Modelling Carryover in REALM

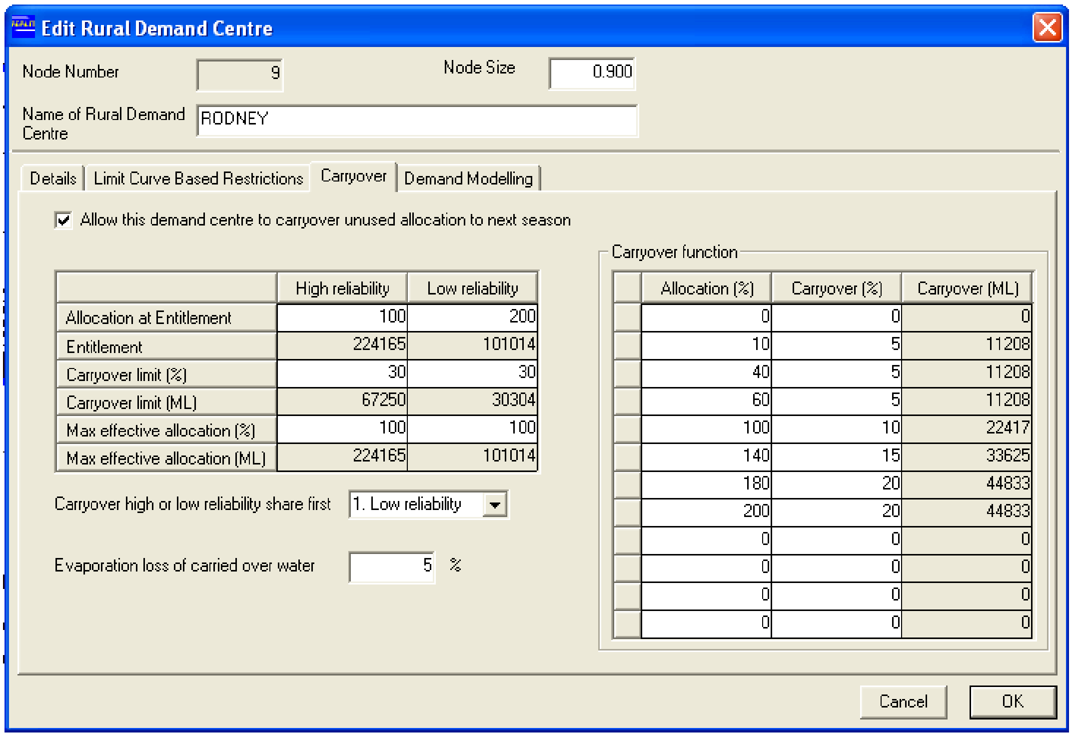
1. Introduction

The ability to model carryover was introduced to REALM for version 6.0. The term 'carryover' refers to a situation where an irrigator may choose to retain some part of any given year's allocation in storage. This water is then available for use in the following year.

The carryover algorithm in REALM has two main steps. The first is to calculate the volume of water carried over at each rural demand node (DC2). This is calculated at each time step with the final calculation undertaken at the end of the irrigation season. The second step adjusts the limit curve at each demand node depending on the volume of water carried over from the previous season.

2. Entering Carryover Parameters

Carryover parameters can be entered for each rural demand centre node (DC2) by selecting the "Carryover" tab. The window shown in Figure 2-1 will be displayed.



- **Figure 2-1: Rural Demand Centre Edit Window – Carryover**

To activate carryover for a rural demand centre, the *Allow this demand centre to carryover unused allocation to next season* box must be checked. This activates the fields in the carryover window so they can be edited by the user.

To specify the point on the limit curve defining high and low reliability water shares, the user should enter percentage allocations into the *Allocation at Entitlement* fields. If the limit curve has been completed (in the "Limit Curve Based Restrictions" tab), the dialog box will automatically calculate the volume of water at each allocation in the *Entitlement* fields. These fields cannot be edited by the user – they are intended as a check to ensure that the correct allocations have been entered.

Note: in order to ensure that all functionality within the carryover window is active, it is strongly recommended that the limit curve be defined for the rural demand centre before carryover parameters are entered.

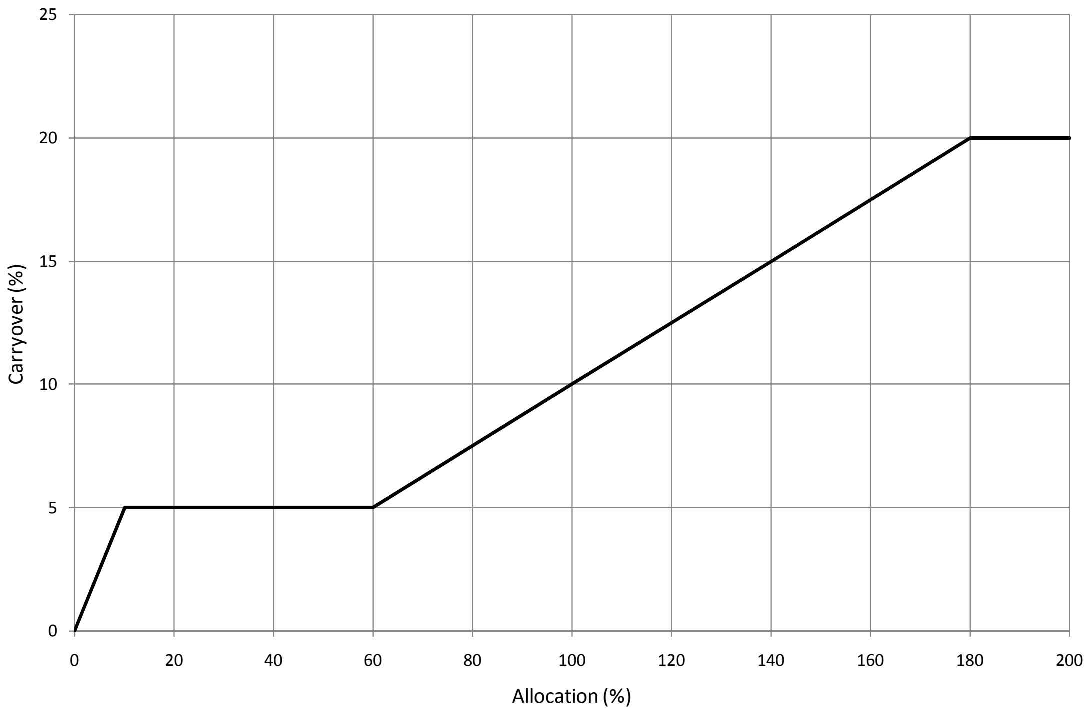
The user may wish to specify the maximum amount of water that can be carried over. This is done by entering percentages in the *Carryover limit (%)* fields. Once again, the dialog box will automatically convert these percentages into volumes via the limit curve in the *Carryover limit (ML)* fields.

The maximum effective allocation is the highest allocation that can be provided in the season following a carryover. This is specified in the *Max effective allocation (%)* fields. The equivalent volume is automatically calculated from the limit curve and placed in the *Max effective allocation (ML)* fields.

Users can specify whether the high or low reliability water share is carried over first by changing the option selected in the *Carryover high or low reliability share first* drop down box. The percentage of the carried over water lost to evaporation is specified in the *Evaporation loss of carried over water* field.

The user must also define the carryover function. The carryover function indicates how much water irrigators will choose to carryover depending on the allocation for that season. Similar to the limit curve, the user should enter percentage allocation values into the *Allocation (%)* field, and percentage carryover values into the *Carryover (%)* field. The dialog box automatically calculates a volume for each allocation in the *Carryover (ML)* field by referencing the limit curve.

The carryover function should be derived from observed or theoretical irrigator behaviour. An example carryover function is shown Figure 2-2, from which it can be seen that 5% of the allocation is carried over for allocations between 10% and 60%. At low allocations, the irrigator is likely to carryover some water to provide a potential supply in case of an even lower allocation season next year. As the allocation rises, the irrigator is likely to commit a greater percentage to carryover and thus create additional flexibility for the following season.



- **Figure 2-2: Example Carryover Function**

3. Carryover Algorithm

The carryover algorithm is documented as a number of steps.

Step 1: Compute desired carryover.

$$DC = \begin{cases} DC_v & - \textit{for all months except end of season (June)} \\ \textit{Maximum of } [DC_v, A_u] & - \textit{at end of season (June)} \end{cases}$$

Where: DC = desired carryover
DC_v = desired carryover from the carryover function
A_u = unused allocation (allocation – delivery)

Step 2: Calculate evaporation loss for carried over water (at end of season only)

$$EL_{ML} = DC \times \frac{EL_{\%}}{100}$$

Where: EL_{ML} = evaporation loss (ML)
$EL_{\%}$ = evaporation loss (%) as specified

Step 3: Total actual carryover is calculated at end of season only

$$AC_t = \textit{Minimum of } [(DC - EL_{ML}), (CL_h + CL_l)]$$

Where: AC_t = total actual carryover (high and low reliability shares)

	CL_h	= High reliability share carryover limit (as specified)
	CL_l	= Low reliability share carryover limit (as specified)

Step 4: At end of season, total actual carryover is split into actual high and low reliability shares. How this is done depends on whether the user specified high or low reliability share to be carried over first. If low reliability share is carried over first

$$AC_l = Minimum\ of\ [CL_l, AC_t]$$

$$AC_h = Minimum\ of\ [CL_h, (AC_t - AC_l)]$$

Where:	AC_l	= actual low reliability share carryover
	AC_h	= actual high reliability share carryover

The reverse calculation is undertaken if the high reliability share is to be carrier over first.

Step 5: At the start of the next season, effective high and low reliability share allocations are calculated

$$A_{eh} = Minimum\ of\ [A_{ehm}, (AC_h + A_h)]$$

$$A_{el} = Minimum\ of\ [A_{elm}, (AC_l + A_l)]$$

Where:	A_{el}	= effective low reliability share allocation (%)
	A_{eh}	= effective high reliability share allocation (%)
	A_{elm}	= maximum low reliability share allocation as specified (%)
	A_{ehm}	= maximum high reliability share allocation as specified (%)
	A_l	= announced low reliability share allocation (%)
	A_h	= announced high reliability share allocation (%)

Step 6: At each time step of new season, annual limits (ML) are adjusted for carryover and off-quota allocation as below

$$AAL = A_{eh} + A_{el} - DC + A_o$$

Where:	AAL	= adjusted annual limit
	A_o	= announced limit

Step 7: Effective allocation, A_e (%) corresponding to the adjusted annual limit, AAL (ML) from Step 5 is calculated from limit curves.

4. Carryover Output

A number of additional system variables were introduced with carryover to allow various carryover parameters to be referenced in carrier equations and thus used in different parts of the model. These are shown in Table 4-1.

- **Table 4-1: Available Carryover System Variables for Variable Capacity Carrier Modelling**

Variable Name	Sub-group	Type	Type Description	Variable Name and Type	Remarks
Node name	Rural demand (DC2)	DCVR	Desired carryover (ML)	RODNEY and LALL	RODNEY is a rural demand node (DC2) name in the system file
		CVRH	Actual high reliability share carryover (ML)		
		CVRL	Actual low reliability share carryover (ML)		
		LALL	Adjusted low reliability share limit (ML)		
		HALL	Adjusted high reliability share limit (ML)		
		CEVP	Volume of carried over water lost to evaporation (ML)		
		ADJL	Adjusted limit (ML)		
		ALVL	Effective allocation (%)		