The Concept of Capacity Sharing, and Responses to Questions Posed on Implications for Irrigators

A Discussion Paper on the Capacity Sharing Project

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by

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INTRODUCTION TO CAPACITY SHARING

Capacity Sharing is an institutional arrangement and property rights structure for allocating water among multiple users of water resource systems which include storage reservoirs. It provides each user, or group of users, of reservoir water with perpetual or long-term rights to a percentage of reservoir inflows and a percentage of total reservoir capacity or space in which to store those inflows, and from which to control releases.

Capacity Sharing is as if each user (individual or group) own their own small reservoir on their own small stream. The concept also includes user rights to percentage shares of unregulated tributary flows downstream of the reservoir(s). Users' reservoir releases, perhaps to supplement their shares of unregulated downstream tributary flows, can be managed through time according to their particular supply reliability preferences. Under Capacity Sharing, each user's demand-side and supply-side decisions are made by each individual decision-making entity, and the probabilities of (not-traded) water supply can be calculated directly from historical or synthesised streamflow data alone.

Capacity Sharing is designed to foster the integration or coordination of supply-side and demand-side management decisions. Supply-side decisions include when and how much water to release from existing storages, as well as the timing and extent of their expansion. Demand-side decisions include those which affect the timing and quantities of water demands. For example, for irrigation, such decisions include which crops to grow, in what quantities and when to plant, as well as when and how much water and other inputs to apply to them.

The integration of supply-side and demand-side irrigation decisions - both operational and planning - was a feature of early water resources computer modelling work for the case of a single decision maker controlling both water supply and farm management decisions, that is, for situations like a big farm dam and irrigation system. Dr Norman Dudley and Professor Warren Musgrave developed the concept of Capacity Sharing and extended it to the supply-side and demand-side integration in multiple user situations.

'Bulk' or 'wholesale' Capacity Sharing allocates system water to a few large groups. These groups may be geographical entities or political jurisdictions like nations, states or regions, or distinguished according to user classes such as irrigation, environmental, urban or industrial. At this level, Capacity Sharing is a precise, concise and transparent mechanism for allocating water through time under uncertainty. However, at the bulk allocation level, by itself, Capacity Sharing is limited in the incentives it provides for efficient use of water and related resources.

At the other extreme, under 'retail' Capacity Sharing, individual end users such as households, firms, and farms each hold their own shares of reservoir capacity, reservoir inflows and downstream unregulated tributary flows. At this level, Capacity Sharing provides great incentives for efficient use of water by the integration or coordinating of supply-side and demand-side management decisions at the individual end-user level. Before using a unit of water at a point in time, each user considers the likely value of that water to himself or herself at a future time. There is no 'use it or lose it' pressure, except for the known probability of large inflows causing one's reservoir share to fill and spill.

Capacity Sharing also provides water property rights which are explicit, exclusive to the shareholder, and enforceable by law. Such property rights form an excellent basis for water markets, for water already in the reservoir or streams, or for long-term rights to future water. With many participants in these markets under retail Capacity Sharing, each user knows the value of water to other users before deciding whether to use a unit of water now or later. There are incentives for water use to move between users and through time to its most valuable use and time of use. This promotes the integration of supply-side and demand-side water management across users through time.

Such retail capacity sharing may not always be feasible for two reasons:

- the extra management complexities caused by users needing to manage their supply side as well as demand side; and

- constraints on the independent release of water by individual users caused by the capacity of either the water distribution system or the reservoir discharge capacity.

Such constraints increase the need for information and planning to integrate the supply-side and demand-side decisions. Mixtures of bulk and retail capacity sharing may be preferred in some situations.

- Individuals determine their own, total carry-over, not a carry-over of part of their allocation which is dependent on the size of the common carryover which, in turn, is determined by administrative/political decisions or policies.
- The probability of water supplies to users are easily calculated, being dependent on streamflows probabilities alone, and not the probabilities of actions of administrators/politicians. This allows the use of modern production and financial planning aids, either directly by users themselves or by their consultants.
- It fosters decentralised integration of supply-side and demand-side management of water by users, for both short term operating decisions and long term planning/investment decisions.
- Individual water users can conduct their own management with essentially no interference from others, unless they do something which violates operating rules or laws. They may or may not choose to interact with other users through participation in water markets when it is advantageous to do so, although physical constraints in the supply system may sometimes limit the extent of their involvement. It will probably be in water users' best interests to enter water markets at some times, depending on their situations relative to the situations of others.
- Individual water users can look ahead to match their own probable water supplies with probable water demands through time, without water trading. With water trading, they can also take the probable water supply and demand situations of others into account through time.
- Because all water users share in the valley's water supply system in the same way, the above advantages apply to each of them in similar ways, according to their requirements and type of use.
- A major advantage of capacity sharing is the potential for markets to separate the various roles of water pricing, whereas these tend to become blurred and lose effectiveness under current centralised pricing. Three main roles of water pricing are to:

  (a) communicate to each user what is the highest value of water to other users (its opportunity cost) now and in the future;
  (b) recover at least some of the operating and capital costs of the water supply and distribution system; and
  (c) determine when the current value of water has risen to the point that supply supplementation is called for.

Capacity sharing allows water marketing to convey the current opportunity costs of water, eliminating the need for centralised pricing to attempt this. Distribution and reservoir costs can be charged on a fixed annual basis, where each users' charge depends on the size of the reservoir capacity share held and their use of the distribution system. That is, the reservoir and distribution system charges would not be directly related to water use. Under capacity sharing, the best time to increase the capacity of existing reservoirs, or to build new dams, would be when the aggregate value of bids for shares for new storage capacity, plus a government subsidy if available, equals or exceeds the construction costs.

Main Disadvantages of Capacity Sharing

A complexity with the operation of capacity sharing using common supply channels is that some constraints would almost certainly need to be placed on the time and rate of reservoir releases of individual reservoir shareholders. In this respect, on-farm storages would be valuable to store these restricted releases. Experience with the operation of the system presumably would be helpful in providing guidance to users of the likely incidence of restrictions due to the delivery capacity limitations of the system. The nature of capacity sharing, with the rights to water being defined closer to its source (the reservoir rather than the users' points of diversion) highlights difficulties which are also present, but less noticeable, in centralised command and control systems. A very important contribution of the proposed detailed modelling part of this overall project will be to help determine just how such complexities can best be overcome under capacity sharing.

- Estimates of supply system losses must be accurate. Regular reconciliations of loss estimates with actual losses are necessary. If, for example, all shareholders were connected to the reservoir(s) by large-capacity pipes, the implementation of capacity sharing would be much simpler. Shareholders could withdraw water from their account simply by turning on their taps, and volumes withdrawn would be recorded by their meter.
- Transmission and reservoir losses from evaporation and seepage, would need to be shared in some way. Transmission losses will vary according to the distance water must travel, and the volume of water accompanying it in the stream. Reservoir losses would be shared according to the proportion of shares held which contain water in them (i.e. when shareholders have zero balances in their accounts, no losses would be incurred). The need for, and complexity of attributing these losses to individual accounts is really only an apparent and short term disadvantage. In the long term,

individual user, or user group, accountability should encourage greater efficiencies in the form of reduced losses.

- In addition to reservoir and tributary inflow capacity shares, each water user would also need a share of the 'delivery capacity' of the distribution system (i.e. the peak flow capacity of water courses and channels etc.), and of the capacity of headworks storages to release water (ie the maximum rate at which water can be released). Both channel capacity limitations and reservoir maximum attainable release rates may mean that all shareholders may not be able to release water from their reservoir shares exactly at the time and rate they prefer.

However, whereas these three points will be seen as immediate disadvantages of capacity sharing when compared to current systems, it is important that they be kept in perspective. As water becomes increasingly scarce and water users become increasingly diverse in their reliability and delivery-timing requirements, maximizing the efficiency and value from water resource use will require that increased attention be paid to each of these three points regardless of the water allocation mechanism in place. For example, accurate estimates of timing, magnitude and spatial location of supply system losses will be necessary to maximize the total benefits from water use, even though impacts on individual users need not be as precise. Similarly, transmission and storage losses should reflect most heavily on those who cause them. The location of their abstraction points and their individual reservoir storage carryovers are important factors. Furthermore, channel and reservoir capacities will need to be allocated according to the timing and volume requirements of the different user types, if best balances of equity and the maximisation of regional benefits are to be achieved. Many of these points will be touched on again in answers to other questions in the rest of this paper.

2. How would a capacity sharing system operate? - What are the mechanics of such a system?

Bulk Capacity Sharing

('Bulk' or 'wholesale' Capacity Sharing allocates system water to a few large groups. These groups may be geographical entities or political jurisdictions like nations, states or regions, or distinguished according to user classes such as irrigation, environmental, urban or industrial. At this level, Capacity Sharing a precise, concise and transparent mechanism for allocating water through time under uncertainty. However, at the bulk allocation level, by itself Capacity Sharing is limited in the incentives it provides for efficient use of water and related resources.

At the other extreme, under 'retail' Capacity Sharing, individual end users such as households, firms, and farms each hold their own shares of reservoir capacity, reservoir inflows and downstream unregulated tributary flows. At this level, Capacity Sharing provides great incentives for efficient use of water by the integration or coordination of supply-side and demand-side management decisions at the individual end-user level. Before using a unit of water at a point in time, each user considers the likely value of that water to him or her at a future time. There is no 'use it or lose it' pressure, except for the known probability of large inflows causing ones reservoir share to fill and spill.)

The operator of the system, say the DWR, would monitor all additions to and non-release subtractions from the main headworks storages for which reservoir capacity shares are allocated. Reservoir shares would be expressed in megalitres to represent a percentage or proportion of total useable storage capacity. For example, as percentage shares of a reservoir with a useable storage capacity of 200 Ml would be 2 Ml when the dam is first built. If the active storage declines because of siltation, the 1% share would fall below 2 Ml. If the storage capacity were increased, however, the original 2 Ml share would not change. In that event the extra storage capacity would result in the availability of additional capacity shares.

Additions include stream inflows and rainfall directly into the reservoir. Subtractions to be monitored are non-release losses including evaporation from the reservoir surface, seepage losses, and reservoir overflow spills. Probably these should be recorded and estimated on a daily basis. From these, plus the ordered releases by each of the bulk users, the contents of each bulk user's reservoir capacity share holdings would then be updated daily by computer. Computer printouts of these records for each bulk user's reservoir capacity 'account' would be sent to the holder of the bulk share periodically. These would be like bank statements. Periodically, perhaps once a year, the sum of the contents of all of the accounts would be adjusted to match the actual, measured contents of the storage(s) in which bulk capacity shares are held. In our earlier modelling work where this was examined, these adjustments were always upward (increases) but minor. This was because of the method used for the estimation of reservoir evaporation from each of the share holder's accounts.

Similarly, the bulk user's percentage share of discharges of important tributaries would be recorded on (probably) a daily basis. Again, some of total flows of these tributaries would be estimated rather than measured. Flows from minor tributaries and bank seepage would modify the estimated transmission losses of water flowing down the main river(s). For bulk capacity sharing, it is envisaged that shareholders would be provided with information on the impacts of these factors on their shares of tributary flows at the point where they enter the main river. It would be their responsibility to advise individual irrigators of expected net yield (at their receival points) of these flows, and of those emanating from reservoir releases. However, the task of calculating these losses would need to be conducted by the river system manager (DWR) who is responsible for ensuring water withdrawals do not exceed entitlements from the various flows.

Bulk managers would then keep track of the quantities and locations of their share of water in the main river, whether from reservoir releases or downstream tributary flows. They would take transmission losses into account, depending on factors like volumes of stream flows and seasonal conditions. Again, it may be more efficient for the river management (DWR) to actually provide this information on quantities and locations of their share of water in the main river. The individual bulk shareholders, however, would still face the need to factor such information into their management planning methods and models.

For individual irrigators operating under bulk sharing, their methods of ordering water deliveries to their farms could be similar to the present situation. Just how similar or different will be better known after the detailed modelling in this project is completed. Under bulk sharing the methods of water charging, notices of pumping times and volumes allowed, and notices of water used could remain quite similar to the present procedures.

Under capacity sharing, transfers of shares of reservoir capacity, and percentage of reservoir inflows and flows of downstream tributaries would be possible between the bulk shareholders. For example, environmental managers may find it advantageous to increase their percentage shares of downstream tributary flows to better match natural, historical flow patterns and reduce their percentage shares of reservoir inflows and capacity, if the relative prices suit them. Such a trade may well suit irrigators at the bulk sharing level. Trading of water already in the main storage reservoirs is expected to be quite active, mainly to trade unexpected surpluses to some and deficits to others.

Should someone, say a landholder, wish to engage in intensive water-use activities, such as agroforestry, or the construction of a dam or other structure in the head-waters of a reservoir which reduces inflow into the existing reservoir, such a person would need to purchase a quantity of reservoir inflow rights, from a (bulk) holder of those rights, in order to offset the resulting effect on streamflows.

Multiple reservoirs

In the Namoi Valley, there are two main reservoirs supplying water to irrigators, Keepit and Split Rock. Split Rock is located on a major tributary upstream from Keepit. Earlier work has indicated that when two large dams are located on the same river with no important inflows between them, the capacity of the two could be added together for capacity sharing management. Bulk users would be recorded as having shares and contents in the combined total capacity. This simplification may not apply to Keepit and Split Rock because of tributary inflows and estimations occurring between these storages. If the assumption is not valid then bulk shareholders could own percentage shares of reservoir inflows and volumetric shares of reservoir capacity held in both reservoirs. So far as timing and quantities of releases to irrigators is concerned, the results should be similar for either case.

For this study, it was the original intention of the CWPR to treat the Peel River as a tributary of the Namoi downstream of Keepit. That is, the dams on the Peel would not be considered explicitly, with all projected Peel River management effects on its discharge into the Namoi being taken into account. For completeness sake, the DWR plans to include the operation of those dams in the daily model of the river. Whether or not this means that bulk users on the lower Namoi would have capacity shares in the relatively small Peel storage reservoirs remains to be seen, but the end result will probably not be greatly different.

Retail Capacity Sharing and Retail/Bulk Capacity Sharing

Under retail capacity sharing, both individual and small groups of irrigators would have their own percentage capacity shares of reservoir inflows, reservoir capacity and downstream tributary flows. In the case of small groups, they should share some important similarities, such as having similar supply reliability preferences, and sharing the same smaller supply channel (whether constructed or natural). This would minimise conflicts arising from different preferred times of reservoir releases, and minimise seepage and evaporation losses that are often associated with having small quantities of water flowing in supply channels at different times.

The operator of the system (DWR) would be responsible for all monitoring, recording, and communicating. These responsibilities would be similar to those for bulk capacity sharing, but they would apply to a much larger number of smaller share holders. To streamline operations, capacity share accounts and other information would be stored and analysed on computer. It could be distributed to shareholders electronically and/or on computer printouts. For groups of farms, copies could go to each farmer, or just to the allocator of water within the group. Computer connections would allow continual, instant transfer of current account positions to each shareholder, as with bulk capacity sharing. There should be little difference in the workload to operate either bulk or retail capacity share systems, since the processing would be computerised.

Under retail capacity sharing, it is envisaged that the system controller would be responsible for notifying the shareholders of the locations of their water, comprising both releases and tributary flows. These could be expressed in terms of their volume and estimated time until arrival at the received points. Provision of such information would require sophisticated monitoring and system modelling, (the latter probably stemming from the DWR daily flow hydrology model).

Information available to shareholders would probably include estimates of travel times of future releases, and the expected constraint on the size of those releases (due to the need to limit total releases to suit channel capacities). This would help farm managers plan the time of their next releases from their reservoir share in relation to their on-farm storage contents and capacities. The accuracy of this information would improve over time as more is learnt about how shareholders operate their reservoir releases through time. For example, individuals would be less constrained in their timing and quantities of orderings if most others order early and hold large quantities in their on-farm storages.

For combinations of bulk and retail capacity sharing, the individual members of the group sharing the bulk supply would probably place their orders in a similar manner to the present, but again the detailed modelling to be undertaken in this project should clarify this. It is for these reasons that we expect that the movement of irrigators, from bulk to retail shareholders could be a voluntary process spread over some years. Some may continue under the bulk system indefinitely.

3. What changes would occur to the water quantity currently available to each irrigator if capacity sharing was used?

If capacity sharing were to be introduced, the date upon which transition calculations are to be based is very important. That is because various changes to the level of demand for water for irrigation and for other purposes has altered over time, which in turn, has affected the reliability of irrigation water supplies. The objective of calculating how many tributary and storage capacity shares each irrigator should hold under capacity sharing, is to determine what portfolio of shares would be needed to provide similar (the same) quantities and reliabilities of supplies at each irrigator's receival point. The modelling to be conducted in this study will enable the sensitivity of the selection of this date as well as the portfolio of shares required to meet this object, to be assessed.

Having provided water users with portfolios of capacity shares that reflect their previous volumetric allocations and supply reliability, it is important to realise that from that point on, individual irrigators will be able to alter their own supply reliabilities in several ways. It is also important to know that under capacity sharing, however, other water users can not be affected by any such alterations without compensation via the relevant market, except to the extent that channel and reservoir release capacity constraints might affect the timing and efficiency of deliveries.

Under capacity sharing, individual irrigators may alter their long term average reliability of supplies by altering the ratio's of three factors: total irrigation demand; storage capacity shares and; tributary percentage shares. The table below indicates the direction of change in water availability values arising from changes to these factors.

			Water availability as controlled releases per unit area of irrigation	
Total Irrigation Area	Storage Capacity Share (Ml)	Tributary Shares (%)	Mean Reliability (%)	Mean Supply Volume (Ml)
–	0	0	+	?*
+	0	0	–	?*
0	–	0	–	?*
0	+	0	+	?*
0	0	–	–	–
0	0	+	+	+

* These impacts can only be accurately determined with computer modelling - which should be straightforward task.

Would there be any trade offs in the amount or reliability of water available to an irrigator?

Each irrigator can make their own tradeoffs between the amount and reliability, as indicated in answer to the first part of this question. Again, the use of open, shared channels or rivers, rather than individual pipes, causes interdependence between the users. If one user wanted an extremely high reliability of supply, and others did not, that user could find themselves in a position of 'spending' a great deal more reservoir water to get it to their point of diversion, perhaps because of an otherwise dry river bed in drought time, than if many of them had such reliability requirements and shared the extra drought-induced transmission losses. One of the efficiency-promoting features of capacity sharing is that individuals – especially distant ones – are confronted with their own transmission losses. A capacity share, however, could be devoted to keeping some minimum flow in the channel or river, but this would involve low-reliability shareholders foregoing water for the benefit of high-reliability users. The former would be, in effect, subsidising the latter, and therefore would not be advocated on efficiency grounds.

4. How secure is a capacity share?
- Can it be impacted on by other users or institutions?

The original formulation of capacity sharing specified that the rights would be held in perpetuity, so that holders would make correct long-term investment decisions whenever opportunities arose through time. It was envisaged that the only way for capacity shares to be removed from a shareholder would be via market transfers, unless the individual broke some laws introduced to protect natural or built assets. If society decided that water resources were needed for an existing or new use, the relevant body should enter the market for reservoir capacity shares, reservoir inflow shares or downstream tributary shares, and purchase them from whomever values them least. Whereas the value of a unit of land depends on its location, a unit of water in a reservoir or stream is indistinguishable from any other. Hence it is difficult to imagine a case in which some particular shareholders share would be needed specifically.

But should part or all of a particular shareholder's share be required, governments would have the power to resume the shareholding and pay compensation, for which market prices should serve as a good guide. Shares to the various water resources would be traded between existing users in the water market. Perhaps public donations would be sought for purchases for some purposes, as is done in the USA for environmental uses. Again, only those who value the resources least would choose to sell.

However, some have suggested that the rights should not be held in perpetuity, but be held as some form of long-term lease which would come up for re-negotiation after a number of years notice. If leases can be devised so as not to harm long-term investments and resource management, they could provide a return to society in the form of leasing fees. Some such system may be needed if capacity sharing is to gain the necessary political acceptance for its introduction.

There is some interaction of reservoir users, due to 'internal spills'. Capacity sharing contains the very firm rule that any inflows exceeding the unfilled space of a shareholder's reservoir capacity share is lost to that user, being shared among others whose share is not yet full. Marketing of unused storage space could provide for some flexibility. This could be done by buying or renting extra reservoir empty space or capacity from another shareholder. Hence, in the absence of a market for reservoir water, it could be that a user could become accustomed to receiving such internal spill water from some other users, probably those who have chosen a higher reliability level and hence maintain higher storage levels on average. If some of those high-reliability users were replaced by low-reliability users, the individual could find their windfall water gains disappearing. Since they had no secure rights to such water in the first place, it seems rather odd to consider this an important impact.

However, under capacity sharing with marketing of reservoir water, as has been always included in the concept, such internal spills are unlikely to occur in practice. Before an individual shareholder could lose reservoir water by an internal spill, they would surely sell it in the market for reservoir water unless spilling of the whole reservoir appeared inevitable. In this last situation, water would be of little value, to either the seller or the shareholder who might have gained the internal spill. Modelling would help define the best mechanisms for trading new inflows, but probably the water from such a rain event could be traded a couple of days in retrospect. That is, the internal spills would not be recorded immediately. Then potential buyers and sellers would have a clearer idea of the quantities they wished to trade. Should the inflow event have filled the whole reservoir, trading would be zero.

5. Who are the people and institutions most likely to be considered as capacity share holders and what are the likely proportions of water held by the various groups?

Capacity Share Holders

We believe that it is critical that all users be part of a capacity share holding, at either a bulk or retail level. The current uncertainties facing users will not be overcome if some user group, say environmental in-stream flows, does not have a firm capacity share but can be allocated water by some authority on an 'as needed' basis. This will not be appealing to some environmental groups, but others will welcome the firm basis for environmental operations. A very significant problem in emerging water issues is the desire by some environmentalists to have flexible and adaptable access to water until more is known about environmental requirements. Whereas this seems laudable by itself, in injects great extra uncertainty into the water planning of other users. A basic idea of capacity sharing is that all water users be part of capacity sharing. If the initial allocations prove to be unsatisfactory, they can be changed later by market transfers. Of course, this puts extra political pressure on the initial allocation of capacity shares, since each share becomes a valuable asset for sale, if not for the particular use of the individual user. This is a main reason for the need for the daily model to show the allocation of bulk capacity shares needed to closely duplicate the base-date sequence of flows to each user class over an historical period of data.

A major research initiative by this Centre is the examination of the feasibility of also allocating wetlands managers with percentage shares in the volumetric capacity of reservoirs and percentage shares in reservoir inflows and downstream tributary flows. Such shares are marketable, and purchase of more by the wetlands would, of course, require funds from government or non-government sources. Stored reservoir water is also marketable. Hence, after the initial allocation, irrigators and other users will not have their water supplies reduced unless they choose to sell water from their reservoir shares in the short term, or sell rights to capacity shares in the long run, at prices which compensate them for their reduction.

The Centre is to conduct a new study funded by the Land and Water Resources Research and Development Corporation which will follow earlier, preliminary work which modelled the operation of a capacity share dedicated to supplementing the reservoir releases of other users to maintain river in-stream flows. Again, reservoir water and capacity shares are marketable.

This complete allocation of water to capacity sharing replaces concepts such as 'Environmental Contingency Allowances' and 'constraints' on other users forcing them to make releases at specific times to maintain in-stream flows. It may well be in the interest of all users for the body responsible for environmental flows to provide financial incentives for irrigators to change their release times somewhat, by greater use of their on-farm storages, in order to maintain instream flows. The secure property rights structure of capacity sharing provides a basis for various forms of market arrangements. This could not occur under conventional allocation procedures.

Under capacity sharing the river manager may need to hold a small 'miscellaneous' bulk share for small assorted uses. Or perhaps 'stock and domestic' could be expanded to include such uses. Because of the uncertainties involved in moving to the new system, and perhaps because of the lack of sufficient monitoring equipment in the short term, it may also be advisable to have a small bulk share of reservoir capacity, inflows and tributary flows devoted to correcting buffering errors of various kinds. With more experience these errors may be overcome, and these shares could be sold progressively.

6. What would be the best mechanisms for managing the implementation of such a system from the current system?

The first task is modelling to determine how large the various bulk allocations to the main user groups would need to be, to give each approximately the same sequences of flows over an historical data period to that which they would get at the transition date or 'base case'.

Whereas a detailed answer to this question depends heavily on the results of the detailed modelling, some general points can be made. It seems absolutely critical to us that at least each major user class should receive a bulk capacity share. The user classes would include irrigators, environmental uses, stock and domestic, urban, various industrial users, and perhaps others. As indicated, the first task of the modelling is to determine how large the bulk share of each user group would need to be for each of them to receive approximately the same average quantities of water as exists in the base case. The base case may refer to some point in the past, perhaps the recent past. It may also include agreed modifications to provide extra water for environmental purposes. However, whatever base position is chosen, it is our view that the environmental share should be a capacity share, as it would be for all other users. Perhaps DWR, along with some environmental groups, may not agree to this formulation. They may want to have environmental use requirement set on a different basis. In our view, however, this would largely defeat the main advantages of capacity sharing:

- to give all users <u>secure</u> property rights to supplies of <u>known probabilities</u>
- promote the integration of supply-side and demand-side management through retail management, and
- to facilitate the operation of markets for water resources.

The second task after the initial determination of the respective sizes of the 'bulk' allocation percentage share holdings is to consider what should be an appropriate speed of movement toward retail capacity sharing. Some uses, such as individual towns and environmental requirements, will probably always remain bulk shareholders. Whether the latter would remain as one environmental grouping, (with one body managing all environmental requirements from, say, upstream points like Chaffey Dam to the Barwon) should have little impact on irrigators, so long as each group has a defined bulk share.

A feature of capacity sharing is that some irrigators can operate as retail shareholders from the start, with others sharing in a bulk capacity share. The bulk share may be operated for irrigators by the DWR in much the same way as they do now. In this event the DWR would determine the amount of the bulk-share contents to carry-over for future periods, perhaps with input from irrigators who are members of the bulk-share group. Members of the bulk-share group may later elect to become retail members as they become aware of advantages in self management. The size of their retail share holdings of reservoir capacity, inflows and downstream tributary flows would be relatively easy to translate from a bulk share portfolio.

A suggested time sequence for change would be as follows:

1) Determine bulk capacity share for all user groups
2) Allocate bulk shares, but continue to operate irrigator shares as for volumetric allocations
3) Advise each irrigator of their retail share portfolio which comprises part of the bulk irrigation share portfolio (which would be public knowledge)
4) Develop computerised water accounting system for the river operator to test and run in parallel with volumetric allocations
5) Permit irrigators to change to retail shares

7. How would water transfers take place under capacity sharing?

Initially, probably only two types of water transfers would occur. One would be the transfer of units of water (probably as megalitres) already in the main storage(s). Where, for example, Seller A agrees to sell x megalitres of water from her account, to Buyer B for transfer to his account. After checking first that Seller A has that quantity in her account at that time, and second, that Buyer B has space in his account, the record keeper (probably the DWR), would record the transfer and the changed account levels. This transaction would appear in the periodic water balance statements of both the buyer and seller, as well as in the keeper's records.

The other form of transfer operating initially would be transfers of long-term rights to percentages of reservoir inflows, storage capacity, and downstream tributary flows. The record keeper would first verify titles held by sellers and buyers to see that the proposed transfers are feasible. Other factors, including distribution system effects, may also need to be checked, such as the capacity of the distribution system in the buyer's area and possible impacts of underutilising the distribution system in the seller's area. Also, any rules of inter-regional transfer would need to be checked. These distribution-system problems with permanent transfers of water rights apply to any water allocation system and are not limited to capacity sharing.

Various mechanisms exist for bringing buyers and sellers together and establishing agreed prices and quantities to trade. Each comprise some form of market. Specialised brokers could be used. Alternatively, regular auctions could be held for trading both stored water and long-term rights. These may be supplemented by irregular auctions after, say, important rain events. Some of these market forms may work better in some cases, others in others. Determining the final form is not seen as important at this point.

After the system has been operating for some time, other forms of trading may be worthwhile, such as futures trading of water, or contingent trading. The first is a contract to trade a quantity at a price at a future date, without conditions. The second is similar, but depends on certain conditions eventuating. A common example in the USA is where farmers enter an agreement, for a price, to guarantee to sell water to towns should certain-sized water shortages occur.

The essential point of transfers under capacity sharing is the clarity about just what is being traded - rights to water with specific probabilities of its availability in the quantities agreed upon. For water stored in the reservoir, the probability is one (certainty), but with rights to future water, the probabilities vary with the streams involved. Probabilities do change, however, as the historical record increases, and as long-term climatic change occurs, but these are long-term events and apply to any kind of distribution system, not just capacity sharing.

8. How would off allocation flows be incorporated into capacity sharing?

When all user groups have capacity shares in the water resources of a valley, it is very unlikely that there would be any off-allocation flows of any value to anyone. Because all tributary flows will be part of the capacity shares held by someone, they would not constitute off-allocation flows as currently defined. Only reservoir spills may fit into that current category, but with a flood controllers holding a share of reservoir capacity, they are likely to sell any spill water unless there is so much water in the system that it has little value.

However, if some irrigators participate in bulk capacity sharing, where that bulk share is operated by a manager (in a similar manner to the current system), and if a percentage of downstream tributaries form part of that capacity share, then off-allocation may be declared by the bulk-share managers similarly to the present situation. This would be in addition to any total reservoir spill not sold by the flood control body.

9. How would inflows into the dam be allocated to share holders and would any share holders have priority?

Two types of reservoir capacity sharing have been written about in the literature. One involves the sharing of reservoir inflows on a percentage basis, the other on a priority basis. Under percentage inflow sharing, which is our preferred option, and the only one referred to so far, users' probability of water supply can be increased by them increasing their holding of inflow shares. This increase could be obtained by buying inflow shares from someone else, as noted above. Under priority sharing of inflows, however, the highest priority user would get all, or a high percentage, of water entering the reservoir, probably up to a maximum quantity per period. Whereas a small quantity of inflows can be allocated on a priority basis without disrupting the sharing of water to percentage very much, problems appear to increase rapidly as the quantity allocated in this way increases. We would recommend, therefore, that only some water, such as that for stock and domestic purposes, be allocated in this way. Such priority-shared inflows would be stored in and released from the holder's percentage share of reservoir capacity, as with percentage share holdings.

10. What other costs would share holders bear in such a system?

The costs of monitoring water use by shareholders - metering of quantities pumped, etc., should change little. Becoming supply managers as well as demand managers will, as well as improving returns, cause some extra costs to users. However, computer and related communication technology is improving rapidly at falling real costs. Monitoring of where the river valley water comes from and goes to, by the relevant controlling authority (DWR) would not appear to be much greater under capacity sharing than what it should be, if efficiency of water management is to be promoted, under non-capacity sharing alternatives.

Capacity sharing, however, gives an improved scope for the method of charging for water supply services through water pricing. It is one of the advantages of capacity sharing, as noted above under Question 1. Water pricing to promote efficient water use can be left to the water markets, which means that water charges can be levied on capacity shares held and on water distribution services. Reservoir costs are independent of the quantity of water supplied, so that the recovery of such costs can be charged according to the size of capacity share held. The costs of operating the distribution system are also likely to be rather unrelated to the quantity of water supplied in a particular year, so that fixed annual charges may be appropriate for recovery of them also. Users need to bear in mind that the average quantity of water released from a reservoir share will depend on their chosen reliability of supply.