COLORADO RIVER REPORT

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Prepared by

The Sierra Club
COLORADO RIVER TASK FORCE

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Cover photos: 1) Colorado River, Kawuneeche Valley, Rocky Mountain National Park, CO. 2) Entrance to Monument Canyon, Colorado National Monument, CO. 3) Confluence of Green River and Colorado River, Canyon ands National Park, UT. 4) Vulcan's Anvil and Lava Falls from Toroweap Point, Grand Canyon National Park, AZ. 5) Lava Falls from Toroweap Overlook, Grand Canyon National Park, AZ. 6) Canals, Colorado River Reservation, Parker, AZ. 7) John James Hunter (Tohono O'Odham) displaying fish caught in drained canal during visit with Hopi grandfather, Colorado River Reservation, AZ. *All photographs copyright Stephen Trimble.*

Figures: Figures in the report are from: D. Pontius. 1997. Colorado river Basin Study. Report to the Western Water Policy Review Advisory Commission. (see reference 1)

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Finally, the Chairman is joined by the individual members of the Task Force in acknowledging each other for their good humor and hard work on a lengthy and complex volunteer project.

EXECUTIVE SUMMARY

The Colorado River is the major water artery in the Southwest, a region that is drier than the deserts of North Africa. In spite of the lack of rainfall and very high summer temperatures, this dry desert is now home to tens of millions of people and includes some of the major agricultural areas in the United States. By exploiting the Colorado River, which gets most of its water from snowmelt in the Rocky Mountains, Americans have made the desert bloom with cotton, alfalfa, fruits, vegetables, specialty food plants, houses, and artificial recreation areas. An inhospitable desert has become a playground, and the Colorado River has become a plumbing system.

The creation of this plumbing system has wreaked havoc on the river and its riparian environment throughout the Colorado River Basin. Not only is the Colorado River, which serves the entire Southwest, never a mighty river (at 3% the size of the Mississippi), but adjuncts of the main plumbing system have also removed water through transbasin diversions.

The end result of the engineering marvel that was once a river is that most of the native fish are endangered, that major bird migration stops are severely truncated and degraded, that some of the most spectacular scenery in the world is less spectacular or in jeopardy, and that the national and world economies are at risk. This last conclusion is, perhaps, the least expected but is the obvious result of untrammeled exploitation of a limited natural resource. Because the population and the large agricultural industry of California and Arizona depend for their very existence on uninterrupted supplies of Colorado River water and because the Colorado River plumbing system is overallocated and oversubscribed, the human population has unwittingly left itself with an inadequate cushion of safety.

Our interests and recommendations address the environmental problems throughout the Colorado River Basin, but it is important to note that re-orienting the management goals for this river system will also greatly benefit the human population and economy by reducing dependence on the unsustainable use of the plumbing system. Our conclusion that the system is unsustainable is based on the historic occurrence of extended drought, earthquakes, primarily in the extreme southwestern segment of the basin, and continued population growth.

The report recommends a concerted and integrated effort to rehabilitate the Colorado River. Issues and recommended actions are ranked, concentrating on those areas which are considered crucial and where efforts have a significant chance of successfully improving the environment. Social and potential economic barriers have been considered, and policy stances, actions, and alliances are suggested.

COLORADO RIVER DELTA — Relatively small quantities of water — 32,000 acre-feet per year most years with a pulse of 260,000 acre-feet every fourth year — appear to be the minimum amounts necessary to revitalize much of the Delta in Mexico. In addition, it is important to protect the surge flows due to El Niño events so that this water may flood the Delta and flow into the Sea of Cortez. The Salton Sea, an accidentally-filled remnant of the Delta within the U.S., deserves some level of rehabilitation providing the rehabilitation uses sustainable methodologies that are likely to succeed and that rehabilitation does not depend on the use of direct flows from the Colorado River.

ENDANGERED SPECIES — The Endangered Species Act is of central importance throughout the river system. The totoaba, a fish, and the vaquito porpoise, both residents of the Sea of Cortez, are clearly endangered, and it is equally clear that the management of the Colorado River in the United States is directly, and perhaps solely, to blame for their predicament. The Endangered Species Act is not limited to domestic species and should be a major tool in attempts to save these residents of the Sea of Cortez, as well as for saving all of the native fish of the Colorado River. The native fish of the Colorado all evolved within the constraints of a river that had very high peak flows and very low late season flows, where drought was a common occurrence. Changes to that ecosystem to guarantee available water for municipal and agricultural uses and to provide consistent hydropower have decimated the ecosystem's natural inhabitants and put them well along the road to extinction.

INSTREAM FLOW — Instream flow has had little standing in water deliberations in the West, but public perceptions and values are clearly changing, and saving some measure of the natural streams and native fish has clearly become increasingly important. Improving the acceptance and value of instream flows in the legislatures of the Colorado River Basin states must be a major goal.

THE GRAND CANYON — The Grand Canyon, one of the premier natural wonders of the world, has had its ecosystem and natural geomorphic evolution threatened by reduced flows, lack of new silt, and absence of seasonal peak flows. The most significant culprit in the assault on the Grand Canyon ecosystem is Glen Canyon Dam. Some relief may well be attained by significant changes in dam operation. Whether reoperation of the dam can adequately compensate for the environmental degradation caused by the dam must await more data before a definitive answer can be given. The Glen Canyon Institute is currently conducting a Citizens Environmental Assessment, with some funding from the Sierra Club Colorado River Task Force, which, it is hoped, may greatly aid in answering this question.

UNSUSTAINABLE WATER USE — The Colorado River System is being utilized for urban population growth and for agriculture to an extent that is unsustainable. Although the Upper Basin States are not using their full allotments, California is exceeding its share by more than 800,000 acre-feet. The growing areas near St. George, Utah, and Las Vegas, Nevada are attempting to divert additional water for continued growth. Under intense

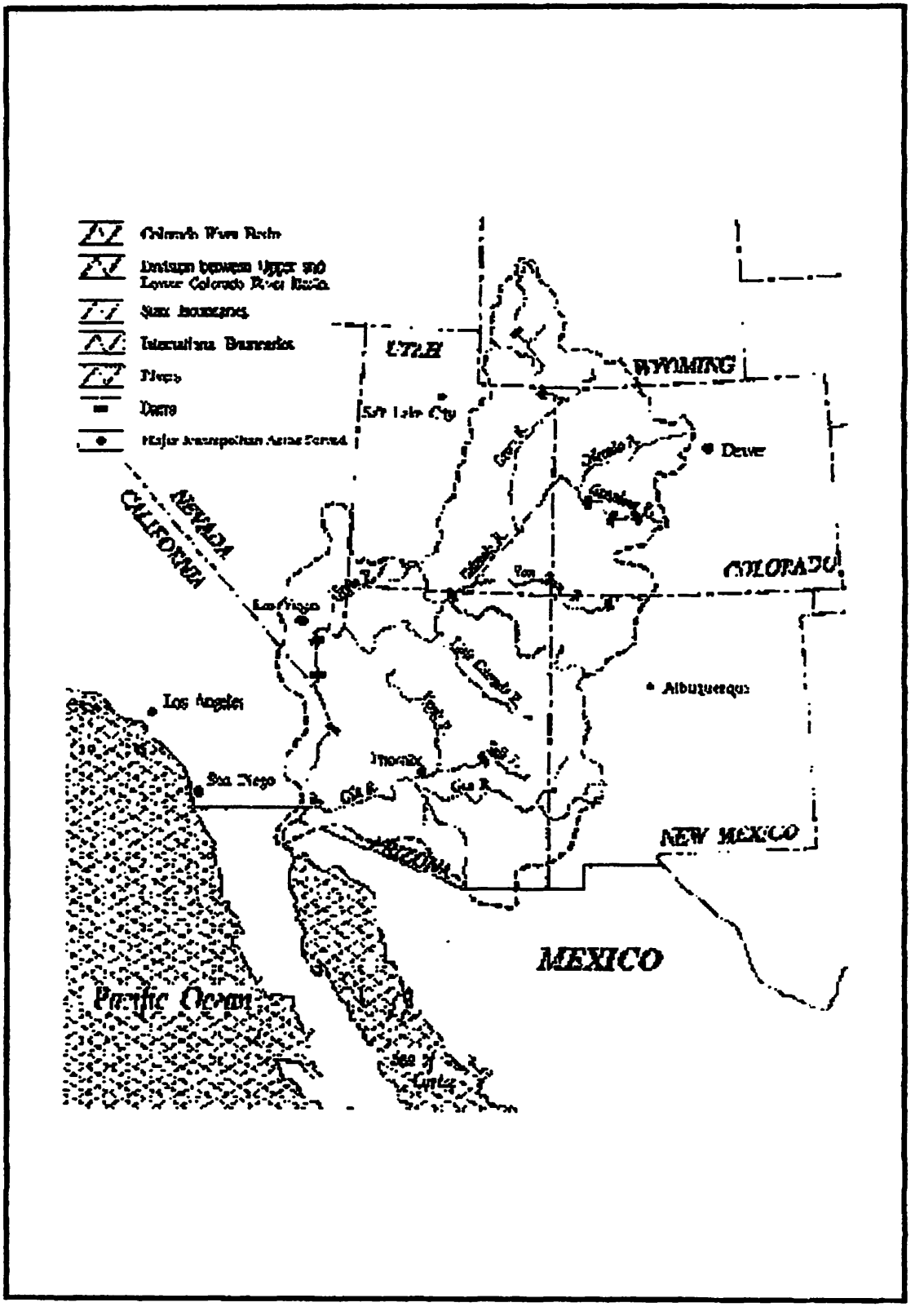
pressure from the six other basin states and the Secretary of the Interior, California is currently developing a long-term plan to reduce its use of Colorado River water to its 4.4 million acre-feet allocation. It is important that California be forced to fully adhere to this plan and that areas without sufficient water to sustain larger populations must be restricted from contributing to the unsustainable condition of the entire river basin.

TRANSBASIN DIVERSIONS — Transbasin diversions of water from less populated regions to sustain human endeavors in populated basins have forever altered the ecology of the Southwest. Few new transbasin diversions can be engineered only because most unpopulated basins have already been raided for water. Of the small number still being considered, the Animas–La Plata Project, which in its current form is no longer a transbasin system, Homestake II, Uncompahgre Valley Water Users Association's AB Lateral, and Union Park projects, all in Colorado, and the Gooseberry Narrows Project in Utah should be vigorously opposed.

WATER QUALITY — Extensive water diversion has resulted in water with too much salt and selenium and with Total Maximum Daily Loads in violation of the Clean Water Act. Forcing the EPA to demand and the states to develop TMDL allocation and implementation processes to meet the requirements of the Clean Water Act are a necessity.

GLEN CANYON RESTORATION — The possibility that Glen Canyon Dam may be too great a price to pay for a small measure of extra security for the Upper Basin States is an important consideration. Decommissioning of the dam would clearly restore the riverine ecosystem from Lake Powell to Lake Mead to a near-natural condition and would also restore one of the unique, magnificent canyons of the Southwest. The intent of the Washington County Conservancy District in southwestern Utah to pipe water from Lake Powell and the desire of Las Vegas to obtain water any way that it can threaten any eventual restoration of this extraordinary canyon.

FACILITY TRANSFERS AND WATER EXCHANGES — Water facility transfers have already been the subject of guidelines developed by the Sierra Club. Constant vigilance is required to be sure that such transfers, which require Federal legislation, are in compliance with environmental laws and in the best interest of the public. Water marketing and water exchanges could work contrary to good environmental practice or could be effective management tools for allocating water in a more environmentally sensitive fashion.



The Colorado River Basin

INTRODUCTION

"Too thick to drink, too thin to plow" is the adage that described the Colorado River before dam development turned the river into a plumbing system. This report describes the hydrology and sediment transport of the river basin along with and in relation to the political boundaries and basic agreements that manage the river. It then goes on to characterize important problems, both current and future, associated with the way the river is managed. Finally, policies, actions, and alliances that should help restore the Colorado River ecosystem to a more balanced condition are suggested.

The Colorado River Task Force was created at the suggestion of Sierra Club volunteers with expertise in water issues in the West who were concerned that the piecemeal approach to the vast environmental problems along the Colorado were doomed to failure. These volunteer activists realized that isolated, parochial efforts, no matter how well intentioned, sometimes worked against each other and expended vast amounts of energy and resources without the clear goals necessary to have lasting effect. The goals of the Task Force are to provide an integrated overview of the Colorado River basins and to suggest and recommend policies and actions that will promote the restoration of a sustainable ecosystem along the river corridor.

BACKGROUND

The Colorado River begins in the upper elevations of Wyoming, Colorado and New Mexico and flows southwest through the high deserts of the Colorado Plateau and the low deserts of the Sonoran and Mojave. At its terminus is a great delta formed by eons of sediment deposition transported from the mighty upstream canyons. The river naturally terminates in the Sea of Cortez near Puerto Penasco, Mexico.

"Natural" hardly describes the river system anymore. With reservoir storage capacity nearly five times its annual flow rate and demands that exceed its annual flow rate, the highly regulated river rarely reaches the Sea of Cortez.

The river basin was divided into Upper and Lower Basins in 1922 with the dividing line situated at Lee Ferry, a point on the Colorado one mile below the mouth of the Paria River.[a] The Upper Basin includes all of the Utah, Colorado, Wyoming and New Mexico portions of the basin and the portions of Arizona that drain to the river above Lee Ferry. The Lower Basin includes the remainder of Arizona, Nevada, and California.

Early studies by the U.S. Geological Survey estimated annual flows at Lees Ferry to be 16.8 million acre-feet/year (maf/y). These studies were based on three years of gauging at Lees Ferry and reconstituted flows at gages up and downstream. The negotiators of the Colorado River compact assumed an average annual flow at Lee Ferry of 16 maf/y.

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[a] Lee Ferry is defined in the Colorado River Compact as "a point in the main stream of the Colorado River one mile below the mouth of the Paria River." Lees Ferry (sometimes Lee's Ferry) denotes the site of a USGS gage approximately one-quarter mile above the mouth of the Paria and, now, just downstream of Glen Canyon Dam.

They divided the river into equal apportionments of 7.5 maf/y for both the Upper and Lower Basin, allowing a 1.0 maf/y surplus that would be available to the Lower Basin.

The Bureau of Reclamation estimated in 1988 that the average inflow to Lake Powell was 11.55 maf/y from 1963 to 1986 and that the average from 1914 to 1957 was 12.71 maf/y. Dale Pontius, in his Colorado River Basin Study for the Western Water Policy Review Advisory Commission[1], catalogs flow volumes and notes their extensive variability in various time periods. As he notes, "the wettest 10-year period on record (1914 to 1923) saw an average annual flow of 18.8 maf" and also indicates that "tree-ring studies covering hundreds of years suggest a long-term average annual flow of about 13.5 maf/y." Unfortunately, the river's waters were apportioned during the wettest period in the last 100 years.

Physical Geography

Three major tributaries, the Green, the Colorado, and the San Juan rivers, join to form the Colorado River above Lee Ferry. The Green River headwaters are in the Wind River and Wyoming Range mountains of western Wyoming. The largest reservoir on a Colorado River tributary is behind the Bureau of Reclamation's Flaming Gorge Dam on the Green River. The average annual flow of the Green at Flaming Gorge is about 1.5 million acre-feet. Downstream of Flaming Gorge, at Echo Park in Dinosaur National Monument, another major tributary, the Yampa River, joins the Green. The Yampa remains free-flowing with no storage facilities and would be a refuge for native fish, were it not for the presence of predatory non-native northern pike and channel catfish.

The Colorado River, originally called the Grand River, begins in the Rocky Mountains of Colorado. The mainstem heads in the Gore Range, Never Summer Range, and Grand Lake in Rocky Mountain National Park. There are 17 transmountain diversions taking water from the mainstem tributaries to the Front Range metropolitan area of Denver. The biggest of these is the Colorado/Big Thompson, which supplements irrigation and municipal water for northern Colorado. The Blue River, a major tributary to the mainstem has both the Green Mountain Reservoir and Dillion Reservoir, which is relied on by the Denver Water Department, the largest water utility on the Front Range.

The largest tributary to the Colorado River mainstem in Colorado is the Gunnison River originating in the Elk, Collegiate, Sauguche, and the north side of the San Juan Ranges with the Aspinall Unit (Blue Mesa, Morrow Point and Crystal Reservoirs) located half-way down the river basin. The Aspinall Unit is just above the Black Canyon of the Gunnison, a 2000-foot deep gorge that provides the river an entrance to the Colorado Plateau. There are many smaller reservoirs in the various tributaries throughout Colorado.

The Colorado and the Green River join downstream of Moab, UT in Canyonlands National Park at the upstream end of Cataract Canyon. Forty miles downstream from the confluence, after dropping through several hundred feet of rapids, begins the famous and

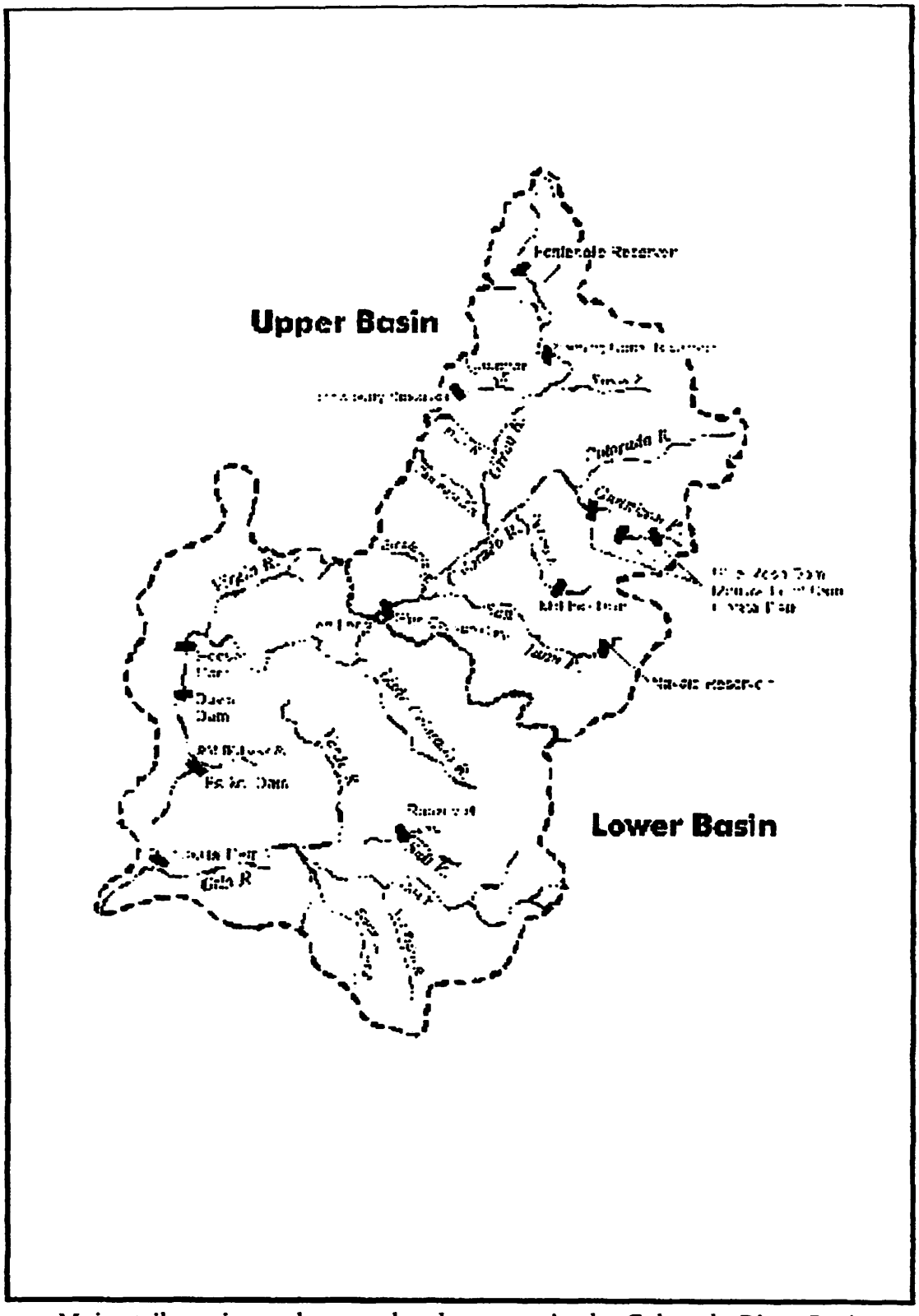
now inundated Glen Canyon. Glen Canyon was a little known but spectacular array of fanciful and beautiful rock formations with narrow slots, arches, and giant spires, only the topmost parts of which are visible above the waters of Lake Powell. Now, when the reservoir behind Glen Canyon Dam is full, half of Cataract Canyon is also inundated.

Joining the Colorado midway through Glen Canyon is the San Juan River. This much smaller tributary drains the mountains of northern New Mexico and southwestern Colorado before flowing through southern Utah, past the towns of Bluff and Mexican Hat, and entering Lake Powell. Navajo Reservoir on the San Juan is the third largest reservoir in the Upper Basin behind Lake Powell and Flaming Gorge.

Of the total flow at Lees Ferry discussed above, about 45% comes from the Colorado, 40% from the Green and 10% from the San Juan. The remaining 5% is from tributaries to Glen Canyon. The two largest of these are the Escalante and Dirty Devil, which drain the high plateaus of southern Utah. The hundreds of slot canyons contribute small flows on an annual basis, but on any given day can add large amounts, sometimes causing shock waves on the reservoir.

Below Lee Ferry, the Colorado enters the 5000-foot deep Grand Canyon. It also enters a much drier watershed. While some of the tributaries seem mighty to local residents, the annual flow of all Lower Basin tributaries is less than 15 % of the total flow at Lees Ferry. Most of the water used along the Colorado River originates in the Upper Basin. It is worth noting that the percentages just presented are based on variable periods of record.

The Lower Basin tributaries, by definition, enter the Colorado River below Lee Ferry. The Little Colorado River, draining the high Mogollon Rim, Chugach Mountains and White Mountains of eastern Arizona, enters through deep canyons at the upstream end of the Grand Canyon. While the Little Colorado occasionally contributes huge flood flows, during dry periods, the river is intermittent and the only flows reaching the mainstem surface in Blue Springs five miles upstream of the confluence. Blue Springs get their name from the bluish tint imparted to the



Major tributaries and water developments in the Colorado River Basin

river flows by the fine silt. The Little Colorado River provides necessary refuge for some of the remaining endangered fishes in the basin.

The tributaries in the Grand Canyon are numerous, but very small. The contribution to annual flow of the river is negligible when compared to their beauty and ecological importance. For example, the Kanab ambersnail exists only in the stream below the remarkable falls known as Vasey's Paradise.

Below the Grand Canyon, there are essentially no small stream tributaries but there are three relatively large rivers, the Virgin, the Gila, and the Bill Williams Rivers. The Virgin River, which drains southwest Utah and southeast Nevada, enters a major arm of Lake Mead northwest of Las Vegas. The Virgin River drainage has several small reservoirs and is currently being considered for additional water supply reservoirs by Washington County in southwest Utah. Washington County is one of the fastest growing areas of Utah, and a proposal to develop a new town of 35,000 on school trust lands in the county has been advanced. Utah has concluded that the Virgin River and Kanab Creek are subject to the exclusive use of the State, based on the Supreme Court Decree in *Arizona v. California*. Current projections from the Utah Division of Water Resources are that depletions from these waterways will increase from 81,000 af in 1990 to 145,000 af in 2040. These depletions will decrease the flow in the lower Colorado River resulting in less water available on an annual basis to the Lower Basin.

Below Lake Mead, the Bill Williams River enters the Colorado in Lake Havasu. A combination of the Santa Maria River, the Big Sandy, and Burro Creek, the Bill Williams River drains the Sonoran Desert mountains of northwest Arizona. The reservoir at the confluence of the Santa Maria and Big Sandy, the Alamo Reservoir, may be one of the largest but least known Federal water boondoggles. Built for flood control by the Corps of Engineers, there is no development along the mainstem below the dam. Although the Corps has attempted to find users, there is no contract for water delivery from the reservoir to any water user. In other words, this may be the most useless (unless we consider warm water fisheries) reservoir in a region of many reservoirs.

Just above Yuma, AZ, the Gila River was, historically, a major tributary. It drains most of southern Arizona, southwestern New Mexico, and some of northern Mexico. Its tributaries include the Santa Cruz, Salt, San Pedro, and Blue Rivers, which drain the highlands of southwest New Mexico and eastern Arizona. In its currently developed condition, the Gila River rarely flows into the Colorado River. This fact is striking when compared to the average annual flows prior to major development; the average annual flow of the Gila from 1904 through 1920 was slightly in excess of 1.1 maf. Flows over that period also demonstrate the episodic character of desert flows with the greatest one-year flow totaling 4.67 maf and the smallest less than 74,000 af. Similarly, five-year averages in that timespan ranged from 271,000 af to 1.73 maf. Two mainstem reservoirs, the San Carlos upstream and Painted Rock downstream, control the mainstem flows. The

Santa Cruz River is drained by groundwater usage in Tucson. The Salt River has five major reservoirs and provides the bulk of water for urban and irrigated areas near Phoenix. The only flow in most years passing Phoenix is wastewater return flow; it is subsequently used for cooling water at the Palo Verde power plant.

Average annual flows do not begin to explain the hydrology of the Colorado River basin. Under natural conditions, the river almost never flows at its average annual flow rate. Seasonality controls the annual high and low stages and sediment transport on the river. Seasonal cycles are controlled by snowmelt in the headwaters and winter rains on the lower tributaries. Peak river flows occur from May through July as the Rocky Mountain snows melt. The lowest annual mainstem flows occur in the late summer. High flows in the winter and early spring result from heavy rains and rain on snow events in the mountains of the Lower Basin flooding the Bill Williams, Gila, or Virgin Rivers. High, short duration peaks in the Glen and Grand Canyon regions occur in the late summer due to heavy monsoon-driven thunderstorms. The source and timing of flooding also controls sediment movement throughout the basin.

With development of at least 22 reservoirs on the mainstem and major tributaries (not including the Lower Basin tributaries), the mainstem flows have begun to resemble a plumbing system. Annual peak flows have been decreased by up to tenfold; annual low flows at Yuma are at least five times higher than predam conditions. The reason for this is that irrigation demands in California and Arizona peak in late summer. Municipal demands in Las Vegas also peak in the summer. Thus, the reservoirs, when managed as designed, take the top off the peak flows in late spring and early summer and distribute them far more evenly throughout the year. Evaporation and bank storage losses in all of the main reservoirs claim as much as 15% of the annual flow in the river system. The far downstream end of the river below Morelos Dam, the Delta in Mexico and Sea of Cortez, receives water only in rare years, when there is a sufficient surplus in the system that more flow than Mexico's entitlement is delivered, and Mexico is unable to use the surplus.

Sediment Transport

The old adage, "too thick to drink, too thin to plow," indicates that it is not only variation in flow rate but also variation in sediment transport that are central to the basin ecosystem. Sediment transport varies much more than the flow rate from year-to-year. Early in the 1900's, high flows following a drought caused four times the annual sediment flow (up to 150,000 af/y at Lees Ferry) as occurred after 1941. Since, 1963, sediment has accumulated in the reservoir behind Glen Canyon Dam, largely in the upstream delta, at the rate of 37,000 af/y.[2]

In the early part of the century, basinwide range conditions were at a minimum due to extended drought and the advent of livestock grazing. Subsequent high-flow years initiated a cycle of erosion that caused both many deep gullies in the Southwest and also high sediment loads on the Colorado River, most of which were deposited below Topock

Gorge, just above Lake Havasu. There are various reasons for the drop in sediment after 1941, but the primary one is that a geomorphic threshold was exceeded during the just mentioned high-flow years.

Sediments are of great importance to the ecosystem as they are the primary source of nutrients and of the seedbeds necessary for riparian and wetland vegetation. The episodic nature of sediment flow throughout the basin has been well documented. According to Andrews[3], "the decrease in mean annual sediment loads in the Colorado River near Grand Canyon after 1941 is quite large, nearly 100 million tons/year..." (90,718,000 English tons/year). This period also is the period with the best sediment gauging. The average flow at Lees Ferry drops to less than 60,000,000 tons/year from a five-year average of 186,000,000 ton/year. In Utah for example, the average load at Cisco is 8,000,000 ton/year, a drop of 10,000,000 t/y from the 1930 to 41 average; the average load at Bluff became 18,000,000 t/y, where the previous average had been 44,000,000 ton/year; and the average load at Green River became 15,000,000 t/y, where the average from 1930 to 1941 had been 24,000,000 t/y. By far, the San Juan River at Bluff had the largest decrease. Tributaries within Glen Canyon add almost 20% of the sediment inflow in less than 5% of the water inflow. Although the difference in pre-1941 and post-1941 sediment loads may seem to be largely due to climate changes, the many reservoirs built along the river actually have had much greater effect.

Most of the runoff in the San Juan River is in the higher elevation headwaters while most sediment results from the lower reaches. Almost 80% additional sediment results from 10% additional flow. Similar results are seen on the Colorado River. For their flow, the Little Colorado and Paria River contribute much more sediment than any other portion of the watershed. This is clear evidence that upper watersheds contribute most of the water flow while watersheds on the Colorado Plateau contribute most of the sediment.

Flaming Gorge Reservoir Dam operations have caused major aggradation (alteration of streambed morphology by sediment deposition) on the Green River. Midchannel bars below the Yampa River indicate that the available load on the Green exceeds the river's transport capacity. Transport capacity decreases as the annual peaks decrease. As much as 500,000 af of sediment is bound within the Green River between the Yampa River and Cataract Canyon. Reoperation of the Flaming Gorge Dam to more closely mimic the natural hydrograph should help move some of this stored sediment further downstream and into Lake Powell.

The Lower Colorado Basin, including the Delta, is currently sediment starved. Lake Powell effectively traps all incoming sediment. The Paria and Little Colorado contribute about 15% of the predam load to the Grand Canyon. While the river often cannot transport this load, it is deposited at depth so that it is not useful to riparian communities. Any sediment escaping the Grand Canyon, as well as the Virgin River load, is deposited in Lake Mead. The Bill Williams River load is deposited in Alamo Reservoir. Only the Gila River and bank sloughing, which is largely constrained by riprap programs,

contribute significant sediment to the lower river. There is substantial sediment at high channel levels, some of which was deposited in the early 1900's, but the plumbing system does not allow river flows to reach these levels anymore.

The Law of the River

The Law of the River is an accumulation of numerous compacts (interstate agreements ratified by Congress), legislation, treaties (international agreements), intrastate agreements, and court decisions (disagreements between states are heard and decided by the U.S. Supreme Court). The foundation of the Law of the River is the Colorado River Compact of 1922, signed in 1923 by six of the seven basin states (Arizona did not sign the Compact until 1944).

Based on the high estimate of annual flow in the Colorado River system, the 1922 Colorado River Compact split the flows of the Colorado River into 7.5 maf/y for the Upper and Lower Basin. The compact requires the Upper Basin to deliver an average 7.5 maf/yr, over every ten-year period, to the Lower Basin at Lee Ferry. After that, the Upper Basin may develop up to 7.5 maf/yr in consumptive uses. With the lower, observed flows, the Upper Basin may develop the difference between the annual flow at Lee Ferry and 7.5 maf/y. Any annual surpluses go to Lower Basin states. The Upper Basin currently absorbs the entire effect of the overestimate of flow. The issue of how the waters in the tributaries in the Lower Basin are allocated has not yet been fully adjudicated. Current thinking is that the million acre-feet extra to be delivered to the Lower Basin are coming from the Gila and Virgin Rivers.

The 1928 Boulder Canyon Project Act, which authorized the construction of Hoover Dam creating Lake Mead, also divided the Lower Basin's share among California, 4.4 maf; Arizona, 2.8 maf; and Nevada, 300,000 af. While California and Arizona have allocated the majority of their apportionment to agricultural use, Nevada uses most of its allocation for Las Vegas with a small proportion going to two Indian reservations. Irrigation with that water is almost nonexistent.

The California Seven-Party Agreement was signed in 1931 by Imperial Valley Irrigation District (IID), Coachella Valley Water District (CVWD), Palo Verde Irrigation District (PVID), Metropolitan Water District of Southern California (MWD), Los Angeles Department of Water and Power, the City of San Diego, and San Diego County. The latter three water agencies conveyed their water rights to MWD. MWD takes its water from Lake Havasu at Parker Dam through the Colorado River Aqueduct. Further downstream, IID and CVWD get their water from a diversion at Imperial Dam through the All American Canal. The extent of these diversions in the Lower Colorado Basin is difficult to comprehend. At Parker Dam, the All American Canal diverts 1.2 maf/y, and across the river, the Central Arizona Project is pumping 1.6 maf/y to Phoenix and Tucson. The last U.S. diversion, Imperial Dam and Canal is taking 3.1 maf/y into the Imperial and Coachella Valleys' agricultural lands,