



# Section 8

## Options for Meeting Future Water Needs

### 8.1 Developing Options for Future Water Needs

This section outlines the broad strategies that can be used to address Colorado's water supply needs. These strategies are comprised of different methods or "options" that can be implemented independently or in combination with other options. When several options are combined, the resulting portfolio of options is termed a water supply alternative. A group of individual options that are similar in nature can also be combined into "families of options" as described in the next subsection. Implementation of the Identified Projects and Processes is critical to meeting Colorado's future water demands. Unless these projects and plans move forward, significant additional water supplies, in addition to the remaining gaps projected in Section 6, will be required.

As discussed in Section 6, through the Basin Roundtable process it was determined that approximately 80 percent of Colorado's future water supply needs can be addressed via projects and processes that are being pursued by local water providers. Water supply options that could be used to address the remaining 20 percent and the uncertainty associated with the Identified Projects and Processes were developed during the Basin Roundtable process. This section discusses these options and their pros and cons.

### 8.2 Families of Options

The Identified Projects and Processes listed in Section 6 and additional future options generally fall under one of the following categories, or "families" of options:

- Water Conservation, including:
  - Active M&I Conservation
  - Agricultural Efficiency Measures
- Agricultural Transfers, including:
  - Permanent Agricultural Transfer
  - Interruptible Agricultural Transfer
  - Rotating Agricultural Transfer Following with Firm Yield for Agriculture
- Development of Additional Storage, including:
  - Development of New Storage Facilities

- Enlargement of Existing Storage Facilities
- Conjunctive Use of Surface Water and Groundwater, including:
  - Bedrock Aquifers
  - Alluvial Aquifers
- M&I Reuse, including:
  - Water Rights Exchanges
  - Non-potable Reuse
  - Indirect Potable Reuse
- Control of Non-Native Phreatophytes

The options included under these categories can be evaluated individually or in combination to help meet the remaining water supply needs for each basin. The likelihood that these options will be successfully implemented and sustainable depends, in part, on the public and institutional support. That support is to a large extent dependent on how well each option meets the SWSI water management objectives. Thus, the above options were evaluated in terms of their performance according to the management objectives and grouped into alternatives.

A brief description of water use in Colorado can help put in context the limitations of some of these alternatives that would produce additional water supplies through increasing the efficiency of water uses. More detail regarding basic provisions of Colorado water law can be found in Section 4. At the start of the SWSI Basin Roundtable process, the overriding objective of compliance with the Colorado water rights system and interstate compacts provided the framework for evaluating potential strategies for meeting future water needs. A primary tenet of Colorado water law applicable to water rights change of use is that return flows resulting from beneficial use of water under an appropriation are "owed" to the stream, where they provide water for subsequent appropriators. This tenet derives from the fact that typically not all the water diverted from the stream is 100 percent consumed. For example, when irrigating crops, water may seep into the ground as it is conveyed through the irrigation canal or infiltrate into the ground once it is applied to the field. Much of this

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infiltrated water makes its way back to a surface water stream and is then diverted by downstream water users.

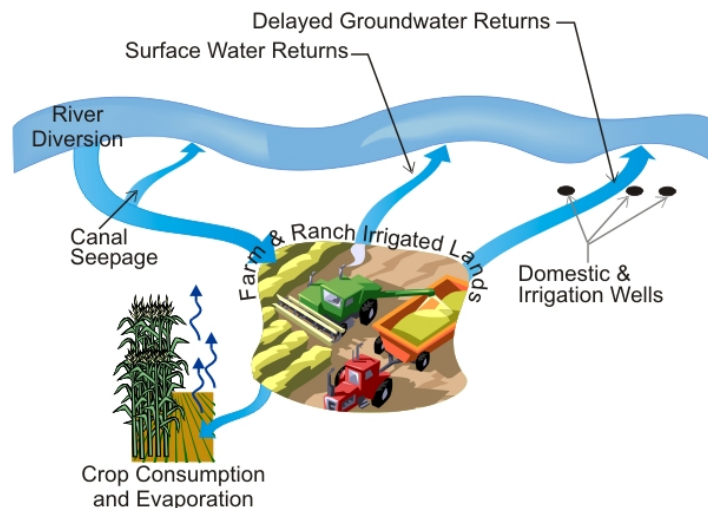
Figure 8-1 is a schematic of the return flows from agricultural water use. Under water law, appropriators have a legal right to rely on the continuation of stream conditions in effect when they made the appropriation, including return flows to the stream from diversions made by other appropriators. The result of this pattern of water use is that water in Colorado can be diverted and used and then subsequently rediverted and used many times, as return flows from one irrigator's use of water form the supply for a downstream user's water right. Other benefits of these return flows include the recharge of aquifers. Many domestic and irrigation wells would dry up if groundwater recharge from historical irrigation practices were not maintained. Return flows can also result in improved riparian habitat and more even stream flows, which help maintain year-round fisheries that would otherwise not exist. Thus, for example, many of the small urban creeks that flow through urban areas support riparian habitat and aquatic species as a result of return flows from lawn irrigation and other urban water uses.

### 8.2.1 Conservation

#### 8.2.1.1 Municipal and Industrial Water Conservation

M&I water conservation programs result in improved water use efficiency. M&I water savings occur through the modification of water-using fixtures (e.g., showers, landscapes, cooling towers) and behaviors (e.g., showering time, irrigation schedules, maintenance schedules, etc.). The effects of conservation on M&I water demand are the result of both passive and active water conservation efforts. These conservation efforts, though somewhat unpredictable in their rate of success since they require changes in consumer behavior, can be effective means of reducing water supply needs, with little cost to the community.

Table 8-1 summarizes five levels of water conservation developed during SWSI. Each level shows examples of water conservation programs that a utility or water provider might implement at the given level of



**Figure 8-1**  
*Return Flows from Agricultural Use of Surface Water*

conservation effort. In addition, the table indicates an estimated percent reduction in total M&I demand that might result from each level of conservation; and a generalized cost of the water savings at each level. Such generalized savings and costs may vary with the program implementation conditions of each water provider. The percent savings and generalized costs of each level of water conservation effort are described in detail in Appendix E (SWSI Water Demand Forecast Report).

- Level 1 Water Conservation Savings:** This level is defined as water savings that result from the impacts of plumbing codes, ordinances, and standards that improve the efficiency of water use. These conservation savings are sometimes termed "passive" savings because water utilities do not actively fund and implement the programs that produce these savings. These savings occur as new construction and remodeled buildings become more water efficient over time. In addition, landscaping ordinances contribute to these passive savings. Level 1 conservation is included in the SWSI baseline water demand forecast.

In contrast, water conservation savings resulting from utility-sponsored water conservation programs are referred to as "active" savings. The options included as potential future options for SWSI in terms of M&I conservation, correspond to the different levels of active conservation (Level 2 through 5) are described below.

**Table 8-1 Active Conservation Matrix**

Level	Types of Programs	Percent Reduction in Future M&I Demand				Cost \$ per AF
		2000	2010	2020	2030	
1	Plumbing codes	n/a*	2.5%	4.5%	6%	\$0
	Fixture standards from National Energy Policy Act					
2	Metering	n/a*	4%	4%	4%	\$100
	Leak detection		(6.5%)	(8.5%)	(10%)	
3	All of the above (Level 2)	n/a*	5%	8%	10%	\$500
	Education		(7.5%)	(12.5%)	(16%)	
	Rebates for toilets and washers					
	Audits: residential and commercial					
	Landscape audits					
	Increasing rate structure					
4	All of the above (Level 3)	n/a*	10%	15%	20%	\$1,000
	Steep pricing rate and surcharges		(12.5%)	(19.5%)	(26%)	
	Rebate for landscape changes					
	Turf replacement & restrictions					
	Rebates for irrigation sensors & controllers					
	Sub-metering of master-meter properties					
	Fixture retrofit upon sale of property					
	Ordinance eliminating single-pass cooling					
5	All of the above (Level 4)	n/a*	15%	25%	35%	\$2,000
	Replacement of all inefficient water fixtures & appliances		(17.5%)	(29.5%)	(41%)	
	Eliminate leakage by all customers					
	Eliminate high-water using landscape					
	Install non-water using urinals by non-residential customers					

n/a\* The 2000 level of water use implicit in the county gpcd values includes "current" conservation savings. The percent reduction indicated for Levels 2 through 5 is "above and beyond" the Level 1 reduction; the cumulative percent reduction is shown in parentheses.

Note that emergency conservation programs and short-term drought-response restrictions are not included among these long-term water conservation programs. Temporary drought restrictions include requests for voluntary demand reductions or mandatory water use restrictions during drought conditions. This type of demand modification usually involves drastic, temporary behavioral changes such as not watering the lawn or washing the car. Droughts can also result in permanent water conservation benefits, such as retrofitting indoor plumbing devices with more efficient water saving devices or reducing or eliminating high water use landscaping. During the most recent drought, it was reported that mandatory restrictions resulted in short-term water demand reductions of 20 to 30 percent (Kenny and Klein 2004).

- **Level 2 (Basic) M&I Conservation:** This level of conservation consists of programs for metering and leak detection, and can generally achieve about a 4 percent water demand reduction in addition to the passive conservation reductions. It is assumed that water providers would continue to fund programs to

maintain this level of savings in future years, thus the estimated percent reduction is a steady percent.

- **Level 3 (Moderate) M&I Conservation:** This level of conservation typically includes programs for metering and leak detection, education, rebates for water-efficient toilets and washers, and a rate structure that promotes effective water use. This level of effort generally corresponds with implementation of the nine water conservation measures recommended by the CWCB for consideration in Colorado water conservation plans. This level of conservation can generally achieve about 5 percent water demand reduction in the short- to mid-term (10 years).
- **Level 4 (Aggressive) M&I Conservation:** This level of conservation typically includes programs above and beyond moderate conservation, including steep pricing rate and surcharges, rebate for landscape changes, residential and commercial audits, turf replacement and restrictions, rebates for irrigation sensors and controllers, sub-metering of master-meter properties, and fixture retrofit upon sale of properties. This level of conservation can generally

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achieve about 10 percent water demand reduction in the short- to mid-term (10 years).

- Level 5 M&I Conservation:** Program savings are influenced by the level of participation and compliance with a given program. The prior levels of conservation effort (2 through 4) assume a reasonable level of program participation. Level 5 assumes total participation by all customers and is intended to represent a maximum level of effort in water use efficiency. Such a level of conservation is estimated to achieve about 15 percent water demand reduction in the short- to mid-term (10 years).

It is important to note that the matrix shown in Table 8-1 shows *future* conservation potential. The SWSI baseline county water use values of gpcd are based upon year 2000 data and therefore implicitly include the "current" level of conservation effort. One cannot simply apply an assumed level of conservation to a county demand number and expect the referred percent savings, because water providers may be at or above the assumed level of conservation.

It is also important to note that the *realistic* level of future water demand varies by location given the currently implemented or budgeted water conservation programs. For example, Level 3 conservation represents a set of conservation programs similar to what Denver Water has already implemented, as of the base year 2000. Continued implementation of Level 3 programs will further increase market saturation and enhance program savings. Therefore, the future water demand for Denver County should be further reduced by the Level 3 percentages to reflect the future impacts of continuing the *currently* implemented conservation programs. Furthermore, Denver Water is considering for future implementation a set of programs commensurate with Level 4. Thus, if the additional programs are implemented, it would be realistic to further reduce the Denver County demand projections by the difference between Level 3 and Level 4 (i.e., simply apply the Level 4 percent reduction). This would provide a realistic projection of future water demand for Denver County. However, the base period of the SWSI analysis is 2000. Therefore, the level of conservation in the year 2000 is assumed for the *current* conservation level.

In order to develop a more realistic assessment of future water demand throughout the state, the appropriate *current* (year 2000) level of conservation was identified

for each county. The classification of the level of effort for each county is subjectively based on a review of available water conservation plans submitted by water providers to the CWCB and survey results collected by the Colorado Municipal League. The resulting classification of each county is summarized in Table 8-2. It is estimated that these current active conservation programs will result in water demand savings ranging from 3 to 14 percent by basin, or an estimated 231,000 AF, by 2030 if the current level of effort is sustained into the future. More detail on the estimated M&I conservation savings is provided in Appendix E.

**Table 8-2 Current Level of Water Conservation Effort**

County	Level of Current Conservation Effort - 2000				
	1	2	3	4	5
Adams			✓		
Alamosa		✓			
Arapahoe			✓		
Archuleta		✓			
Baca		✓			
Bent			✓		
Boulder			✓		
Broomfield		✓			
Chaffee		✓			
Cheyenne	✓				
Clear Creek	✓				
Conejos	✓				
Costilla	✓				
Crowley		✓			
Custer	✓				
Delta	✓				
Denver			✓		
Dolores		✓			
Douglas			✓		
Eagle			✓		
El Paso		✓			
Elbert		✓			
Fremont		✓			
Garfield			✓		
Gilpin	✓				
Grand		✓			
Gunnison		✓			
Hinsdale	✓				
Huerfano	✓				
Jackson	✓				
Jefferson			✓		
Kiowa	✓				
Kit Carson	✓				
La Plata			✓		
Lake	✓				
Larimer			✓		
Las Animas			✓		
Lincoln		✓			

**Table 8-2 Current Level of Water Conservation Effort (cont.)**

County	Level of Current Conservation Effort - 2000				
	1	2	3	4	5
Logan		✓			
Mesa			✓		
Mineral			✓		
Moffat		✓			
Montezuma		✓			
Montrose		✓			
Morgan			✓		
Otero		✓			
Ouray	✓				
Park	✓				
Phillips	✓				
Pitkin			✓		
Prowers		✓			
Pueblo		✓			
Rio Blanco	✓				
Rio Grande	✓				
Routt		✓			
Saguache	✓				
San Juan	✓				
San Miguel	✓				
Sedgwick			✓		
Summit		✓			
Teller			✓		
Washington	✓				
Weld		✓			
Yuma		✓			

Source: survey by Colorado Municipal League.

### 8.2.1.2 Evaluating New Supply from M&I Water Conservation

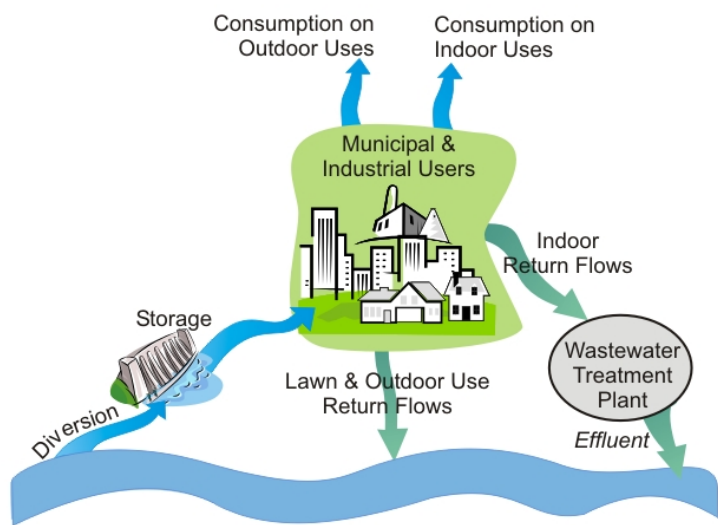
The ability to develop new supplies from water conservation or to carry over conserved water for later use is dependent on the type of water rights used. The potential for conservation must be evaluated on an individual M&I water provider basis, considering the types of water rights owned and the return flow obligations that apply to these water rights. Figure 8-2 illustrates the M&I return flow cycle for surface water diversions. The benefits of water conservation include:

- Implementation costs can be significantly lower than new water supply development or other alternatives.
- There are no permitting requirements to implement water conservation.
- Implementation is within the control of the local water provider and does not require approval of other entities.

- No new diversions are required from rivers or streams.
- Existing water supplies can be stretched to supply demands of new growth.
- Lesser environmental impacts than new water storage development.
- Can reduce water and wastewater treatment, distribution, collection, capital, and operations and maintenance costs.

Some of the issues involved in evaluating the net available water supply produced from M&I water conservation are:

- M&I direct flow water rights cannot be stored or carried over for drought periods (absent a change of use proceeding in water court), thus conserving water and reducing the demand on direct flow rights may not create reliable supply to meet new demands (for example for new growth.)
- CU water rights, such as transbasin, non-tributary, groundwater, or CU agricultural transfers, on the other hand, can be stored. If the overall demands on CU supplies can be reduced, the "saved" water can be used to meet the demands of new growth, improve reliability or both, if adequate storage is available to carry over the conserved water for use in drought periods.
- Many M&I water users have substantial agricultural rights that provide for the diversion of the entire historical amount of irrigation use as long as CU is not increased and historical return flows are maintained.



**Figure 8-2**  
**Return Flows from M&I Use of Surface Water**

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In these instances, wastewater returns and return flows from lawn irrigation have been quantified and may be used to maintain historical return flows such that historical CU is not increased. Conservation that results in reduced volumes of wastewater or lawn return flows can require M&I users to acquire additional water supplies to maintain these historical returns.

- Augmentation plans can be developed that account for wastewater and lawn return flows, and only require that the M&I CU be replaced. As a result, conservation would not result in an increase in supply unless the M&I CU is reduced, such as through the reduction in total irrigated areas of lawn. The assumed CU is usually decreed in an augmentation plan and as a result, any attempt to use conserved water would require a re-opening of the augmentation decree to re-quantify CU. This action would likely be costly and could present a high level of risk to the water provider.
- M&I landscape irrigation return flows, in addition to satisfying downstream rights, also creates delayed return flows than can have instream and riparian environmental benefits, and maintains aquifers for domestic and irrigation wells.

### 8.2.1.3 Agricultural Conservation (Efficiency Improvements)

Agricultural conservation or agricultural efficiency implementation is a means to create new water supply that must be carefully evaluated since Colorado water law and interstate compacts may limit or preclude the use of this option to increase supply. This option involves increasing the efficiency of water used for irrigation, so that more of the water that is diverted from streams and rivers or pumped from groundwater meets the direct CU needs for agricultural crops. Typical agricultural efficiency measures include canal lining or the conversion of irrigation practices and technology from flood irrigation to gated pipe or the installation of sprinklers or drip irrigation systems. These measures are designed to reduce the delivery losses that occur as water is diverted from a stream or as groundwater is pumped and delivered to the farm or ranch or as it is applied to the crops.

Table 8-3 shows the range of expected application efficiencies for different types of irrigation practices and the approximate costs to install these irrigation delivery systems.

**Table 8-3 Estimated Efficiencies and Costs for Irrigation Methods**

Type of Irrigation	Range of Efficiency	Average Capital Cost/Acre	Average Annual Cost/Acre
Flood	30-50%	—	—
Furrow	40-60%	\$37	\$30
Gated Pipe	~60%	\$178	\$51
Center Pivot Circle	~85%	\$433	\$64
Center Pivot with Corner	~85%	\$568	\$80

The benefits of agricultural efficiency measures include:

- Increased ability to deliver water to the crops can stretch existing supplies. This benefit would apply to water short irrigators that would benefit if additional water could be delivered to their crops. If the irrigator that has water short crops typically experienced 50 percent losses, reducing those losses will result in an increased delivery to the water short crops and a resulting increase in crop CU.
- Agricultural efficiency may reduce non-crop CU. Some of the CUs and losses may be due to tailwater from irrigation ponding at the end of fields and evaporating, rather than returning as surface or groundwater return flows.
- There may be potential water quality benefits. Canal seepage and/or flood or furrow irrigation may result in the leaching of minerals from the soils that result in impacts to the water quality of the return flows. Lining canals or the installing sprinklers may reduce the leaching of these minerals. This must be examined on a site-specific basis, as some irrigated fields may require periodic flushing of salts and minerals that accumulate in the soils in order to remain productive. The benefits of these improvements accrue to many, and programs like the Colorado River Salinity Control Program exist to encourage these types of improvements.
- No new diversions are required from rivers or streams.
- Permits are not required for implementation.

There are a number of potential issues and conflicts that must be evaluated for the potential implementation of agricultural efficiency measures.

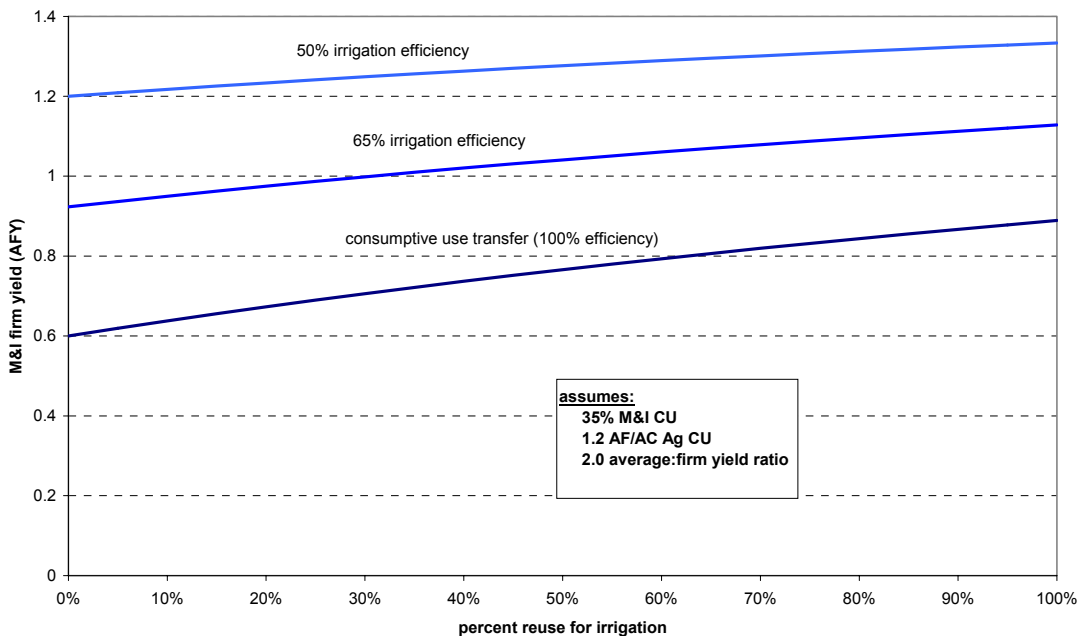
- Historical agricultural return flows are a vital part of the flows in all basins and downstream surface water diverters and downstream states have relied on these return flows.

- These return flows, in addition to satisfying downstream water rights, also create delayed flows that can have instream and riparian environmental benefits and maintain aquifers for domestic and irrigation wells.
- Typically, any water that is saved by efficiency measures such as canal lining or the conversion of irrigation practices and technology from flooding to gated pipe, center pivot circle, and center pivot with corner can only be used on lands for which the appropriation was originally made. Selling or delivering "saved" water to other users would constitute an improper expansion of use.

### 8.2.2 Agricultural Transfers

Agricultural uses currently account for more than 80 percent of the water diverted and consumed in Colorado. Many agricultural users hold senior water rights that can potentially be changed in use to provide a significant source of M&I water supply. In agricultural transfers, farm land is usually "dried up" or no longer irrigated and the water historically used for irrigation of this land is used for meeting M&I or other needs, such as dedication to CWCB for instream flow purposes.

Section 4 of this report describes the general background of agricultural transfers. The total water available under a change of agricultural water rights typically depends on the historical CU of the water for agricultural purposes: this is a measure of the water right for transfer. In addition, the yield of an agricultural water right may depend upon the location of the new use of the water. For example, in general, if the water is to be diverted through the same ditch system as historically, a transfer to M&I use may allow diversions of all of the water previously diverted at the historical farm headgate though the historic CU cannot be increased. The water that may be diverted on a transfer of water from an agricultural use to one out of the basin will be limited to the historical CU. Meanwhile the historical return flows must be maintained; storage may be needed to ensure that other water rights that historically relied on return flows are protected. After the historical return flows have been replicated, it is legal for the transferred "consumable" water to be used and reused to extinction. A graph illustrating the yield from an agricultural transfer project, shown in conjunction with the reuse of a portion of the return flows used for M&I irrigation of landscaping, is provided in Figure 8-3.



*Figure 8-3*  
**Firm Yield to M&I User from the Dry Up and Transfer of 1 Acre of Irrigated Agricultural Water Use**

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In some areas of the state, and particularly the Front Range, agricultural transfers are commonly used to develop supplies to meet M&I needs, and are important options included in the SWSI process. Three types of agricultural transfers are discussed: permanent, interruptible, and rotating.

### 8.2.2.1 Permanent Agricultural Transfers

Permanent agricultural transfers involve the permanent acquisition of agricultural water rights, the cessation of irrigation on the historically irrigated lands (dry up), and the transfer or change of a water right to M&I or other uses, such as dedication to the CWCB for instream flow purposes.

The benefits of permanent agricultural transfers include:

- A permanent water right is acquired and future uncertainty over future water supply availability is reduced.
- Agricultural water rights generally have more senior priorities; these senior rights provide a more reliable supply since the water right will be in priority for longer periods than a junior or new water rights filing. Less storage is required to produce a firm annual yield than from new in-basin water supply development projects with junior water rights.
- Permitting may be simpler for such transfers than for development of a new water supply project, since the agricultural water to be acquired has already been diverted from the stream system and a portion consumed. This can result in a higher level of certainty than construction of a new reservoir storing junior water rights, where environmental issues and the effects of new depletions will be evaluated.
- Overall basin depletions are not increased.
- Return flows from the historic CU are consumable and can be reused.
- Lesser environmental impacts than a new water storage project.

Permanent agricultural water transfers, though widely practiced in certain areas of the state as a water supply option for M&I users, have several potential issues and conflicts:

- Localized socio-economic impacts result from dry-up of agricultural lands. Irrigation of agricultural lands has historically resulted in the development of a local economy. In addition to supporting the farmer or

rancher, associated economic benefits of the irrigated agriculture may form the basis of the entire economy of the local community. Permanent dry-up of lands may have a significant negative effect on the local community unless the irrigated lands are converted to other uses such as residential, commercial, or industrial.

- Dry land has a substantially lower assessed value than irrigated agricultural land. In Colorado, unless the farm or ranch has development potential, much of the value of a farm or ranch may be derived from the water rights. Once the water rights are transferred and the land no longer irrigated, the assessed value is reduced significantly. This results in a significant loss of tax base to the local governments and school districts.
- A water court procedure is required to change the use of agricultural water rights. This procedure can be a very lengthy and expensive process, and is not without risk.
- Revegetation of formerly irrigated lands is required by law under certain circumstances. Colorado statute, in some instances, requires that an entity transferring and permanently drying up irrigated lands ensure that the land is revegetated with plants not requiring supplemental irrigation. This can be a difficult and costly process.
- Continued agricultural use of lands maintains the open space nature of the property to the benefit of the general public. If water is transferred from irrigated lands, the land may be more susceptible to development for other uses, since agricultural use will be harder to support.
- There is a potential loss of wetlands and riparian habitat. Return flows from irrigated agriculture often result in the creation of local wetlands and riparian habitat.
- Approximately 2 to 3 AF of storage is required to produce 1 AF of firm annual yield for M&I use. Agricultural transfer yields are not, by themselves, firm since they are typically seasonal and susceptible to drought conditions. Storage is needed to carry over agricultural supplies from the irrigation season to the non-irrigation months and to ensure that adequate water can be stored in average to above average runoff years for use in below average years.
- Return flows from agricultural lands may provide important seasonal instream flow benefits, the timing of which may be altered by a transfer. Flood irrigation

of mountain meadow hay fields often result in delayed return flows of high quality, cold water, supporting aquatic habitat in the late fall and winter months.

- There is a potential impact on groundwater tables and wells in the area unless historical returns are made in the exact location. Many domestic and irrigation wells are kept viable by the return flows from irrigation.

### 8.2.2.2 Interruptible Agricultural Transfers

Interruptible agricultural transfers consist of temporary arrangements where agricultural water rights can be used for other purposes. The agreement with agricultural users allows for the temporary cessation of irrigation so that the water can be used to meet other needs.

Interruptible agricultural transfers offer several benefits:

- A permanent transfer of agricultural water rights may not be needed, avoiding some of the negative impacts of a permanent dry up of agricultural lands.
- Interruptible agreements are useful during below average runoff conditions, when the available supplies to meet M&I, environmental, or recreational needs are reduced. The need to construct significant volumes of new storage to carry over water from average to above average runoff years for use in below average years can be minimized.
- Since agricultural water rights are often more senior, the temporary transfer of this water to other uses can result in meeting an M&I, environmental, or recreational need during critical dry periods without the expense and issues of a permanent agricultural transfer or the development of storage or an expensive new water supply project.
- A better or more stable income to agricultural users can be assured, since during a drought supplies may not be adequate to produce a crop, even if the agricultural water right were used for irrigation and the net income from an interruptible arrangement can exceed the revenue that would be realized from farming that year.

There are numerous potential issues and conflicts with interruptible transfers that may limit the usefulness of this option as a tool for meeting future water needs:

- One premise of an interruptible supply arrangement is that the agricultural water right will remain in irrigation in perpetuity. An interruptible arrangement will be of very limited benefit to meet long-range water supply needs unless the interruptible supply arrangement is

permanent and the farmer is bound to keep the water in agricultural use.

- Interruptible agreements must be evaluated on a case by case basis, as not all agricultural rights can be transferred to M&I water use. For example, interruptible transfers are very limited in the Denver Metro and South Metro subbasins of the South Platte, where there is very little agricultural water use that can be interrupted on an annual basis and transferred to existing M&I intakes.
- The agricultural rights involved in the interruptible transfer must have dry year yields. Many agricultural water users also experience significant shortages during below average runoff conditions and these supplies may be of little benefit in a dry year.
- The determination of the transferable amount can be complicated; as in a water transfer the rights of those other water users must be protected. There must be a mechanism to ensure that the transfer does not result in an increase of historical CU and return flows are maintained during the temporary interruption. CRS 37-9-309 allows the State Engineer to approve and administer interruptible transfers under certain conditions. Otherwise a change of water right will be required.
- Soil, weed, labor, and equipment management issues must be considered during those periods when the interruptible transfer is occurring and there is no irrigation. A farm operation involves not only the planting, irrigating, and harvesting of crops, but the hiring of labor and maintenance of equipment. In addition, the management of soil erosion and weed growth will be issues on irrigated fields that are temporarily dried up.
- Some agricultural crops, such as orchards, vineyards, and some hay crops are difficult to fallow and may not be appropriate for an interruptible transfer.

### 8.2.2.3 Rotating Agricultural Transfers with Storage to Firm Agricultural Demands

A third concept was developed during the Basin Roundtable process in an attempt to capture the benefits of a permanent agricultural transfer without the negative impacts. This concept, rotating agricultural transfers with storage to firm agricultural supply consists of a type of interruptible agricultural transfer arrangement involving several agricultural parties and one or more M&I users. Each agricultural user would agree not to irrigate for 1 year out of a set period of years corresponding to the

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number of agricultural users in the program making the flows available to M&I users. For example, if 10 agricultural users joined the arrangement, each would take their turn not irrigating in 1 year out of 10. The M&I user would obtain a constant annual yield, with this yield coming from a different agricultural user each year. An additional element would be to set aside a portion of the water from the agricultural lands not irrigated in each year to be placed into storage to firm the yield to the agricultural users that are part of the agreement. This agricultural firming pool would be used in below average years to increase the yield for those agricultural users that are irrigating that year.

The benefits of this rotating agricultural transfer approach include:

- M&I reliability is improved since there is a guaranteed additional supplemental supply of water each year.
- A better or more stable income can be provided to agricultural users, since an income would be guaranteed during the fallowing year and the firming of agricultural yield will result in a more predictable farm yield during a drought.
- A permanent transfer of agricultural water rights may not be needed, avoiding some of the negative impacts of a permanent agricultural transfer.
- Maximizes the benefits of a non-tributary groundwater conjunctive use program. Non-tributary, non-renewable groundwater has a firm annual yield that does not vary from wet to dry years as long as the resource is not significantly depleted. The life of this groundwater resource could be extended by relying on a rotating agricultural fallowing program in average to above average years and pumping groundwater only during below average years. In these below average years, the yield from the rotating fallowing can be used to firm the yield of the agricultural users that are irrigating during those years.

Potential issues and conflicts with rotating agricultural transfers include:

- As for other interruptible supply arrangements, the lands involved remain in irrigation in perpetuity. The agricultural users would need to bind themselves to continue agricultural irrigation use and to fallow the land for a year as required.
- This may be more expensive approach than a permanent agricultural transfer. Incentives would

need to be significant to induce an agricultural user to forego the right to sell the water in the future. Annual payments would be required for the agricultural users that are fallowing each year. In addition, the transaction costs to assemble a suitable program could be significant.

- Some agricultural crops, such as orchards, vineyards, and some hay crops are difficult to fallow and may not be appropriate for a rotating fallowing program.
- Agricultural supplies under a rotating program may not be in the needed location or of sufficient quantity. The water from the fallowed lands must be transferred to the M&I water supply intakes if the yield is to be used for this purpose rather than instream needs.
- A change of use from agricultural to M&I or other uses would likely be required. Determination of the transferable amount can be complicated and other water users must be protected. Legal and engineering costs will be incurred.
- Soil, weed, labor, and equipment management issues must be considered for the fallowed lands. A farm operation involves not only the planting, irrigating, and harvesting of crops, but the hiring of labor and maintenance of equipment. In addition, the management of soil erosion and weed growth will be issues on irrigated fields that are temporarily dried up.
- Storage would be required to firm the yield for all parties. M&I users would need storage to carry irrigation season water over to the non-irrigation months and storage will be needed to firm the agricultural supplies and provide for the replacement of delayed return flows from the fallowed lands.

### 8.2.2.4 Water Bank

In addition to permanent agricultural transfers, water banks have been authorized by the Colorado legislature. A pilot program was established in the Arkansas Basin. The water bank provides a mechanism for leasing water on a short-term basis without permanently transferring a water right to another user. Entities with stored water rights have the options to lease their water during times of drought or when it will not be put to beneficial use.

The benefits of water banks include:

- Water supplies are improved for users acquiring water from the water bank.

- Agricultural use can be preserved by allowing alternative uses on an interim basis, without a permanent dry up.
- A better or more stable income to agricultural users can be provided, since the net income from a lease can exceed the revenue that would be realized from farming in a dry year.
- Provides for flexibility in water management, as there is a free market mechanism through which water supplies can be transferred within a basin.

The potential issues and conflicts with the use of water banks for meeting future water needs include:

- Water may not be available from the water bank when needed. There is no guarantee or requirement for a party to place its water in a bank.
- Determination of transferable amount can be complicated and other water users must be protected.
- Soil, weed, labor, and equipment management issues must be considered during those years when irrigation is not occurring.
- Challenges in starting a market. An entity needs to be responsible for implementing advertising and maintaining the Bank.

### 8.2.3 Development of Additional Storage

Storage projects capture water during high flow years and seasons to be used during low flow periods. These storage projects include the construction of new reservoirs, enlargement of existing reservoirs, or rehabilitation of existing reservoirs that have reduced storage volumes due to various structural problems (e.g., spillways unable to meet the current probable maximum flood criteria, etc.). Storage options included in the SWSI process include the construction of new storage facilities to capture legally available flows under a new water rights appropriation, the construction of new storage facilities to maximize the yields of existing water rights, including exchange priorities and conditional storage rights, and the enlargement of existing reservoirs. The rehabilitation of existing reservoirs that are under voluntary or mandatory storage restrictions was evaluated during the Basin Roundtable process. It was determined that while there are many reservoirs with restricted capacities, the total potential storage to be gained from rehabilitation efforts is small in comparison to Colorado's overall need. This issue is discussed in greater detail in Section 10.

#### 8.2.3.1 New Storage Projects

New storage projects include the construction of dam embankments to create on-channel or off-channel reservoirs. Off-channel reservoirs require the construction of diversion or pumping facilities from the river or stream to deliver the diverted water to storage. Another option for the development of new storage is the conversion of gravel pits to gravel lakes. These lakes are formed by reclaiming and lining pits created through gravel mining operations. Diversion or pumping facilities are also required to deliver water to gravel lakes. Storage options will vary greatly in their feasibility, and project considerations, such as firm yield, capital costs, and permitting are site specific.

The benefits of developing new storage projects include:

- Water sources will be diversified if the water to be stored is from a new source. This can reduce the risk of supply shortfalls as not all water sources may experience shortages at the same time.
- The development of storage to capture unappropriated water can potentially reduce the pressure to transfer water from existing uses (i.e., agricultural water) to meet future water needs.
- The reliability of the overall water supply system can be increased and the risks reduced. The development of additional new storage can help protect against potential water shortages due to structural failures such as storage restrictions or the temporary inability to use a supply due to water quality concerns such as those associated with a forest fire in the watershed.
- Existing water rights are not affected if the water to be stored is under a new water right.
- The development of storage for unappropriated water captures an unused resource.
- The development of storage maximizes compact entitlements for beneficial use within the State of Colorado.
- Overall system efficiencies are increased by minimizing system spills.
- The yields of exchanges and non-potable reuse for irrigation are increased. Maximizing the reuse of consumable return flows requires storage, since return flows occur year-round, but reuse for irrigation only occurs during the summer months.
- Storage is required to firm the yield of transfers of agricultural water rights. If storage is not constructed,

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additional agricultural water rights will be needed to ensure adequate supply during below normal runoff conditions.

- New reservoirs provide flat water recreation opportunities. Boating, swimming, and lake fishing opportunities are increased.
- Storage often provides consistent flows below the storage facility that can provide ideal cold water fishery habitat. Many of the Gold Medal fisheries in Colorado are below storage facilities.
- There is the potential for hydropower generation.

The potential issues and conflicts in developing new storage projects include:

- There may be environmental impacts to the aquatic and terrestrial environment. These impacts are likely to be more significant than those resulting from enlarging existing storage facilities.
- Loss of recreation associated with free-flowing streams, such as fishing, rafting, and kayaking.
- Water quality impacts can be associated with impounded water.
- Cultural impacts associated with inundation of lands.
- Permitting and mitigation can be more expensive and lengthy than other water supply options and have an uncertain outcome.
- A significant amount of storage may be required to produce an acre-foot of firm yield. The amount of storage required will be basin and water rights specific.

### 8.2.3.2 Expansion of Existing Storage Facilities

The expansion of existing storage facilities can be a cost-effective means to develop additional storage. Options for increasing storage in existing facilities include raising dam embankments, dredging of sediments, and deepening reservoirs and raising spillway levels.

The expansion of existing storage facilities has several benefits including:

- There are likely to be less environmental and recreational issues than for new storage, since the reservoir already exists.
- Permitting and mitigation requirements may be less difficult than for construction of a new storage facility.

- Existing water rights are not affected if the water is to be stored under a new water right.
- The expansion of storage to capture unappropriated water can potentially reduce the pressure to transfer water from existing uses (i.e., agricultural water) to meet future water needs.
- The expansion of storage for unappropriated water captures an unused resource.
- The expansion of storage helps to maximize compact entitlements for beneficial use within the State of Colorado.
- Overall system efficiencies are increased by minimizing system spills.
- The yields of exchanges and non-potable reuse for irrigation are increased. Maximizing the reuse of consumable return flows requires storage, since return flows occur year-round, but the demand for irrigation is seasonal.
- Storage is required to firm the yield of transfers of agricultural water rights. If additional storage is not constructed, additional agricultural water rights will be needed to ensure adequate supply during below normal runoff conditions.

The potential issues and conflicts in expanding existing reservoirs include:

- Environmental and recreation impacts can also occur here depending on the size of facility.
- Expanding existing storage facilities does not diversify water sources and the risks of structural failures or water quality catastrophes are not reduced.
- Permitting and mitigation, though typically less difficult than that for new storage, can still be expensive and lengthy with an uncertain outcome.
- A significant amount of storage may be required to produce an acre-foot of firm yield. The amount of storage required will be basin and water rights specific.
- There are a limited number of reservoirs that can be enlarged. Many reservoirs are not cost-effective to enlarge.
- There is a limited volume of increased storage available through reservoir enlargements.
- The enlargement of existing reservoirs may not be cheaper than new storage. The original dam embankments and spillways, in many instances, were

not designed or constructed to current engineering standards. Upgrading the existing facilities to be compatible with an enlargement may not be cost-effective.

## 8.2.4 Conjunctive Use of Surface Water and Groundwater

Colorado's groundwater supplies are abundant but are limited in many areas by physical or legal availability or economic feasibility issues. Physical limitation affects the reliability and sustainability of groundwater as a source of supply. Physical availability measures the amount of water an aquifer can produce, both in the short- and long-term, and primarily affects the sustainability of the resource. Legal availability relates to the amount of water that can be extracted from an aquifer under the water rights administration system that exists in a particular area, and can affect the reliability of the supply.

In the context of water supply, aquifers can be categorized as being renewable or non-renewable. Aquifers that are located adjacent to rivers in the alluvial floodplain deposits usually have a hydrologic interaction with those rivers, and dynamically get water from or discharge water to the rivers throughout their reaches. Aquifers of this type are referred to as tributary aquifers. They usually are unconfined aquifers that are relatively shallow. Tributary aquifers are considered to be a renewable source of water since they are hydrologically linked to renewable supplies such as precipitation and infiltration of surface water.

The other category of aquifer, non-renewable, is one that is not replenished from renewable sources such as rivers or infiltration of rainfall. Non-renewable aquifers generally are located deep below the land surface, in consolidated bedrock deposits, and would be classified as confined aquifers. A non-renewable aquifer may be capable of producing water reliably under varying climate conditions (wet and dry years); but it may only last 50 to 100 years and would therefore not be considered a sustainable resource. Recharge of non-renewable bedrock aquifers is very slow and withdrawal rates usually exceed recharge. As water levels decline in a non-renewable aquifer additional wells would be required to maintain a given pumping rate. These non-renewable aquifers are unreliable as a permanent, sustainable water supply.

Conjunctive use of surface water and groundwater can maximize the benefits and reliability of both surface water and groundwater sources of supply. In its simplest form, conjunctive use involves using surface water when surface supplies are ample, such as during average to above average runoff conditions, and recharging aquifers with available surface water. When surface water supplies are in short supply, such as during below average runoff conditions, groundwater supplies would be used to a larger degree to meet demands. Both bedrock and alluvial aquifers can be used in a conjunctive use water supply operation by serving as a water storage bank. Deposits are made in times of surface water supply surplus and withdrawals occur when available surface water supply falls short of demand.

### 8.2.4.1 Bedrock Aquifer Conjunctive Use

Bedrock aquifer conjunctive use involves capturing and using surplus surface water supplies for immediate use or injecting these surplus surface water supplies into the bedrock aquifer through wells. The intent is to extend the life of non-renewable groundwater sources.

The benefits of bedrock aquifer conjunctive use storage and recovery include:

- Maximizes the benefits of bedrock aquifers and extends their long-term reliability. The use of surplus surface water supplies can reduce the need to withdraw non-renewable groundwater. The recharge of the aquifer extends the life of the groundwater reserve.
- Evaporation is minimized. Once the water has been recharged, there is no additional evaporation as compared to surface water storage.
- There may be fewer environmental impacts than surface reservoir storage.
- Requires less surface area for water storage.
- The permitting process is simpler than for developing surface water storage.
- Existing infrastructure designed for peak demands can be used during non-peak demand periods. Existing wells developed to meet peak demands can be used as injection wells during non-peak periods.
- Potable quality water can be withdrawn. Most bedrock aquifers are of potable water quality and do not require water treatment except for disinfection.

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- Fewer risks of contamination and disruption of supply. Being far below the surface insulates the supply from contamination and since aquifer supplies would typically be extracted using multiple wells there is redundancy built into the system.
- Significant volumes of potential aquifer storage are available. Most of the major bedrock aquifers in Colorado have significant volumes of storage.

Issues and conflicts with implementation of bedrock aquifer conjunctive use include:

- Surface water supplies must be available for recharge.
- The surface water diverted for recharge to a bedrock aquifer must be treated both to potable water quality and must be chemically compatible with the native aquifer groundwater so that dissolved constituents do not precipitate and clog the aquifer.
- All of the recharged water may not be recoverable.
- Recharge rates for non-tributary aquifers often are low.
- High energy costs are incurred for aquifer recharge and pumping.
- May require the construction of specialized wells or refitting of existing wells that can be used to both inject and pump water. Such wells are referred to as aquifer storage recovery wells, or ASR wells.
- There may be a need for additional infrastructure (wells, surface water storage, and water treatment) constructed to meet peak demands.
- Additional surface storage may be needed to capture peak surface water flows that would be used later to recharge the aquifer. Surplus supplies are normally available during peak runoff periods, which can be when water demands are highest and existing wells will not be available for recharge.

### 8.2.4.2 Alluvial Aquifer Conjunctive Use

Alluvial aquifer conjunctive use involves diverting surplus surface water supplies and recharging the alluvial aquifer. Recharging is typically accomplished by canal infiltration or spreading basins, and then pumping the groundwater when needed as a source of supply or when the timing of accretions to the river system is needed to meet demands (for example, stream depletion requirements or streamflow enhancements). The benefits of alluvial aquifer conjunctive use include:

- Maintains high groundwater levels, benefiting wetlands, nearby streams and other nearby surface water features.
- Evaporation is minimized. Once the water has been recharged, there is no additional evaporation as compared to surface water storage.
- There may be fewer environmental impacts than for surface reservoir storage.
- Often requires less land for water storage.
- The permitting process is simpler than developing surface water storage.
- Streamflows can be diverted and recharged without additional treatment costs.
- Existing structures can often be used for recharge, such as river diversion structures and canals.
- Recharge can occur with low capital and operating costs since the recharge can occur through ditch or pond seepage as opposed to pumped injection.
- Tributary aquifers usually have a high recharge rate.
- Significant volumes of potential aquifer storage are available.
- Can be used to regulate streamflows for environmental enhancements. Timing the stream accretions from alluvial recharge can occur so that the water is accreted to the stream to benefit the environment.
- Can be used to augment agricultural well pumping. Timing the accretions from alluvial recharge can occur so that the water reaches the stream to match and augment depletions from agricultural well pumping.

Issues and conflicts with implementation of alluvial aquifer conjunctive use and storage and recovery include:

- Surface water supplies must be available for recharge.
- May lead to high water table conditions, which could reduce infiltration rates and be potentially damaging to nearby structures.
- The water quality may be degraded during recharge as additional salts and minerals may be leached during the infiltration.
- Advanced water treatment may be required if the recovered water is used for potable purposes. Alluvial

aquifers are also recharged by agricultural and urban return flows and may be high in salts, minerals and nitrates. Advanced water treatment techniques, such as reverse osmosis, are commonly used to treat alluvial aquifer water for M&I use. The disposal of the waste streams from reverse osmosis treatment can be very expensive.

- The recharged water will eventually return to the river system if not used or recaptured, and so may not be recoverable when needed.
- Additional wells may need to be constructed to meet peak demands.
- Storage may need to be developed to capture peak surface water flows that are used for later recharge.
- A water court approval process, which may be lengthy and expensive, is required.

### 8.2.5 Municipal and Industrial Reuse

M&I reuse involves a second or consecutive uses of consumable water supplies that have first been used to meet municipal or industrial needs but not fully consumed. The first aspect important to understand in reuse projects is the consumptive and non-consumptive components of water use. Water use is generally divided into CU (i.e., water that is in effect consumed and eliminated from the system) and non-CU (i.e., water returning to the system after use by infiltration into the ground, or water returning to the system as effluent from wastewater treatment plants after use in households). Reuse projects seek to recycle that portion of the water not consumed.

M&I consumable return flows can be reused through several methods. Three general types of reuse projects were included for consideration in the SWSI process: water rights exchanges, non-potable reuse and indirect potable reuse.

#### 8.2.5.1 M&I Reuse by Water Rights Exchanges

M&I reuse by water rights exchanges involves the exchange of legally reusable return flows for water diverted at a different location. Water is diverted at one source in exchange for water replaced to downstream users from a different source. In an M&I reuse exchange, the amount of non-CU water returned to the system, e.g., via effluent flows and/or return flows from landscape irrigation, depends on the CU associated with the

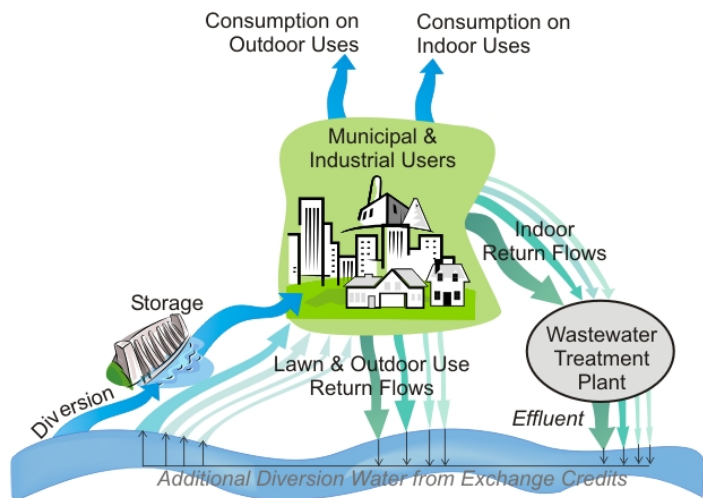
demand (i.e., the higher the CU, the lower the percent of total diversions that can be reused).

The non-CU water can be reused multiple times, theoretically to extinction, with the total available water reduced with each application, since each time the water is diverted for reuse, a portion of it is consumed by the use. A schematic illustrating the exchange of consumable return flows is shown in Figure 8-4.

The increases in yield that can be achieved through the successive use and reuse of the return flows to extinction are shown in Figure 8-5. For example, if there are no return flows from the use of 1 AF of consumable water, then there is no additional yield and the total yield is one acre-foot. If 50 percent of the return flows from an M&I use of consumable water were exchanged and the return flows from each successive use used to extinction, the total yield realized from 1 AF of consumable water is 1.6 AF. This is based on an assumed M&I CU of 35 percent and return flows of 65 percent.

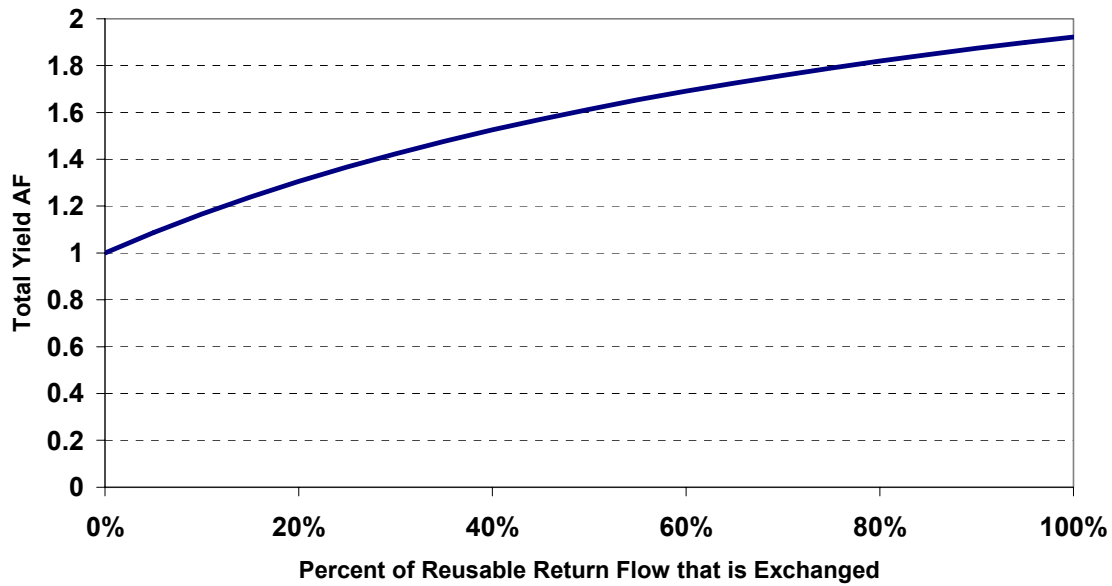
Potential benefits of exchanging reusable flows include:

- Improves M&I reliability by providing for additional yields.
- Maximizes water use through successive uses.
- Maximizes beneficial use of water.
- May not require additional diversion structures or other facilities.
- Lesser environmental impacts than a new water supply project.



**Figure 8-4**  
**M&I Water Rights Exchange**

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**Figure 8-5**  
*Total Yield from Exchange of 1 AF of Consumable Water Based on Reuse to Extinction*

Potential issues and conflicts involving reuse by exchange include:

- There must be adequate exchange potential (physical supply) available at the upstream point of diversion.
- The substitute supply (the reusable water that is used to replace the water diverted by exchange) must be suitable for downstream water uses as required by statute.
- There may be water quality objections from downstream users. The substitute supply may be of a different water quality from what the downstream user would have received absent the exchange. A water court procedure allows these issues to be addressed.
- Storage may be needed to regulate year round effluent return flows. The timing of return flows may not match the times when there is exchange potential. For example, winter effluent may need to be stored for exchange to agricultural users during the irrigation season.
- Previously unused reusable effluent historically resulted in reduced or more junior river calls controlling the river.
- As water availability decreases, M&I users are looking to develop or expand the reuse of existing reusable return flows via water rights exchanges. To the extent these reusable flows have been returning to the rivers, they have been used by downstream water users.

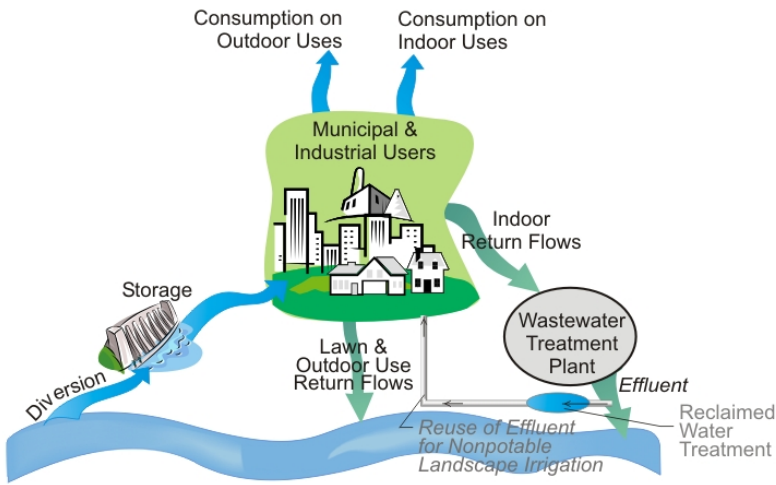
- As reusable supplies that have been historically used by downstream users are reused, river calls may become more senior, impacting all users.

### 8.2.5.2 Non-potable Reuse

Non-potable reuse involves the capture and use of legally reusable return flows for the irrigation of urban landscapes or for industrial uses such as cooling or process water. Since return flows from landscape irrigation are hard to capture in one location, non-potable reuse to date has involved the reuse of consumable effluent discharged from wastewater treatment facilities. The effluent undergoes additional treatment to meet non-potable reuse standards. This treatment usually involves filtration and additional disinfection.

As noted, it is infeasible to capture return flows from landscape irrigation, though additional yield could be achieved if the landscape irrigation return flow points and amounts are identified and exchanged to upstream points. A schematic illustrating non-potable reuse for landscape irrigation is shown in Figure 8-6.

Figure 8-7 shows how the total yield from 1 AF of consumable water based on the percent of the effluent return flows that are used for landscape irrigation can be increased. For example, if 50 percent of the effluent return flows from an M&I use of consumable water were reused for landscape irrigation the total yield realized from 1 AF of consumable water is 1.25 AF.



**Figure 8-6**  
**Irrigation Reuse**

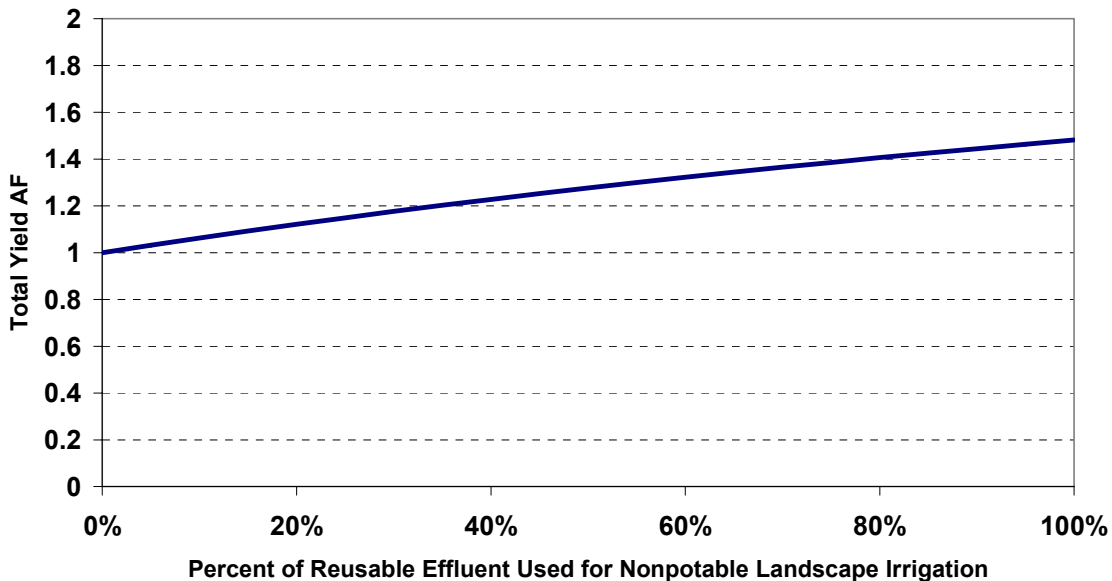
- Does not use higher quality drinking water for irrigation.

Potential issues and concerns include:

- Can be very expensive.
- Must have consumable effluent to reuse or identified return flows.
- Wastewater treatment plant needs to be near irrigation demands.
- Must have storage to regulate year round effluent flows and meet demands during irrigation season.
- As M&I users develop or expand the reuse of existing reusable return flows via water rights exchanges less water may be available to downstream users.

Potential benefits of non-potable reuse include:

- Improves M&I reliability.
- Maximizes successive uses of water.
- Maximizes beneficial use of water.
- May not require new diversion structures.
- Lesser environmental impacts than a new water supply project.
- Previously unused reusable effluent historically resulted in reduced or more junior river calls controlling the river.
- River calls may become more senior, impacting all users.
- Public acceptance of the reuse of effluent for landscape irrigation must be achieved.



**Figure 8-7**  
**Total Yield from Non-potable Reuse of 1 AF of Consumable Water Based on One-time Reuse for Landscape Irrigation**

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### 8.2.5.3 Indirect Potable Reuse

Indirect potable reuse involves the capture of legally reusable return flows and reintroduction of these captured flows into the municipal raw water supply. The return flows that are captured may have been discharged to a river or stream and mixed with other waters. Other options include the capture of treated wastewater effluent and additional treatment. The captured flows are then reintroduced into the M&I raw water supply system. The water may require advanced water treatment methods beyond the existing level of treatment used for the current water supply before the recaptured water was introduced into the raw water supply.

Potential benefits of indirect reuse include:

- Improves M&I reliability.
- Maximizes use through successive use.
- Maximizes beneficial use of water.
- Lesser environmental impacts than a new water supply project.
- May not require new diversion structures.

The potential issues and conflicts of indirect potable reuse are:

- Can be very expensive. Infrastructure and operations and maintenance costs will be high.
- Must have consumable effluent to reuse.
- Raw water treatment plant and/or pump back station needs to be constructed. Infrastructure is required to divert and store return flows, pump back to raw water supply storage and additional treatment.
- Existing and future regulatory compliance concerns. SDWA regulations have to be met at a minimum. Concerns over disinfection byproducts and pollutants in captured return flows can result in expensive, advanced water treatment processes.
- The disposal of water treatment waste products is becoming increasingly problematic and costly.
- Previously unused reusable effluent historically resulted in reduced or more junior river calls controlling the river.

- As M&I users develop or expand the reuse of existing reusable return flows via water rights exchanges less water may be available to downstream users.
- River calls may become more senior, impacting all users.
- Public acceptance of the reuse of return flows for drinking water must be achieved.

### 8.2.6 Control of Non-Native Phreatophytes

This option would consist of a basinwide or a focused-area program for the removal and control of non-native phreatophytes that consume water that could otherwise be used by any of the basin users: agricultural, M&I, recreational, or environmental. Non-native phreatophytes are invasive plant species that consume water. Of particular concern in Colorado are tamarisk trees. Methods of removal include: mechanical removal, prescribed burning, biological control, and herbicide application. While state and federal programs are beginning to evaluate phreatophyte control options in more depth, the costs and benefits (e.g., yields) of phreatophyte control programs are largely unknown at this time. Demonstration projects are planned in the Rio Grande and Arkansas Basins, and USGS is updating estimates of potential water savings.

Potential benefits of non-native phreatophyte control are:

- Benefits all users: M&I, Agriculture, Environment, and Recreation in accordance with water right priorities.
- Reduces non-beneficial consumption of water.
- Creates additional supplies without new water storage or other infrastructure.

Potential conflicts or issues associated with non-native phreatophytes are:

- Any water saved would be administered under the water rights system.
- Does not benefit specific users and thus funding by water users will be a challenge.
- Would require regional cooperation and funding from a regional, state or federal agency.
- It is not clear that the vegetation that replaces the non-native species will use less water.