Economic analysis of reserve policy options for the Northern Region Sustainable Water Strategy

A WORKING PAPER FOR THE DEVELOPMENT OF THE DRAFT NORTHERN REGION SUSTAINABLE WATER STRATEGY

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Preface

As part of developing the Draft Northern Region Sustainable Water Strategy, Frontier Economics was engaged to undertake an economic assessment of water allocation management options and reserve policy options. This report presents those findings. The bulk of this work was undertaken in March and April 2008, and has informed discussions within the Northern Region Sustainable Water Strategy Consultative Committee and working group meetings. It has also assisted in formulating a range of proposals presented in the Draft Strategy.

The information presented in this working paper should be considered along with the information presented within the Draft Northern Region Sustainable Water Strategy.

Economic analysis of reserve policy options for the Northern Region Sustainable Water Strategy

Summary

This report investigates the economic and public policy justification for a number of broad water allocation management options, and qualitatively assesses the costs and benefits of specific options.

The report finds that there is a case that system reserve policy should be modified to limit the likelihood of there being insufficient water for irrigation deliveries. This allows entitlement holders to increasingly use individual carryover arrangements to manage dry periods.

The report also finds that there is a strong case for enhancing individual carryover arrangements, and that there are changes that could be made to better align individual incentives with storage management outcomes. This can be done by relaxing the '30% limit on carryover', maintaining the '100% limit on carryover and allocation' and changing the order of deeming such that carryover is recorded firstly against an entitlement holder's low-reliability water share.

Finally, the report finds that there is no clear justification for government intervention to resize entitlements or to purchase entitlements to generally supplement entitlement reliability. Resizing of entitlements would do little to help irrigators but may be costly and cause confusion. The Government purchase of entitlements would be expensive, inflexible and poorly targeted approach to managing water allocation reliability, and alternative policies may be able to provide increased benefits from this expenditure.

1 Introduction

1.1 BACKGROUND

The information presented in this working paper should be considered along with the information presented within the Draft Northern Region Sustainable Water Strategy. The Strategy provides a comprehensive background of the issues.

The Northern Region Sustainable Water Strategy Discussion Paper, released by DSE in January 2008, outlined the region's potential resource position into the future (specifically in light of climate change scenarios) and flagged a range of potential policy/management options to deal with potential increases in water scarcity, variability, and uncertainty.

The next stage of the process is to develop a Draft Northern Region Sustainable Water Strategy (Draft NRSWS) that incorporates stakeholder input and outlines a set of recommendations for water management in the Northern Region for the next 50 years.

Through the NRSWS, a number of options will be developed to address reduced water availability, managing this risk in a flexible manner. The Draft Strategy will consider the social, economic and environmental impacts of preferred and non-preferred options. This project involves an economic analysis of some of the costs and benefits of selected potential management options (for water allocation only, not environmental options).

1.2 OUR ROLE

Frontier Economics has been engaged by the Victorian Department of Sustainability and Environment (DSE) to provide economic advice to inform the assessment of potential management options being considered under the Draft Northern Region Sustainable Water Strategy (NRSWS).

1.3 SCOPE

The broad water allocation management options being considered in this report are[1]:

- System reserve and storage policy;
- individual carryover arrangements;
- resizing of entitlements; and
- Government purchase of entitlements.

We have investigated the economic and public policy justification for each intervention, and then qualitatively assessed the costs and benefits of specific options.

[1] Under some of these broad options, there are sub-options or detailed alternatives.

2 Framework for assessment

2.1 HIGH-LEVEL FRAMEWORK FOR POLICY EVALUATION

A feature of the current water management arrangements that are in place in the northern region of Victoria is the active water market. This is a mechanism that gives individual water users the ability to manage aspects of:

- Long-run supply security — by buying additional entitlements or choosing a mix a high and low reliability entitlements.
- Within-year risk management and flexibility — by buying or selling water allocations within a season.
- Inter-year risk management and flexibility — by buying or selling water allocations within a season, and carrying this water over into subsequent seasons.

The growing emphasis on the use of the water market suggests that a central element of the NRSWS will be to consider ways to strengthen existing market tools as well as to safeguard current market arrangements from foreseeable risks. Notably, climate change poses a number of risks to the way in which the market is designed. Factors that hinder or distort markets (causing incomplete markets / market failure) may be addressed by government intervention (see box quote).

Market failure and Government intervention

Participants in fully competitive markets interact and trade on the basis of complete price signals to reconcile their needs with the scarce resources available. Markets are often imperfect or incomplete, however, resulting in market failures such as the market failure for public goods (for example, defence), externalities (for example, environment and health), market power/imperfect competition (resulting in anticompetitive behaviour) and information failures.

Where markets are perceived to fail, governments may intervene to correct for possible adverse effects.

Governments should only intervene providing that the benefits of government action are likely to exceed the costs on a community-wide basis. Where governments decide to intervene, programs need to be designed to address the relevant problem and produce the greatest possible net benefits (that is, be the best option available). In addition to market failure, governments might also act to address distortions created by previous government intervention (government failure); again, for economic efficiency, the benefits of such action need to outweigh the costs.

Source: Productivity Commission 2005, p. 84.

There are a number of options available to government to address market failure, or risks of market failure. In terms of the management of climatic risk and water storages, the market failures of most policy relevance are caused by shared/joint benefits or costs of storage decisions. This requires an understanding of the role of government, and who is best placed to manage certain types of risks.

The high-level framework we have adopted for assessing policy options in the NRSWS is based on the role of government intervention in markets. These options focus on the features of the resource management and use, and how markets arrangements capture (or failure to capture) these characteristics.

Importantly, policy options can be assessed on how they address:

- public good aspects of volumes of water required for irrigation water delivery;
- non-excludability of spill consequences from storage decisions;
- flexibility and adaptability to react efficiently to future climatic conditions (variability or reductions in water availability); and
- information availability on the 'best available science' of future water availability.

The presence of market failure does not, by itself, justify government intervention. Government intervention can be costly and introduces its own distortions, especially if the intervention is poorly targeted to achieving the relevant objective. Government intervention is only warranted when it produces net economic, social or environmental benefits to the community. This means that the private costs and benefits have to be assessed in a way that considers transaction costs as well as the costs and benefits of the government intervention itself.

2.2 APPROACH TO ASSESSING SPECIFIC POLICIES

The methodology for assessing each of the management options includes the following steps:

- Broadly describing the option and identifying whether there is any case for government intervention according to the high-level framework based around the presence of market failures.
- Describing the specific proposed management rule, as well as alternative approaches that could be adopted, as a way to address the market failure.
- Qualitatively assessing the economic benefits and costs of the policy intervention and alternatives.
- Discussing how the policy can be optimally implemented to maximise social outcomes and other considerations.
- Summarising conclusions / recommendations for the management option.

3 System reserve and storage policy

3.1 WATER MANAGEMENT ISSUE AND ROLE OF GOVERNMENT

In order to deliver irrigation water, water is required to fill the irrigation delivery systems over the length of the season. For a given irrigation district, there is a minimum required volume. This is required before allocations can be made and before carryover can be used. Current storage management policies only commence accumulation of reserves for the following year once high reliability entitlements have been fully (100%) allocated.

This means that there is some risk water might not be delivered at the beginning of an irrigation season based on current storage management practices, particularly in light of the potential impacts of climate change on seasonal allocations outlined in the NRSWS scenarios.

Although individual irrigators can buy and sell water access entitlements and allocations, and can now carryover water between seasons, they are unable to individually manage the risk of non-delivery. Non-delivery occurs until the system has a 1% allocation.

The market failure, and hence role of active management at the system level, stems from the public good characteristics of the volume required to commence water delivery and continue water deliveries throughout the irrigation season — namely non-excludability.

This suggests a potential role for government to limit the risk of non-deliverability via storage management policies.

The NRSWS gives the Victorian Government the opportunity to consider the desired likelihood of avoiding system failure (given the knowledge of climate change risk) and intervene through storage reserve policies.

3.2 PROPOSED MANAGEMENT INTERVENTION

The proposed management intervention is to alter storage management policies in order to commence the accumulation of reserves earlier in the allocation schedule — a system reserve. This would set aside volumes, for delivery systems in subsequent seasons, before full allocations are made.

3.3 ASSESSMENT OF ECONOMIC BENEFITS AND COSTS

In general, earlier accumulation of reserves would have three significant consequences, listed below, with the magnitude of the resultant changes being determined by the detail of the system reserve policy.

- Reduce the likelihood of non-deliverability at the start of a season.
- Increase expected allocations in dry years.
- Decrease expected allocations in wet years.

An example of the effect on allocations is presented in figure 5.2 of the Draft NRSWS.

Individual irrigators already have access to carryover arrangements that enable them to make private trade-offs between the second and third elements, whereas a system reserve policy is the only policy identified that addresses the first of these.

The likelihood of non-deliverability is affected by:

- The volume of 'delivery' water required
  - This is determined by the timing of the start and end of irrigation season, whether water deliveries occur throughout the full or partial system, and the progress of an infrastructure upgrades that might reduce system losses); and
- The reserve policy
  - This volume of system reserve accrued by this policy depends on the rules regarding when reserve accumulation starts and stops, and the rate at which it is accumulated.

If the policy objective is to avoid years when delivery is not possible at the beginning of the season, then the following needs to be considered:

- No policy can ensure ongoing future deliverability with certainty — due to uncertainty over future inflows.
- Risk aversion suggests a conservative approach, but how conservative?
- Modelled outcomes are estimates based on historical data and have limitations in the face of future uncertainty.

3.3.1 Assessment of expected benefits

The expected benefits from implementing the reserve policy are primarily to avoid the potential costs of non-deliverability at the commencement of the season, by reducing the risk that this would occur. If non-delivery did occur:

- Rights would have to be qualified
  - The NRSWS Discussion Paper identified that taking actions to minimise the qualification of rights would be pursued (p. 42).
- Water that has been carried over by individuals would not be able to be delivered.
  - With zero allocations and no means to access water held in storage, this would jeopardise the survival of perennial plantings such as trees, vines and perennial pastures — which take a number of years to replace to productive capacity.
- Urban water as well as stock and domestic water would be unavailable to those areas that have this water delivered through the irrigation infrastructure.

- The cost of carting water as an alternative supply to these urban and stock and domestic users is extremely costly.
- The cost of very high level water restrictions to manage limited urban supplies is extremely costly.

- Partial irrigation system closure, to reduce volume required for deliverability
  - As with non-delivery for all irrigators, the cost to those areas that do not have their irrigation system open for delivery is that their carryover water to manage dry year risks cannot be delivered and used.
  - There is also a stakeholder management / political issue of choosing which regions of the irrigation system remain open. The economic costs of this is that arbitrarily selecting some districts for delivery will not necessarily maintain delivery to the highest value users.
- Reduced season length, to reduce volume required for delivery
  - This can ensure early season deliveries but can restrict some industries through shortening the season length.
  - It may also limit the opportunities for opportunistic cropping presented by a good autumn break.

These benefits are substantial, given that the avoided costs are considered to be potentially catastrophic costs.

The potential benefits of a system reserve that are related to limiting the risk of non-deliverability at the commencement of a season will be captured if a conservative system reserve policy is set that significantly limits the likelihood of this occurrence.

The definition of 'conservative' would take into account the presumably risk-averse approach that DSE has to the occurrence of such an adverse event and could be modelled on:

- A climate change scenario at least as severe as expected — such as a continuation of recent low inflows (1997-2007).
- A recognition that the 116 years of historical records are a sample of historical variability — therefore a minimum reserve policy that achieves 0 years of 0% allocation based on the 116 year sample may not be suitably conservative.
- A recognition that the REALM model and other hydrological models are only representations of water management systems — therefore a minimum reserve policy that is modelled to achieve 0 years of 0% allocation may not be suitably conservative, as they cannot predict outcomes with 100% accuracy.

It should be noted that the benefits from increases in expected allocations in dry years and the cost of decreases in expected allocations in wet years should not be attributed to the system reserve policy given that this trade-off can already be made (or offset) by individual irrigators making decisions that exercise their individual carryover arrangements.

3.3.2 Assessment of expected costs

The costs of implementing a system reserve policy include:

- Administration and management costs of the rule change, including stakeholder management;
- Increased likelihood of spill events; and
- Costs from foregone production if average allocations are reduced.

The potential costs of the system reserve policy increase as the level of system reserve held increases. This can be compared to the marginal benefits (avoided costs) of system reserve which are large up to the point that deliverability is effectively ensured (low risk of non-delivery). Beyond this point, once risk of non-deliverability has been limited, the benefits of additional system reserve are small or negligible because individuals can achieve the similar result using carryover.

It should be noted that, given the MDB Cap on diversions, the increase in spills does not significantly reduce the volume of water available to irrigators, rather it reduces the volume of water commandable for environmental purposes (more environmental flows occur from spills and less from managed releases). This may be an environmental cost if water use for environmental benefit is restricted.

3.4 OPTIMAL RESPONSE

The above discussion of benefits and costs suggests that the optimal system reserve policy should be set to effectively ensure deliverability (very low likelihood of non-delivery) — if it is not too costly to do so. Accumulating reserves beyond the point of ensuring deliverability cannot be justified based on the market failure relating to the volume required to commence water delivery and continue water deliveries throughout the irrigation season. Rather, it would have to be based on other properties of the system reserve policy as compared to individual carryover arrangements (see appendix examining differences between system reserves and individual carryover).

A conservative approach to effectively ensuring deliverability may use a criteria for modelling such as 0 years of <2% allocations, or 0 years of <5% allocations (depending on the degree of conservatism), if the continuation of recent low inflows (1997-2007) climate assumption is made.

For a given volume of delivery water required, such as for the current state of irrigation infrastructure, the risk of non-deliverability will be further reduced if infrastructure upgrades are made (such as the proposed Food Bowl Modernisation Project). Alternatively, the system reserve policy can be flexibly designed and defined to keep the same risk profile if and when these infrastructure upgrades are made.

The objective of effectively ensuring deliverability can be met by a suite of reserve accumulation policies, such as:

1. Start accumulating reserve at an allocation of 30% (HRWS). From this point, sets aside 1ML reserve for each 2ML improvement in the water resource. Cease accumulating reserves at an allocation of 50% (HRWS).

This policy would accrue a maximum reserve of 339 GL. (Option 5 presented to the Working Group).

2. Start accumulating reserve at an allocation of 20% (HRWS). From this point, sets aside 1ML reserve for each 3ML improvement in the water resource. Cease accumulating reserves at an allocation of 90% (HRWS). This policy would accrue a maximum reserve of 594 GL.
3. Start accumulating reserve at an allocation of 10% (HRWS). From this point, sets aside 1ML reserve for each 4ML improvement in the water resource. Cease accumulating reserves at an allocation of 100% (HRWS). This policy would accrue a maximum reserve of 509 GL.

Each of these policies has their own pros and cons. Commencing reserve accumulation at 30% allocation may be desirable because it is known that the water market can function with this amount of water — a 29% allocation is the minimum observed total allocation to Goulburn irrigators (in 2005-06). However, this may not secure the system reserve in the year after a low allocation season, such as in a year with a 29% allocation. Commencing reserve accumulation at 20% may be desirable because it commences accumulation earlier and therefore the rate of accumulation can be slower whilst still providing the same limit on risks on non-deliverability. The 20% allocation level is the level at which qualification for urban water users ceases, and also the level at which decisions to extend irrigation season length begin to be made.

Moreover, this discussion suggests that flexibility should be permitted in the detail of the system reserve policy. This flexibility is achieved if the policy objective is announced — such as limiting the risk of non-deliverability as modelled by REALM given the volume required by the infrastructure. The objective of *limiting the risk of non-deliverability* could be demonstrated by an accumulation approach that meets this objective under current circumstances, rather than announcing the fixed details of an accumulation policy.

3.5 CONCLUSIONS/RECOMMENDATIONS

With increasing scarcity and uncertainty associated with the impacts of climate change there is a strong case for modifying the current system reserve policy to limit the likelihood of there being insufficient water to enable irrigation deliveries.

The optimal system reserve policy should be set to balance the likelihood of potentially catastrophic costs associated with system failure in a sequence of dry to very dry years with the likelihood and consequences of additional spills in wet years. Without being able to quantify these likelihoods and consequences, the government seems justified in taking a relatively conservative position to effectively ensure deliverability (low likelihood of non-delivery). However, the actual design of the rule could be specified in a manner that allows for flexibility into the future to deal with improvements in information about the impacts of climate change and in regard to the physical system characteristics (the volume of water required to meet a desired level of service).

4 Individual carryover

4.1 WATER MANAGEMENT ISSUE AND ROLE OF GOVERNMENT

Water availability in northern Victoria has historically been highly variable. Traditionally, large storages have been managed to reduce year-to-year variability with allocation policies to secure allocations for the future year before making allocations above 100% of high reliability entitlements in the current year.

The ability of irrigators to smooth their allocations *between* years has only been possible in Victoria since 2006-07 when individual carryover arrangements were introduced. Irrigators making individual carryover decisions need to weigh up the known value of water in the current season against the potential value of that water to them in the following season (numerical examples are provided in appendix B).

Carryover provides irrigators with a mechanism to access capacity (air space) in the major storages. Before this time, irrigators effectively faced a 'use it or lose it' decision with their water since any unused or unsold water in accounts at the end of the season were forfeited. Carryover water, however, can only be delivered and used if allocations of 1% or greater are announced (i.e. non-delivery is avoided).

Allowing individuals to access storage addresses the current absence of a market with respect to inter-seasonal storage of allocations. The current use of individual carryover is limited by the transitional arrangements that were put in place for carryover implementation in 2006-07.

Carryover is a valuable tool for irrigators to manage their inter-seasonal risks of water availability, but its use is currently capped at 30% of an individual's entitlement volume (the 30% rule). Also, current management limits the volume carried over from the end of a season plus all subsequent allocations in the following season to a maximum of 100% of the water entitlement volume (the 100% rule).

It is notable that there was significant use of carryover in the 2006-07 irrigation season, with 130GL being carried over. Carryover has and will continue to become an increasingly important mechanism if the more severe climate change scenarios eventuate, giving irrigators the ability to manage this risk.

The Government is investigating whether further loosening of restrictions to current carryover arrangements may be appropriate to increase the inter-seasonal allocative efficiency aspects of the water market.

4.2 PROPOSED MANAGEMENT RULE

While carryover is a valuable tool for irrigators to manage their inter-seasonal risks of water availability, it can have third party impacts if the carryover policy does not take into account the consequences on storage management.

This impact is demonstrated in the working group discussions. On the left of figure 1, storages at capacity can hold the full volume of high-, low-reliability water shares, and next seasons reserve. On the right of figure 1, allowing individuals to carryover could reduce storage capacity for firstly low-reliability shares and then next season's reserve if there is no policy to deal with spills caused by carryover.

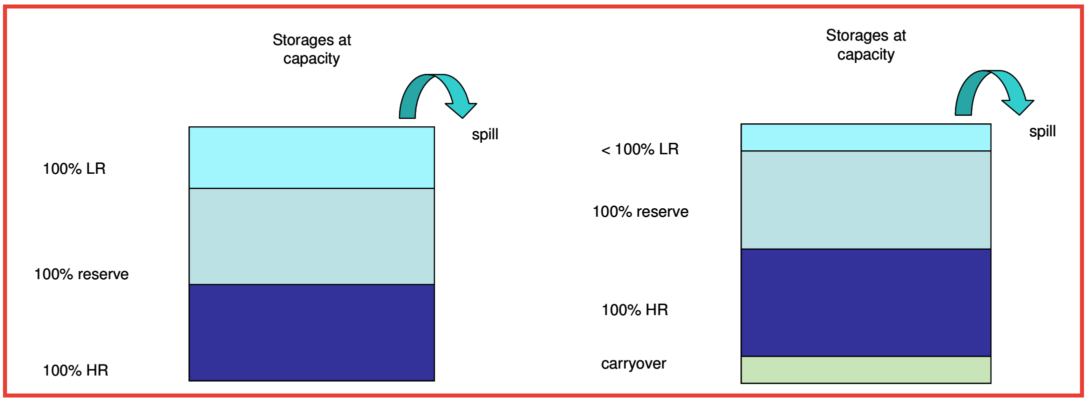

Figure 1: Spill in storages due to individual carryover

Source: NRSWS Working Group discussions, 26 February 2008.

This issue is currently managed by specified carryovers rules in the following way:

> The volume carried over from the end of a season (minus the 5% deduction for evaporation) plus all subsequent allocations in the following season will be limited to a maximum of 100% of the water entitlement volume. [the 100% rule]

And,

> 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 firstly against an entitlement holder's high-reliability water share(s) up to the 30% limit[2]. [the 30% rule]

The Draft NRSWS is considering if it is appropriate to make changes to existing carryover arrangements. In the following we provide comment on the key aspects of the current carryover policy.

4.3 DISCUSSION OF BENEFITS AND COSTS

4.3.1 Assessment of expected benefits

There are benefits to irrigators from increasing their access to storage space by increasing the volume that they can carryover. This can be done by:

[2] The current 30% rule applies to both the high and low reliability water shares.

- relaxing the 30% rule; and/or
- relaxing the 100% rule.

There are also benefits from decreasing the risk that irrigators face from receiving capped allocations due to the volume that they have carried over. This can be done by:

- relaxing the 100% rule, and/or
- changing the order of deeming such that carryover is recorded firstly against an entitlement holder's low-reliability water share (which is less likely to receive significant allocations than an entitlement holder's high-reliability water share).

4.3.2 Assessment of expected costs

Relaxing the 30% rule would be likely to incur only limited administrative costs, and in the presence of the 100% rule individual carryover decisions would not impact on third parties. It should be noted that irrigators make individual decisions to determine the volume they carry over (up to any limit) — and as the volume an individual carries over increases, so does the risk that carryover volumes will cap the allocations received if there is a 100% rule in place. Changes in the likelihood of foregone allocations should only be considered an economic cost of any policy change if the foregone allocation is closely correlated to a foregone volume in storage (such as an external spill), otherwise it is represents a transfer.

Relaxing the 100% rule could have third-party impacts on other entitlement holders (see figure 2) if carryover volumes are large. This may be able to be managed by more complex rules that limit these risks but this may also increase administrative complexity.

Changing the order of deeming would be likely to incur only administrative costs. In fact, this also prevents the need for 'work-around' solutions that are currently implemented by individuals — such as holding high and low reliability products under different names, and only carrying water over in the name holding exclusively low reliability entitlements. This means that administrative costs could actually reduce as the administrative burden of these work-around solutions is reduced.

If the order of deeming were to be changed, there may be equity concerns for those irrigators that do not own low reliability water access entitlement. Under the sales deal, no low reliability entitlements were granted to water entitlement holders in districts such as Sunraysia, and if a water user does not own low reliability entitlement then they would not be advantaged by the change. However, if the order of deeming were changed this would not disadvantage such irrigators because they could still exercise individual carryover decisions against their high reliability entitlements (as currently occurs). Also, such irrigators would be able to purchase low reliability entitlements in the market.

4.4 OPTIMAL RESPONSE

The 30% rule

As stated, carryover is a valuable tool for irrigators to manage their inter-seasonal risks of water availability, but its use is currently capped at 30% of an individual's entitlement volume. As stated in working group discussions, the original justification for this was to limit impacts of unused water spilling into the system reserve at the end of the season. However, there is little reason why anyone would not use or sell their water rather then lose it to the system reserve pool, so this impact is expected to be limited.

The working group discussions suggested:

> Now that carryover is widely accepted it makes sense to increase individual carryover capacity to at least 50% of HR water shares, and maybe more against LR water shares.

This increase is certainly movement in the right direction. Further discussion of what, if any, consequences for system management led to the initial 30% limit, or why this might be inappropriate, would be valuable to support arguments why increasing this limit is feasible.

If the 30% cap was only a phasing-in mechanism, then the 130 GL of carryover observed in 2005-06 shows the enthusiastic reaction from individual water users and suggests further loosening of this seemingly arbitrary restriction may be idely supported.[3]

Initially, we can see no constraints to raising the limit on carryover to 100% of high and low reliability water, particularly when the 100% rule is also in place (see below). There may be some merit in progressively raising this limit to provide some assurance against any unexpected consequences.

The 100% rule and the order of deeming

As stated, current management requires:

> The volume carried over from the end of a season (minus the 5% deduction for evaporation) plus all subsequent allocations in the following season will be limited to a maximum of 100% of the water entitlement volume.

If the limit for carryover plus allocation were increased to above 100% for high reliability entitlements, then individual carryover decisions could impact on the reliability of low reliability water products. It could also impact on the system reserves if the volume held in excess of 100% was large (figure 1).

The effect of increasing the carryover plus allocation limit to above 100% for low reliability water would be to reduce the reliability of low reliability water.

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[3] It is noted that, in the Goulburn system, the sales water deal allocated low reliability entitlement to high reliability entitlement holders at 48% of the HR held. This means that a 30% cap on LR carryover is equivalent to 14.4% of high reliability entitlement.

As such, it is our view that, unless storage capacity becomes a tradable product in itself, that a total limit of 100% of HR and LR in combination is required to avoid the risk of third party impacts (see appendix C).

However, currently the policy is that water carried over will be credited first to customers' high reliability accounts. As shown in the following, our initial feeling is that this represents an overly conservative approach, and that it undermines the private value of both high and low reliability water shares.

In figure 2, it is assumed that each type of water product effectively has its own airspace in storage, and that two types of irrigators share the storage (only Irrigator L (on the left) utilises carryover, Irrigator R (on the right) does not). If carryover is deemed to accrue to the high reliability water product first, it is effectively held over in the high reliability airspace. As inflows provide water for high reliability allocations, the 100% rule will mean that when Irrigator L reaches 100% (carryover plus allocations) before Irrigator R, subsequent inflows will accrue to Irrigator R. This effectively bolsters the reliability of Irrigator R's high reliability water product via internal spills from Irrigator L. The storage does not physically spill until reserves and low reliability allocations have been filled — an external spill. If carryover water faces an unnecessary risk of internal spill then this will result in under-utilisation of carryover provisions.

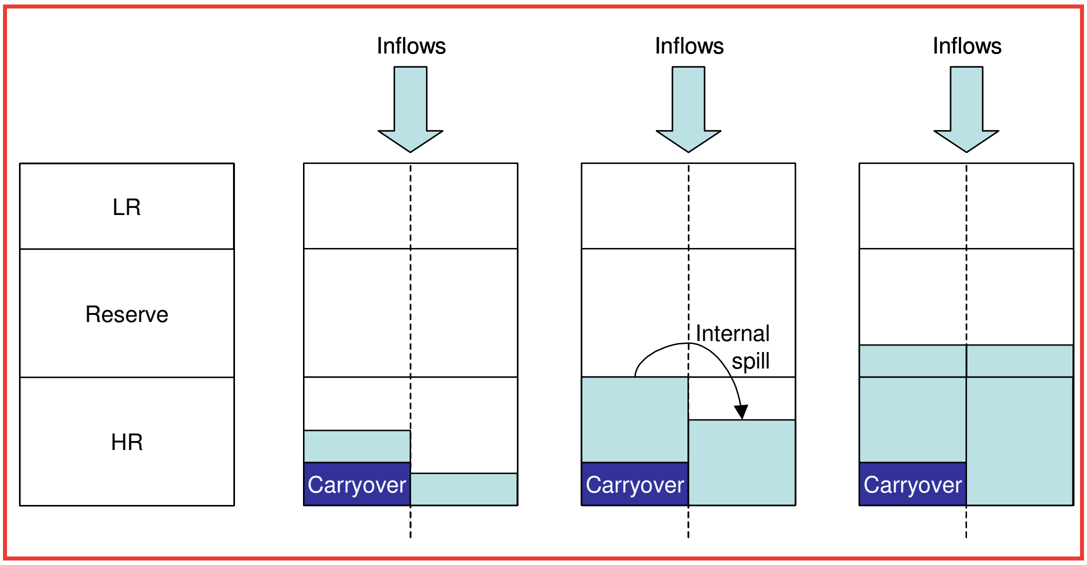

Figure 2: Storage consequences given high reliability deeming first

Figure 3 is based on similar assumptions, except that carryover is deemed to accrue to the low reliability water product first (therefore it is effectively held over in the low reliability airspace). As inflows provide water for high reliability allocations, both types of irrigators are allocated water to their high reliability entitlement at the same rate. Reserves then fill. As low reliability allocations are made, carryover decisions start to have an impact — the 100% rule will mean that when Irrigator L reaches 100% (carryover plus LR allocations) before Irrigator R, subsequent inflows will accrue to Irrigator R via internal spills. Compared to the previous example, when carryover is deemed to accrue to the low reliability water product first, this internal spill is much more likely to be followed by an actual spill event.

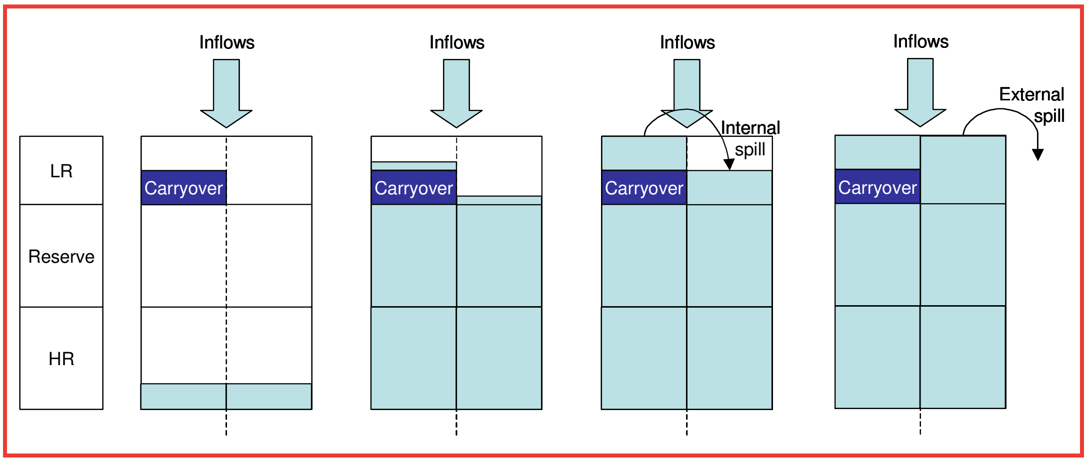

Figure 3: Storage consequences given low reliability deeming first

We believe that a more optimal and easily implementable approach would be to adjust the deeming order for carryover to be credited to low reliability entitlements first. This aligns incentives more closely with spill consequences, and ensures that the 100% rule maintains a close alignment of individual incentives to system outcomes.

Linking the carryover with high-reliability water shares first is not well aligned with the physical occurrences in storages, where low reliability is the first type of water product whose volume is affected by individual carryover decisions if no spill rules were in place.

In fact, switching the order in which this water is deemed to accrue will align the incentives for individual carryover most closely with spill conditions in storages — were internal spills are highly correlated with external spills. This also prevents the need for 'work-around' solutions that are currently implemented by individuals — such as holding high and low reliability products under different names, and only carrying water over in the name holding exclusively low reliability entitlements. This also links the low reliability water product closely with airspace access arrangements.

In general, adjusting deeming rules and loosening the 30% cap on both HR and LR would help define the value of the low reliability water entitlement product as a mechanism for accessing storage airspace and hence carryover between seasons. In practice it creates the possibility that Sunraysia irrigators may purchase LR water shares just to access additional storage for their carryover. In essence in a world of climate change and continual low allocations, this may see the value of LR water shares move from the water attributes to the storage attributes of this product. This raises the possibility of whether it may be feasible to actually unbundle storage rights from the water rights in the same way that distribution capacity shares have recently been unbundled. There is precedence for this in St George in Queensland, however, this would be a much more significant reform and many of the benefits may be obtained through the simpler changes outlined above. Anothed opportunity to liberalise carryover rules by accessing airspace in storages is briefly canvased in appendix C.

4.5 CONCLUSIONS/RECOMMENDATIONS

There is a strong case for enhancing individual carryover arrangements. Such changes would provide inter-seasonal allocative efficiency benefits, could better align individual incentives with storage management outcomes, and can be cost-effectively designed and implemented to prevent third party impacts.

Suggested changes include:

- Relaxing the 30% rule (possibly up to 100%);
- Maintaining the 100% rule; and
- Changing the order of deeming such that carryover is recorded firstly against an entitlement holder's low-reliability water share.

5 Resizing of entitlements

5.1 WATER MANAGEMENT ISSUE AND ROLE OF GOVERNMENT

Under climate change scenarios, current entitlement volumes will have a lower reliability than they have had in the past as the resource available for allocation is reduced.

Resizing involves scaling down all high- and low-reliability entitlements by a predetermined factor. Resizing to reduce the total volume of all entitlements would improve the reliability of entitlements.

Entitlement holders would not receive any financial compensation for this, as the aim of resizing is to improve the reliability of all entitlements.

However, there is no clear market failure here because individuals can resize their own entitlements through the market to ensure an improved reliability of supply of the water required to meet their needs.

Reduced seasonal allocations as a result of climate change provide entitlement holders with information about the reliability of their water shares.

There is no clear role for government intervention on resizing entitlements to maintain currently levels of reliability in the face of climate change.

If irrigators, or entitlement holders more generally, are not aware of potential consequences of climate change on the reliability of their entitlement then direct information provision could address this. For example, the NRSWS Discussion Paper itself increased the available information on this topic.

5.2 ASSESSMENT OF BENEFITS AND COSTS

5.2.1 Benefits

If there is a resizing entitlements to 0.9*HRWS and 0.8*LRWS, under the continuation of recent low inflows (1997-2007) climate assumption there is expected to be a minor improvement in the total volume of water allocated against HRWS in 67 years out of 100 (but noticeably less water allocated against HRWS in other years) and low-reliability allocations are slightly improved.

5.2.2 Costs

The setting of the entitlement resizing is highly sensitive to the climate changes assumptions, and reduces the total water deemed available. For example, if historical inflows were to continue:

- There is a minor increase in reliability of HRWS, but the total volume of water allocated to HRWS is reduced in 98 years out of 100.

- The reliability of LRWS is improved markedly, and while a greater volume of water is allocated against LRWS in 33 years out of 100, the total volume of water allocated is less in 50 years out of 100.
- It does not prevent years with 0% allocations.

This means that if a resizing policy is implemented that is calibrated to an expected continuation of recent low inflows (1997-2007) climate change scenario then there are significant costs if this climate change scenario does not eventuate. The chart below shows that allocations to low reliability entitlements will be significantly constrained by a resizing policy.

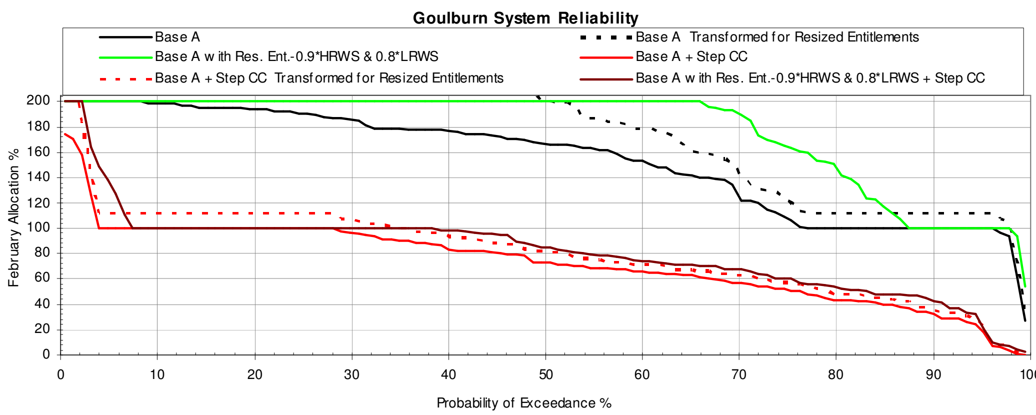

Figure 4: Example modelling of Goulburn Reliability

There are also costs from increased uncertainty/sovereign risk faced by water users from future potential rule changes, as well as from transaction costs of increased participation in water markets by entitlement holders that may seek to buyback water after their water portfolio was reduced due to resizing.

5.3 CONCLUSIONS/RECOMMENDATIONS

There is no clear market failure or case for government intervention, nor do the expected benefits and costs provide a basis for intervention. Resizing of entitlements would do little to help irrigators but may be costly and cause confusion. Selecting an optimal resizing option is also highly sensitive to climate change outcomes.

If a resizing policy is targeted at maintaining the reliability characteristics of entitlement products in the face of changing climate and inflow characteristics, it may be appropriate to instead inform irrigators and other water users of the available information and expected changes to reliability so that they can make their own informed decisions.

6 Government purchase of entitlements

6.1 WATER MANAGEMENT ISSUE AND ROLE OF GOVERNMENT

Under climate change scenarios, current entitlement volumes will have a lower reliability as the resource available for allocation is reduced.

It order to improve the reliability of water users' entitlements, a volume of entitlement could be purchased on the market by the managing authority (G-MW) on behalf of the Victorian Government and operated as a reserve. This reserve could be operated to support the reliability of all water users, to target irrigator water reliability in dry years and environmental water reliability in wetter years, or otherwise. Under such an option, this purchase would be funded by the Victorian Government (not directly by water users[4]).

However, under existing water management arrangements, individuals can already make decisions to alter the reliability of their water portfolio by buying or selling high and/or low water access entitlements, utilising individual carryover arrangements or buying and selling allocations within a given irrigation season. This suggests that there is no market failure requiring government intervention because individuals can already make decisions through the market to improve their reliability of water supply to meet their needs.

There are potential public good environmental benefits of the option, but there are also many existing avenues to directly fund environmental water purchases.

6.2 ASSESSMENT OF BENEFITS AND COSTS

6.2.1 Benefits

Under historical inflows, HR allocations are improved marginally, and LR allocations improved significantly.

However as a response to a continuation of recent low inflows, it is not a very effective strategy. In very dry years there is very little improvement in seasonal allocation, while the improvement in HR and LR allocations is relatively small.

6.2.2 Costs

Purchase of 100 GL of HRWS on the Goulburn system alone would cost approximately $250 million. Repeating the exercise on the Murray would bring the total cost to around $500 million.

The water market impacts of entitlement purchase on this scale could be significant, and have interactions with water entitlement purchasing behaviour by individuals and for the environment.

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[4] This wording differs from early working group discussions which suggested the "purchase would be funded by water users".

6.3 CONCLUSIONS/RECOMMENDATIONS

There is no clear justification for government intervention to purchase entitlements to generally supplement entitlement reliability, and such an intervention would effectively be counter to Victoria's commitment under the National Water Initiative risk assignment framework (Paragraph 48) which states that:

> *Water access entitlement holders are to bear the risks of any reduction or less reliable water allocation, under their water access entitlements, arising from reductions to the consumptive pool as a result of: (i) seasonal or long-term changes in climate...*

Moreover, the modelling suggests that as a response to the continuation of recent low inflows (1997-2007) climate change scenario, it does not significantly improve allocations in dry years, and the benefits are highly sensitive to climate changes outcomes.

The Government purchase of entitlements would be expensive and alternative policies may be able to provide increased benefits from this expenditure. Such alternatives will bring greater net social benefits if they are targeted programs with specific objectives, rather than an across-the-board spending to marginally alter entitlement reliability.

7 Conclusions

In brief, the conclusions/recommendations from this report can be summarised as follows:

- Recommended policies
  - There is a case that system reserve policy should be modified to limit the likelihood of there being insufficient water for irrigation deliveries.
  - There is a strong case that individual carryover arrangements should be enhanced, and that there are changes that could be made to make individual incentives more closely aligned with storage management outcomes. This can be done by:
    - Relaxing the 30% rule
    - Maintaining the 100% rule
    - Changing the order of deeming such that carryover is recorded firstly against an entitlement holder's low-reliability water share.
- Policies not recommended
  - There is no clear justification for government intervention to resize entitlements. Resizing of entitlements would do little to help irrigators but may be costly and cause confusion.
  - There is no clear justification for government intervention to purchase entitlements to generally supplement entitlement reliability. The Government purchase of entitlements would be expensive, is inflexible and poorly targeted with no clear objectives thus creating further uncertainty, and alternative policies may be able to provide increased benefits from this expenditure.

Appendix A: Differences between system reserves and individual carryover

As discussed in section 3, accumulating reserves beyond the point that conservatively limits the risk of non-deliverability cannot be justified based on the market failure relating to the volume required to commence water delivery and continue water deliveries throughout the irrigation season. Doing so would have to be based on other properties of the system reserve policy as compared to individual carryover arrangements. The similarities and differences in functions provided by system reserve and individual carryover are presented in table 1.

Desirable property / characteristic	System reserve	Individual carryover
Enables water to be shifted between years to manage dry year risk	Yes	Yes
Tailors to different risk profiles of individual irrigators / crop types	No	Yes
Helps manage the risk of insufficient water to operate the system	**Yes**	**No**
Robust to climate assumptions	Yes	Yes
Effect on evaporation easily taken into account	Yes - actual	Yes – assumed 5%
Later timing of reserve decision — allows decision making with more available information	Early season, as allocations are announced	Late season, as end of irrigation year approaches
Effect on spill easily taken into account (multi-storage, and 'taking water off irrigators' issues)	Yes	No

Table 1: Comparing system reserve and individual carryover

Appendix B: Carryover numerical examples

Irrigators making individual carryover decisions need to weigh up the known value of water in the current season against the potential value of that water to them in the following season.

The value of water in the current season is derived from the benefit the water has if used on farm or sold in the water market. A proxy for this is the prevailing market price of water allocation transfers — the price at which irrigators can buy or sell water to adjust on-farm water use decisions or carryover decisions.

The potential value of water in the following season depends significantly on water availability in the next irrigation season — particularly announced water allocations, but also prevailing climatic conditions[5]. Again, a proxy for the benefit the water has if used on farm or sold in the water market is the expected trading price of water allocation transfers.

Table 2 considers the expected value of a decision to carryover 20ML against a 100ML of high reliability water share, under different possible water availabilities.

Future water availability	HR alloc. (%)	LR alloc. (%)	Future market price ($/ML)	Carryover available (ML)	Total value of carryover ($)
Extremely scarce	30	0	$1,000	20	$20,000
Very scarce	50	0	$500	20	$10,000
Scarce	80	0	$150	20	$3,000
Average	100	0	$80	0	$0
Abundant	100	50	$50	0	$0
Very abundant	100	100	$30	0	$0

Table 2: Potential value of carryover, carryover of 20ML against 100ML of HR

Table 2 can be interpreted as follows:

- If it eventuates that water is extremely scarce in the following year and announced allocations are 30% for high reliability water shares and 0% for low reliability water shares, then the price of water is expected to be in the order of $1,000/ML. In this case, the carryover decision provides an

[5] More generally, the value of water in a given season will be influence by the factors that affect water supply/availability as well as factors that affect water demand, including seasonal conditions, prevailing and expected commodity prices, and availability of on-farm substitutes for water (such as fodder).

additional 20ML on the irrigator's account (than would have otherwise been available) that has a total value of $20,000.

- If it eventuates that water is scarce in the following year and announced allocations are 80% for high reliability water shares and 0% for low reliability water shares, then the price of water is expected to be in the order of $150/ML. In this case, the carryover decision provides an additional 20ML on the irrigator's account (than would have otherwise been available) that has a total value of $3,000.
- If it eventuates that water availability is average in the following year and announced allocations are 100% for high reliability water shares and 0% for low reliability water shares, then the price of water is expected to be in the order of $80/ML. In this case, however, the carryover decision does not provide any additional water on the irrigator's account (than would have otherwise been available) because under current carryover rules allocations are capped at 100%. This means that the value of the carryover water is $0.

The likelihood (expected probability) of each of these water availability scenarios depends on the current levels of storages and weather outlooks. For example, if weather conditions and storage inflows were hard to predict, the expectations over water availability in the following season could be completely based on current storage levels and an assumed distribution of possible inflows (Table 3).

Water availability	Expected probability if storage level was significantly below average	Expected probability if storage level was slightly below average	Expected probability if storage level was above average
Extremely scarce	15%	5%	1%
Very scarce	20%	15%	4%
Scarce	40%	20%	10%
Average	20%	40%	40%
Abundant	4%	15%	30%
Very abundant	1%	5%	15%

Table 3: Expected probabilities of water availability scenarios

Alternatively, this can be presented graphically as distribution curves of expected water availability (Figure 5).

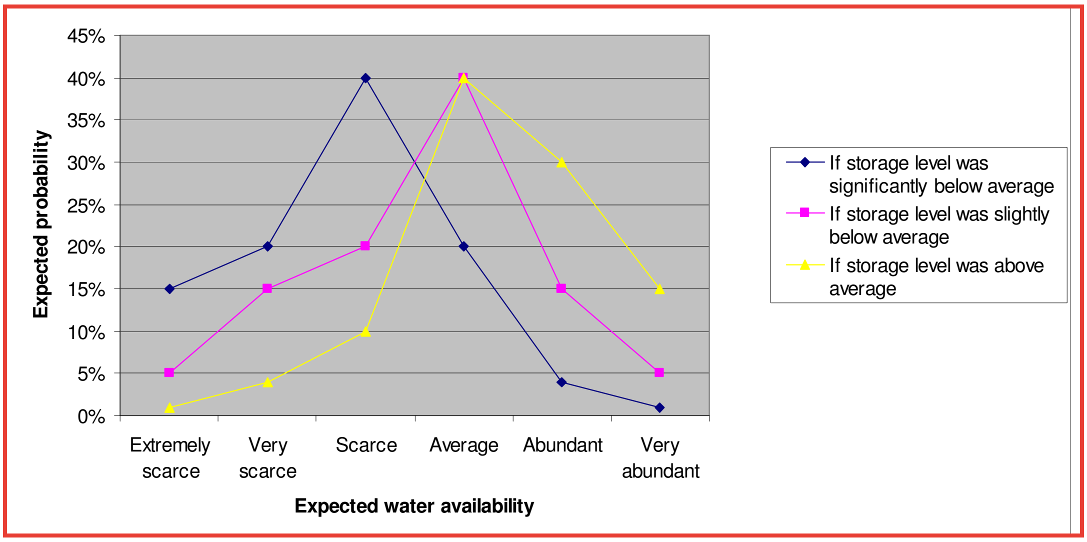

Figure 5: Possible distribution curves of expected water availability

If an irrigator had a relatively neutral approach to risk management, as opposed to being risk averse, then the decision to carryover is governed by the expected likelihood of various water availability scenarios and the value of carryover in each scenario. Risk neutrality means that the expected value of carryover is derived by adding up the value of carryover in each scenario multiplied by the probability of that scenario occurring. For example:

Expected value of 20ML carryover if storage level was significantly below average =

Extremely scarce		15%	x	$20,000
Very scarce	+	20%	x	$10,000
Scarce	+	40%	x	$3,000
Average	+	20%	x	$0
Abundant	+	4%	x	$0
Very abundant	+	1%	x	$0

= $6,200

Given this is based on a decision to carryover 20ML, this is equivalent to $310/ML. Given the above assumptions of likelihood of scenarios and market price in each scenario, this suggests that:

- If the storage level was significantly below average and if the current market price for water allocations was $300/ML or less, then it would be worthwhile deciding to carryover water.
- If the storage level was significantly below average and if the current market price for water allocations was $320/ML or more, then water is more valuable in the current season and it would not be worthwhile carrying over water into the following season.

Similarly,

Expected value of 20ML carryover if storage level was slightly below average =

Extremely scarce		5%	x	$20,000
Very scarce	+	15%	x	$10,000
Scarce	+	20%	x	$3,000
Average	+	40%	x	$0
Abundant	+	15%	x	$0
Very abundant	+	5%	x	$0

= $3,100

Given this is based on a decision to carryover 20ML, this is equivalent to $155/ML

Expected value of 20ML carryover if storage level was above average =

Extremely scarce		1%	x	$20,000
Very scarce	+	4%	x	$10,000
Scarce	+	10%	x	$3,000
Average	+	40%	x	$0
Abundant	+	30%	x	$0
Very abundant	+	15%	x	$0

= $900

Given this is based on a decision to carryover 20ML, this is equivalent to $45/ML

The difference between the expected value of carryover in the three scenarios is being driven by:

- The likelihood that carryover is highly valued; and
- The likelihood that carryover is lost, even though water would not be very valuable in these cases because water is abundant.

It is important to note that if irrigators are risk averse, they can use carryover as an insurance tool to guard against water shortfalls in the following season. This means that they are more willing to carryover water (for a given water price and expected value) due to the additional advantages of risk management it provides.

Appendix C: Liberalising carryover to access available airspace

Rather than access airspace through the link between entitlements and the airspace required to store allocations to these entitlements, it may be possible to create a new mechanism for carryover that utilises airspace in storages at times when it would otherwise be unused.

It has been suggested that the basis for the new carryover mechanism may be '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' — as long as it does not result in third-party impacts to other users.

The appropriateness of such as new carryover mechanism depends on:

- No third-party effects
  - No reduction in reliability of water supplied for other users
  - No reduction in carryover opportunities provided by existing mechanisms
- Availability of new carryover mechanism
- Process of determining available airspace

No third-party effects

For the new carryover to avoid causing third-party impacts, the risks of external spill are recognised and borne by individuals using this new carryover mechanism — they would have to bear the risk of losing their carryover if the storage spills.

Availability of new carryover mechanism

It has been suggested that the option of renting airspace to store carryover should only available when storages are less than 50% full approaching the end of the season. Alternatively there could be no limitation on its availability, with the onus all on individuals to judge the risk associated.

Limiting the circumstances when the carryover mechanism is available aims 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. The decision of which circumstances are appropriate to make the carryover mechanism available, however, is arbitrary and can not be made in a way that guarantees that carryover will not be lost due to spill. The question is: *Why should rules be required to mitigate the risk of individuals losing carryover when these individuals are able to make their own risk-based decisions?*

Irrigators are well-placed to assess their own preferences for bearing the risks of carryover. It should also be noted that if a spill does occur, then storages are full with water relatively abundant and the market price of water is relatively low.

This means that carryover is most valuable (high expected value) when storages are low because:

1. It is expected that the water supply will be short in the following year therefore the expected market price of the water is high.

2. There is a low risk of loss from spill, therefore a high probability of realising this value.

The examples set out in appendix B consider the expected value of carryover water, as well as the expected value of the water lost due to current spill rules, under various storage conditions. In general, irrigators are best placed to determine whether or not they are willing to bear such risk.

Process of determining available airspace

Working group discussions suggested that 'In May during each season, G-MW, as the operator of the storages, would make a decision on the volume of airspace available for use in this manner.'

The choice of this volume available could be made to mitigate the risk of individuals losing carryover, with a low probability of spill in the following season, as well as considering the risk of increasing costs on storage management.

The amount of available airspace does not have to be guaranteed, since spill rules would apply.

Defining the product

Available airspace can provide the basis for a new mechanism.

It may be appropriate to define the product as the units of the volume of airspace that the owner has access to for carryover purposes — rather than requiring irrigators to use the extra airspace that they gain access to.

It may be appropriate to define the product as a share of the total volume of airspace determined to be available. This volumetric expression of this amount would be share of the deemed available airspace if 100% was ultimately available — similar to the expression of entitlements and allocations. This framework is familiar to water users and help manage situations where spills occur and less than 100% of the airspace is ultimately available.

In the event of spill

If a spill occurs, water that is associated with this new carryover mechanism should be deemed to spill prior to water associated with allocations, reserves and carryover that is associated with entitlements.

Ideally, the spill volume would be derived from actual spill and airspace allocated for access for carryover would be proportionally reduced — only carryover volumes in excess of this allocation would be lost from irrigator's water accounts. Such accounting enables irrigators to secure their carryover with increased certainty by holding additional airspace — this also links storage spill outcomes to carryover accounting outcomes more closely.

$$\text{Allocated airspace} = \text{Airspace share held} \times \frac{\text{Actual airspace used/available for carryover}}{\text{Determined airspace available for carryover}}$$

Even though this would suggest that carryover would spill *if* any irrigators fully used the accessible airspace *and* the actual airspace was less than determined, the trigger for enacting this calculation could be the event of an external spill.

An alternative proposition is that water is 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.

Allocating available airspace

Alternative auction mechanisms are possible:

- Uniform price auction — where bidders pay the lowest successful unit price
- Discriminating price auction — where bidders pay the unit price they bid.

For example, on May 15 G-MW could 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:

- With a single clearing price set at the lowest successful bid within the volume available, or:
- Without a clearing price, but by accepting all the highest bids up to the volume available.

Although economic theory states that the revenue outcomes of this two mechanism will be equivalent under certain conditions, in practice the uniform price auction may not raise as much revenue for G-MW but will be perceived as more equitable given that all participants pay the same clearing price.

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