

Appendix F6
Option Characterization – Reuse

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1.0 Introduction

Many municipal and industrial entities that receive Colorado River water have implemented wastewater reuse programs and have plans to develop additional supply through future reuse. Development of reuse above current plans has been proposed to provide a “new” supply in those areas currently relying upon water supply from the Colorado River. A number of reuse options were submitted for consideration in the Colorado River Basin Water Supply and Demand Study (Study). The submittals are summarized in appendix F2 and the original submittals are available via links from the electronic version of appendix F2 on the compact disc that accompanies this report and the version of appendix F2 on the Study website at <http://www.usbr.gov/lc/region/programs/crbstudy.html>.

Eleven options were submitted related to reuse to increase the supply the Study area. Many of these submittals were related to specific reuse programs, specific uses of reuse water, or geographic-specific reuse opportunities. The major areas of potential reuse are shown in figure F6-1.

Due to the large number of geographic specific approaches and limitations, a set of Colorado River Basin (Basin)-wide option groups and representative options were developed based on the type of reuse:

- Municipal Wastewater Reuse
- Industrial Wastewater Reuse
- Grey Water Recycling

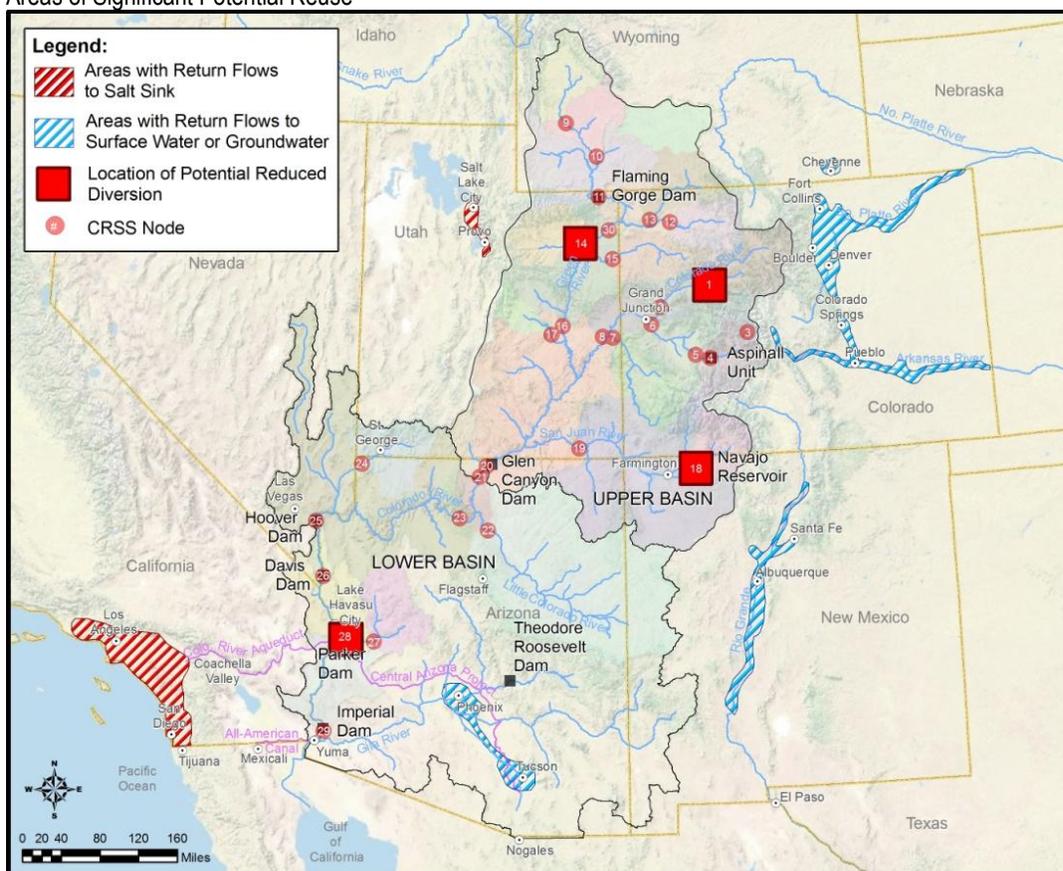
This appendix summarizes the types of options received, the assumptions made and methods used to characterize the options, and the characterization results. Additional detail related to the options characterization is included in appendix F3. Attachment A of appendix F3 contains more detailed descriptions of the ratings. Attachment B provides the methods used for completing the unit cost calculations. Attachment C presents the detailed characterization information and is available on the compact disc that accompanies this report and on the Study website.

For each type of reuse, the option was only considered to provide new supply to the adjacent areas or areas where return flow does not augment Colorado River flow. This consideration was due to the balance between diversions, consumptive use, and return flow within the hydrologic basin that results in most return flows becoming available for downstream purposes.

In addition, states such as Colorado, Wyoming, and New Mexico have regulatory frameworks that dedicate return flows to other users or require return flow for water rights purposes. In these states, the potential for reuse was limited by these downstream return flow considerations. In other areas, such as Southern California, physical infrastructure capacity limited the amount of reuse that could be effectively developed.

Implementation of additional reuse programs helps meet local demands in the Study Area. The areas of greatest potential for reuse exist outside of the hydrologic basin and generally include a portfolio of water supplies (groundwater, local supplies, other imports), including Colorado River water. These supplies each have their own cost, reliability, water quality, and other factors that lead to agency preferences related to which supply (current or future) would be reduced under lower demand scenarios. Under purely financial considerations, it is unlikely that the Colorado River supply is the marginal supply in the portfolio. Given the complexity of regional and local water management decisions, it was simply assumed that increased development of reuse reduces water demands proportionally to the magnitude of supply from Colorado River and non-Colorado River sources. However, because these demand reductions benefit more than just Colorado River water users, the cost of achieving these reductions is assumed to be shared by the beneficiaries. Figure F6-1 shows the primary reuse locations.

FIGURE F6-1
Areas of Significant Potential Reuse



2.0 Municipal Wastewater Reuse

Nine of the options propose reusing potentially available municipal wastewater to varying degrees. Concepts related to reuse of municipal wastewater in major urban areas were considered for either non-potable purposes such as irrigation or for potable purposes through indirect or direct methods.

One representative Basin-wide option was developed for this group, but includes regional differentiations related to types of reuse. For example, non-potable reuse was considered in all major municipal areas receiving Colorado River water. However, indirect potable reuse was considered for areas in Southern California and Arizona due to the current and already planned high levels of non-potable reuse programs. The municipal reuse representative option includes reuse for parks, golf courses and other traditional municipal uses. When potential yield of a representative option exceeds 200 kafy, the representative option was characterized in progressive 200 kafy “steps” to represent likely project phasing.

2.1 Non-potable Reuse in California, Colorado, Utah, Arizona, New Mexico, and Wyoming

The potential for traditional non-potable reuse (providing treated wastewater for landscape irrigation) for golf courses, parks, and industry was evaluated for California, Colorado, Utah, Arizona, New Mexico, and Wyoming. Golf course demand was assessed based on the typical number of golf courses per person, with a typical number of acres per course and local evapotranspiration. About 37 percent of existing courses are supplied with reuse water, resulting in an additional potential non-potable reuse demand of about 275,000 acre-feet (af). This potentially overlaps to some extent with the broader municipal systems considered below.

As noted above, reuse potential in Colorado, New Mexico, and Wyoming is limited by regulatory considerations. These states were assumed to have a reuse potential of about 80,000 af. This amount of reuse was derived from estimates of additional reuse potential in Colorado (CWCB, 2010), conversations with Wyoming water managers, and direct experience with assessing reuse potential in New Mexico. Reuse in Utah was limited by the total diversion out of the hydrologic basin to the Wasatch Front of 20,000 af (i.e., the potential reuse supply is greater, but this is the maximum benefit to the Basin). Arizona was estimated to have a reuse potential of about 250,000 af based on information provided by the Arizona Department of Water Resources. Because of infrastructure limitations, California was estimated to have a total reuse potential of 600,000 af. For both Arizona and California, it was assumed that of these totals about one third could be applied for non-potable reuse, with the remaining amount available for indirect or direct potable reuse. Overall, traditional non-potable reuse potential was assumed to be about 360,000 af.

Because traditional non-potable reuse is commonly practiced in the Southwest, these options were assumed to require about 3 years for feasibility, 2 years for permitting, and 5 years for implementation, for a total of 10 years.

Unit annual costs for traditional non-potable uses were derived from the augmentation study (Colorado River Water Consultants, 2008) at about \$1,500 per af.

In addition to yield, timing, and cost, the non-potable reuse option was characterized using several other criteria. A summary of the findings for all criteria is shown in table F6-1. Non-potable projects of this size have not been implemented in the Study Area previously. Permitting, legal, and policy implementation will be more difficult for the indirect potable option than for more-traditional non-potable reuse. There is some implementation risk due to the amount of capital required. There is also some risk of infrastructure failure and risk of escalating costs because of the energy-intensive nature of the options. The option scores poorly under operational flexibility as a result of the likely associated debt service for a stranded asset. Energy needs are estimated at 500 kilowatt hours (KWh) per af. This energy would come from

the grid resulting in a mix of fuel sources. If the option resulted in fewer releases to the Lower Basin, due to a reduction in demand for Colorado River water, then hydropower would be reduced. This effect would be most notable for larger implementations. The non-potable option could increase salinity in the Basin because salts are not discharged with the wastewater. Recreation impacts are largely neutral. If the demand for Colorado River water is reduced, resulting in higher streamflows, the effect would be largely positive toward the “other” environmental factors, but disposal in inland areas may be environmentally challenging and there may be some localized long-term effects related to ocean brine disposal for larger implementations. No appreciable positive or negative impacts to socioeconomics are noted.

2.2 Indirect Potable Reuse in Southern California and Arizona

In California and Arizona, indirect potable reuse was assumed as the most likely method of reuse for most reuse beyond that which is already included in demand scenarios. Indirect potable reuse supply can be re-introduced into municipal water supply reservoirs or groundwater basins, blended with other supply sources, treated, and provided for both indoor and outdoor uses. Based on a review of the available wastewater discharges to the ocean in Southern California, it was determined that the primary limitation on this option is the ability to integrate it into the Metropolitan Water District of Southern California’s system. From discussions with Metropolitan Water District personnel, it was assumed that no more than 600,000 af could be integrated into the regional system. As noted previously, Arizona indicated a 275,000-af potential for reuse. When traditional non-potable reuse is removed from these estimates, there is about 570,000 af of indirect potable reuse potential remaining.

Although indirect non-potable reuse systems exist in some areas of the state, as much as 10 years would likely be needed for feasibility and permitting, with an additional 5 years for implementation, for a total time of 15 years.

Costs for the indirect potable options were based on a parametric cost estimating tool, resulting in a unit annual cost of about \$1,800 per af attributable to additional treatment costs. Capital costs to treat and convey the water were estimated to be approximately \$4.8 billion.

Other key criteria were characterized very similarly to the non-potable reuse option, with a few exceptions. More energy would be needed (4,300 KWh per af) due to more-stringent treatment requirements. Indirect or direct reuse is not widely practiced at this scale and may encounter public resistance. Overall water quality, given the removal of salt load (i.e., through reverse osmosis treatment) for these options, will improve. However, there may be localized long-term impacts from ocean brine disposal.

3.0 Industrial Wastewater Reuse

Byproduct wastewater flows are generated from a variety of industries that are not discharged through municipal wastewater systems. Non-potable reuse of byproduct water from various industries was proposed to meet demands. In this case, the only representative option is general industrial wastewater reuse.

The consideration of industrial reuse targeted specific industries and byproducts. The target industries largely lie within the self-supplied or “self-served industrial” category. Targeting 10 percent of the latter category demand results in about 40,000 af of potential reused water.

Industrial reuse included treatment of produced water with total dissolved solids concentrations on the order of 15,000 milligrams per liter. Additional costs for collection and distribution of this water resulted in a unit annual cost of at least \$2,000 per af.

Other key criteria were characterized very similarly to the indirect potable reuse option, with a few exceptions. Slightly less energy would be needed because of less-stringent treatment requirements. However, hauling the product water from the distributed locations may require diesel fuel as a significant energy source. Non-potable reuse is already a widely accepted process and would encounter little public resistance. Lastly, this option could increase salinity in the Basin because the salts are not discharged with the wastewater.

4.0 Grey Water Reuse

Grey water is generally defined as untreated wastewater that has not been contaminated by any toilet discharge, has not been affected by unhealthy bodily wastes, and does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes (California Building Standards Commission, 2010). The reuse or recycling of this water at individual homes or communities can be used for non-potable purposes. This group of options assumes reuse of water for non-potable purposes at individual homes and is limited by the amount of residential wastewater generated as well as the seasonal nature of the associated non-potable demand. The representative option is described as: Grey Water Reuse in Adjacent Urban Areas.

4.1 Grey Water Reuse in Adjacent Urban Areas

A portion of the municipal wastewater in adjacent areas may be available for grey water reuse. It was assumed that approximately 50 percent of overall residential indoor water use (from washing machines, showers, and sinks) could be considered gray water. This 50-percent use is a gross assumption. Actual potential will vary significantly from place to place. It was further assumed that grey water could only be used for residential non-potable demands, which were estimated as 60 percent of the total household demand. Finally, it was assumed that an ultimate adoption rate of 50 percent by 2060 was achievable. These assumptions resulted in an annual yield of about 178,000 af by 2060.

It is important to note that in many adjacent urban areas, such as the Front Range in Colorado, Colorado River grey water is treated and re-diverted for reuse by municipalities or for use by other downstream diverters entitled to the return flows under Colorado Water Law. Use of grey water for irrigation may reduce treatment costs; however, unless the actual outdoor irrigation consumptive use is decreased, there will be no net supply increase to the system.

Grey water reuse options were also assumed to be implementable within a 10-year timeframe, largely related to legal issues associated with plumbing code consistencies and health and safety concerns (individual systems). As with other options, it was assumed that these options had broad support.

Grey water recycling costs were derived from information at www.greywateraction.org, which estimated that the cost to install a sand filter to drip irrigation system was between \$5,000 and \$10,000. Assuming a cost of \$5,000, with payments spread over 30 years to be consistent with

other financial options and a single home using 0.07 af per year, grey water recycling had the highest cost of the reuse options based on the distributed nature of the systems at a unit annual cost of \$4,200 per af.

Key criteria for the grey water reuse option were characterized similarly to the other reuse options with a few exceptions. Grey water reuse scored well on operational flexibility because it would likely be implemented on a case-by-case basis, resulting in little debt service. In addition, grey water reuse rated high for permitting and other environmental factors in that reduced wastewater discharge to sewer systems would result.

5.0 Characterization Results

A summary of the characterization findings are shown in table F6-1. The top portion of the table shows the estimated quantity of yield, earliest timing of implementation, and estimated cost. The bottom portion of the table shows the 17 criteria and associated ratings (“A” through “E”) and is color-scaled. In general, “C” is typically designated as mostly neutral; “A” is largely positive; and “E” is largely negative. Refer to appendix F2 for specific criteria descriptions and rating scales.

6.0 References

California Building Standards Commission. 2010. California Plumbing Code.

Colorado River Water Consultants. 2008. *Study of Long-Term Augmentation Options for the Water Supply of the Colorado River System*.

Colorado Water Conservation Board (CWCB). *Statewide Water Supply Initiative*. 2010.

TABLE F5-1
Summary Characterization Ratings for Reuse Options

