seasonally adjusted 100 per cent limit**

An alternative to a permanent change to the 100 per cent rule would be seasonal adjustments to the limit. These could be made by Goulburn-Murray Water based on the risk of the storage spilling in the following season.

**An example:**

If in March Lake Eildon is only 20 per cent full, Goulburn- Murray Water w=could assess the risk of a spill in the following season to be extremely low, and allow the limit on the volume of carryover plus seasonal allocation to be set at 130 per cent for the following year.

This decision would be made to mitigate the risk of individuals losing their carryover. However, there would still need to be a spill rule governing individuals losing their carryover in the event of a spill, as it is reasonable that the individual bears the risk associated with their opportunistic use of storage capacity.
**Carryover against low-reliability before high-reliability water shares**

The Draft Strategy is seeking comment on its specific amendment to carryover arrangements that would allow entitlement-holders to record carryover against low-reliability water shares before high-reliability water shares. This would reduce the risk of missing out on allocations in the following season (ie. effectively losing carryover). Under the proposal, where an entitlement-holder has both high- and low-reliability water shares linked to the same allocation bank account, water allocations carried over will be deemed to be recorded first against low-reliability water shares, then against high-reliability water shares.

The existing carryover rules state that any water in an individual’s allocation bank account (ABA) at the end of the season must be carried over first against their high-reliability water share before their low-reliability water share. Allocation and carryover water no longer has an associated reliability, so this rule simply refers to the storage space associated with an individual’s high-reliability or low-reliability water shares. Water that is carried over is neither high- nor low-reliability, but rather, allocation that is already owned by the individual.

Allowing entitlement-holders to carry over against their low-reliability water shares before their high-reliability water shares would minimise the risk of seasonal allocations limited by the 100 per cent rule in the following season. This is because low-reliability water shares are fully allocated far less frequently than high-reliability water shares. Carryover is effectively lost to the individual only when the storages are close to being full.

There has been some concern expressed that allowing carryover against low-reliability before high-reliability water shares (and subsequently reducing the risk of losing carryover) will significantly impact on the system reserve. It is true that water carried over in individual accounts is less likely to be redistributed to all irrigators through seasonal allocations. However, carryover does not reduce the total amount of water available in a system. By encouraging efficient water use, carryover should increase the amount available in a given year. Effectively, those that save water are rewarded, at the expense of those who were opportunistically relying on accessing other people’s unused water at the end of each year.

Allowing carryover to be recorded against low-reliability entitlements would provide individuals with additional flexibility in managing their own water availability. However, not all individuals currently own low-reliability entitlements. This change would directly benefit those who do own low-reliability entitlements. For those who do not currently own low-reliability entitlements, the benefits are less direct, but it would provide an additional risk management tool to these individuals (available on the open market).

In considering this option, it is important to acknowledge that individuals can already achieve this within the existing rules, and that many individuals are already purchasing low-reliability entitlement to this end. Figure 2 illustrates how, within the current rules, individuals can carry over first against their low-reliability water shares.
Some entitlement-holders are creating a separate ABA for their LRWS, then trading unused allocations into the new ABA (linked to LRWS) so that this will be carried over against LRWS, rather than HRWS. As LRWS receive allocations less often than HRWS, this reduces the risk of them missing out on allocations (effectively losing their carryover as a result of the 100 per cent rule) as allocations increase. The cost is $129.70 to set up the new account, and $61.90 to transfer unused allocation into the new ABA.

Some entitlement-holders who do not own LRWS are purchasing it, setting up a separate account and then trading unused allocations into the new ABA (linked to LRWS) so that this will be carried over against that entitlement. The additional cost is the cost of LRWS (currently about $100-$150/ML).

Presumably, individuals doing this are making conscious decisions that the associated transaction costs are outweighed by the reduced risk of receiving limited allocations next season.

The above demonstrates that there is significant additional flexibility available within the existing carryover rules (albeit with some inconvenience). In light of this, should the rules be amended to officially allow carryover against low-reliability water shares before high-reliability water shares? This would provide entitlement-holders maximum flexibility to manage their own reserves while reducing the risk of missing out on allocations as they reach 100 per cent.

Validating the five per cent rule

When water is stored for longer periods (rather than being used in the current season), this results in additional evaporation. The five per cent rule was implemented to account for the additional evaporation that occurs as a result of carryover. Five per cent was deemed to be a reasonable assumption, and recent hydrological modelling has validated it.

In the Murray system, evaporation accounts for at least five per cent of annual diversions in 70 per cent of years (see Figure 3). In the Goulburn system, it accounts for five per cent of annual deliveries in about 25 per cent of years (see Figure 4).

In light of this information, it is unlikely there will be a change to the five per cent rule.
Figure 3. Net evaporation compared to annual diversions/delivery in Victoria’s share of the Murray system

Figure 4. Net evaporation compared to annual diversions/delivery in the Goulburn system
Carryover to supply critical human needs in towns

Over the past two seasons, carryover has been an essential tool in ensuring urban water corporations can supply critical human needs (and ease the community impacts of severe restrictions). Without this tool, there would have been increased pressure for the Minister for Water to qualify rights. Qualifications effectively reallocate water between users during times of extreme scarcity. This can create uncertainty for some entitlement-holders (including rural water users and environmental managers) and impede effective planning. While sometimes this cannot be avoided, proposals within this Draft Strategy aim to minimise the need to qualify rights. By reducing the risk of qualifications of rights, rural water users and environmental water managers are provided with greater certainty.

To this end, providing urban water corporations with maximum flexibility to manage their risk is a priority action. Urban water corporations would need to be able to carry over at least 50 per cent of their entitlements to ensure Stage 4 restricted demands could be supplied in the following year. However, the 100 per cent limit may well be more restrictive than the 30 per cent limit for water corporations who are trying to manage the risk of not supplying critical human needs. It is suggested that there is little point in an urban water corporation being able to carryover more water if they are still limited in how much they can receive the following year. The economic cost of carrying over more water will be greater – instead of missing out on allocations at 70 per cent, they would miss out on allocations at 50 per cent.

Varying the 100 per cent rule for urban water corporations could be done with little impact on other users. However, for equity reasons with other users this is not currently proposed. This will be further considered as part of the review of carryover arrangements.
Section 2 – Use of carryover in 2006/07 and 2007/08

The following information forms an initial assessment of the use of carryover in 2006/07 and 2007/08. The information supports the carryover proposal within the Draft Strategy and will be a useful input into the second stage of the review of carryover arrangements.

Assessing carryover from 2007/08

**Volume of carryover**

In the regulated systems, in the order of 273 GL of unused allocation has been carried over from season 2007/08 to the current season (2008/09) after the five per cent deduction for evaporation. Of the total volume, 251 GL has been carried over by irrigators, while around 21 GL has been carried over in bulk entitlements held by urban water corporations or the Minister for the Environment.

This compares to a total of 128 GL that was carried over from 2006/07 into the 2007/08 season, of which 106 GL was carried over by irrigators.

Table 1 provides information on the volume of water carried over in each water system. For each water system, the volume of carryover is also described as an equivalent seasonal allocation and compared to the volume of carryover last season.

**Table 1. Volumes of water carried over into 2007/08 and 2008/09**

<table>
<thead>
<tr>
<th>Water system</th>
<th>Carryover by irrigators</th>
<th>Equivalent HRWS allocation</th>
<th>Total carryover</th>
<th>Carryover into the 2007/08 season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murray</td>
<td>146 GL</td>
<td>12%</td>
<td>166 GL</td>
<td>110 GL</td>
</tr>
<tr>
<td>Broken</td>
<td>7 GL</td>
<td>26%</td>
<td>7 GL</td>
<td>N/A</td>
</tr>
<tr>
<td>Goulburn</td>
<td>95 GL</td>
<td>9%</td>
<td>96 GL</td>
<td>18 GL</td>
</tr>
<tr>
<td>Campaspe</td>
<td>2 GL</td>
<td>6%</td>
<td>2 GL</td>
<td>N/A</td>
</tr>
<tr>
<td>Loddon</td>
<td>0.4 GL</td>
<td>1%</td>
<td>0.7 GL</td>
<td>N/A</td>
</tr>
<tr>
<td>Bullarook Creek</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

For water shares in the regulated systems of northern Victoria with carryover, the water register has also provided statistics on the volume of carryover recorded against each of those shares. This data can be used to assess the impact of the current rules on the communal pool for 2008/09 as well as to get a better picture of irrigator behaviour.
Impact of current rules on the communal pool for 2008/09

Water carried over against entitlements is not returned to the system reserve. However, given the value of water and the extremely dry conditions it is unlikely that such a volume of water would have remained unused if carryover was not available.

Attempting to second guess (based on carryover statistics) how much unused water was carried over by conscious decision to save the water is difficult. However, a couple of categories might give a rough indication of the amount of water carried over inadvertently:

1. Where carryover is a small proportion of entitlement volume (less than 10 per cent), and a small absolute volume (less than 10 ML).

   Carryover of small amounts that are only a small proportion of entitlement volume could indicate that the entitlement holder had a little of their allocation left over, but did not actively try to carry over a significant volume of water.

2. Low volume entitlements (less than 10 ML) with the maximum 30 per cent carryover.

   Many of these entitlements are likely to be derived only from domestic and stock supplies. Where the maximum 30 per cent carryover is recorded against such entitlements, this could indicate that these entitlements where not being used at all and water was carried over by default.

On the Murray there was 5.3 GL of carryover in the first category, and 2.3 GL of carryover in the second category.

On the Goulburn, 6.7 GL of carryover fell in the first category, with 2.2 GL in the latter.

Based on these categories, the volume of additional unused water that would have been returned to the system reserve if carryover was not in place would have been very small. This volume would be less than the amount needed for a one per cent allocation increase in the Murray or Goulburn systems.

Analysis of use of carryover by irrigators

Carryover against high-reliability water shares

Approximately 15 per cent of all Murray high-reliability shares and 25 per cent of Goulburn high-reliability shares have zero carryover. Water shares may fall into this category if their usage and trade (or deemed usage) exactly equals the volume allocated, or if there has been any over-use against a water share.

Statistics available on water shares with carryover provide an insight into irrigator behaviour on the Murray and Goulburn systems. Figures 5 and 6 provide analysis of the proportion of entitlement volume carried over against water shares in each system. Please note that the categories showing this are after the five per cent deduction for evaporation has been applied.

The graphs only present information on high-reliability water shares greater than 10 ML. This is because many small volume high-reliability water shares are derived from domestic and stock rights that are either not being used (full carryover) or have deemed full usage.
On the Murray, approximately 140 GL was carried over against high-reliability water shares. 1,633 water shares have a relatively small amount (less than five per cent of entitlement volume) of carryover. 1,411 water shares have the maximum volume of carryover (30 per cent of high-reliability water shares volume), with the remainder distributed fairly evenly between the categories in between these two extremes.

On the Goulburn, approximately 84 GL was carried over against high-reliability water shares. 1,962 water shares have a relatively small amount (less than five per cent of entitlement volume) of carryover. 980 water shares have the maximum volume of carryover. Relatively fewer water shares have carried over a high proportion of their entitlement volume.
**Carryover against low-reliability water shares**

On the Murray approximately 6 GL was carried over against low-reliability water shares. 3,523 low-reliability water shares (79 per cent of the total) had zero carryover, while 927 (21 per cent) had some carryover recorded. Of these, 537 low-reliability water shares had the maximum volume of carryover.

On the Goulburn approximately 11 GL was carried over against low-reliability water shares. 5,643 low-reliability water shares (79 per cent of the total) had zero carryover, while 1,541 (21 per cent) had some carryover recorded. Of these, 810 low-reliability water shares had the maximum volume of carryover.

Figures 7 and 8 provide analysis of carryover recorded against low-reliability water shares in each system.

**Figure 7. Carryover for low-reliability water shares on the Murray system**

![Graph showing carryover for low-reliability water shares on the Murray system]

**Figure 8. Carryover for low-reliability water shares on the Goulburn system**

![Graph showing carryover for low-reliability water shares on the Goulburn system]

Carryover can be recorded against low-reliability water shares in a couple of scenarios:
1. Both high- and low-reliability water shares linked to a single allocation bank account (ABA) – if unused water exceeds 30 per cent of the volume of the high-reliability water shares then the remainder would be eligible to be carried over against low-reliability water shares.

2. If an ABA has been set up linked only to a low-reliability water shares to enable water to be carried over firstly against low-reliability water shares.

It is difficult to deduce from the data available how much water has been carried over against LRWS as a result of individuals actively setting up their accounts to achieve this.

However, in total there are 169 ABAs in the Murray system linked only to low-reliability water shares. On the Goulburn there are 271 such ABAs set up.

The majority of these are likely to have been set up so that water can be transferred into these ABAs to carryover firstly against low-reliability water shares. However, some accounts may be in this state due to high-reliability water shares being sold alone, leaving only the low-reliability water shares attached to the original ABA.

Summary of carryover use

While a large number of high-reliability water shares have little or no carryover, there is also a significant number of water shares with the maximum amount of carryover recorded on them.

There is not only more carryover on the Murray, but a higher proportion of high-reliability water shares with the maximum amount of carryover. This is not surprising given the greater area of permanent plantings in the Murray system.

While the amount of carryover recorded against low-reliability water shares is relatively low, a number of entitlement holders on both the Goulburn and Murray systems are already actively managing their accounts to carry over water firstly against their low-reliability water shares.

Assessing the proposed changes to the rules

This section does not seek to discuss in detail all the policy considerations relating to the proposed changes to the rules of carryover. The data available is useful in assessing the costs and benefits of the proposed first step changes to the rules, both in terms of individual entitlement holders and the communal pool.

Lifting the 30 per cent limit to 50 per cent

Demand

There is clearly demand to carryover more than 30 per cent of entitlement volume. Counting all water shares there are around 2,800 high-reliability water shares on the Goulburn and 3,900 high-reliability water shares on the Murray that have carried over the maximum 30 per cent.

Demand was highest amongst FMIT customers (now Lower Murray Water customers), 45 per cent of which carried over the maximum volume. In Lower Murray Water’s area this figure was 24 per cent of all high-reliability water shares owners.

This is backed up by anecdotal evidence of Sunraysia irrigators with the maximum 30 per cent of carryover ‘parking’ additional water to carryover with upstream irrigators who were not intending to carry much water over.

While the above figures are clouded by a large number of low volume water shares that may not be being used, even after filtering out water shares less than 10 ML, around 1,400 Murray and 1,000 Goulburn irrigators carried over the maximum 30 per cent against their high-reliability water shares.

Impact of change

Allocation written off from individual accounts linked to water shares at the end of last year was in the order of 8 GL on the regulated Murray system and 6 GL on the regulated Goulburn system. Allocation is
written off if it is in excess of the amount that can be carried over. Much of this write-off was likely to be against unused low volume entitlements.

Raising the 30 per cent limit to 50 per cent would mean that some of this water would be carried over in individual accounts rather than being written off and returned to the communal pool. However, given the relatively small volume written off, the impact of this proposed change on the communal pool is not anticipated to be significant.

**Carryover recorded against low-reliability water shares first**

**Demand**

Irrigators are already carrying over water against low-reliability water shares. In total around 17 GL was carried over against low-reliability water shares in the Murray and Goulburn systems.

Some irrigators are already actively managing their accounts to carry over water firstly against their low-reliability water shares. While it is difficult to ascertain exactly how many have been actively set up to this end, a total of 440 ABAs in these systems already enable carryover against low-reliability water shares first.

While the total amount carried over against low-reliability water shares is relatively low, this is reflective of the additional transaction costs to do so, as well as expectations for low seasonal allocations in 2008-09.

Table 2 summarises details recorded in the water register of trades of low-reliability water shares since these entitlements were created with unbundling on 1 July 2007.

**Table 2. Low-reliability water shares trades (1 July 2007 to 3 September 2008)**

<table>
<thead>
<tr>
<th>Water system</th>
<th>Trades</th>
<th>Volume traded</th>
<th>Median price ($/ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murray</td>
<td>300</td>
<td>21,868 ML (21.9 GL)</td>
<td>$137</td>
</tr>
<tr>
<td>Goulburn</td>
<td>530</td>
<td>55,726 ML (55.7 GL)</td>
<td>$183</td>
</tr>
</tbody>
</table>

Of this trade, approximately 6.6 GL of low-reliability water shares has been purchased by irrigators in Sunraysia – presumably mostly for carryover purposes.

While the trade figures themselves do not illustrate how much entitlement is being traded for carryover purposes, they do indicate that there is already an active market in the trade of low-reliability water shares.

Individuals who wish to carry over water against low-reliability water shares first are able to do so already, and individuals without low-reliability water shares are able to purchase entitlement on the market fairly cheaply.

**Impact of change**

Allowing carryover to be recorded against low-reliability water shares first should not materially alter the impact on the communal pool at the start of the season when allocations are low. With the 100 per cent limit on carryover plus seasonal allocations against a water share, carryover recorded against high-reliability water shares reduces the total resource required to reach 100 per cent allocations against high-reliability water shares.

Carryover against LRWS first would allow irrigators to reduce their risk of receiving limited seasonal allocations in the following year (or ‘losing’ their carryover). The trade-off is obviously that carryover recorded against low-reliability water shares no longer reduces the total resource required to reach 100 per cent allocations against high-reliability water shares. Instead this carryover water effectively feeds back into the communal pool as allocations approach 100 per cent low-reliability water shares.

It is important to remember that carryover does not reduce the total amount of water available in a water system. In fact, on balance it will increase the amount of water in a given system in future years by promoting efficient use. Carryover simply affects the distribution of water between account holders:
Prior to carryover, any unused water was re-distributed amongst all entitlement holders at the end of the water year.

With the current carryover rules, unused water remains in individual accounts as carryover. Carryover recorded against high-reliability water shares would be effectively re-distributed communally as allocations approach 100 per cent.

Carryover recorded against low-reliability water shares is less likely to be re-distributed given the lower chance of low-reliability water shares allocations. This is beneficial to the individual that has carried water over.

Entitlement holders are already able to carry over water firstly against their low-reliability water shares. Individuals with a significant amount of carryover who judge there is a reasonable probability of high allocations in the following season are already likely to do so.
Section 3 – Initial analysis of environmental carryover options
The Draft Strategy identifies the water needs of northern river systems as a series of volume based additional water requirements. As it is not expected that sufficient water could be recovered to meet all needs for several reasons, other measures should be considered to maximise environmental benefits from available water. Environmental carryover is one measure that could provide benefits in meeting water needs for a given volume of water. Carryover could be used as an efficiency measure to improve how far a recovered ‘bucket’ of water will go in meeting water needs. Carryover could provide these benefits because:

- the environment often requires water in a different pattern to when the irrigation season can supply the water
- large volumes are required to be ‘banked’ in storage for multiple years in order to provide enough water to reach floodplain wetlands.

This section of the paper provides an initial assessment of how carryover could be used to provide environmental benefits. Further assessment is required on this use of carryover, including work regarding possible impacts on other entitlement holders. The further assessment will take place as part of the second stage of the carryover review.

Current management arrangements
There are currently three types of arrangements that allow water to be ‘banked’ in an environmental account and used in the future:

- ‘Extended use’: applies to low-reliability sales water. This allows water to be held in an environmental account for up to six months after the year in which it is allocated. The intent is to allow the environmental manager to make a decision how best to use the water in a winter/spring with some certainty of the water available from previous year’s allocation. After six months, any water held in the ‘extended use’ account is lost.
- Barmah rules: apply to water set aside to water the Barmah Forest. This allows annual environmental water allocations to be banked for several years to create larger periodic floods for the Barmah Forest. Water held in the Barmah account is borrowed by other entitlement holders in droughts and is paid back when high reliability allocations reach 30 per cent.
- Murray Flora and Fauna Entitlement (27.6 GL): These are the same rules as for irrigator’s high-reliability water shares. They allow up to 30 per cent of the entitlement to be carried over to the following year. However, total water available in the following year can not exceed 100 per cent of the entitlement (i.e carryover is lost as allocation approaches 100 per cent). This is aimed at providing options to manage water use in and between extreme drought years.

Initial analysis undertaken
A range of carryover options (see below) have been tested on the Goulburn River below Lake Eildon, the Goulburn River below Goulburn Weir, the Campaspe River below Lake Eppalock, and the Campaspe River below the Warranga Western Syphon.

The options have been tested for a range of scenarios:

- Base case – long-term average, based on the historical flow records (1890/91-2006/07)
- Scenario B – CSIRO medium climate change predictions at 2055
- Scenario D – Continuation of recent low inflows (1997/98-2006/07).

In addition, to test the impact of reducing frequency of events (a possible response to lack of enough environmental entitlement), the carryover options were tested for the Goulburn River below Lake Eildon with environmental demands in only every second year.

The preliminary assessment assumed enough environmental entitlement was available to meet the environmental needs on average over the 116 years. This means that the analysis assesses the ability of each carryover option to meet the pattern of environmental flow needs, rather than the adequacy of the volume of entitlement provided.
This approach has been initially taken given that current shortfall volumes are based on trying to meet the full range of environmental demands, including overbank requirements for wetlands. The resultant shortfalls are so large that any carryover option does not perform particularly well as water is being demanded every year. Further prioritisation of flow components is to be targeted in the near future.

The assessments were assuming there was only high reliability water shares, only low reliability water shares, or half each of high and low reliability shares.

The results of the preliminary analysis of each option under each scenario for each river reach are given in Attachment A.

**Option 1: no carryover**
- This option assumes that carryover is not available to the environment against either high- or low-reliability.

**Option 2: carryover against low reliability and high reliability entitlement capped at 100 per cent**
- Carryover is set first against low- and then high-reliability water shares.
- The total volume available for use in any given year cannot exceed 100 per cent of entitlement.
- As allocation increases, the sum of allocated water and carryover water is capped at 100 per cent of entitlement.
- As allocations increase to 100 per cent, carryover water is lost.
- All carryover has five per cent deducted for increased evaporative losses on 1 July.

**Option 3: extended use policy applied to low-reliability entitlement only**
- Carryover is held against low-reliability water shares only (option assessed assumes high- and low-reliability water allocated can be carried over against low-reliability shares before high-reliability water shares). This option is more efficient than the current rule which requires water to be carried over against high reliability entitlement first.
- Carryover water can be held for up to six months in storage and is lost from the account after this time.
- As airspace in the dam reduces, carryover water is lost. If the dam spills, the only water available is that allocated in the current year.

**Option 4: extended use policy applied to low- and high-reliability entitlement**
- Carryover is held against low-reliability and high-reliability water shares (option assumes high- and low-reliability water allocated can be carried over against low-reliability shares before high-reliability water shares).
- Carryover water can be held for up to six months in storage and is lost from the account after this time.
- As airspace in the dam reduces, carryover water is lost. If the dam spills, the only water available is that allocated in the current year.

**Option 5: carryover limited only by dams spilling**
- Water allocated or carried over can continue to be built up and carried over.
- As airspace in the dam reduces, carryover water is lost. If the dam spills, the only water available is that allocated in the current year.
- All carryover has five per cent deducted for increased evaporative losses on 1 July.

**Summary of preliminary results**
Each river reach behaves somewhat differently, having a different mix of environmental water demand, water allocations and dam spilling behaviour. A summary of results is given in Attachment A.

With no carryover, the efficiency of entitlement use ranges from about 60 per cent to 80 per cent. That is, 20 per cent to 40 per cent of the environmental need is not met even though there is enough water entitlement on average to do so.
With carryover only limited by the dam spilling, the efficiency can be improved to about 80 per cent to 90 per cent (ie. shortfalls reduce to 10 per cent to 20 per cent).

Under the base case, with a mix of high- and low-reliability entitlement, there is progressively improving efficiency of entitlement use from no carryover; to 100 per cent entitlement limited option; to extended use (low only); to extended use (low and high); to dam spill only limited carryover. In some reaches, the improvement between options can be quite small.

There are significant gains in efficiency of environmental entitlement use available from use of carryover. The option of carryover capped at 100 per cent of entitlement provides significant benefits over having no carryover. However, under current conditions and medium climate change, the options of - extended use (both low-only and high- and low-reliability entitlement) and dam spill limited only carryover - almost always provide greater benefit than the 100 per cent entitlement limited carryover option.

Extended use benefits are only achieved if carryover is allowed against low reliability before high reliability entitlement. Carryover only limited by dam spills always provides the most efficient environmental entitlement use.

Further detailed analysis is required before decisions are made on the most appropriate changes to the 100 per cent carryover rule. The second stage of the carryover review will focus on this and include analysis of environmental needs.
Attachment A: Ability to meet environmental needs using each carryover options under range of climate scenarios for selected reaches on the Campaspe and Goulburn – Preliminary Analysis

Table A.1 Goulburn River below Lake Eildon:
Additional water still required to meet environmental need – as a percentage of total water requirements (and number of years when environmental needs not met)

<table>
<thead>
<tr>
<th>Carryover option</th>
<th>Base case</th>
<th>Scenario B: medium climate change</th>
<th>Scenario D: continuation of recent low inflows</th>
<th>Scenario D (but meet needs only every 2nd year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High- and low-reliability entitlement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>32% (67)</td>
<td>30% (73)</td>
<td>44% (93)</td>
<td>59% (46)</td>
</tr>
<tr>
<td>100 per cent entitlement limit</td>
<td>22% (53)</td>
<td>12% (37)</td>
<td>9% (32)</td>
<td>45% (46)</td>
</tr>
<tr>
<td>Extended use: low-reliability entitlement only</td>
<td>18% (39)</td>
<td>10% (35)</td>
<td>10% (36)</td>
<td>35% (37)</td>
</tr>
<tr>
<td>Extended use: high- and low-reliability entitlement</td>
<td>16% (37)</td>
<td>10% (35)</td>
<td>10% (36)</td>
<td>28% (32)</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>15% (34)</td>
<td>9% (29)</td>
<td>7% (24)</td>
<td>20% (27)</td>
</tr>
<tr>
<td><strong>High-reliability entitlement only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>23% (69)</td>
<td>26% (71)</td>
<td>42% (88)</td>
<td>57% (50)</td>
</tr>
<tr>
<td>Extended use</td>
<td>9% (27)</td>
<td>6% (25)</td>
<td>9% (33)</td>
<td>21% (34)</td>
</tr>
<tr>
<td>Dam spill only, limited carryover</td>
<td>9% (32)</td>
<td>6% (26)</td>
<td>6% (24)</td>
<td>16% (29)</td>
</tr>
<tr>
<td><strong>Low-reliability entitlement only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>49% (65)</td>
<td>81% (93)</td>
<td>*</td>
<td>64% (46)</td>
</tr>
<tr>
<td>Extended use</td>
<td>33% (40)</td>
<td>69% (79)</td>
<td>*</td>
<td>42% (28)</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>28% (34)</td>
<td>49% (58)</td>
<td>*</td>
<td>31% (22)</td>
</tr>
</tbody>
</table>

*Note – Under Scenario D, low-reliability entitlement only is unable to meet environmental needs on average due to very small number of years with any allocation.

**Comments on results**

- Under all water availability scenarios, high-reliability entitlement only produces more efficient watering the low-reliability entitlement, with mixed high/low in between the two.
- Under base case, high- and low-reliability entitlement, 100 per cent option better than no carryover, extended use is better than 100 per cent, and dam spill only carryover is slightly better than extended use.
- For Scenario B and Scenario D, there is not much difference between all options except no carryover for high- and low-reliability entitlements and low only. Scenario B and low-reliability entitlement only shows dams spill only significantly better than extended use.
- With demands in only every second year, efficiency of use gets substantially worse, and there is substantial improvement in efficiency for all options – from 100 per cent option to extended use (low) to extended use (both) to dam spill only.
Table A.2 Goulburn River below Goulburn Weir:
Additional water still required to meet environmental need – as a percentage of total water requirements
(and number of years when environmental needs not met)

<table>
<thead>
<tr>
<th>Carryover Option</th>
<th>Base case</th>
<th>Scenario B: medium climate change</th>
<th>Scenario D: continuation of recent low inflows</th>
</tr>
</thead>
<tbody>
<tr>
<td>High- and low-reliability entitlement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>35% (41)</td>
<td>32% (55)</td>
<td>23% (77)</td>
</tr>
<tr>
<td>100 per cent entitlement limit</td>
<td>30% (39)</td>
<td>17% (37)</td>
<td>10% (28)</td>
</tr>
<tr>
<td>Extended use: low-reliability entitlement only</td>
<td>25% (35)</td>
<td>20% (40)</td>
<td>14% (42)</td>
</tr>
<tr>
<td>Extended use: high- and low-reliability entitlement</td>
<td>24% (35)</td>
<td>20% (40)</td>
<td>14% (42)</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>19% (28)</td>
<td>11% (24)</td>
<td>10% (26)</td>
</tr>
<tr>
<td><strong>High-Reliability entitlement only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>38% (42)</td>
<td>33% (58)</td>
<td>23% (79)</td>
</tr>
<tr>
<td>Extended use</td>
<td>23% (34)</td>
<td>18% (37)</td>
<td>13% (41)</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>19% (27)</td>
<td>12% (24)</td>
<td>10% (30)</td>
</tr>
<tr>
<td><strong>Low-reliability entitlement only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>41% (63)</td>
<td>73% (95)</td>
<td>*</td>
</tr>
<tr>
<td>Extended use</td>
<td>32% (55)</td>
<td>66% (88)</td>
<td>*</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>26% (42)</td>
<td>42% (54)</td>
<td>*</td>
</tr>
</tbody>
</table>

*Note – Under Scenario D, low-reliability entitlement only is unable to meet environmental needs on average due to very small number of years with any allocation.

**Comments on results**

- Under all water availability scenarios, high-reliability entitlement is not substantially more efficient than mixed high- and low-reliability entitlement, with low worse under Scenario B.
- The efficiency of use increases from no carryover to 100 per cent to extended use to dam spill only option under most cases. 100 per cent option is slightly better than extended use under Scenario B and D.
- For high- and low-reliability entitlement and high-reliability only entitlement, efficiency improves from Base case to Scenario B to Scenario D. For the same order, efficiency worsens for low-reliability entitlements only.
Table A.3 Campaspe river below Lake Eppalock:
Additional water still required to meet environmental need – as a percentage of total water requirements (and number of years when environmental needs not met)

<table>
<thead>
<tr>
<th>Carryover option</th>
<th>Base case</th>
<th>Scenario B: medium climate change</th>
<th>Scenario D: continuation of recent low inflows</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High- and low-reliability entitlement</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>27% (57)</td>
<td>22% (72)</td>
<td>27% (87)</td>
</tr>
<tr>
<td>100 per cent entitlement limit</td>
<td>25% (56)</td>
<td>17% (59)</td>
<td>9% (33)</td>
</tr>
<tr>
<td>Extended use: low-reliability entitlement only</td>
<td>18% (38)</td>
<td>12% (34)</td>
<td>10% (33)</td>
</tr>
<tr>
<td>Extended use: high- and low reliability entitlement</td>
<td>14% (28)</td>
<td>10% (31)</td>
<td>10% (33)</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>14% (28)</td>
<td>9% (28)</td>
<td>9% (32)</td>
</tr>
<tr>
<td><strong>High-reliability entitlement only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>21% (65)</td>
<td>16% (64)</td>
<td>25% (81)</td>
</tr>
<tr>
<td>Extended use</td>
<td>10% (27)</td>
<td>4% (15)</td>
<td>8% (29)</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>10% (27)</td>
<td>4% (16)</td>
<td>7% (25)</td>
</tr>
<tr>
<td><strong>Low-reliability entitlement only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>38% (50)</td>
<td>43% (64)</td>
<td>*</td>
</tr>
<tr>
<td>Extended use</td>
<td>21% (28)</td>
<td>27% (39)</td>
<td>*</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>21% (28)</td>
<td>21% (31)</td>
<td>*</td>
</tr>
</tbody>
</table>

*Note – Under Scenario D, low-reliability entitlement only is unable to meet environmental needs on average due to very small number of years with any allocation.

**Comments on results**

- Under Base case and Scenario B, high-reliability entitlement not substantially more efficient than mixed high- and low-reliability entitlement and low-reliability entitlement only.
- Extended use (high/low) and dam spill only options are similarly efficient.
- Under Base case and Scenario B, 100 per cent option is more efficient than no carryover, but worse than extended use.
- Under Scenario D, 100 per cent is similar to extended use and dam spill only options.
- Efficiency under the Scenario B is better than for the Base case with high- and low-reliability entitlement and with high-reliability only entitlement.
Table A.4 Campaspe river below Warranga Western Channel Syphon: Additional water still required to meet environmental need – as a percentage of total water requirements (and number of years when environmental needs not met)

<table>
<thead>
<tr>
<th>Carryover Option</th>
<th>Base case</th>
<th>Scenario B: medium climate change</th>
<th>Scenario D: continuation of recent low inflows</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High- and low-reliability entitlement</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>33% (59)</td>
<td>27% (63)</td>
<td>26% (72)</td>
</tr>
<tr>
<td>100 per cent entitlement limit</td>
<td>29% (55)</td>
<td>23% (56)</td>
<td>13% (42)</td>
</tr>
<tr>
<td>Extended use: low-reliability entitlement only</td>
<td>22% (45)</td>
<td>18% (47)</td>
<td>15% (46)</td>
</tr>
<tr>
<td>Extended use: high- and low-reliability entitlement</td>
<td>19% (39)</td>
<td>16% (43)</td>
<td>15% (46)</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>16% (33)</td>
<td>11% (31)</td>
<td>11% (35)</td>
</tr>
<tr>
<td><strong>High-reliability entitlement only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>29% (56)</td>
<td>25% (54)</td>
<td>24% (67)</td>
</tr>
<tr>
<td>Extended use</td>
<td>16% (32)</td>
<td>13% (34)</td>
<td>12% (38)</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>14% (30)</td>
<td>10% (25)</td>
<td>9% (30)</td>
</tr>
<tr>
<td><strong>Low-reliability entitlement only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No carryover</td>
<td>41% (56)</td>
<td>42% (71)</td>
<td>*</td>
</tr>
<tr>
<td>Extended use</td>
<td>26% (35)</td>
<td>29% (42)</td>
<td>*</td>
</tr>
<tr>
<td>Dam spill only limited carryover</td>
<td>21% (30)</td>
<td>19% (29)</td>
<td>*</td>
</tr>
</tbody>
</table>

*Note – Under Scenario D, low reliability entitlement only is unable to meet environmental needs on average due to very small number of years with any allocation.

**Comments on results**

- Under all water availability scenarios, high-reliability entitlement only produces more efficient watering the low-reliability entitlement, with mixed high- and low-reliability entitlements in between the two.
- Efficiency under base case is not as good as for the Scenario B, which is not as good as under Scenario D.
- The efficiency of use increases from no carryover to 100 per cent to extended use (low) to extended use (high/low) to dam spill only option under most cases. 100 per cent option is slightly better than extended use under step climate change.