

Chapter 9. Options for Meeting Future Water Needs in Eastern Sierra and Colorado River Regions of California (cont.)

Colorado River Hydrologic Region

Description of the Area

The Colorado River Region encompasses the southeastern corner of California. The region's northern boundary, a drainage divide, begins along the southern edge of the Mojave River watershed in the Victor Valley area of San Bernardino County and extends northeast across the Mojave Desert to the Nevada stateline. The southern boundary is the Mexican border. A drainage divide forms the jagged western boundary through the San Bernardino, San Jacinto, and Santa Rosa Mountains, and the Peninsular Ranges (including the Laguna Mountains). The Nevada stateline and the Colorado River (the boundary with Arizona) delineate the region's eastern boundary (Figure 9-4).

Covering over 12 percent of the total land area in the State, the region is California's most arid. It includes volcanic mountain ranges and hills; distinctive sand dunes; broad areas of Joshua tree, alkali scrub, and cholla communities; and elevated river terraces. Much of the region's topography consists of flat plains punctuated by hills and mountain ranges. The San Andreas fault traverses portions of the Coachella and Imperial Valleys. A prominent topographic feature is the Salton Trough in the south-central part of the region.

The climate for most of the region is subtropical desert. Average annual precipitation is much higher in the western mountains than in the desert areas. Winter snows generally fall above 5,000 feet; snow depths can reach several feet at the highest levels during winter. Most of the precipitation in the region falls during the winter; however, summer thunderstorms can produce rain and local flooding. Despite its dry climate and rugged terrain, the region contains large and productive agricultural areas and popular vacation resorts. [Table 9-14](#) shows the region's population and crop acreage for 1995 and 2020.

Table 9-14. Population and Crop Acreage

	Population (thousands)	Irrigated Crop Acreage (thousands of acres)
1995	533	749
2020	1,096	750

Most of the population is concentrated in the Coachella and Imperial Valleys. Major cities in the Coachella Valley include Palm Springs, Indio, and Palm Desert. Other urban centers in the region are the Cities of El Centro, Brawley, and Calexico in Imperial Valley; the Cities of Beaumont and Banning in the San Geronio Pass area; and the Cities of Needles and Blythe along the Colorado

River.

Agriculture is an important source of income for the region. Almost 90 percent of the developed private land is used for agriculture, most of which is in the Imperial, Coachella, and Palo Verde Valleys. The primary crops are alfalfa, winter vegetables, spring melons, table grapes, dates, Sudan grass, and wheat. Recreation and tourism are another important source of income for the region. In Coachella Valley, the Palm Springs area and adjoining communities are an important resort and winter golf destination. Recreational opportunities provided by the more than 100 golf courses in the Coachella Valley, water-based recreation on the Colorado River and Salton Sea, and desert camping all contribute to the area's economy.

Water Demands and Supplies

Table 9-15 shows the water budget for the Colorado River Region. Agricultural water demand makes up the majority of the water use in the region. There are two major areas where water is used for wildlife habitat in the region, the Salton Sea National Wildlife Refuge and the Imperial Wildlife Area. There are also several private wetlands.

Table 9-15. Colorado River Region Water Budget (taf)^a

	1995		2020	
	Average	Drought	Average	Drought
Water Use				
Urban	418	418	740	740
Agricultural	4,118	4,118	3,583	3,583
Environmental	39	38	44	43
Total	4,575	4,574	4,367	4,366
Supplies				
Surface Water	4,154	4,128	3,920	3,909
Groundwater	337	337	285	284
Recycled and Desalted	15	15	15	15
Total	4,506	4,479	4,221	4,208
Shortage	69	95	147	158
^a Water use/supply totals and shortages may not sum due to rounding.				

About 90 percent of the region's water supply is from surface deliveries from the Colorado River

(through the All American and Coachella Canals, local diversions, and the Colorado River Aqueduct by means of an exchange for SWP water). Other supplies are from groundwater, SWP water, local surface water, and recycled water. Bulletin 160-98 base year groundwater overdraft in the region was estimated to be about 70 taf and occurs in the Coachella Valley.

Major water agencies in the region are the Palo Verde Irrigation District, Imperial Irrigation District, Coachella Valley Water District, Bard Water District, Mojave Water Agency, Desert Water Agency, and San Geronio Pass Water Agency.

The region's primary shortages with existing supplies are expected to occur in the Coachella planning subarea because of groundwater overdraft. (In the future, reduction in California's Colorado River water use to the State's basic apportionment creates an average year shortage of as much as 0.9 maf in the South Coast Region. This 2020 shortage is shown in the South Coast water budget.)

Supplies from the Colorado River

Most of the water supply in the region comes from the Colorado River, an interstate (and international) river whose use is apportioned among the seven Colorado River Basin states by a complex body of statutes, decrees, and court decisions known collectively as the law of the river. Table 9-16 summarizes key elements of the law of the river. USBR acts as the watermaster for the Colorado River, and all users of Colorado River water must contract with USBR for their supplies. Figure 9-4 shows the locations of key Colorado River storage and conveyance facilities.

Table 9-16. Key Elements of the Law of the River

Document	Date	Main Purpose
Colorado River Compact	1922	Equitable apportionment of the water from the Colorado River system between the two basins. The Upper Basin and the Lower Basin are each provided a basic apportionment of 7.5 maf annually of consumptive use. The Lower Basin is given the right to increase its consumptive use an additional 1 maf annually.
Boulder Canyon Project Act	1928	Authorized USBR to construct Boulder (Hoover) Dam and the All American Canal (including the Coachella Canal), and gave congressional consent to the Colorado River Compact. Also provided that all users of Colorado River water must enter into a contract with USBR for use of the water.
California Limitation Act	1929	Limited California's share of the 7.5 maf annually apportioned to the Lower Basin to 4.4 maf annually, plus no more than half of any surplus waters.

Seven Party Agreement	1931	An agreement among PVID, IID, CVWD, MWDSC, City of Los Angeles, City of San Diego, and County of San Diego to recommend to the Secretary of Interior how to divide use of California's apportionment among the California water users. Details are shown in Table 9-17.
U.S. - Mexican Treaty	1944	Guarantees Mexico a supply of 1.5 maf annually of Colorado River water.
U.S. Supreme Court Decree in <i>Arizona v. California, et al.</i>	1964	Apportions water from the mainstream of the Colorado River among the Lower Division states. When the Secretary determines that 7.5 maf of mainstream water is available, it is apportioned 2.8 maf to Arizona, 4.4 maf to California, and 0.3 maf to Nevada. Also quantifies tribal water rights for specified tribes, including 131,400 af for diversion in California.
Colorado River Basin Project Act	1968	Requires Secretary of the Interior to prepare long-range operating criteria for major Colorado River reservoirs.
U.S. Supreme Court Decree in <i>Arizona v. California, et al.</i>	1979	Quantifies Colorado River mainstream present perfected rights in the Lower Basin states.

Within California, local agencies' apportionments of Colorado River water were established under the Seven Party Agreement (Table 9-17), which has been incorporated into water delivery contracts which the Secretary of the Interior has executed with California water users. Uses occurring within a state are charged to that state's allocation. Thus, federal water uses or uses associated with federal reserved rights (e.g., tribal water rights) must also be accommodated within California's basic apportionment of 4.4 maf/yr plus one-half of any available surplus water.

Table 9-17. Annual Apportionment of Use of Colorado River Water (all amounts represent consumptive use)

Interstate/International		
Upper Basin States (Wyoming, Utah, Colorado, New Mexico, small portion of Arizona)		7.5 maf
Lower Basin States (Arizona, Nevada, California)		7.5 maf
	Arizona	2.8 maf
	Nevada	0.3 maf

California		4.4 maf
Republic of Mexico ^a		1.5 maf
^a Plus 200 taf of surplus water, when available. Water delivered to Mexico must meet specified salinity requirements.		
Intrastate (Seven Party Agreement)^b		
Priority 1	Palo Verde Irrigation District (based on area of 104,500 acres).	
Priority 2	Lands in California within USBR's Yuma Project (not to exceed 25,000 acres).	
Priority 3	Imperial Irrigation District and lands served from the All American Canal in Imperial and Coachella Valleys, and Palo Verde Irrigation District for use on 16,000 acres in the Lower Palo Verde Mesa.	
Priorities 1 through 3 collectively are not to exceed 3.85 maf/yr. There is no specified division of that amount among the three priorities.		
Priority 4	MWDSC for coastal plain of Southern California-550,000 af/yr.	
Priority 5	An additional 550,000 af/yr to MWDSC, and 112,000 af/yr for the City and County of San Diego ^c .	
Priority 6	Imperial Irrigation District and lands served from the All American Canal in Imperial and Coachella Valleys, and Palo Verde Irrigation District for use on 16,000 acres in the Lower Palo Verde Mesa, for a total not to exceed 300,000 af/yr.	
Total of Priorities 1 through 6 is 5.362 maf/yr.		
Priority 7	All remaining water available for use in California, for agricultural use in California's Colorado River Basin.	
^b Indian tribes and miscellaneous present perfected right holders that are not identified in California's Seven Party Agreement have the right to divert up to approximately 85 taf /yr (equating to about 50 taf/yr of consumptive use) within California's 4.4 maf basic apportionment. These users are presently consumptively using approximately 32 taf/yr (assuming about 25 taf/yr of unmeasured return flow).		
^c Subsequent to execution of the Seven Party Agreement, San Diego executed a separate agreement transferring its apportionment to MWDSC.		

The major local agencies in California using Colorado River water in the Colorado River Region are PVID, BWD, IID, and CVWD. The Reservation Division of USBR's Yuma Project provides water to Colorado River Indian tribes in California. The remainder of California's Colorado River water use occurs in the South Coast Region (Chapter 7). Figure 9-5 is a plot of Lower Basin states' apportionments compared with historical Colorado River water use. As shown in the figure,

California's use has historically exceeded its basic apportionment, because California has been allowed to divert Arizona's and Nevada's unused apportionments, and to divert surplus water. With completion of the Central Arizona Project and the 1996 enactment of a state groundwater banking act, Arizona used more than its basic apportionment in 1997. Reduction of California's Colorado River use from current levels to 4.4 maf annually (when surplus water is not available) has significant water management implications for the South Coast Region. In calendar year 1996, actual consumptive use of the Lower Basin states (without considering USBR's unmeasured return flow credit of 239 taf) was:

Nevada	241 taf
Arizona	2,813 taf
California	5,256 taf
Total Lower Basin	8,310 taf

Within the Colorado River Region, IID, BWD, and PVID receive virtually all of their supplies from the Colorado River. IID and CVWD's Colorado River supplies are diverted into USBR's All American Canal at Imperial Dam; CVWD is served from the Coachella Branch of the AAC. PVID diverts via the Palo Verde Canal from the Colorado River near Blythe. BWD receives its supplies from facilities of USBR's Yuma Project, which serves lands in both California and Arizona.

The interstate allocations provided in the 1922 Compact were made after a period of relatively wet hydrology on the Colorado River. Some have suggested that the allocations overstate the river's normally available water supply, even without consideration of subsequent calls on that water supply for tribal water rights and endangered species fishery water needs. [Table 9-18](#) provides an overview of average river hydrology. While consumptive use from the mainstem in the Lower Basin is assumed to be its basic apportionment of 7.5 maf, Upper Basin use is still well below its Colorado River Compact apportionment. Current projections are that the Upper Basin will not reach its full Compact apportionment until after 2060.

Table 9-18. Estimated Colorado River Flow and Uses^a

	maf
Average Flow (1906-95)	
Upper Basin	15.1
Lower Basin	1.4
Total	16.5
Current Uses	
Upper Basin	3.8
Lower Basin (mainstem) ^b	7.5

Mexico	1.5
Mainstem Evaporation and Losses	1.9
Total	14.7
Average Flow into Reservoir Storage (16.5 - 14.7)	1.8
^a Prepared by the CRB.	
^b Reflects restriction on MWDSC's diversion as Central Arizona Project and Southern Nevada Water System increase diversions to Arizona's and Nevada's basic apportionments.	

Supplies from Other Sources

Local agencies contracting with the SWP for part of their supplies are shown in Table 9-19.

Table 9-19. SWP Contractors in the Colorado River Region

Agency	Maximum Annual Contract Entitlement (taf)	SWP Deliveries in 1995 (taf)
Coachella Valley WD	23.1	23.1
Desert Water Agency	38.1	38.1
Mojave Water Agency ^a	75.8	8.7
San Geronio Pass Water Agency	17.3	0
^a Contract entitlement covers both South Lahontan and Colorado River Regions; 7.3 taf of this amount is allocated to Colorado River Region.		

Neither CVWD nor DWA have facilities to take direct delivery of SWP water. Instead, both agencies have entered into exchange agreements with MWDSC, whereby MWDSC releases water from its Colorado River Aqueduct into the Whitewater River for storage in the upper Coachella Valley groundwater basin. In turn, MWDSC takes delivery of an equal amount of the agencies' SWP water. San Geronio Pass Water Agency, which serves the Banning/Beaumont area, also lacks the facilities to take delivery of SWP water, and to date has received no actual supply from the SWP. SGPWA will receive SWP supply when the Department completes its extension of the East Branch of the California Aqueduct in 2000.

Groundwater, local surface water, and water recycling provide the remaining supplies for this region.

CVWD, working with DWA, has an active groundwater recharge program for the upper end of the Coachella Valley (generally, the urbanized part of the valley). CVWD recharges groundwater with imported Colorado River supplies and with Whitewater River flows using percolation ponds constructed in the Windy Point area. CVWD and DWA levy extraction fees on larger groundwater users in the upper Coachella Valley. Imperial Valley, the largest water-using area in the region, does not have significant supplies of usable groundwater.

Local Water Resources Management Issues

Management of California's Colorado River Water

The major water management issue in this region is California's use of Colorado River water in excess of its basic annual apportionment of 4.4 maf. In the past, Arizona and Nevada were not using the full amount of their basic apportionments, and in accordance with the law of the river, California was able to use the amount apportioned to, but not used by, Nevada and Arizona. Discussions among the seven basin states and ten Colorado River Indian Tribes over changes to Colorado River operating criteria and ways for California to reduce its Colorado River water use began as early as 1991. The drought in Northern California prompted California to request that USBR make surplus water available, so that maximum use could be made of Colorado River water in Southern California. These discussions over changes to reservoir operations and how surplus or shortage conditions could be established continued for a time in a forum known as the "7/10 process."

More recently, the California local agencies, working through the Colorado River Board of California, have been developing a proposal for discussion with the other basin states to illustrate how, over time, California would reduce its use to the basic apportionment of 4.4 maf/yr. Drafts of the proposal, known as the Colorado River Board draft 4.4 Plan, have been shared with the other states. Efforts are being made to reach intrastate consensus on the plan in 1998. As Bulletin 160-98 goes to press, the most current version of the draft plan is the December 1997 version. The following text is based on that version.

As currently formulated, the draft plan would be implemented in two phases. The first phase (between the present and 2010 or 2015) would entail implementing already identified measures (such as water conservation and transfers) to reduce California's Colorado River water use to about 4.6 to 4.7 maf/yr. The second phase would implement additional measures to reduce California's use to its basic annual 4.4 maf apportionment in those years when neither surplus water nor other states' unused apportionments was available. One of the fundamental assumptions made in the plan is that MWDSC's Colorado River Aqueduct will be kept full, by making water transfers from agricultural users in the Colorado River Region to urban water users in the South Coast Region. (The Colorado River Aqueduct's capacity is a maximum of 1.3 maf/yr. However, as shown in [Table 9-17](#), MWDSC has a fourth priority right to only 550 taf annually--the remaining capacity of the aqueduct has historically been filled with unused apportionment water of other entities or with water from hydrologic surpluses.)

In the December 1997 draft plan, specific actions were included in the first phase: core water transfers (every year water transfers) such as the existing IID/MWDSC agreement and the proposed IID/SDCWA transfer; seepage recovery from unlined sections of the All American and Coachella Canals; drought year water transfers similar to the PVID/MWDSC pilot project; groundwater banking in Arizona; and conjunctive use of groundwater in areas such as the Coachella Valley. The actions are described in more detail below. The draft plan recognizes that transfers of conserved water must be

evaluated in the context of preserving the Salton Sea's environmental resources, and also that plan elements must address environmental impacts on the lower Colorado River and its listed species.

Other actions to occur as part of the first phase would include implementation of the San Luis Rey Indian water rights settlement authorized in PL 100-675 and implementation of measures to administer agricultural water entitlements within the first three priorities of the Seven Party Agreement. Examples of such measures include quantifying amounts of water conserved or transferred, and annually reconciling water use with water allocations (e.g., overrun accounting).

An important element of the CRB draft 4.4 plan is the concept that existing reservoir operating criteria be changed by USBR to make optimum use of the river's runoff and available basin storage capacity. California agencies developed new proposed operating criteria that are included in the draft plan. The draft plan contemplates that changes in operating criteria would be part of both the first and second phases. The other basin states have been cautious in their reaction to California's proposals for reservoir reoperation, and have suggested, for example, that new criteria should not be implemented until California has prepared the environmental documents and executed the agreements that would be needed to begin implementation of the plan. (In its 1995 five-year review of Colorado River operating criteria, USBR had announced that it planned no changes to existing criteria.)

The second phase of the CRB draft 4.4 plan would include additional average year and drought year water transfers. Specifics on these transfers would be developed during the first phase of plan implementation. One suggested component is construction of desalting facilities on rivers tributary to the sea, to divert and treat agricultural drainage water that would otherwise enter the sea. The treated water could be conveyed to urban water users in the South Coast Region via the Colorado River Aqueduct. As with any alternative that would reduce the amount of relatively fresh water reaching the sea, the environmental impacts of this approach would require careful evaluation. Other components of the second phase would include further transfers of conserved agricultural water to the South Coast and further work on reservoir operating criteria. Implementation of some elements of phase two of the plan may extend beyond the Bulletin 160-98 planning horizon.

Sidebar: Colorado River Board of California

The Colorado River Board of California is the State agency responsible for administering California's Colorado River water allocation, and for dealing with the other basin states on river management issues. The Board is composed of six members representing the California agencies who were signatories to the 1931 Seven-Party Agreement, two public members, and two ex-officio members (the directors of the Department and DFG). The six local agencies represented on the CRB are CVWD, IID, LADWP, MWDSC, PVID, and SDCWA. CRB's office and staff are located in Glendale.

Tribal Water Rights

Colorado River Indian Tribes. As a result of the 1964 U.S. Supreme Court decree in *Arizona v. California*, California's basic apportionment of Colorado River water was quantified and five lower Colorado River Indian Tribes were awarded 905 taf of annual diversions, 131 taf of which were allocated for diversion in and chargeable to California pursuant to a later supplemental decree.

In 1978, the tribes asked the court to grant them additional water rights, alleging that the U.S. failed to

claim a sufficient amount of irrigable acreage, called omitted lands, in the earlier litigation. The tribes also raised claims called boundary land claims for more water based on allegedly larger reservation boundaries than had been assumed by the court in its initial award. In 1982, the special master appointed by the Supreme Court to hear these claims recommended that additional water rights be granted to the Indian tribes. In 1983, however, the Supreme Court rejected the claims for omitted lands from further consideration and ruled that the claims for boundary lands could not be resolved until disputed boundaries were finally determined. Three of the five tribes--Fort Mojave Indian Tribe, Quechan Indian Tribe, and Colorado River Indian Tribe--are pursuing additional water rights related to the boundary lands claims. A settlement has been reached on the Fort Mojave claim and may soon be reached on the CRIT claim. Both settlements would then be presented to the special master. The Quechan claim has been rejected by the special master on the grounds that any such claim was necessarily disposed of as part of a Court of Claims settlement entered into by the tribe in a related matter in the mid-1980s. As with all claims to water from the mainstem of the Colorado River and any determination by the special master, only the U.S. Supreme Court itself can make the final ruling.

If both the Fort Mojave and CRIT settlements were approved, the tribes would receive water rights in addition to the amounts granted them in the 1964 decree.

San Luis Rey Indian Water Rights Settlement Act. The San Luis Rey Indian Water Rights Settlement Act (Public Law No. 100-675; 102 Stat. 4000 [1988]) is to provide for the settlement of the reserved water rights claims of the La Jolla, Rincon, San Pasqual, Pauma, and Pala Bands of Mission Indians. Litigation (affecting the interests of the United States, the City of Escondido, the Escondido Mutual Water Company, the Vista Irrigation District, and the Bands) and proceedings before the Federal Energy Regulatory Commission involved tribal water rights claims to the waters of the San Luis Rey River and questions about the validity of rights-of-way granted by the U.S. across tribal and allotted lands. The act authorizes and directs the Secretary of the Interior to arrange for a 16taf/yr supplemental supply of water to benefit the Bands and the local communities. This supply can be obtained either from water development from public lands in California outside the service area of the CVP, from water salvaged as the result of lining part of the AAC or Coachella Canal, or through a contract with MWDSC. Title II of PL 100-675 authorized the Secretary of the Interior to line parts of the canals, and permitted the Secretary to enter into an agreement or agreements with PVID, IID, CVWD, and/or MWDSC for the construction or funding. The act did not authorize appropriation of federal funds for canal lining.

Water Conservation Programs

There have been several large-scale water conservation actions involving Colorado River water users, as shown in [Table 9-20](#).

Table 9-20. Existing Colorado River Region Water Conservation Actions

Year	Action	Participants	Comments/Status	Estimated Savings
1980	Line 49 miles of Coachella Branch of All American Canal	USBR, CVWD, MWDSC	Project completed.	132 taf/yr

1988	IID distribution system improvements and on-farm water management actions	IID, MWDSC	Multi-year agreement, extends into 2033. Projects MWDSC has funded include canal lining, regulatory reservoir and spill interceptor canal construction, tailwater return systems, non-leak gates, 12-hour delivery of water, drip irrigation systems, linear-move irrigation systems, and system automation. MWDSC has funded over \$150 million for conservation program costs through 1997.	107 taf/yr in 1998
1992	Groundwater banking in Arizona	MWDSC, CAWCD, SNWA	Test program to bank up to 300 taf.	MWDSC and SNWA have stored 139 taf in Arizona groundwater basins.
1992	PVID land fallowing	PVID, MWDSC	Project completed. Two-year land fallowing test program. Covered 20,215 acres in PVID. MWDSC paid \$25 million to farmers over a two-year period.	Total of 186 taf was made available from the program, although the water was subsequently released from Lake Mead when flood control releases were made from the reservoir.
1995	Partnership agreement	USBR, CVWD	Provides, among other things, for studies to optimize reasonable beneficial use of water in the district.	N/A

Salton Sea

The present day Salton Sea was formed in 1905, when Colorado River water flowed through a break in a canal that had been constructed along the U.S./Mexican border to divert the river's flow to agricultural lands in the Imperial Valley. Until that break was repaired in 1907, the full flow of the river was diverted into the Salton Sink, a structural trough whose lowest point is about 278 feet below sea level. Within geologic time, the Colorado River's course has altered several times. At times, the river discharged to the Gulf of California as it does today. At other times it flowed into the Salton Sink. Lake Cahuilla, the most recent of several prehistoric lakes to have occupied the Salton Sink, dried up some 300 years ago.

Over the long term, the sea's elevation has gradually increased, going from a low on the order of 250 feet in the 1920s to its present level of about 226 feet. The sea's maximum elevation in recent years was 225.6 in 1995. Since some shoreline areas are relatively flat, a small change in elevation can result in a large difference in the extent of shoreline submerged. Levees have been constructed to protect adjacent farmland and structures at some sites along the shoreline; the remaining managed acreage of the Salton Sea National Wildlife Refuge is also protected from the sea by levees.

The Salton Sea is the largest lake located entirely within California, with a volume of about 7.5 maf at its present elevation of -226 feet. The sea occupies a closed drainage basin if there were no inflows to maintain lake levels, its waters would evaporate as did those of prehistoric Lake Cahuilla. The area's average annual precipitation is 3 inches or less, while average annual evaporation is in excess of 5 feet. The sea receives over 1 maf of inflow annually, primarily from agricultural drainage. The largest sources of inflow (about 80 percent of the total) are the New and Alamo Rivers which drain agricultural lands in the Mexicali and Imperial Valleys and flow into the sea's southern end. The New River also receives untreated and minimally treated wastewater flows from the Mexicali area; monitoring results generally indicate that pollution associated with wastewater discharges does not reach the sea because of its distance from the Mexican border.

In 1924, President Coolidge issued an executive order withdrawing seabed lands lying below elevation 244 feet for the purpose of receiving agricultural drainage water. That order was expanded in 1928 to lands below elevation 220 feet. The sea supports waterbased recreational activities, and has had a popular corvina fishery. During the 1950s, the highest per capita sport fishing catches in California were from the Salton Sea. Over the years, concerns about the sea's salinity have been voiced in the context of maintaining the recreational fishery that was established with introduced species able to tolerate high salinities.

The sea also provides important wintering habitat for many species of migratory waterfowl and shorebirds, including some species whose diets are based exclusively on the fish in the sea. Wetlands near the sea and adjoining cultivated agricultural lands offer the avian population a mix of habitat types and food sources. An area at the sea's south end was established as a national wildlife refuge in 1930, although most of that area is now under water as a result of the sea's rising elevation. Some of the 380 bird species wintering in the area include pelicans, herons, egrets, cranes, cormorants, ibises, ducks, grebes, falcons, plovers, avocets, sandpipers, and gulls. The Salton Sea is considered to be a major stopover point for birds migrating on the Pacific Flyway, and has one of the highest levels of bird diversity of refuges in the federal system.

Historically, salinity has been the water quality constituent of most concern at the sea. Present levels are about 44,000 mg/L TDS (seawater is about 35,000mg/L TDS). This high level of salinity reflects long term evaporation and concentration of salts found in its inflow. Selenium has been a more recent

constituent of interest, due to its implications for aquatic species. Although selenium levels in the water column in the sea are less than the federal criterion of 5ug/l, this concentration can be exceeded in seabed sediment and in influent agricultural drainage water. Agricultural drain flows also contribute significant nutrient loading to the sea, which supports large algal blooms at some times of the year. These algal blooms have contributed to odor problems and low dissolved oxygen levels in some areas of the sea.

Over the years, USBR and others have considered potential solutions to stabilize the sea's salinity and elevation. Most recently, the Salton Sea Authority (a joint powers authority consisting of Riverside and Imperial Counties, IID, and CVWD) and others have been performing appraisal level evaluations of some of the frequently suggested alternatives. Categories of alternatives considered include:

- Diking off part(s) of the sea to create evaporation pond(s) adjoining the primary water body. This approach would divert part of the sea's water into managed impoundments, where the water would be concentrated into a brine and the salts would eventually be removed. The facilities would be sized to maintain a primary waterbody at some desired salinity concentration and elevation. The desired salinity concentration would probably be near that of ocean water (or slightly greater) to maintain the recreational fishery.
- Pumping Salton Sea water and exporting it to some other location. Possible discharge locations include nearby dry desert lakebeds (to create evaporation ponds), evaporation ponds to be constructed near the sea, the Gulf of California, or the Laguna Salada in Mexico.
- Building treatment facilities (such as a desalting plant) to remove salts from inflows to the sea.
- Importing fresh water to the sea. The most apparent source would be the Colorado River, but only in years when flood control releases were being made in excess of U.S. needs.

Maintaining a viable Salton Sea has several water management implications. First will be the actions needed to stabilize the sea's salinity in the near-term, such as the Authority's diking proposal. Eventually, a long-term solution will need to be developed. A wide range of costs has been mentioned for a long-term solution, including amounts in the billion-dollar range. Some of the possible long-term solutions suggested would entail constructing facilities in Mexico, bringing a greater level of complexity to their implementation. Other water management programs in the region, such as proposals to transfer conserved agricultural water supplies, will have to be evaluated in terms of their impacts on the sea. Recent proposals to desalt water in the Alamo or New Rivers and to transport that water in the Colorado River Aqueduct to the South Coast for urban water supply have raised concerns about maintaining the sea's environmental productivity. Such proposals might be implemented as part of the second phase of CRB's draft 4.4 Plan. (In 1997, CVWD filed an application with the SWRCB for water rights to storm water flows and drainage flows in the Whitewater River at the sea's northern end. MWDSC made a similar filing for agricultural drainage flowing into the sea's southern end.)

Congressional legislation introduced in 1998 would authorize expenditure of federal funds for a multi-year study of the sea's resources and potential solutions for managing its salinity.

Coachella Valley Groundwater Overdraft

Most PSAs within the Colorado River Region have sufficient water to meet future water needs, with the exception of Coachella Valley. Groundwater overdraft is occurring in the upper (urbanized) part of the valley; DWA and CVWD have been managing extractions in that basin to minimize future overdraft. Imported surface water at the upper end of the valley has provided a source of recharge water.

Groundwater overdraft is also occurring in the lower (agricultural) portion of the valley, an area that roughly coincides with CVWD's Improvement District No.1. CVWD estimates that actual 1995 water use within the district was about 520 taf, part of which was supplied by overdrafting the groundwater basin. (Irrigators in the lower valley are supplied by surface water from the Coachella Canal and by groundwater.) The district is in the process of preparing a groundwater management plan for the lower valley, and has considered alternatives including basin adjudication, water conservation, water recycling, and direct or in lieu recharge with water imported from the Colorado River or from the SWP. CVWD estimates that overdraft in the lower valley is about 170 taf/yr. Overdraft calculated from Bulletin 160-98 water budgets is 70 taf/yr for the upper and lower valley combined.

Lower Colorado River Environmental Water Issues

Listed fish species on the mainstem of the Colorado River include the Colorado squawfish, razorback sucker, humpback chub, and bonytail chub. Restoration actions to protect these fish may affect reservoir operation and streamflow in the mainstem and tributaries. Other species of concern in the basin include the bald eagle, Yuma clapper rail, belted kingfisher, southwestern willow flycatcher, and Kanab ambersnail.

In 1993, USFWS published a draft recovery implementation plan for endangered fish in the upper Colorado River Basin. The draft plan included protecting instream flows, restoring habitat, reducing impacts of introduced fish and sportfish management, conserving genetic integrity, monitoring habitat and populations, and increasing public awareness of the role and importance of native fish.

Problems facing native fish in the mainstem Colorado River and its tributaries will not be easily resolved. For example, two fish species in most danger of extinction, the bonytail chub and razorback sucker, are not expected to survive in the wild. Although there was a commercial razorback fishery until 1950, in recent years most stream and reservoir fisheries in the basin have been managed for non-native fish. These management practices have harmed residual populations of natives. Many native fish are readily propagated in hatcheries, and thus recovery programs include captive broodstock programs to maintain the species. Reestablishing wild populations from hatchery stocks will have to be managed in concert with programs to manage river habitat. For example, although 15 million juvenile razorback suckers were planted in Arizona streams from 1981-90, the majority of these planted fish were likely eaten by introduced predators. In 1994, the states of Colorado, Wyoming, and Utah reached an agreement with USFWS on protocols for stocking non-native fish in the Upper Basin consistent with native fish recovery efforts. In a program which began in 1989, USBR and other state and federal agencies have cooperated to capture, rear, and successfully reintroduce about 15,000 razorback sucker larvae in Lake Mojave.

Instream flows in the mainstem and key tributaries are being evaluated as components of native fish recovery efforts. State and federal agencies are conducting studies to estimate base flow and flushing flow needs for listed and sensitive species in various river reaches. An example of flushing flow evaluation occurred in the spring of 1996 when releases from Glen Canyon Dam were increased for several days to attempt to redistribute sediment and create shallow water habitat in the mainstem below the dam.

In a 1997 court action involving the southwestern willow flycatcher, an environmental group filed a lawsuit against USBR and USFWS under the ESA's citizen suit provisions. The group alleged that USBR's operation of Lake Mead was endangering the flycatcher's habitat at the upper end of Lake

Mead. The federal district court for Arizona ruled in favor of USBR, but the environmental group appealed the district court's decision to the Ninth Circuit Court of Appeals. The appellate court subsequently declined to hear the case, letting the district court's decision stand.

Lower Colorado River Multi-Species Conservation Program

In 1995, DOI executed partnership agreements with California, Nevada, and Arizona to develop a multi-species conservation program for ESA-listed species and many non-listed, but sensitive, species within the 100-year floodplain of the lower Colorado River, from Glen Canyon Dam downstream to the Mexican border. In 1996, a joint participation agreement was executed to provide funding for the program. USFWS has designated the LCRMSCP steering committee as an ecosystem conservation and recovery implementation team pursuant to ESA. The steering committee is composed of representatives from the three states, DOI, Indian tribes, water agencies, power agencies, environmental organizations, and others.

The conservation program will work toward recovery of listed and sensitive species while providing for current and future use of Colorado River water and power resources, and includes USBR's Colorado River operations and maintenance actions for the lower river. Over 100 species will be considered in the program, including the southwestern willow flycatcher, Yuma clapper rail, and the four listed fish species mentioned above. Developing the program is estimated to take three years. Costs of program development and implementation of selected interim conservation measures, estimated at \$4.5 million, are to be equally split between DOI and the nonfederal partners.

USBR initiated a formal Section 7 consultation process with USFWS, who issued a five-year biological opinion on USBR operation and maintenance activities from Lake Mead to the southerly international boundary with Mexico in 1997. USBR has estimated that the cost of implementing the biological opinion's reasonable and prudent alternatives and measures could be as high as \$26 million.

The steering committee is currently participating in funding several interim conservation measures. These include a razorback sucker recovery program at Lake Mojave, restoration of Deer Island near Parker, Arizona, and a "Bring Back the Natives" program sponsored by the National Fish and Wildlife Foundation.

Water Management Options for the Colorado River Region

The only forecasted shortages within the Colorado River region are those resulting from groundwater overdraft in Coachella Valley. Implementing the draft CRB 4.4 Plan entails developing options in the Colorado River Region to keep MWDSC's Colorado River Aqueduct flowing at its full capacity, as described

earlier. The reduction in California's use of Colorado River water to the basic 4.4 maf apportionment reduces the supply available to California by as much as 0.9 maf/yr.

Table 9-21 shows a list of options for the region, and the results of an initial screening of the options. The retained options were evaluated (Table 9A-3 in Appendix 9A) based on a set of fixed criteria discussed in Chapter 6. These options could be used for implementing the draft CRB 4.4 Plan and for reducing the Colorado River Region's groundwater overdraft.

Table 9-21. Colorado River Region List of Water Management Options

Option	Retain or Defer	Reason for Deferral
Conservation		
Urban		
Outdoor Water Use to $0.8ET_o$	Retain	
Indoor Water Use	Retain	
Interior CII Water Use	Retain	
Distribution System Losses	Retain	
Agricultural		
Seasonal Application Efficiency Improvements	Retain	
Flexible Water Delivery	Retain	
Canal Lining and Piping	Retain	
Tailwater Recovery	Retain	
Modify Existing Reservoirs/Operations		
Reoperating Colorado River System Reservoirs	Defer	Concurrence of USBR and other basin states not yet obtained.
New Reservoirs/Conveyance Facilities		
Additional Conveyance Capacity for Colorado River Water	Defer	California's current excess use of Colorado River water.
Groundwater/Conjunctive Use		
Groundwater Recharge Project at East Mesa	Defer	Scoped as one-time program.
Water Marketing		
Interstate banking	Retain	
Intrastate banking and transfers	Retain	
Land fallowing program	Retain	
Water Recycling		
Water recycling options	Defer	Water recycling options would not generate new water supply.

Desalting		
Brackish Groundwater		
---	---	---
Seawater		
---	---	---
Other Local Options		
Desalting local drainage water	Defer	To be evaluated in phase 2 of draft CRB 4.4 Plan.
Lining All American Canal	Retain	
Additional Lining of Coachella Canal	Retain	
Weather Modification	Defer	Complicated by interstate management issues.
Statewide Options		
See Chapter 6.		

Water Conservation

Urban. Urban water demand forecasts for 2020 assume that BMPs are in place; consequently, only those urban conservation efforts which exceed BMPs are considered as options. All urban conservation options were retained. Reducing outdoor water use to 0.8 ETo in new development would attain 9 taf/yr of depletion reductions, while extending this measure to include existing development would reduce depletions by 18 taf/yr. Reducing indoor water use to 60 gpcd and 55 gpcd would reduce depletions by 2 and 3 taf/yr, respectively. Reducing commercial, institutional, and industrial water use by 3 percent and 5 percent would save 1 and 2 taf/yr, respectively. Reducing distribution system losses to 7 and 5 percent would result in 9 and 13 taf/yr of depletion reductions, respectively.

Agricultural. The 2020 agricultural water demand forecasts assume that EWMPs are in place. As with the urban water management options, only those agricultural conservation efforts which exceed EWMPs are considered as options. Improving seasonal application efficiency to 80 percent from the base of 73percent could reduce depletions by 50 taf/yr. Improving flexible water delivery, canal lining (on-farm and distribution system), and tailwater recovery systems could together realize 140 taf/yr in depletion reductions. However, the ability to implement conservation options that would reduce the amount of fresh water inflow to the Salton Sea must be evaluated on a project-specific basis. Goals for preservation of the sea's environmental resources may limit the extent of feasible conservation measures.

Land Fallowing. Programs such as the Palo Verde test land fallowing program could be implemented to provide water for transfer to urban areas in the South Coast Region during drought periods. In 1992, MWDSC conducted a two-year land fallowing test program with PVID. Under this program, growers in PVID fallowed about 20,000 acres of land. The saved water, about 93 taf/yr, was stored in Lower Colorado River reservoirs for future use by MWDSC (the water was later released when Colorado River flood control releases were made from Lake Mead). MWDSC paid each grower \$1,240 per fallowed acre, making the cost of the water to MWDSC about \$135/af. Similar programs could be implemented in the future to provide about 100 taf/yr during drought years. Future land fallowing agreements would need to consider the availability of storage for the transferred water.

Potential Sources of Water for Intrastate Marketing

The ability to market conserved water has already been demonstrated in the region. Table 9-22 summarizes some potential sources of water for intrastate transfers. Such transfers could make up some of the shortages in the South Coast Region resulting from California reducing its use to California's basic apportionment of 4.4 maf.

Table 9-22. Potential Colorado River Water Conservation Programs

Program	Participants	Comments/Status	Estimated Savings
Lining of All American Canal	USBR, IID, CVWD, MWDSC	Authorized by PL 100-675. Final EIS/EIR published. Preferred alternative is constructing a new, lined parallel canal.	Not implemented yet. Potential of 67.7 taf/yr savings.
Agreement for a long-term transfer of up to 200 taf/yr	IID, SDCWA	SCDWA and IID executed an agreement in 1998. Initial agreement negotiated for wheeling water in MWDSC's Colorado Aqueduct. EIR/EIS not yet prepared.	Not implemented yet - up to 200 taf/yr savings
Additional lining of Coachella Canal	USBR, others	Authorized by PL 100-675. Draft EIR/EIS issued.	Not implemented yet. Potential of 25.68 taf/yr savings.

Construction of additional conveyance capacity from the Colorado River Region to the South Coast Region has been a recent subject of discussion. Proposition 204 provides funding for a feasibility study of a new conveyance facility from the Colorado River to the South Coast Region. Conveyance facilities mentioned include a new aqueduct from the Imperial Valley area to San Diego (on the United States side of the border), as well as San Diego's participation in enlarging the existing aqueduct serving Tijuana, Mexico. Tijuana's situation is similar to San Diego's, in that Tijuana is seeking to expand its urban supplies by negotiating transfer of agricultural water from the Mexicali Valley. Figure 9-6 is a map of the U.S. - Mexican border area, showing the area's larger water facilities. A preliminary engineering study of constructing a new canal from Imperial Valley to SDCWA's service area has been prepared for SDCWA. Additional work, including geotechnical exploration and environmental studies, would be needed to evaluate the project's feasibility. The

preliminary study highlighted the need to evaluate desalting the water that the aqueduct would supply, to enable San Diego's continued reliance on a high level of water recycling. New conveyance facilities from the Colorado River Region to the South Coast Region have been deferred from evaluation in Bulletin 160-98 because it does not appear that they would be constructed within the Bulletin's planning horizon, given the other basin states' concerns about California's use of Colorado River water and the international complexities associated with a joint project with Mexican agencies.

SDCWA and IID have been negotiating a potential transfer of water saved due to extraordinary conservation measures within IID. The agencies initially executed a 1995 MOU concerning negotiation of a transfer agreement, followed by 1998 execution of an agreement specifying the transfer's terms and conditions. The agreement has a minimum 45-year term, and can be extended for an additional 30 years. An initial transfer of 20 taf would begin in 1999, with the annual quantity of transferred water increasing to a maximum of 200 taf. In order to transfer the acquired water, SDCWA (a member agency of MWDSC) has negotiated an initial wheeling agreement with MWDSC for use of capacity in MWDSC's Colorado River Aqueduct. Environmental documentation for the transfer is pending.

Past conservation projects in the region have included land fallowing, canal lining, distribution system reservoir and spill interceptor canal construction, and irrigation distribution system improvements. Some proposed projects to recover canal seepage include:

- Lining part of the All American Canal. Public Law 100-675 authorized the Secretary of the Interior to line the canal or to otherwise recover canal seepage, using construction funds from PVID, IID, CVWD, or MWDSC. USBR's environmental documentation evaluated a parallel canal alternative, several in-place lining alternatives, and a well field alternative, and concluded that the preferred alternative was the construction of a concrete-lined canal parallel to 23 miles of the existing canal. The parallel canal alternative has the potential to conserve an estimated 67.7 taf annually of Colorado River water. Recently, the well field alternative has been reevaluated and found to be infeasible. The well field alternative, although less expensive than canal lining, has been set aside because of international concerns about groundwater extraction near the border.
- Lining the Remaining Section of the Coachella Canal. This project would involve lining the remaining 33.4 miles of the Coachella Canal, which loses about 32.4 taf/yr through seepage. Four alternatives that have been identified are conventional lining, underwater lining, parallel canal, and no action. It is estimated that the preferred alternative, conventional lining, would conserve 25.7 taf/yr.

Intrastate Groundwater Recharge or Banking

IID has proposed a groundwater recharge project at East Mesa in the Imperial Valley. The proposed recharge project would divert a portion of flood control releases from Lake Mead to a recharge site or sites located along the alignment of the old, unlined Coachella Canal. (The old canal was abandoned when an adjacent lined canal was constructed.) IID estimates that up to 20 taf could be recharged in 1998. IID prepared a mitigated negative declaration for a one-time program in 1998, when flood control releases are occurring. Since Colorado River flood control releases have historically been infrequent, future water supply for such a recharge program would be available only occasionally. This option was scoped as a one-time project and is not considered as a 2020-level option in Bulletin 160-98.

MWDSC has executed agreements with three entities to study the potential of groundwater banking arrangements that would involve storing surplus Colorado River water, when available, in groundwater basins near its Colorado River Aqueduct. The water would be withdrawn for use in the South Coast in drought years. An agreement with Cadiz Land Company covered a potential project that would entail constructing a 35-mile pipeline from the Cadiz Valley/Fenner Valley area, and diverting up to 100 taf/yr of surplus Colorado River water to storage. Estimated available groundwater storage capacity is 500 taf, with drought year withdrawal capability of 100 taf. This arrangement could additionally have a marketing component; perhaps 20 to 30 taf/yr of recharge in Cadiz and Fenner Valleys could be blended with Colorado River water and delivered to the South Coast Region. An agreement with Catellus Development Company covered a potential groundwater storage site in the Mojave Desert with an estimated capacity of 600 taf. The withdrawal capability of this site is estimated at about 150 taf/yr. A third agreement was with CVWD. CVWD is presently performing pilot studies to estimate recharge and withdrawal capabilities in the lower valley. (MWDSC and CVWD have already been evaluating increased recharge at the upper end of the valley, in the Whitewater River drainage basin.)

Technical studies of the feasibility of these projects remain to be completed, and environmental documentation has not yet been prepared. It appears likely that at least 100 taf/yr of drought year supplies could be provided through this group of potential storage sites.

Interstate Banking/Conservation

Under an existing agreement between MWDSC and the Central Arizona Water Conservation District, MWDSC can store a limited amount of Colorado River water in Arizona for future use. The Southern Nevada Water Authority is also participating in the program. The agreement stipulates that MWDSC and SNWA can store up to 300 taf in central Arizona through the year 2000. As of 1997, MWDSC has placed 89 taf in storage and SNWA has placed 50 taf in storage, for a total of 139 taf. About 90 percent of the stored water can be recovered, contingent upon the declaration of a surplus. When MWDSC is able to draw on this source, it can divert up to a maximum of 15 taf in any one month. The stored water would be made available by Arizona foregoing the use of part of its normal supply from Central Arizona Project. MWDSC plans to recover the stored water at times in the future when its Colorado River Aqueduct diversions may be limited. Like the East Mesa project described in the preceding section, this interstate project was a one-time action, and is not considered as a 2020-level option in Bulletin 160-98.

In its 1996 session, the Arizona Legislature enacted legislation establishing the Arizona Water Banking Authority. The Authority is authorized to purchase unused Colorado River water and to store it in groundwater basins to meet future needs. Conveyance to storage areas is provided by the Central Arizona Project. The legislation further provided that the Authority may enter into agreements with California and Nevada agencies to bank water in Arizona basins, with the following limitations:

- Regulations governing interstate banking would need to be promulgated by the Secretary of the Interior.
- The Arizona Department of Water Resources finds that DOI's regulations adequately protect Arizona's rights to Colorado River water.
- The ability to bank interstate water would be subordinate to banking of water to supply Arizona needs.
- Interstate banking would be precluded in years when Arizona is using its full apportionment of

2.8 maf (including water being delivered to Arizona for banking by Arizona agencies), unless surplus conditions were declared for the river system.

- Interstate withdrawals from the bank are limited to 100 taf/yr, although there is no statutory limitation on annual deposits.

Under this legislation, future interstate banking in Arizona would have a maximum annual yield of 100 taf. However, Arizona may effectively limit withdrawals in drought years by declining to decrease its diversions of surface water to allow recovery of the banked water. USBR released draft rules and regulations for the interstate banking program for public comment in December 1997, and is presently reviewing the public comments.

Reoperating Colorado River System Reservoirs

Member agencies represented by the CRB have discussed proposing reservoir operating criteria to the Secretary of the Interior that would benefit California while protecting the apportionments of the other basin states and satisfying Mexican treaty obligations. Such criteria would also constitute part of the package of actions for California to transition its use of river water from current levels to 4.4 maf/yr. Operations studies have evaluated specific shortage and surplus criteria for the river system, including selection of desired probabilities for water supply reliability and reservoir operating elevations.

Results of the operations studies performed by CRB and by USBR suggest that there could be minimal hydrologic risk to using reservoir reoperation particularly as a limited-term measure to help California reduce its Colorado River use as a water management option for this region. As described in Chapter 3, the Colorado River has a high ratio of storage capacity to average annual runoff. Projections of consumptive use for the upper basin states suggest that those states will not attain full use of their compact apportionments until after year 2060. USBR's surplus declarations to date have not adversely impacted the other states' use of their apportionments for example, flood control releases were made both in 1997 and 1998, and are expected in 1999. The more significant impediment to implementing reoperation would be concerns of the other basin states about impacts of an extended period of reoperation on future shortages, considering the river's variable year to year runoff.

For Bulletin 160-98, reservoir reoperation is not evaluated as a water management option and no numerical evaluation is made, since consensus of USBR and the basin states has not yet been obtained.

Weather Modification

A fundamental management issue associated with Colorado River water supplies is the apparent overstatement of the Compact apportionment relative to the river's historical hydrology. There have been proposals over the years to augment the river's base flow to provide additional supplies. For example, USBR had developed a proposed pilot program in 1993 to evaluate cloud seeding potential in the Upper Basin. The State of Colorado did not favor moving ahead with this program.

Weather modification has recently been raised again as part of a possible menu of options to resolve California's use in excess of the 4.4 maf basic apportionment, although no specific proposals have been made. In concept, this option would entail cloud seeding in the Upper Basin to increase runoff, and might yield a 5 percent increase in base flow from the area seeded. Large-scale weather modification projects are typically difficult to implement due to institutional and third-party concerns,

and can require several years of study and testing prior to being placed in operational status. Weather modification on the Colorado River is also complicated by interstate management issues. This option has been deferred for these reasons.

Options for Coachella Valley

As discussed earlier, MWDSC has executed an agreement with CVWD to study banking of surplus Colorado River water, when available, in the lower Coachella Valley. Banking programs typically entail putting more water into the groundwater basin than is extracted, to address losses and to avoid potential localized impacts to existing basin pumpers. Over the long term this extra recharge would help stabilize groundwater basin levels. CVWD is presently in the planning stages of expanding its existing pilot recharge/extraction site in the lower valley. CVWD also plans to form a groundwater replenishment district to help manage overdraft.

MWDSC and CVWD are evaluating additional recharge possibilities in the Whitewater River drainage at the north end of the valley. Water recharged in this area could come from surplus Colorado River flows, from year-to-year purchases of SWP water or purchase of SWP entitlement, or from other water marketing arrangements that could take advantage of SWP/CRA conveyance. For example, CVWD purchased about 39 taf of water from other SWP contractors in 1996, on a one-time basis. Additional recharge possibilities in the Whitewater drainage have not yet been quantified, and are not evaluated further in Bulletin 160-98.

CVWD could, as other SWP urban water contractors are doing, participate in the permanent transfer of agricultural entitlement water provided for in the Monterey Agreement contract amendments. CVWD could also purchase water from other sources, by way of exchange with MWDSC, subject to negotiation of conveyance in the SWP and CRA. Since no specific proposals are currently pending, this option is not quantified in the Bulletin.

Statewide Options

Statewide water supply augmentation options are discussed and quantified in Chapter 6.

Options Likely to be Implemented in the Colorado River Region

Applied water shortages are forecasted to be 147 taf in average years and 158 taf in drought years. Ranking of retained water management options for the Colorado River Region is summarized in Table 9-23. Table 9-24 summarizes options that can likely be implemented by 2020 to relieve the shortages.

Options identified for this region will likely be used for reducing Coachella Valley overdraft and for managing water to benefit the South Coast Region, as called for in CRB's draft 4.4 Plan. An evaluation of these options is shown in Table 9A-3 in Appendix 9A. Bulletin 160-98 assumes that water made available by option implementation is first allocated to reduce overdraft within the region, and that remaining water is then available for use in the South Coast Region.

For readers interested in comparing Bulletin 160-98 options with the draft CRB 4.4 Plan, Table 9-25 summarizes the Bulletin's findings in a format similar to that used in the draft CRB 4.4 Plan. There is an important differences between the two documents Bulletin 160-98 assumes that water conservation

due to EWMP implementation occurs as part of base demand forecasts and not as an optional measure. Actions that may be implemented as part of phase two of the draft CRB 4.4 Plan are not shown in the table, because they have not yet been formulated and quantified.

Table 9-23. Options Ranking for Colorado River Region

Option ^a	Rank	Cost (\$/af)	Potential Gain (taf)	
			Average	Drought
Conservation				
Urban				
Outdoor Water Use to 0.8 ET _o - New Development	M	750	9	9
Outdoor Water Use to 0.8 ET _o -New and Existing Development	M	b	18	18
Indoor Water Use (60 gpcd)	M	400	2	2
Indoor Water Use (55 gpcd)	M	600	3	3
Interior CII Water Use (3%)	M	500	1	1
Interior CII Water Use (5%)	M	750	2	2
Distribution System Losses (7%)	M	200	9	9
Distribution System Losses (5%)	M	300	13	13
Agricultural				
Seasonal Application Efficiency Improvements (76%)	H	100	22	22
Seasonal Application Efficiency Improvements (78%)	M	250	36	36
Seasonal Application Efficiency Improvements (80%)	M	450	50	50
Flexible Water Delivery	L	1,000	30	30
Canal Lining and Piping	L	1,200	45	45
Tailwater Recovery	H	150	65	65
Water Marketing				
Intrastate Banking	H	b	-	100
Interstate Banking	M	b	-	50

Land Fallowing Program	M	140	-	100
Other Local Options				
Lining All American Canal	H	120	68	68
Additional Lining of Coachella Canal	H	b	26	26
Statewide Options				
See Chapter 6.				
^a All parts of the amounts shown for the highlighted options have been included in Table 9-24.				
^b Data not available to quantify.				

Table 9-24. Options Likely to be Implemented by 2020 (taf): Colorado River Region^a

		Potential Gain (taf)	
		Average	Drought
Applied Water Shortage		147	158
Options Likely to be Implemented by 2020			
	Conservation ^b	215	215
	Modify Existing Reservoirs/Operation	-	-
	New Reservoirs/Conveyance Facilities	-	-
	Groundwater/Conjunctive	-	-
	Water Marketing	-	250
	Recycling	-	-
	Desalting	-	-
	Other Local Options	94	94
	Statewide Options	8	7
	Expected Reapplication	2	2
Total Potential Gain		319	568
Remaining Applied Water Shortage		0	0
^a Options in excess of regional needs to reduce groundwater overdraft are available for implementing the draft CRB 4.4 Plan in South Coast Region.			

^b Water supply for San Diego CWA/IID transfer provided by agricultural conservation which could be any mix of base demand forecast EWMP implementation (210 taf) and future agricultural conservation options (190 taf).

Table 9-25. Future Actions Described in Bulletin 160-98 That Could be Part of Draft CRB 4.4 Plan Implementation^a

Action	Potential Gain (taf)	
	Average	Drought
Agricultural conservation ^b to meet SDCWA/IID Agreement	200	200
Other agricultural conservation ^b from EWMP implementation and optional conservation measures	200	200
Intrastate groundwater banking from MWDSC agreements with Cadiz, Catellus, or Coachella	-	100
Interstate groundwater banking from Arizona groundwater bank	-	50
Possible future land fallowing agreement between MWDSC and PVID	-	100
Lining All American Canal	68	68
Additional lining of Coachella Canal	26	26
Statewide Options	8	7
Total	502	751
<p>^a Since this table shows future actions, it does not include the 1980 Coachella Canal lining, 1988 MWDSC/IID agreement, or 1992 MWDSC/CACWD/SNWA agreement described earlier in this chapter.</p>		
<p>^b These actions are subject to environmental review to ensure that reduced depletions will not have significant impacts to the Salton Sea.</p>		

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