The Colorado River
The Story of a Quest for Certainty on a Diminishing River

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CHAPTER I

BACKGROUND

Background

The State of Colorado is currently addressing Colorado River issues on multiple fronts. Within Colorado, through the Colorado Water for the 21st Century Act (HB 2005-1177 or HB-1177)\(^1\) we are engaged in an ambitious effort to identify future water needs within each of the state’s major river drainage basins and develop consensus solutions to address those needs.

Under HB-1177, there are nine basin roundtables and an Interbasin Compact Commission (IBCC). Each roundtable consists of representatives of counties, municipalities, water conservancy districts, water conservation districts, special water districts, ditch and reservoir companies and the environmental, sportsmen and recreation communities. The IBCC consists of two representatives elected by each roundtable, six at-large members appointed by the Governor, a Director of Compact Negotiations, also appointed by the Governor, and two legislative representatives, one each appointed by the Chairs of the House and Senate Agriculture Committees.

HB-1177 allows individual roundtables to enter into intrastate compacts. These intrastate compacts would be among two or more roundtables. The roles of the IBCC includes establishing a common state-wide technical platform, establishing a positive environment that will encourage negotiations among the individual roundtables and ratifying any intrastate compacts that are ultimately negotiated.

On the interstate front, representatives of the State of Colorado and a coalition of its major Colorado River water users are actively engaged with representatives of the other six Basin States and the United State Department of the Interior to address a number of very difficult mainstem Colorado River issues. On February 28, 2007, the Bureau of Reclamation issued a draft environmental impact statement on alternative shortage criteria (Shortage Criteria DEIS)\(^2\) that will be used to guide the operation of Lake Mead when water supply conditions are insufficient to meet normal year apportionment of 7.5 million acre feet per year for the Lower Basin States of California, Nevada and Arizona. The Secretary of the Interior is scheduled to complete a record of decision by the end of 2007.

At the urging of the Secretary of the Interior, the Basin States (States) have negotiated an umbrella agreement or understanding. The States’ agreement includes proposed shortage criteria,

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1 CRS 37-75-101 through 106.

a conjunctive management of Lake Powell and Lake Mead, a study of long-term river “augmentation” strategies, and proposed efficiency measures and projects that would save or better utilize existing supplies on the Colorado River below Lake Mead. The Shortage Criteria DEIS includes the States proposed shortage criteria as one of four different alternatives.

From the Upper Basin’s perspective, the hydrology benefits from the States proposal are relatively small. The proposed conjunctive or coordinated operation of Lake Mead and Lake Powell will slightly reduce the risk of Lake Powell dropping below the minimum elevation necessary to generate hydroelectric power (minimum power head). This slight reduction in the risk of Powell dropping below minimum power head is offset by a slight increase in the amount of water the Upper Basin delivers from Lake Powell over the period of the agreement. The States’ proposed shortage criteria and conjunctive management plan would be on an interim basis. The criteria are intended to be effective only through 2025.

The primary benefits of the States proposal are political. In theory, the proposal addresses a number of salient political problems on the Colorado River system and reduces the risk of inter-state litigation during the life of the agreement.

On both the intrastate and interstate fronts, the common denominator is certainty.

**The Water Community and It’s Quest for Certainty**

Perhaps from the days of Roman Empire, the common quest of water providers is certainty of supply. Within the State of Colorado and within the Colorado River Basin, the concept of certainty underlies much of the federal and state water law.

The motivation for the 1922 Colorado River Compact in the Upper Basin was a recognition that the Lower Basin was growing faster than the Upper Basin. The Upper Basin States wanted a compact in order to avoid the application of the prior appropriation doctrine on an interstate basin basis. The Upper Basin States wanted certainty that a water supply would exist for their projects when they had the demand and the resources to build projects. In the Lower Basin, nature provided a very erratic and unruly river. There were both periods of great floods and extremely low flows. The Lower Basin, primarily California, wanted the certainty provided by the construction of a large reservoir to regulate the flows of the Colorado River. Thus, both basin needed each other’s support to accomplish their goals.

The Imperial Irrigation District (IID) had a particular problem with water supply certainty. Prior to the construction of the All-American Canal, the IID supply canal went through The Republic of Mexico and then back north into California to the Imperial Valley. When Congress passed the

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Boulder Canyon Project Act of 1928 (1928 Act), it authorized the construction of Hoover Dam, which provided both flood control protection and river regulation for the lower river. It also authorized the construction of the All-American Canal, which now provides IID with water delivered through a canal route which is on All-American ground. It provided for a Congressional apportionment of mainstem water supplies among the three Lower Basin States and since the Arizona Legislature refused ratification, the 1928 Act engineered a political path for a six-state ratification of the 1922 Compact.

After World War II, the four Upper Basin States got together and negotiated the Upper Colorado River Basin Compact with little difficulty or controversy. The Upper Colorado River Basin States had strong motivation. They desired federal funding for water development in the Upper Colorado River Basin. Congress was not willing to authorize projects and appropriate large sums of money until the states had provided legal certainty for the water which would be utilized by the authorized Upper Basin projects. In 1948, Congress, the four Upper Basin States, and Arizona (which has Upper Basin lands that are tributary to the San Juan River) ratified the Upper Colorado River Basin Compact (1948 Compact). In 1956, Congress passed the Colorado River Storage Project Act (CRSPA), which authorized the construction of Lake Powell, Navajo Reservoir, Flaming Gorge Reservoir and the Curecanti Unit (which has been renamed the Aspinall Unit) and provided for the comprehensive development of the Upper Basin. The primary purpose for the construction of these large reservoirs is to provide carryover storage to allow the Upper Basin States to meet their obligations at Lee Ferry under the 1922 Compact thereby increasing certainty to both basins.

In 1952, Arizona filed its fourth lawsuit related to the Colorado River in the U.S. Supreme Court. Arizona’s goal was to provide certainty for the water supply for the proposed Central Arizona Project (CAP). Because California held a different interpretation than Arizona on the water supply available to the Lower Basin States under the 1922 Compact and 1928 Act, Congress was not willing to authorize and fund the CAP.

In 1963, the U.S. Supreme Court decided the case in favor of Arizona and in 1964 issued its Arizona v. California decree. Unfortunately, in 1968 Arizona had to give up some of its legal certainty for the CAP. In return for its support for the CAP, California’s powerful congressional delegation required a provision in the 1968 Colorado River Basin Project Act that makes California’s 4.4 million acre feet normal year apportionment senior to the CAP and to the Las Vegas Valley pipeline out of Lake Mead.

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Most recently, the focus of the Seven Basin States and the Department of the Interior has been on the operation of Lake Mead during surplus and shortage conditions.

Again, the common theme is certainty. Prior to the 1990s and the completion of the CAP, the water supply available in the Colorado River system generally exceeded the demands. Until recently, the Secretary never had to make any difficult decisions related to allocating either a surplus or shortage.

Today, conditions are fundamentally different. Recently, demands for Colorado River water have exceeded its supply. The Secretary and all the Basin States face difficult decisions. At least for the moment, the States have chosen a strategy of dialogue and negotiations rather than confrontation. The risks of confrontation are simply too great.

Within Colorado, certainty underlies our basic system of water law and it is the primary motive behind many of our current disputes. The law was originally developed to provide certainty for the miners and irrigators that first diverted water out of a stream and applied it to beneficial use. The concept behind an augmentation plan is that newer or junior water users get judicial certainty that its plan can truly offset the impacts to downstream senior users.

For water suppliers, three primary factors increase certainty. First, is the seniority of the water rights, obviously the more senior, the more reliable the rights. In the Colorado River Basin, water rights perfected by use prior to the signing of the Colorado River Compact cannot be impaired or called out to meet compact delivery requirements. These rights have additional certainty against a future basin wide call under the 1922 Compact.  

The second factor in certainty is surface or underground storage. In general, systems with greater storage have more certainty. The amount of certainty provided by storage can, however, vary depending on the operational criteria used by the owner. If an owner operates a reservoir to provide a firm yield through a relatively infrequent drought, the certainty or reliability is enhanced.

The final factor is redundancy. Systems with more than one source of supply have more reliability and thus certainty, than single source projects. Denver Water, for example, obtains its water supply from three different basins, the Fraser River, the Blue River (both the Blue and Fraser are tributaries to the Colorado), and the South Platte River. Unfortunately, currently only the more populous municipalities or major industrial users in Colorado can afford the luxury of redundant systems.

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8Article VIII of the 1922 Compact states “Present perfected rights to the beneficial use of water of the Colorado River system are unimpaired by this compact.”
The Colorado IntraState Compact (a/k/a/ HB-1177) Process

The HB-1177 process has now been underway since early 2006. The legislation includes direction to each basin roundtable to make a needs assessment and determine how much unappropriated water is available. The needs assessment is intended to include not only consumptive uses, but the water or streamflows necessary for environmental, water quality and recreation purposes as well.

The Statewide Water Supply Initiative (SWSI) began before the start of the HB-1177 process. SWSI is sponsored and managed by the Colorado Water Conservation Board (CWCB). SWSI looked at future water demands and available supplies throughout the State of Colorado.

To no one’s surprise, SWSI concludes that by 2030 there are going to be significant shortages or “gaps” in future supplies throughout most of Colorado, but especially along the Front Range. The identified shortfall in the Arkansas River Basin is 17,100 acre feet (af). In the South Platte River Basin it is 90,600 af. In contrast, the shortages in the San Juan, mainstem Colorado, Gunnison and Rio Grande Basins are 4,900 af, 3,000 af, 2,400 af and 100 af respectively.

To conduct their needs assessments, individual roundtables will start with the information provided in the SWSI report. However, a number of basins have already concluded that the SWSI report, while a good starting point, is either incomplete or already out of date. For example, the Colorado and Yampa/White Roundtables have approved an energy development water needs assessment. The SWSI process began before much of the current energy boom started. The initial SWSI report contained little information concerning the water needs of a future oil shale industry, its related municipal and power impacts or other potential energy projects that may require water such as coal gasification.

SWSI Assumption Concerning Water Availability

The River Basin fact sheets for the Colorado, Gunnison, Yampa/White and San Juan/Dolores Basins published by the CWCB in March 2002 includes the following statement: “Depending upon the interpretation of the Compacts, other laws, and the amount of water in the river, Colorado’s right to the consumptive use of water under the compacts may range from 3.079 maf to 3.855 maf per year. Colorado currently consumes an average of 2.3 maf per year with facilities in place using up to 2.6 maf per year.”

With a supply of 3.079 to 3.855 million acre feet (maf)/year and a demand of only 2.3 to 2.6 maf/year, it appears that Colorado has a lot of water available to develop - 500,000 to 1,250,000 af/year.

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9Statewide Water Supply Initiative Executive Summary, November 10, 2004, Figure E5-8. An acre foot of water is 326,000 gallons. It is approximately enough water to serve to two families of four for a year.

10The fact sheets can be obtained from the CWCB at http://cwcb.state.co.us.
The higher number is based on an aggressive interpretation of the 1922 Compact. An interpretation that may have an historical basis, but the reality is that the water may be neither physically or legally available. It is also an interpretation that is very controversial within the other Basin States and within Colorado itself.

The lower number is based on a hydrologic study similar to a firm yield analysis, conducted by the Bureau of Reclamation (Reclamation) commonly referred to as the “Hydrologic Determination.” A Hydrologic Determination was last signed by the Secretary of the Interior on February 2, 1989.\textsuperscript{11} It is required by the federal legislation authorizing the Navajo Indian Irrigation Project and the San Juan-Chama Project.\textsuperscript{12} The Secretary of the Interior is currently reviewing a new updated Hydrologic Determination.\textsuperscript{13}

The assumption that Colorado has at least 500,000 af per year of Colorado River water remaining to develop is relatively common. Within the HB-1177 process, it is often coupled with another common assumption that Colorado’s other major river systems (North Platte, South Platte, Arkansas and Rio Grande) are fully utilized.

For example, the “Multi-Basin Water Supply Investigation” prepared for the Northern Colorado Water Conservancy District and which proposes a large transmountain diversion out of the Yampa Basin, makes the following statement: “SWSI estimates that the amount of water available for development under the 1922 and 1948 compacts to be around 700,000 af.”\textsuperscript{14}

The CWCB staff presentation to the SWSI phase II GAP Committee on February 26, 2006, included the following conclusion:\textsuperscript{15}

\begin{itemize}
  \item 150,000 af/year minimum available after
  \item existing firming projects
  \item meeting future in-basin future needs
  \item oil shale development
\end{itemize}

There is a big difference between 150,000 af and 700,000 af. The CWCB’s 150,000 af estimate includes the development of a number of future projects, including oil shale. In both of the above examples, the basic assumption is that Colorado has some amount of Colorado River water available to develop. Whether it is 150,000 or 700,000, is it really there?


\textsuperscript{12}76 Stat. 96. (1962).

\textsuperscript{13}Memo from Randy Seaholm to the CWCB dated May 7, 2006. It is attached as Appendix D.

\textsuperscript{14}Boyle Engineering, Multi-Basin Water Supply Investigation, November 2006, at page 2-4.

\textsuperscript{15}Power point prepared by Rick Brown, February 2, 2006, slide #39.
Does Colorado Really Have Surplus Colorado River Water Available?

As both the interstate and intrastate discussions proceed, we need to recognize and discuss the major uncertainties and challenges facing the Colorado River. Climate change or “global warming” raises serious new uncertainty factors on a system that seeks to minimize uncertainty. Almost all of the science that I have read suggests that the Colorado River is facing a future with less stream flow. A recent National Academies of Sciences report makes the same conclusion. Additionally, there have been a number of paleohydrology studies that suggest the 1900s may have been unusually wet. Therefore, even without the climate change factor, there may be cause for concern. The policy implications of less water in the Colorado River are very disturbing, not only for the State of Colorado and its sister Basin States but for the nation as a whole.

The policy implications of less water go far beyond the use of water for consumptive uses. It will have serious implications for the interagency efforts to protect and recover any endangered species throughout the Colorado River Basin. Indeed, the reduced flows may trigger the listing of additional species under the Endangered Species Act (ESA).

Reduced flows may have serious impacts on both stream based and reservoir based recreation throughout the Basin. A warmer Colorado River Basin may change the vegetation in the Colorado River watershed in ways we cannot predict. There may also be new water quality problems from the reduced flows and changes in the shape and timing of the hydrograph.

If we assume that today’s Colorado River is being fully utilized by the seven Basin States and Mexico, then a future with less water will mean that all future new uses will come through the transfer or restriction of existing uses, through efficiency improvements, through augmentation from sources outside the Colorado River Basin or precipitation enhancement. Less water in the river will mean that shortages in the Lower Basin will be the rule not the exception. It means that within Colorado, we are going to have to carefully consider any decisions concerning future development. Is the basic assumption underlying SWSI that Colorado has remaining Colorado River water to develop still valid?

Author’s Note and Motivation for the Paper

As previously mentioned, I believe the people of Colorado are facing very difficult decisions concerning our water future. It is my view that if HB-1177 is to succeed, the professional water community needs to encourage a broad and transparent statewide dialogue among the community itself, the numerous elected and appointed officials on the boards, commissions, city and town councils, the legislature and the public.

Water policy decisions are long lasting. Water supply projects and their related impacts have lifetimes that are measured in centuries. Many of the projects we currently rely on are over a hundred years old, the Uncompahgre Project for example. The consequences of bad decisions are also long lasting and too often painful. I believe we all have a responsibility to avoid repeating the kind of decisions that led to the current crisis in the South Platte River Basin where farms that have used tributary groundwater for several generations are now without a water supply. The impact reaches far beyond the farmers to the small towns that rely on agriculture and ultimately to the cultural stability of the region.

I further believe that we are facing new challenges and realities that will test our collective ability to make rational decisions. What we do in Colorado will impact the entire Basin. What is happening in the remainder of the Basin impacts Colorado. To the extent our climate is changing, we may already be in an era where worldwide transportation, agriculture and energy policies impact our water supplies and those impacts will continue for a long time.

As an employee of the Colorado River Water Conservation District (River District), I have had the good fortune of participating in forums that address interstate issues; the Upper Colorado River Commission Engineering Committee and the Seven State negotiations. I’m also active in intrastate issues; the IBCC, Roundtables and numerous multi-party negotiations among the River District, our West Slope partners and East Slope entities. Most recently, I began participating on the Colorado Climate Project’s Climate Action Panel.

The reader should recognize what I will readily admit; I am biased. The River District has a responsibility under its statute to provide for and protect the water supplies for its present and future residents. I am very passionate about protecting the quality of life in western Colorado, and a healthy Colorado River system is vital to maintaining that quality. However, I also recognize that the West Slope’s present and future economy is integrally tied to Colorado’s Front Range.

I must also admit up front that there are many different views and interpretations of the Colorado River Compact and the other provisions of the “Law of the River.” My views are only one of many.

In the following chapters, I try to give the reader an understanding of historical perspective of both development and legal issues on the Colorado. What led us to the situation we are in today? What are our options and what are the ramifications of the decisions we face today?
CHAPTER II

THE COLORADO RIVER BASIN
YESTERDAY AND TODAY

The Colorado River drains approximately 242,000 square miles of the southwestern United States. It drains parts of seven states and two countries.\(^\text{17}\)

Its headwaters arise in the high Rocky Mountains, primarily in Colorado, Wyoming and Utah. The river flows approximately 1,400 miles from the headwaters of the Green River above Pinedale, Wyoming to its mouth in the Gulf of California. It is the second longest river in the Continental United States.

Although considered one of the great rivers of North America, the flow as measured by the natural discharge at its mouth is really quite modest.\(^\text{18}\) For example, both the Colorado River and the Columbia River Basin drain an area of approximately 250,000 square miles. However, the average annual natural discharge of the Columbia is 13 times that of the Colorado.\(^\text{19}\) In fact when compared with other U.S. rivers based on natural discharge, the Colorado is slightly larger than the Hudson, but slightly smaller than the Illinois River.\(^\text{20}\)

The reason is simple. The Colorado River is primarily a desert river. The basin itself averages about 12” per year in precipitation.\(^\text{21}\) Most of the runoff originates as snow in the high mountains that rim the Basin, the San Juans, the central Colorado Rockies, the northern Colorado Rockies, the Uintahs, the Wind River and Wyoming ranges. These mountains range in elevation from about 10,500’ to over 14,000’.

The Colorado River Basin can be naturally divided into two major basins; an upper basin and a lower basin. It is often described as an hourglass with the neck being the river section before it enters the Grand Canyon near the historic site of Lee’s Ferry. The upper river drains the high mountains that rim the upper basin and the high mesas and plateaus in between.

\(^{17}\)The total drainage area of the Colorado River Basin is 244,000 square miles. Of this, 242,000 square miles is in the United States and 2,000 is in the Republic of Mexico. Many also believe the Salton Sink, comprised of the Imperial Valley, Salton Sea and Coachella Valley is a natural or geologic part of the Colorado River Basin. If included, it would add another 7,800 square miles to the Basin. See House Document 419, page 31.

\(^{18}\)By “natural discharge” I mean the flow if it was unaffected by man. It is also sometimes referred to as a “virgin flow.”

\(^{19}\)Fritz van der Leeden “Water Resources of the World, Selected Statistics,” TABLE 5-72.

\(^{20}\)id.

\(^{21}\)House Document 419, page III-55.
Figure II-1: Map of the Colorado River Basin
The lower river begins as the river enters the Grand Canyon and runs to its mouth in the Gulf of California. The upper and lower river basins can be further divided by their major tributaries.

**Lower Basin Tributaries**

The Gila River is the major tributary on the lower river. It drains over 53,000 square miles of central and southern Arizona and western New Mexico. While it is a very large drainage area, the Gila River System watershed is primarily desert. Almost all of the runoff originates on a very small portion of the watershed along the Mogollon Rim and the White Mountains. The Mogollon Rim runs from central Arizona south and eastward into New Mexico. The elevation ranges from 6,000' to 8,000'. The White Mountains in eastern Arizona and western New Mexico have a handful of peaks that exceed 10,000'.

The Gila River is a “wasting” river. In 1947, Reclamation estimated that the natural flow of the Gila River at its confluence with the Colorado River near Yuma was 1,272,000 af per year. Because the study period was 1897-1943, this is probably a high estimate. Other studies have suggested a natural flow more in the range of one million af per year. However, the estimated natural flow of the Gila River as it enters the Phoenix, Arizona area for that same 1897 to 1943 period is 2,280,000 af per year, over a million acre feet more that its flow at the mouth. Thus, as it flows from Phoenix to its mouth, it naturally loses or “wastes” over a million acre feet of water.

Although it may contribute a relatively small portion of the flow of the Colorado River at its mouth, the Gila River is the most politically sensitive and difficult tributary of the Colorado River. In all but the very wettest months of rare years the Gila River is completely used and no water makes it past the Phoenix area, let alone all the way to Yuma.

The Gila River system is almost exclusively used in Arizona with a little bit of use in New Mexico. While the issue of how much water Arizona uses upstream versus the amount that would “waste away” if it were not being used may seem like trivia, it is at the very heart of the unresolved legal issues still simmering within the Basin. The Gila River was Arizona’s primary motivation for initiating four different Supreme Court cases and could easily be the motivation for future interstate litigation. Additionally, as a lower elevation watershed, the Gila River’s future may be in the most jeopardy due to future climate changes.

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23House Document 419, TABLE CXLVI, page 284.

24House Document 419 estimates the virgin flow of the Colorado River at 16,270,000 af at Lee Ferry for the same 1897-1943 period. (See TABLE CXL, page 281).

25See footnotes #7 and #8. Again, this estimate is probably high based on the 1897 to 1943 period of record.

26Check the USGS website, [http://waterdata.usgs.gov](http://waterdata.usgs.gov) for the historic flows for the Gila River below Painted Rock and the Gila River near Dateland, Arizona.
The other two major sub-basins in the Lower Basin are the Little Colorado River Basin and the Virgin River Basin. The Little Colorado River Basin drains about 25,000 square miles of northeastern Arizona and west central New Mexico. The Little Colorado River has even less natural discharge per square mile than the Gila River. Reclamation estimated the average annual discharge of the Little Colorado at Grand Falls to be in the range of 200,000 to 240,000 af per year. Grand Falls is about 60 miles upstream of the confluence of the Little Colorado River and the Colorado River in Grand Canyon National Park. Like the Gila, the Little Colorado River is a very flashy river. Its primary watersheds are the northern slopes of the Mogollon country and the White Mountains. Major portions of the Lower Little Colorado River mainstem are dry for most of the year.

The Little Colorado River is politically important because it drains and runs through the Navajo and Hopi Indian Reservations within Arizona and the Zuni Indian Reservation in western New Mexico. None of these tribes has quantified its reserved water rights.

The Little Colorado River is environmentally important because after the completion of the Glen Canyon Dam, the Little Colorado is a primary source for sediment for the Grand Canyon river ecosystem. The very lower portion of the Little Colorado also provides habitat for the Humpback Chub, a native fish species listed as endangered under the ESA.

The Virgin River and its tributaries drain very southwestern Utah, the very northwest corner of Arizona and southeastern Nevada. The Virgin River has its headwaters in the high country of southern Utah east of Cedar City. Its principal tributary in Nevada is the Muddy River. The drainage area is approximately 11,000 square miles. The estimated natural flow of the river at Littlefield, Arizona is 310,000 af per year. The Virgin River and Muddy River flow directly into Lake Mead. When Lake Mead is high, location of the confluence of the two streams is underwater in Lake Mead. The Virgin River is politically significant for a number of reasons. The river is the primary source of water for southeastern Utah. The St. George area of southeast Utah is experiencing significant growth.

In fact, the State of Utah is moving forward with the development of a pipeline project that would supply the St. George area with water from Lake Powell. There is no formal agreement among Arizona, Nevada and Utah dividing the waters of the Virgin River. However, there have been informal discussions among the three states.

The second reason for the political importance of the Virgin River is that within Nevada, there are over 20,000 acres of irrigated lands in primarily the Muddy River Basin. Reclamation estimates that the annual consumptive use for agricultural purposes in Nevada is approximately

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27House Document 419, TABLE LXXIV, page 152. Again, remember that this is probably higher than the long term average.


29House Document 419, page 158.
100,000 af per year.\textsuperscript{30} This consumptive use is not included in Nevada’s 300,000 af of mainstem apportionment, therefore the transfer of this water from agricultural to municipal use is a potential source of water for Las Vegas.\textsuperscript{31}

\textbf{Upper Basin Tributaries}

There are also three principal tributaries or sub-basins in the Upper Basin; the Green River Basin, the Upper Colorado River Basin and the San Juan River Basin.

The Green River drainage includes southwestern Wyoming, northeastern Utah and northwestern Colorado. The Green River drains over 44,000 square miles, an area about the size of the State of Pennsylvania. The estimated natural flow of the Green River at its confluence with the Colorado River in Canyonlands National Park is approximately 5.1 maf per year.\textsuperscript{32}

The Green River itself has its headwaters in the high Wind River Mountains above Pinedale, Wyoming. From there it runs due south through southwestern Wyoming high desert country. It picks up inflow from the western slopes of the Wind River Mountains and eastern slopes of the Wyoming Range.

The Green River crosses into Utah in what is now Flaming Gorge Reservoir. Below Flaming Gorge Dam the river turns toward the southeast and enters Colorado in what is referred to as Browns Park. Before jogging back to the west to again enter Utah, the Green River picks up its largest tributary, the Yampa River. The Yampa River drains approximately 6,000 square miles of northwest Colorado and south central Wyoming.

Back in Utah, the Green is joined by its major Utah tributary, the Duschene River. The Duschene River drains the southern slopes of the Uintah Mountains. It is the largest tributary of the Colorado River system that flows from west to east. The Duschene may also be Utah’s most important stream. A portion of its waters are diverted to the west out of the Colorado Basin into Utah’s Wasatch front, primarily through the Central Utah Project (CUP).\textsuperscript{33}


\textsuperscript{31}The Southern Nevada Water Authority has filed an application for federal rights of way. The proposed 7 state agreement addresses the SNWA proposal in paragraph 8. The November 26, 2006 draft of the agreement is attached as Appendix B.

\textsuperscript{32}This number is the author’s estimate. It is based on the Final Report of the Engineering Committee to the Upper Colorado River Basin Compact Commission, dated November 29, 1948. Part II of this report includes a comprehensive table of estimated virgin stream flows for 1914-1945. The Engineering Committee estimated the flow at 5.4 maf per year. The Committee estimated in natural flow af Lee Ferry to be 15.7 maf per year. I use a longer term average of 14.8 maf per year which corresponds to a flow the Green River of 5.1 maf per year.

\textsuperscript{33}According to the Colorado River System Consumptive Uses and Losses Reports for 1991 to 2000, prepared by the Department of the Interior, Utah was exporting about 110,000 af per year on average, with a maximum of 163,000 af in 1992.
The White River joins the Green approximately forty miles south of its confluence with the Duscheene. The White River drains an area of western Colorado that could, at some future time, be the epicenter of an oil shale industry.

The Green River drainage basin is rich in energy resources including natural gas, oil, coal, and oil shale reserves. The Green River is an important environmental resource. It is home to four endangered fish species under the ESA. The stretch of river from the Colorado above Lake Powell then up the Green and again up the Yampa is the longest continuous unblocked stretch of occupied habitat within the Colorado River system for these fishes.\(^{34}\)

The Colorado River mainstem basin covers the Colorado River and its tributaries above its confluence with the Green River. Prior to 1921, this stretch of the Colorado River was referred to as the Grand River.\(^{35}\)

The basin drains an area approximately 25,600 square miles, less than half the drainage area of the Gila River system and approximately 55% of the drainage area of the Green, yet it is the largest contributor of flow to the river system. The estimated natural flow of the Colorado mainstem is in the range of 6.6 maf per year.\(^{36}\)

The Colorado River has its headwaters in Grand County, Colorado, originally at the natural outlet of Grand Lake.\(^{37}\) As the river flows to the west, it is joined by its major tributaries; the Blue River, the Eagle River, the Roaring Fork River which enters the river at Glenwood Springs, Colorado, the Gunnison River at Grand Junction, Colorado and the Dolores River near Cisco, Utah. Of these tributaries, the Gunnison River is the largest, draining an area of 8,000 square miles and providing a natural flow of approximately 2.3 maf per year. The Colorado mainstem and its tributaries drain the spine of the Colorado Rocky Mountains and the northern slopes of the San Juan Mountains. Its watershed also includes parts of the White River, Uncompahgre and Grand Mesa Plateaus.

The headwaters of the Colorado River mainstem are home to a number of transmountain diversions which divert Colorado River water across the Continental Divide to the Colorado Front Range. These transmountain diversions serve municipal and agricultural needs from Pueblo to Fort Collins including the Metropolitan Denver and Colorado Springs areas.

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34The Upper Colorado River Basin Endangered Fishes Recovery Program has published numerous reports and studies on the Green River system. The Final EIS for the reoperation of Flaming Gorge (November 2005) describes the importance of the Green River in Chapter 1.

35In 1921, Congress changed the name of the Grand River to the Colorado River. The bill was, of course, sponsored by the State of Colorado delegation.

36The author’s estimate using the 7.0 maf per year number reported by the Engineering Committee to the Upper Colorado River Basin Compact Commission. It’s corrected to a lower Lee Ferry estimate. See footnote 29.

37The construction of the Colorado-Big Thompson Project in fact reversed the flow of the natural outlet of Grand Lake. It is now an inlet for project water as it moves from Granby Reservoir through Shadow Mountain Reservoir to the west portal of the Adams Tunnel which is located on the eastern shore of Grand Lake.
The headwaters of the Colorado River mainstem are also home to a booming recreation and second home industry. Like the Green River Basin, the Colorado River Mainstem Basin is rich in oil shale and other energy resources.

The Colorado River mainstem is also home to four fish species listed under the ESA, but its stream habitat has been segmented by diversion dams. Usable or occupied habitat on the Colorado River mainstem is much smaller than on the Green River system.

San Juan River Basin: The San Juan River is the third and southernmost of the upper river’s major sub-basins. The San Juan River drains approximately 23,000 square miles\textsuperscript{38} of four different states: Arizona, Colorado, New Mexico and Utah. While its drainage basin may cover four states, almost all of its flow originates on the southern slopes of the San Juan and San Miguel Mountains in the State of Colorado.\textsuperscript{39}

The estimated natural flow of the San Juan River as it enters Lake Powell is approximately 2.3 maf per year.\textsuperscript{40} The basin drains all or parts of five Indian reservations: the Southern Utes and Ute Mountain Utes in Colorado, the Jicarilla Apaches in New Mexico, the White Mesa Utes in Utah and the Navajo in New Mexico, Utah and Arizona.

Through the San Juan-Chama Project, waters from the San Juan headwaters are diverted across the Continental Divide into the Rio Grande River Basin where it is used for agricultural and municipal purposes including as a municipal supply for Albuquerque and Santa Fe.

Energy resources in the San Juan Basin include coal, oil and natural gas but no oil shale. The river is habitat for two of the four fish species listed under the ESA,\textsuperscript{41} the razorback sucker and the Colorado pikeminnow.

\textsuperscript{38} According to the Engineering Advisory Committee report drainage area by states table, page 33: 20\% Arizona, 25.6\% Colorado, 42\% New Mexico, and 13.4\% Utah. Data are for drainage above Bluff, Utah.

\textsuperscript{39}Engineering Advisory Committee Report, part II, page 20, Colorado contributes 86.7\% of the flow of the San Juan River.

\textsuperscript{40}The author’s estimate using Engineering Advisory Committee Report. See footnote 29.

\textsuperscript{41}Within the Upper Basin, there are two separate Recovery Programs. One is for the San Juan River Basin and one is for the remainder of the Upper Basin.
CHAPTER III

THE DEVELOPMENT OF THE RIVER
AND THE LAW OF THE RIVER THROUGH 1928

The Colorado River Basin Prior to 1922

Some papers or books treat the development of the river and the development of the “Law of the River” separately. But I believe the two completely interdependent. The term “Law of the River” refers to the body of interstate compacts, international treaties, court decisions and decrees, federal and state laws that allocate, regulate and manage water use throughout the basin. Certain features of the Law of the River resulted from the consequences of development and just as importantly, other projects and development features were the by-product of the law.

The basin has been inhabited by native peoples for thousands of years. Irrigation by relatively sophisticated canal systems was a common practice of native people in the Gila and Salt River Valleys. Remains of the old agricultural developments are found throughout the Gila River Valley.

The first European to explore the Colorado River was Hernando de Alarcon, who in 1540 traveled about 100 miles above the Gila River. In 1542, Lopez de Cardenas discovered the Grand Canyon. By the early to mid 1800s, traders, trappers and explorers explored and traversed the Basin.

The discovery of gold in California in 1849 brought more explorers into the lower river and the settlement of Utah by Mormons brought these settlers through the Green River Basin.

In 1851, Fort Yuma was established. In 1857, the War Department sent Lieutenant J.C. Ives up the Colorado River to determine how far up the river navigation was possible. He made it to about the present location of Hoover Dam. In his report, Lieutenant Ives said:

“The region last explored is, of course altogether valueless. It can be approached only from the South, and after entering it, there is nothing there to do but leave. Ours was the first and doubtless will be the last, party of whites to visit this profitless locality. It seems intended by nature that the Colorado River along the greater portion of its lone and majestic way shall be forever unvisited and unmoleded.”

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42House Document 419, pages 45 & 46.
43id, page 48.
44House Document 419, page 48. HD419 does not footnote the original source.
After the Civil War, development of agriculture along Colorado’s Front Range, a mining boom in the central Rockies and Arizona and the construction of transcontinental railroads all led to additional development within the Basin.45

In 1854, irrigation began from Black Forks, a tributary to the Green River. In the 1860s and 1870s, irrigation in Colorado’s high mountain valleys near mining towns began. In 1877, Thomas Blythe made the first filing for Colorado River water in California. Blythe had moved to the Palo Verde Valley in 1856.46

In 1883, the Grand Valley Irrigation Company (GVIC) began delivering irrigation water to lands near Grand Junction, Colorado.47

1902 was a landmark year. In 1902 Congress passed the Newlands Act (named after a senator), also known as the Reclamation Act.48 Among the early projects built by the Reclamation Service were the Uncompahgre Project near Montrose and Delta Colorado, the Grand Valley Irrigation Project near Grand Junction, Colorado, the Strawberry Valley Project in Utah and the Salt River Project in central Arizona.

It was also 1902 when the California Development Company constructed a canal that would deliver water from the Colorado River near Yuma to the Imperial Valley using a gravity route through Mexico referred to as the Alamo Canal. By 1904, there were 700 miles of canal and 75,000 acres were under irrigation within the Salton Sink.49

In 1905, the Alamo Canal configuration led to a disaster. The Colorado River, swollen from flood waters from the Gila River, broke through the Alamo Canal diversion headworks and the entire flow of the Colorado River flowed into the Imperial Valley for 16 months. This flood inundated 30,000 acres of irrigated land and created what is now called the Salton Sea. According to the Reclamation authors of House Document 419, “Here, in the need for flood control was the prime motivating reason for the construction of the Boulder Dam.” House Document 419 summarizes the conditions prior to 1922 as follows:

“Thus by 1920 the situation with respect to the Colorado River had become very tense. Increasing stream depletions were accompanied by increased requirements for irrigation development in California.

45id.
46House Document 419, page 56.
47The GVIC canal has an appropriation date of August 22, 1882. See Water Rights Tabulation for Division 5, Colorado Department of Water Resources.
49House Document 419. Also refer to the Imperial District website, www.iid.com. The Imperial Valley is below sea level. The Alamo Canal route went south through Mexico, then turned north into the Imperial Valley using the Alamo River channel.
and Mexico. The constant threat of an unmanageable break of the river into Imperial Valley during flood stages was also becoming more serious with the rising level of the river and its flood plains within the levees protecting the Imperial Valley. Meanwhile rapid growth of the metropolitan districts of the southern California coastal region was creating a great demand for a large block of power and for additional municipal water supplies. Similar demands for municipal water for the growing city of Denver in the adjacent Platte River Basin were anticipated.

About the same time a keen interest in the Colorado River was being displayed by various public and private agencies, seeking the right to develop hydroelectric power but proposing to provide storage and flood control incidentally.

An extensive investigation by the Bureau of Reclamation to develop ways and means of meeting all of the various needs resulted in the recommendation for the construction of a dam either in Boulder Canyon or Black Canyon for flood control, navigation improvement, irrigation storage, silt control and power development. The long standing need for a canal wholly within the United States also was recognized and it was recommended that such a canal connecting the river at Laguna Dam with the Imperial Valley be constructed and thus eliminate all international complications.”

Legal and Political Developments in the Upper Basin

In the early 1900s interstate water law was a relatively new issue. One of the early legal scholars and leaders was Colorado’s Delph Carpenter. Much has been written about the career of Mr. Carpenter. He is often credited as the father of the interstate water compacts. 50

During his luncheon address at the Colorado River District’s fall water seminar on September 21, 2004, Colorado Director of the Department of Natural Resources Russ George said that the concept of intrastate compacts, and thus HB-1177, was in part based on the principals of interstate compact negotiations as developed by Delph Carpenter. 51

Early on, Carpenter and others first viewed states as sovereigns that could fully use all waters originating within or flowing into a state. However, this concept was quickly dashed by a series of


51Director George referred to the recent book by Daniel Tyler, “Silver Fox of the Rockies, the Autobiography of Delphus Carpenter.” He also credits the idea to attorney Peter Nichols.
The first was *Kansas v. Colorado*\(^{52}\) in 1907 and then *Wyoming v. Colorado*\(^{53}\) in 1922. But even before *Wyoming v. Colorado* was decided, Carpenter feared that if the Lower Basin States (Arizona and California) were to use additional water as the result of projects built by the Reclamation Service, these states would claim a legal priority requiring delivery of a certain quantity of water. Without a compact to protect their ability to develop at a pace consistent with their own needs, the Upper Basin could grow only at the mercy of the Lower Basin.\(^{54}\)

A compact would “prevent a free-for-all race to see who develops the fastest because it would assure each participant state that its rights were permanently protected no matter how long it might take to get its economic engines running.”\(^{55}\) Further, a compact would “avoid costly litigation, assure the supremacy of equitable apportionment instead of prior appropriation across state lines, eliminate future embargoes by the Reclamation Service, and settle title to water rights on the rivers before the construction of dams and reservoirs.”\(^{56}\)

It was not just the development of irrigation projects that concerned Carpenter. He also feared the development of large hydroelectric power dams on the lower river without an agreement protecting future upper river supplies.\(^{57}\)

Thus, in 1919, 1920 and again in 1922 when federal legislation was introduced for federal assistance to build an “All American” canal and dam on the lower river, Congressional representatives from the upper basin were opposed absent an interstate agreement protecting their states’ future water use.\(^{58}\)

On August 19, 1921, Congress gave its approval to an interstate compact and authorized federal participation in the negotiation of the compact.\(^{59}\) Herbert Hoover, then Secretary of Commerce, was named to represent the United States and serve as the compact commission chairman.

A great deal has been written about the details of the compact negotiations and the compromises that led to a successful agreement. I would suggest Norris Hundley Jr., “Water and the

\(^{52}\) *Kansas v. Colorado*, 206, U.S. 46, 117 (1907).


\(^{54}\) Tyler, page 237.

\(^{55}\) id.

\(^{56}\) Tyler, page 238.

\(^{57}\) Tyler, page 241. House Document 419 notes that there was a desire throughout the Basin to give irrigation a preference right over hydroelectric power; page 60.

\(^{58}\) House Document 419, page 60.

\(^{59}\) 42 Stat.171. (1921).
West: The Colorado River Compact and the Politics of Water in the American West” (Berkley, 1975). For the real enthusiasts, minutes of the compact negotiations are generally available in local libraries and probably the Internet as well.

The compact commissioners were unable to craft an agreement that would apportion water among the seven states. Instead they apportioned water between the lower river (Lower Basin) and upper river (Upper Basin). The geographic divide was Lee Ferry, defined as one mile below the confluence of the Paria River and Colorado River. The compact itself was signed on November 24, 1922 in Santa Fe, New Mexico. However, its full ratification would take 22 more years.

The full text of the 1922 Compact is attached as Appendix A. Because of their importance to the issues we now face on the river, several articles of the compact are specifically worth setting out in full:

Article II (a)

“The term “Colorado River System” means that portion of the Colorado River and its tributaries within the United States of America.”

Comment: This definition clearly includes the Lower Basin tributaries.

Article III (a)

“There is hereby apportioned from the Colorado River System, in perpetuity to the Upper Basin and to the Lower Basin, respectively, the exclusive beneficial consumptive use of 7,500,000 acre-feet of water per annum, which shall include all water necessary for the supply of any rights which may now exist.”

Article III (b)

“In addition to the apportionment in paragraph (a), the Lower Basin is hereby given the right to increase its beneficial consumptive use of such waters by one million acre-feet per annum.”

Comment: There is a general misconception that the intent of the compact was to split the use of the water 50/50. As you can see with Article III (b), that is not the case. Some compact scholars contend that Article III (b) was included in the compact to give Arizona additional assurances that it could fully utilize the Gila River System. It may be appropriate to

conclude that the negotiators intended to apportion the mainstem consumptive uses 50/50\(^{61}\) for an interim period of time.

**Article III (c)**

“If, as a matter of international comity, the United States of America shall hereafter recognize in the United States of Mexico any right to the use of any waters of the Colorado River System, such waters shall be supplied first from the waters which are surplus over and above the aggregate of the quantities specified in paragraphs (a) and (b); and if such surplus shall prove insufficient for this purpose, then, the burden of such deficiency shall be equally borne by the Upper Basin and the Lower Basin, and whenever necessary the States of the Upper Division shall deliver at Lee Ferry water to supply one-half of the deficiency so recognized in addition to that provided in paragraph (d).”

Comment: This article may be the most contentious and ambiguous in the compact. In 1922, there was no treaty with Mexico, but the negotiators believed one was inevitable. Note that the aggregate of paragraphs (a) and (b) totals 16 maf per annum. The Mexican Treaty delivery dispute will be described in more detail later in the paper.

**Article III (d)**

“The States of the Upper Division will not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75,000,0000 acre-feet for any period of ten consecutive years reckoned in continuing progressive series beginning with the first day of October next succeeding the ratification of this compact.”

Comment: Note that this provision applies to the “States of the Upper Division” not the Upper Basin. Arizona has Upper Basin territory, but is not a State of the Upper Division.

**Article III (e)**

“The States of the Upper Division shall not withhold water, and the States of the Lower Division shall not require the delivery of water, which cannot reasonably be applied to domestic and agricultural uses.”

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\(^{61}\) Hundley describes the negotiations in detail, pages 185-202.
Comment: In the event of a future compact “call,” the meaning of this article will be very important and likely a subject of future interstate litigation.

Article III (f)

“Further equitable apportionment of the beneficial uses of the waters of the Colorado River System unapportioned by paragraphs (a), (b), and (c) may be made in the manner provided in paragraph (g) at any time after October first, 1963, if and when either Basin shall have reached its total beneficial use as set out in paragraphs (a) and (b).”

Comment: The total of paragraphs (a), (b) and (c) is now 17.5 maf per year. It is also more evidence that the compact negotiators truly believed that they were not apportioning all of the available water in the Colorado River System. Based on my reading of the compact minutes, I’m convinced that the negotiators believed that there was at least 17 million acre feet per year of natural flow at Lee Ferry and between 20 and 22 million acre feet per year of natural flow of the Colorado River.

It is also apparent that the 1922 Compact was just the first step in the ultimate apportionment of the river between the Basins and Mexico. The compact would preserve the appropriative rights of both basins up to 8.5 maf for the Lower Basin and 7.5 maf for the Upper Basin. But, “at some future day a revision of the distribution of the remaining water will be made.”

Article VIII

“Present perfected rights to the beneficial use of waters of the Colorado River System are unimpaired by this compact. Whenever storage capacity of 5,000,000 acre-feet shall have been provided on the main Colorado River within or for the benefit of the Lower Basin, then claims of such rights, if any, by appropriators or users of water in the Lower Basin against appropriators or users of water in the Upper Basin shall attach to and be satisfied with water that may be stored not in conflict with Article III.

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62 The minutes of the first eighteen session of the Colorado River Commission. These minutes suggest that the compact negotiators were not concerned about virgin flows. Minutes of the sixth meeting, page 73, reports that the average actual flow at Yuma was 17,300,000 af/year. The commission derived their estimate of the virgin flow at Lee Ferry by assuming 86% of the Yuma flow was from above Lee Ferry (minutes of the eighth meeting, page 23), this equals 14,964,000 af. Adding back upstream depletions, Table A, page 70, of 2,267,000 af makes a total of at least 17.23 maf per year.

63 There are numerous examples in the recorded testimony and correspondence that confirm this. Tyler reports that Carpenter testified to the Senate in 1925 that the Colorado River had a total supply of 21.6 maf, page 262. On page 249, Tyler reports that R.I. Meeker, Colorado Deputy State Engineer, estimated the annual supply at 20.5 maf, thus he believed there was 4.5 maf for the Mexican burden and future apportionments.

64 Minutes of the eighteenth meeting, Chairman Hoover, page 32.
All other rights to beneficial use of waters of the Colorado River System shall be satisfied solely from the water apportioned to that Basin which they are situate.”

Comment: This is the provision that would allow water rights perfected by use as of November 24, 1922 to continue unimpaired in the face of compact curtailment.

**Boulder Canyon Project Act (1928)**

After the compact was signed, it was relatively quickly ratified by the legislatures of six of the seven Basin States, but it ran into opposition in Arizona. Opposition to the compact was led by Governor George W. P. Hunt. Arizonans were opposed to the ratification of the compact for a number of reasons. Many in Arizona preferred private development of hydroelectric potential of the Colorado River as opposed to federal development. The major issue was the status of the Gila River. The idea that some Gila River water might have to be used to meet a future Mexican Treaty obligation was unacceptable. In his 1986 paper on the Colorado River, the late John U. Carlson states “to Arizonans the Gila had become a sacred river and its use by others a desecration.”

There is a detailed discussion of the Arizona issues in Hundley’s book, (pages 233-276).

Arizona’s opposition to the ratification of the compact left the Upper Basin in a difficult bind. The compact was written with the intent that it would become effective upon ratification of all seven states and Congress (Article XI), thus Arizona had an effective veto over its implementation. However, pressures to continue and expand water development in the Lower Basin were continuing. On June 28, 1924, the City of Los Angeles made a California filing for a right for a 1,500 cfs pipeline from the Colorado River to the Southern California Coastal Plain. Ultimately, Los Angeles and its neighbors would form the Metropolitan Water District of Southern California to build and operate the project contemplated by this filing.

In 1922, 1924 and 1925 and again in 1928 Congressman Phil Swing, whose district included the Imperial Irrigation District, and Senator Hiram Johnson of California introduced federal legislation to authorize construction of an All-American Canal and large mainstem dam in Boulder Canyon.

Upper Basin leaders realized that their continued ability to block passage of a Swing-Johnson bill was in jeopardy. Wyoming’s Compact Commissioner, Frank Emerson, who would be elected Governor in 1926, put it quite clearly:

“Wyoming and the other Upper States are in a strategic position today that we will never have again. Once means is provided for the

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construction of a great control reservoir on the lower Colorado the need for support from the Upper States will be largely gone; once the Colorado River bursts through the man-made levees that stand between it and the great Imperial Valley, as it may do any day, public sentiment will force a bill through Congress providing for relief.”

Delph Carpenter was also concerned about power issues. Southern California’s rapid growth was generating a demand for power as well as water. By 1925, 24 applications involving the Colorado River were pending before the Federal Power Commission. Without ratification of a compact, construction of a large power dam on the lower river could create a priority call on future Upper Basin uses.

Thus, the Upper Basin States were forced to change tactics and adopt a six-state ratification strategy. Tyler credits Carpenter with authorship of the six-state plan. Eventually Congress took control of the six-state process as it became a part of California’s strategy to pass the fourth Swing-Johnson bill in 1928. As the debate in Congress evolved Carpenter turned against the six-state plan, but he could not turn back the tide.

On December 21, 1928 Congress enacted the Boulder Canyon Project Act (1928 Act). The 1928 Act authorized the construction of Boulder Dam and the All-American Canal. The Act authorized the Secretary of the Interior to enter into water and power contracts and it prohibited the Federal Power Commission from issuing any permits or licenses upon or affecting the Colorado River or any of its tributaries, except the Gila River.

The 1928 Act established priorities for the use of the dam and reservoir: “First, for river regulation, improvement of navigation and flood control; second, for irrigation and domestic uses and satisfaction of present perfected rights in pursuance of Article VIII of said Colorado River Compact; and third, for power.”

The act pre-approved a compact agreement among the Lower Division States apportioning:

• 300,000 af to Nevada.

• 2,800,000 af to Arizona plus ½ of the excess or surplus waters unapportioned by the Colorado River Compact.

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68 Tyler, page 257.

69 Tyler, page 259.

70 Tyler, pages 259-263.

71 45 Stat 1057.(1928).
• The State of Arizona would have exclusive beneficial consumptive use of the Gila River and its tributaries within Arizona.

• The waters of the Gila River and its tributaries, except return flows to the Colorado River, would not be used to satisfy a treaty obligation to Mexico.

• None of the three states could withhold water or require the delivery of water which cannot be reasonably applied to domestic and irrigation uses.

• Provisions of any agreement would be subject to the Colorado River Compact and would take effect upon ratification by Arizona, California, and Nevada.

To address the problem created by Arizona’s refusal to ratify the 1922 Compact, the 1928 Act included provisions that it would not become effective until either: 1. All seven states ratified the Colorado River Compact or, 2. Six states ratified the Colorado River Compact, including California, and California enacts legislation limiting itself to not exceed 4,400,000 acre feet of water available under paragraph III (a) of the Colorado River Compact plus not more than one half of any excess or surplus water unapportioned by said compact.

Finally, the 1928 Act directed the Secretary to make investigations and public reports of the feasibility of projects in the seven states and to formulate a comprehensive scheme for control and the improvement and utilization of the waters of the river.

On March 4, 1929 the California Legislature enacted the California Limitation Act as contemplated by the 1928 Act. Then, on June 25, 1929 President Hoover promulgated Public Proclamation Number 1882. This proclamation declared that “All prescribed conditions having been fulfilled, the said Boulder Canyon Project Act approved December 21, 1928, is hereby declared to be effective this date.”

Thus, eight years after Congress authorized the negotiation of an interstate compact, a compact was effective and the first essential elements of the Law of the River were in place. The 1922 Compact and 1928 Act opened the door to a new era in the development of the river. History would also show that inconsistencies between the two and flawed assumptions concerning the basis of the river hydrology would lead to many future political and legal battles. Fundamental disagreements over specific provisions of the 1922 Compact and 1928 Act remain unresolved today.

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CHAPTER IV
THE DEVELOPMENT OF THE RIVER
AND THE LAW OF THE RIVER FROM 1929 THROUGH 1968

Introduction

In mid 1929 as President Hoover was declaring the Boulder Canyon Project Act (1928 Act) effective, forces beyond the control of the President were already underway that would have a profound impact on the Colorado River Basin.

From the authorization of the compact negotiations in 1921 through 1929 there was a period of prosperity referred to as “The Roaring 20s.” While it was a prosperous period for business, most farmers did not prosper. Congress was not inclined to fund Reclamation projects which would increase farm production and further reduce prices.

From 1925 to 1929 the average price of a common stock on the New York Stock Exchange more than doubled. Then on October 24, 1929, known as Black Thursday, stock values crashed. Prices crashed again on the following Tuesday, October 29, 1929 leading to panic. From October 1929 until Franklin D. Roosevelt became president in March 1933, the economy slumped almost every month. In 1925 the unemployment rate was an estimated 3%, by 1930 is was about 9% and an astounding 25% in 1933.73

At the same time, subtle changes were happening in the global atmosphere. The jet stream is a band of fast moving air current in the upper troposphere. There are three jet streams; the polar jet, the subtropical jet and the equatorial jet. Jet streams in the Northern Hemisphere flow from west to east in a wavelike fashion. They change constantly, both horizontally and vertically.74 In the winter months, primarily the polar jet, and occasionally the subtropical jet steer moist Pacific storms onto the mountains that rim the Colorado River Basin.

For reasons we don’t fully understand even today, about the time Congress was debating the 1928 Act, Mother Nature was making small adjustments to global circulation patterns. Beginning about 1930, fewer winter storms or perhaps storms with a little bit less moisture hit the Colorado Rockies. For the period of 1920 to 1929 the estimated natural flow of the Colorado River at Lee Ferry was over 18,600,000 af per year. From 1930 to 1939 the estimated flow would only be 12,700,000 af per year, a drop of almost 6,000,000 af per year.75


75 House Document 419, TABLE CXL, page 281.
The changes would go beyond the Colorado River’s winter months. A seven year drought began in 1931 in the American Plains. A series of storms and record high temperatures during this period would be referred to as the “Dust Bowl.” Water surface temperatures in the North Atlantic Ocean, as measured by the Atlantic Multi-Decadal Oscillation Index (AMO) would shift to a positive (or elevated temperature) phase. The 1930s would see an increase in tropical storms and hurricanes in the Gulf of Mexico.

The combined effects of drought and economic depression would provide new energy for the construction and development of water infrastructure throughout the West. It would also fuel a great migration from the Midwest to Southern California and eventually to the Colorado Front Range and Arizona.

While World War II would end the Great Depression, the general dry conditions in the Colorado River Basin would continue until some time in the mid to late 1960s when nature would again make a change.

**Developments on the Lower River**

On July 3, 1930 President Hoover signed legislation providing an initial appropriation of $10.66 million for the construction of Hoover Dam. By 1935 the dam was completed and the first water stored. Hoover Dam was actually constructed in Black Canyon, not Boulder Canyon. It impounds Lake Mead. Lake Mead had an initial storage capacity of 32.5 million acre feet. Hoover Dam is a major hydroelectric resource with an installed capacity of 1,500 megawatts.

In 1933, the Metropolitan Water District of Southern California (MWD) and Reclamation entered into a cooperative agreement for the construction of Parker Dam. Parker Dam impounds Lake Havasu, which is the pumping forebay for MWD’s Colorado River Aqueduct. Under the cooperative agreement, MWD provided the funding and Reclamation constructed the project. Lake Havasu has a capacity of approximately 700,000 af. This storage capacity is not used for river regulation in a manner similar to Lake Mead. Its power plant has a capacity of 118 megawatts.

The construction of Parker Dam triggered a November 10, 1934 proclamation by the Governor of Arizona declaring martial law and ordering the Arizona National Guard to take possession of the land in Arizona needed for the east abutment of the dam to prevent construction. While it seems comical today, it caused the Secretary of the Interior to issue a stop work order until the issue could be resolved by Congress and the U.S. Supreme Court.

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76 Gregory McCabe, Michael Palecki and Julio Betancourt, “Pacific and Atlantic Ocean Influences on Multidecadal Drought Frequency in the United States.” PNAS, March 23, 2004

77id.

78 In 1964, Reclamation downsized the capacity of Lake Mead to 28.5 million acre feet. See [www.usbr.gov/lc](http://www.usbr.gov/lc). The website has a great deal of information on Hoover Dam and Lake Mead.

The Colorado River Aqueduct was completed in 1940. It has the capacity to deliver about 1.212 million acre feet per year from the Colorado River to MWD’s member agencies in Southern California.

Construction of a new Imperial Irrigation District Diversion Dam and the All American Canal began in 1934. Water was first delivered in February 1942. Construction on the Coachella Canal, which is supplied by the All American Canal, and serves about 85,000 acres just north of the Salton Sea began in 1938. The canal was completed in 1943.

Davis Dam was authorized by Congress in 1943. However, it was not constructed until after World II. The dam, which was completed in 1952, is about 67 miles south of Hoover Dam and 70 miles north of Parker Dam. It impounds Lake Mohave. The primary purposes of Lake Mohave are to serve as an afterbay to allow the Hoover Dam hydroelectric capacity to be used as a load following or “peaking” resource and to allow the United States to better manage deliveries to Mexico. Lake Mohave has a capacity of about 1.7 maf, but an active capacity of only 300,000 af.

California Water Contracts and the Seven Party Agreement

In 1931, at the urging of Reclamation, the California parties contracting for Colorado River water entered into the seven party agreement. The agreement sets the priorities for Colorado River use among the California contracting parties.

The priorities are as follows.\(^8\)

1. Palo Verde Irrigation District for 104,500 acres of (irrigated lands).
2. Yuma Project-California Division for 25,000 acres.
3a. Imperial Irrigation District and Coachella Valley Irrigation District.
3b. Palo Verde Irrigation District, additional 16,000 acres. Total of 1-3b. 3,850,000 af
4. Metropolitan Water District, 550,000 acre feet.
5a. Metropolitan Water District, 550,000 acre feet.
5b. San Diego Water Authority, 112,000 acre feet.
6a. Imperial Irrigation District.
6b. Palo Verde Irrigation District. Total of 6a. & 6b. 300,000 af

Reclamation entered into contracts for delivery of a total of 5,362,000 af per year or nearly one million acre feet more than California’s normal year apportionment of 4,400,000 af per year.\(^9\)

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\(^{8}\) House Document 717, at 108.

\(^{9}\) House Document 419, note 13, page 42.
Seventy years later, the 1931 agreement provisions led to the need for then Secretary Norton to require California entities to negotiate a quantification settlement agreement, allocating the 3.85 maf of agricultural water under priorities 1 through 3b. among the irrigation parties. The QSA is needed to quantify and manage the transfer of water from agricultural uses to municipal uses.

**Arizona v. California - The First Three**

Although Arizona was out muscled by the other six states through congressional action, it continued to oppose both implementation of the 1928 Act and the 1922 Compact.

In 1930, Arizona filed suit in the Supreme Court to have the 1928 Act declared unconstitutional. Arizona argued that inclusion of the Gila River in the definition of the Colorado River System (Article II a) of the compact reduced by 3,000,000 af, the amount of water that could be appropriated for use in Arizona.

The Supreme Court ruled against Arizona. It concluded the 1928 Act was a valid exercise of Congressional authority.

In 1934, Arizona again filed suit in the Supreme Court. This time Arizona’s objective was to obtain testimony from the 1922 compact negotiators so it could be preserved for future litigation. Again, Arizona’s goal was to use the testimony of the negotiators to substantiate a future claim that the intent of Article III (b) of the 1922 Compact was to apportion the Gila River for the exclusive use by Arizona. The Supreme Court refused to accept and hear the suit.

In 1935 Arizona tried again. This time Arizona sought an equitable apportionment suit against the other six Basin States. This attempt was again denied because the Court found that Arizona could not join the United States.

After much internal debate and the death of a key opponent, on February 24, 1944 the Arizona Legislature ratified the 1922 Compact with a simple proclamation.

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82 Arizona v. California, 283 U.S. 423.

83 Hundley, page 289.


85 Jean S. Breitenstein, Attorney for the Colorado Water Conservation Board. Memorandum on the Colorado River, August 3, 1947. In footnote #73, Mr. Breitenstein notes that in Congressional testimony on S. 1175, Eightieth Congress, first session, Royce Tipton and Clifford Stone, on behalf of Colorado, agreed with Arizona’s position on Article III (b).


87 Carlson and Boles, page 34.

“The Colorado River Compact executed at Santa Fe, New Mexico, November 24, 1922 .... is unconditionally ratified, approved and confirmed.”

The Mexican Water Treaty

On February 3, 1944 the United States and Mexico signed an international treaty relating to the division of waters of the Colorado, Tijuana and Rio Grande Rivers. The treaty was ratified by the United States Senate on April 18, 1945 and the Mexican Senate on September 27, 1945.

Article 10 of the treaty guarantees an annual delivery of 1,500,000 af per year to Mexico and an additional 200,000 af per year if there is a surplus. The treaty also contains a provision that:

“In the event of extraordinary drought or serious accident to the irrigation system in the United States, thereby making it difficult for the United States to deliver the guaranteed quantity of 1,500,000 acre-feet a year, the water allotted to Mexico under subparagraph (a) of this article will be reduced in the same proportion as consumptive uses in the United States are reduced.”

However, there is no hydrologic definition of “extraordinary drought.” What is the difference between an extraordinary drought and a normal drought? The Basin States and the Federal Government are currently struggling to address issues related to the drought provision of the Mexican Treaty.

The treaty was the result of many years of negotiation. Breitenstein notes that the United States needed the cooperation of Mexico to build water storage and flood control projects in the Lower Rio Grande Valley. He also notes that the International Boundary Commission held meetings with the seven Colorado River Basin States during the negotiations and that the water formula was approved by five of the seven states (except Nevada and California) in 1943.

Development in the Upper Basin From 1929 Through 1946

Colorado is one of the Basin States where the Great Plains meet the Rocky Mountains. The Continental Divide is only about 60 miles west of Denver. The Continental Divide separates the Colorado River Basin from the Platte River and Arkansas River Basins. Winter storms normally move from west to east dropping more snow on the west slope of the Continental Divide than the east slope. Yet, within Colorado, an overwhelming majority of its people and its farmlands are located east of the Continental Divide. Thus, it was inevitable that Colorado would seek to move water from where it is plentiful, the West Slope, to where it is needed, the East Slope. By the late 1800s, irrigation demands in the South Platte River Basin had already tapped the available supply.

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90 Breintenstein, pages 35-36.
The first transmountain diversions were gravity ditches like the Berthoud Pass Ditch and Grand River Ditch. Construction on the Grand River Ditch which delivers water from the head waters of the Colorado River into the Cache la Poudre River Basin, a tributary of the South Platte River, began in the 1890s.

In 1929, the Denver Board of Water Commissioners entered into a contract with the Moffat Tunnel Improvement District to lease the pioneer or pilot bore tunnel of the Moffat Railroad Tunnel. Denver lined the tunnel and, in 1936, began using it to divert water from the Fraser River Basin, a tributary of the Colorado River, into Boulder Creek. ⁹¹

Efforts to construct the Colorado-Big Thompson Project (C-BT Project) began in 1933 when Royce Tipton was hired to make a report on a transmountain diversion from Grand Lake. This effort would lead to the formation of the Northern Colorado Water Users Association (NCWUA) in 1934 and the West Slope Protective Association (WSPA) about the same time.

In June 1934, the Upper Basin States got together with the Bureau of Reclamation in Denver, Colorado. The states agreed to the following statement: ⁹²

“We favor the negotiation of an Interstate Compact among the four upper states of the Colorado River Basin at the earliest possible date. In the meantime it is our belief that each state should go ahead with its development without objection by other states, as contemplated by the Colorado River Compact, unless the development, in addition to already existing water uses, would in the opinion of such other states or any of them, be considered as approaching too nearly the equitable share of water that under compact might eventually be apportioned to such state out of the waters involved.”

This policy agreement allowed development to proceed in the Upper Basin on projects such as the C-BT without opposition from other states.

In 1937 the NCWUA and WSPA would reach an agreement to allow for the Congressional authorization and construction of the C-BT Project. ⁹³ The NCWA would become the Northern Colorado Water Conservancy District and the WSPA would become the Colorado River Water Conservation District.

The East Slope/West Slope compromise is embodied in Senate Document 80 (SD-80), seventieth-fifth Congress, First Session. The SD-80 compromise was based on a set of principles adopted by the Water Subcommittee of the Colorado Planning Commission in 1936.

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⁹¹ The Moffat Water Tunnel Project, An Achievement in Denver’s Metropolitan Development Program, City of Denver, June 10, 1936.

⁹² Breitenstein, page 67.

⁹³ The history of the C-BT Project is beyond the scope of this paper. The reader should refer to “The Last Water Hole in the West” by Daniel Tyler, University of Colorado Press, 1992.
“14. That any plan of trans-mountain diversion must be conditioned upon the following:

(a) The construction of a major transmountain project not be begun unless and until:

First, a complete survey of such project shall have been made, such survey to include all necessary data to show the effect of the proposed diversion upon existing Western Slope rights and upon the probable future development of the Western Slope areas affected;

Second, a comprehensive plan for such project shall have been prepared;

Third, the comprehensive plan shall include compensating storage, to be constructed as a part of the expense of the project, in the amount shown by such survey to be sufficient so that neither existing Western Slope rights nor probable future Western Slope development will be adversely affected by the proposed transmountain diversion;

Fourth, the comprehensive plan shall also include sufficient legal provisions and safeguards, to be worked out, to prevent the subordination of the Western Slope storage rights created by or affected by such diversion, to any Eastern Slope rights thereby created.

(b) The definite location and adoption of sites for sufficient compensatory storage, to supply future needs and requirements of the Western Slope, which locations are to be made after silt surveys and other adequate tests are made to insure future additional needs and development of the Western Slope in compensatory reservoirs to be subject to the control of the Western Slope water users acting through proper water officials.

(c) That any such project shall be found to be economically feasible after proper investigation.”

The principles outlined by the Water Subcommittee are very similar to, and perhaps inspired by, the ingredients of an effective compact identified by Carpenter. Among Carpenter’s most critical elements were: “Protection of basin-of-origin states had to include both present and future

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95 Tyler, pages 236-237.
needs” and “A compact would prevent a free-for-all race to see who could develop the fastest because it would assure its rights were permanently protected.”

Construction on the first features of the C-BT Project would begin in the late 1930s. Work on the Continental Divide tunnel began on June 23, 1940. Although the project would not be completed until 1957, the first water was diverted through the Adams Tunnel to the Platte River Basin on June 23, 1947.

The C-BT Project now diverts an average of about 230,000 af per year from the headwaters of the Colorado River into the Platte River Basin.

**House Document 419, “The Colorado River,” Eightieth Congress, First Session**

In July 1947, Secretary of the Interior J.A. Krug and Commissioner of the Bureau of Reclamation Michael W. Strauss, submitted the “Interim Report on the Status of the Investigations Authorized To Be Made by the Boulder Canyon Project Act and the Boulder Canyon Project Adjustment Act” to Congress. House Document 419 (HD 419) would become the blueprint for the future development of the Colorado River as well as the genesis of the Upper Colorado River Basin Compact in 1948 and the Arizona v. California Supreme Court litigation from 1952 to 1964. The letter of transmittal of HD 419 to Congress included specific conclusions and recommendations, which prior to submission, were endorsed by President Truman.

**CONCLUSIONS**

“My conclusions are:

(1) That a comprehensive plan of development for the Colorado Basin cannot be formulated at this time;

(2) That further development of the water resources of the Colorado River Basin, particularly large-scale development, is seriously handicapped, if not barred, by lack of a determination of the rights of the individual States to utilize the waters of the Colorado River system. The water supplies for projects to accomplish such development might be assured as a result of compact among the States of the separate basins, appropriate court or congressional action, or otherwise;

(3) That the States of the upper Colorado River Basin and States of the lower Colorado River Basin should be encouraged to proceed expeditiously to determine their respective rights to the waters of the Colorado River consistent with the Colorado River compact;

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96 Make no mistake, Carpenter was a strong supporter and advocate of transmountain diversions, Tyler, pages 247-250.
(4) That construction costs allocated to silt control, recreation, salinity control, the administration of the Mexican treaty and similar purposes, should be non-reimbursable.

RECOMMENDATIONS

I recommend:

(1) That you adopt this as your interim report on the status of the investigations authorized to be made by section 15 of the Boulder Canyon Project Act Adjustment Act (54 Stat. 744);

(2) That you transmit this report, together with the accompanying comments of the States and Federal agencies, your proposed report dated June 7, 1946 and the accompanying basic inventory report of the regional directors to the President, and then to the Congress, in order that they may be apprised of the contents of this comprehensive inventory of potential water resource developments in the Colorado River Basin and of the present situation regarding water rights in the Colorado River Basin, which situation precludes my recommending any projects for construction at this time.”

Sincerely yours,
(Signed) Michael W. Strauss,
Commissioner.

Approved and adopted July 19, 1947.

(Signed) J.A. Krug
Secretary of the Interior.97

Simply put, the Administration was making it clear that in return for future federal appropriations for the development of the Colorado River, the Basin States needed to complete the work started by the 1922 Compact by further apportioning water to the individual states.

The Upper Colorado River Basin Compact

Secretary Krug’s recommendations were not a surprise to the Upper Basin. In fact, the states had been discussing in a conceptual manner an Upper Basin compact for over a decade. Governor Hunt of Wyoming wrote a letter to the governors of the other three states on January 19, 1945 requesting each state appoint a compact commissioner. Colorado initially deferred the request, suggesting that there was not yet sufficient technical information and data upon which to negotiate an informed compact.98

97 House Document 419, Letter of Transmittal.

98 Breitenstein, page 68.
Additional meetings were held in 1946. On July 17, 1946 President Truman appointed Harry Bashore, a former commissioner of Reclamation, as the Federal representative. Colorado Governor John Vivian appointed CWCB Executive Director Clifford Stone as Colorado’s commissioner.  

The first meeting was held in Salt Lake City on July 31, 1946. One of the first actions was to set up an engineering advisory committee. This engineering committee held frequent meetings. Its report became the basis for the negotiations.

From Colorado’s perspective, there were only a few major issues. The biggest question was how much water would Colorado have to give up in order to satisfy the other three states? Colorado clearly understood that in order to obtain a compact it would have to give up some water. The following table from page 3 of the November 29, 1948 Engineering Advisory Committee Report, shows the natural or undepleted contributions to Lee Ferry.

<table>
<thead>
<tr>
<th>State</th>
<th>AF</th>
<th>%</th>
<th>Drainage Area</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>137,200</td>
<td>.87</td>
<td>6,936</td>
<td>6.31</td>
</tr>
<tr>
<td>Colorado</td>
<td>10,968,900</td>
<td>70.14</td>
<td>38,932</td>
<td>35.43</td>
</tr>
<tr>
<td>New Mexico</td>
<td>247,900</td>
<td>1.58</td>
<td>9,646</td>
<td>8.78</td>
</tr>
<tr>
<td>Utah</td>
<td>2,561,000</td>
<td>16.38</td>
<td>37,165</td>
<td>33.20</td>
</tr>
<tr>
<td>Wyoming</td>
<td>1,724,400</td>
<td>11.03</td>
<td>17,210</td>
<td>15.66</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>15,638,500</td>
<td>100.00</td>
<td>109,889</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Thus, Colorado with only 35% of the Upper Basin land contributes 70% of the flow of the river. Initially, Colorado initially asked for a 56% apportionment Arizona asked for all of the water that originated in Arizona and the other three states asked for another 59% (28% Utah, 16% Wyoming, 15% New Mexico).

The minutes reflect that the Federal engineering advisor, J.R. Ritter, proposed the final apportionment compromise.

<table>
<thead>
<tr>
<th>State</th>
<th>Amount</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>50,000 af</td>
<td>51.75%</td>
</tr>
<tr>
<td>Colorado</td>
<td></td>
<td>23.00%</td>
</tr>
<tr>
<td>Utah</td>
<td></td>
<td>14.00%</td>
</tr>
<tr>
<td>Wyoming</td>
<td></td>
<td>11.25%</td>
</tr>
<tr>
<td>New Mexico</td>
<td></td>
<td>50.00%</td>
</tr>
</tbody>
</table>

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99 Consent of Congress for the negotiations was given in section 19 of the 1928 Boulder Canyon Project Act.

100 Minutes, Volume II Meeting 7, pages 63-69.

101 Minutes, Volume II, Meeting 7, page 123.
The above apportionments became Articles III a (1) and (2) of the compact. It is important to note that the negotiators chose not to apportion water to each state based on a fixed amount of water (except for Arizona). Instead, the compact apportions water using percentages. This reflects the reality that the Commission clearly understood that the exact amount of the water available to the Upper Basin under the 1922 Compact could not be fixed.

The Upper Colorado River Commission Compact (1948 Compact) was signed by the commissioners on October 11, 1948. It was quickly ratified by the legislatures of all five states and ratified by Congress on April 6, 1949.102

In addition to Article III (a), several other articles are worth discussion. Article I describes the major purposes of the compact including to provide for the equitable division and apportionment of the use of the waters of the Colorado River System, the use of which was apportioned in perpetuity to the Upper Basin and “to establish the obligations of each state... with respect to the deliveries of water required to be made at Lee Ferry by the Colorado River Compact.”

Article III (b) provides that “apportionment is of any and all man-made depletions.”

Article IV describes what happens in the event of a curtailment that may be required by Article III of the 1922 Compact.

- The quantities and times shall be determined by the Upper Colorado River Compact Commission.

- The penalty for over use is extreme. Article IV (b) requires that if any state (or states) in the ten years immediately preceding the water year in which curtailment is necessary, shall have consumed more than it was entitled to under the apportionments made by Article III (51.75% for Colorado) then such state shall be required to supply at Lee Ferry a quantity of water equal to its total 10 year overdraft before a demand is made on any other state.

Comment: Water users in Colorado with post 1922 Compact rights, but still relatively senior, need to consider how implementation of this provision could impact their diversions. Are the post 1922 seniors going to have to cover the excess depletions by post 1922 juniors for the previous nine years?

- If there are no curtailments caused by over use as described above, then the extent of the curtailment shall be on the same percentage as the consumptive use made by each state in the year immediately preceding the year a curtailment becomes necessary.

Comment: The Commission’s findings are obviously very data intensive. It will be important for each state to have the necessary data. The Commission will have a challenging task to sort out and make sense of the different consumptive-use methodologies used by the states.

The remainder of the compact deals with the operations, funding and duties of the Commission, how to account for reservoir evaporation, and how to address a number of tributary specific issues. For example, under Article XIV, Colorado agrees to subordinate its post 1948 uses of the San Juan River and its tributaries to the extent necessary for New Mexico to make full use of its 11.25% apportionment. To date, this has not been a problem, but it could be in the future.

**Colorado River Storage Project and Participating Projects Act**

After ratification of the 1948 Compact, the Upper Basin States sought federal legislation to assist with the comprehensive development of the Upper Basin. On April 11, 1956 Congress passed the Colorado River Storage Project and Participating Projects Act (CRSPA).

Section 1 (1) authorized the Secretary to construct, operate and maintain Glen Canyon, Flaming Gorge, Navajo and Currecanti (now Aspinall) storage units. The Aspinall Unit was authorized contingent on a further finding of economic feasibility by the Secretary.

Section 1 (2) authorized the Secretary to construct, operate and maintain additional Reclamation projects and referred to these as participating projects.

Section 2 authorized the Secretary to carry out further investigations on a large list of other potential participating projects.

Section 5 set up a mechanism for funding the operation, maintenance and replacements and for the repayment of the federal investments in the project. This is referred to as the Upper Colorado River Basin Fund or “Basin Fund.”

There is a misconception that the Basin Fund creates a pot of money for the development of water projects in the Upper Basin States. That is not the case. The Basin Fund sets up and apportions a repayment mechanism for the use of power revenues to pay for the irrigation features of projects beyond the ability of the irrigators to pay. However, Section 5 (e) is clear that “Revenues so apportioned to each state shall be used only for the repayment of construction costs of participating projects or parts of such projects in the state to which such revenues are apportioned.”

From the Upper Basin’s perspective, the prime accomplishment of the CRSPA has been the construction of Glen Canyon Dam which impounds Lake Powell. Lake Powell has a capacity of nearly 25 million acre feet. Without this storage capacity, it is doubtful that the Upper Basin could meet its obligations under Article III of the 1922 Compact even at today’s level of development.

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104 The act allows the irrigation features to be repaid at any time over a 50 year period without interest. So, from a cost perspective, the repayment is largely fictional. I’m still looking for a banker that will allow me to pay off a 50 year mortgage in years 46 to 50 only at 0% interest.
Arizona v. California - A Fourth Time

After Arizona finally ratified the 1922 Compact in 1944, it turned its attention to the authorization and construction of the Central Arizona Project (CAP).

Discussion of a large project that would bring mainstem Colorado River water into central Arizona began in the 1920s. George H. Maxwell first promoted a plan to bring water from the Parker area to Maricopa County in 1922. The efforts were continued into the 1930s by Fred T. Coulter. Coulter proposed a number of different projects, including one that utilized a dam at the current Glen Canyon Dam site. Coulter, who was elected to the Arizona Senate for six terms, was a primary force in Arizona’s opposition to the 1922 Compact. He died the month before ratification by the Arizona Legislature.

Ratification of the 1922 Compact and completion of a water contract between Arizona and the Secretary of the Interior for 2.8 maf of Colorado River water allowed Reclamation to begin detailed investigations into the feasibility of the CAP. Within Arizona, there was also serious consideration of a state-funded project.

HD 419 considered three basic CAP alternatives: a system of pumping plants and 235 miles of canals from Lake Havasu (Parker Route); a dam in Marble Canyon (just below Lee Ferry), a 143 mile continuous tunnel that would convey water from Marble Canyon Dam into the Verde River, 95 miles north of Phoenix (Marble Canyon Route); and a dam at Bridge Canyon (120 miles upstream of Hoover Dam in the Grand Canyon National Park), a 78 mile tunnel from Bridge Canyon south to the Big Sandy River then 235 miles of canals (Bridge Canyon Route).

In 1947 and 1948, both Senate and House committees held a series of hearings on Colorado River matters. Those hearings highlighted the differences between California and Arizona over the interpretation of both the 1922 Compact and the 1928 Act. Both the House and the Senate considered resolutions instructing the United States Attorney General to initiate the litigation. Nevada and California supported this approach while Arizona and the Upper Basin States opposed it. The resolutions failed.

106 Id.
107 Id.
110 See testimony of S.J. Resolution 145, Eightieth Congress, First Session and H.J.R. 226, 227 and 228, Eightieth Congress, First Session. S.J. Resolution 145 was directing the Attorney General to initiate litigation in the Supreme Court to “determine interstate water rights in the Colorado River.”
For the next several years, Arizona’s Congressional delegation would pursue federal authorization of the CAP. California’s delegation remained opposed. On August 13, 1952 Arizona filed suit in the United States Supreme Court to settle the water rights issues. The suit involved the interpretation of Articles III (a) and III (b) of the 1922 Compact and Section 4(a) of the 1928 Act.

California took the position that Section 4 (a) apportioned 2.8 maf of Article III (a) water to Arizona and this included all of Arizona’s uses including the Gila River. California believed that Arizona was consuming about 2.3 maf/year of Gila River water plus another 1.3 maf/year of other tributary and mainstem uses for a total of 3.6 maf/year.

California argued that 1.0 maf of Article III (b) water was a part of the “excess or surplus waters” within the intent of Section 4 (a). Thus, Arizona was using its full 2.8 maf of III (a) water plus another 800,000 af of surplus water, an unspecified portion of this 800,000 was III (b) water (presumably 500,000 af). Therefore, since Arizona was already consuming more than its likely share of III (a) and (b) water, there was not a safe legal supply of water available for the CAP.

At the time, California had signed contracts for 5.362 maf/year. Under California’s reasoning, 4.4 maf of this was III (a) water under Section 4 (a) and 962,000 af was surplus and excess water under Section 4(a) and a portion of which (perhaps 500,000 af) was its III (b) water. California’s reasoning put Arizona and California in very similar positions. Both had fully used their III (a) and (b) water with the remaining uses as unapportioned surplus.

Arizona took the position that although it was consuming 2.3 maf/year of Gila River water, it was only depleting 1.1 maf of Colorado River water because uses of the Gila should be measured as depletions at the mouth of the Gila. Arizona also took the position that it was entitled to 2.8 maf of III (a) water and all 1.0 maf of III (b) water. Thus, Arizona had a legal supply of 3.8 maf/year, and uses of only 2.4 maf/year (1.1 maf of Gila water and 1.3 maf of mainstem and other tributary water), thus the CAP has a safe legal supply of over 1 million af per year.

After the litigation was filed, California developed a defense based on an argument that the III (a) and III (b) apportionments included the tributaries. California then filed to bring the Upper Basin States into the case. The Court denied the motion as to Colorado and Wyoming and allowed New Mexico and Utah in the case, but only to the extent of their Lower Basin tributary interests.

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112 House Document 419, Comments of the State of California, page 40.
113 Arizona’s position evolved considerably between its comment letter on House Document 419 in 1946, its testimony on S.J.R. 145 in 1948 and the filing of the lawsuit in 1952. My summary is based on the testimony of different individuals on pages 283-285 and pages 371-385 of Congressional record of the the hearings on S.J.R. 145. Arizona assumed that it was entitled to all 1 maf of III (b) water. California assumed that III (b) water would be split 50/50 with Arizona. Nevada? Where in the hell is that?
In 1960, Special Master Simon Rifkind ruled that Section 4 (a) of the 1928 Act applied “only to the water stored in Lake Mead and flowing in the mainstem below Hoover Dam, despite the fact that Section 4 (a) refers specifically to Article III of the 1922 Compact and Article III (a) apportions water from the Colorado River System, which is defined in Article II (a) as including the entire mainstem and the tributaries.”

The master held that the 1928 Act amounted to a Congressional apportionment of the Colorado River mainstem water and that interpreting the 1922 Compact was not needed to decide the case. In 1963, The Supreme Court upheld the Special Master. The Court went on to say that its decision did not affect any issue of interpretation of the 1922 Compact.

One of the compelling reasons that the Special Master made in deciding to limit the case to mainstem water was the fact that Congress did not include New Mexico and Utah in the Section 4 (a) apportionments. It dealt with only three of the five Lower Basin States, the three states, which significantly, are geographically accessible to mainstream water.

The Special Master made several other findings that, after being upheld by the Supreme Court, are important to the situation on the river today. The master ruled that consumptive use is to be measured as diversions at each diversion point on the mainstem less returns to the mainstem. It does not include evaporation and channel losses on water in the mainstream which occur before the water is diverted.

The Special Master also ruled that certain provisions of the 1942 and 1944 contracts between the Secretary of the Interior and Nevada and the 1944 contract between the Secretary of the Interior and Arizona were invalid. These contracts had provisions that required that deliveries of water from the mainstream to users in Arizona and Nevada be reduced by the tributary depletions in those states upstream of Lake Mead.

The 1944 Nevada contract had the following provision: “Subject to the availability thereof for use in Nevada under the provisions of the Colorado River Compact and the Boulder Canyon Project Act, the United States shall, from storage in Lake Mead deliver to the State each year at a point or points...so much water, including all other waters diverted for use within the State of Nevada from the Colorado River system, as may be necessary to supply the State a total quantity not to exceed Three Hundred Thousand (300,000) acre feet each calendar year.”

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120 364 U.S. 940, (1960), page 420 (Appendix 7).
By limiting the contract to Lake Mead and mainstem water, the Special Master’s ruling had the effect of increasing Nevada’s Colorado River supplies by approximately 100,000 af per year, the amount of tributary uses.  

Finally, there are a number of provisions in the decree which was issued on March 9, 1964 that need to be highlighted. Paragraphs II (B) (1), (2) and (3) control the release of water from Lake Mead.

“(1) If sufficient mainstream water is available for release, as determined by the Secretary of the Interior, to satisfy 7,500,000 acre-feet of annual consumptive use in the aforesaid three States, then of such 7,500,000 acre-feet of consumptive use, there shall be apportioned 2,800,000 acre-feet for use in Arizona, 4,400,000 acre-feet for use in California, and 300,000 acre-feet for use in Nevada;

(2) If sufficient mainstream water is available for release, as determined by the Secretary of the Interior, to satisfy annual consumptive use in the aforesaid States in excess of 7,500,000 acre-feet, such excess consumptive use in surplus, and 50% thereof shall be apportioned for use in Arizona and 50% for use in California; provided, however, that if the United States so contracts with Nevada, then 46% of such surplus shall be apportioned for use in Arizona and 4% for use in Nevada;

(3) If insufficient mainstream water is available for release, as determined by the Secretary of the Interior, to satisfy annual consumptive use of 7,500,000 acre-feet in the aforesaid three States, then the Secretary of the Interior, after providing for satisfaction of present perfected rights in the order of their priority dates without regard to state lines and after consultation with the parties to major delivery contracts and such representatives as the respective States may designate, may apportion the amount remaining available for consumptive use in such manner as is consistent with the Boulder Canyon Project Act as interpreted by the opinion of this Court, herein, and with other applicable federal statutes, but in no event shall more than 4,400,000 acre-feet be apportioned for use in California including all present perfected rights;”

Until very recently there were no formal criteria to determine when there was sufficient water to satisfy annual uses in excess of 7,500,000 af as contemplated by (2). The Interim Surplus Guidelines (ISGs) criteria were adopted in 2000. The Secretary is currently developing criteria and

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121 Nevada went into the case viewing it as a chance to get 500,000 af of Colorado River water as an equitable apportionment action. The Master’s ruling gave it about 50% of the 200,000 af increase it was seeking.

guidelines to address when there is insufficient mainstream water as contemplated by (3) (referred to as shortage criteria).

While Colorado and its sister Upper Division states were not a party to the Arizona v. California decision (except for New Mexico and Utah’s Lower Basin tributaries), the Upper Basin has been impacted in a significant manner by the decision. In his 1986 paper, John Carlson put it this way: “by excluding the tributaries from the allocation, the court instantaneously vaporized most, if not all, of the "surplus" water above the Article III (a) 7.5 m. af apportionment” and “despite express disclaimers of any intent to affect issues between the Upper and Lower Basins, the decision’s disregard of Arizona’s and Nevada’s tributaries in determining how to divide the waters of the “Colorado River System” has aggravated, if not generated the current controversy over the Upper Basin’s Mexican Treaty.” Carlson also believed that the decision “expanded Federal control over interstate water rights at the expense of state authority and diminished the potency of interstate compacts.”

My own personal views are that the Supreme Court and Special Master Rifkind may have decided that this was a situation where a little bit of judicial activism and creative interpretation of the 1928 Act offset the potential for a great deal more uncertainty and chaos had the Court decided to take head on the unresolved 1922 Compact issues related to the tributaries. It is even possible that after the dust would have settled from an all out legal fight over the 1922 Compact, Delph Carpenter’s objectives of long term certainty for the Upper Basin states-of-origin would have been impacted or even defeated.

**Upper Basin Development During the 1950s and 1960s**

Within Colorado, the City of Denver further expanded its system into the West Slope. Williams Fork Reservoir was enlarged in 1957 and construction of its Dillon Reservoir and Roberts Tunnel System was completed in 1964. Dillon Reservoir is Denver’s largest reservoir and largest source of yield to its system. It is located on the Blue River, a tributary to the Colorado River just west of the Continental Divide. Dillon Reservoir is connected to the South Platte River by the 26 mile Roberts Tunnel.

Because Dillon Reservoir is located upstream of Green Mountain Reservoir, a component of the Colorado-Big Thompson Project (C-BT), and because Dillon has a priority junior to Green Mountain, Denver Water had to reach an agreement with the United States and the East and West Slope beneficiaries of the C-BT Project before the Dillon Project was considered feasible. Subject to certain conditions, Denver can divert to the East Slope, water that would have been called by the Green Mountain Power Plant. The compromise is adjudicated in what is referred to as the Blue River Decree. Congress approved the Blue River Decree in the 1956 CRSPA.

In August 1962, Congress approved the construction of the Fryingpan-Arkansas Project. The Fryingpan-Arkansas Project diverts water out of the Fryingpan River and Hunter Creek drainages, tributaries of the Roaring Fork River, into the Arkansas River Basin. The project

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124 76 Stat. 389. (1962). The Fryingpan-Arkansas Project is not a participating project under CRSPA.
contemplated a diversion of about 69,000 af per year. Ruedi Reservoir on the Fryingpan River provides storage to insulate the project from downstream senior rights and for future West Slope uses.

In June 1962, Congress approved the Navajo Indian Irrigation Project and the San Juan-Chama Projects as participating projects.\(^{125}\) The San Juan-Chama Project is designed to divert about 110,000 af per year from the headwaters of the San Juan River into theRio Grande River Basin in New Mexico. The Navajo Indian Irrigation Project will ultimately irrigate 110,000 acres of lands on the Navajo Reservation in northwest New Mexico.

By 1968 projects were in place or under construction to provide Colorado River water virtually to every major municipal area in the river basins that rim the Upper Colorado River Basin. Albuquerque, Santa Fe, Pueblo, Colorado Springs, Aurora, Denver, Boulder, Fort Collins, Cheyenne and Utah’s Wasatch Front communities all receive a portion of their municipal water from the Colorado River System.

As authorized by the CRSPA, Navajo Dam was completed in 1963, Flaming Gorge Dam in 1964, Glen Canyon Dam in 1964 and Blue Mesa Dam in 1966. By late 1967, Navajo Reservoir, Blue Mesa Reservoir and Flaming Gorge Reservoir had all filled and Lake Powell was filling under special filling criteria approved by the Secretary of the Interior.

Reclamation had also completed a number of smaller participating irrigation projects including the Silt, Paonia, Colbran, Florida, Smith Fork and Bostwick Park Projects in Colorado, and similar projects in Utah and Wyoming.

**Colorado River Basin Project Act**

The Supreme Court’s 1963 decision and 1964 decree in *Arizona v. California* moved the debate over the CAP back to Congress.

The 89\(^{th}\) Congress was convened on January 3, 1964 and on January 6, 1964 Arizona’s two Senators, Carl Hayden and Paul Fannin introduced legislation (S-75) to authorize the CAP. At the same time California Senators Thomas Kuchel and Frank Murphy introduced their own legislation (S-294). A California Congressman, Craig Hosmer, introduced legislation similar to S-294 in House.\(^{126}\) Obviously, the Californians had a different future in mind for the CAP than the Arizonans.

By this time, it was already well accepted that there was even less water in the Colorado River than believed in 1953 when the litigation had started. In July 1965, Royce Tipton prepared a study for the Upper Colorado River Commission that showed that the long term average natural conditions

\(^{125}\) 76 Stat. 96. (1962).

\(^{126}\) Johnson, page 149.
flow at Lee Ferry was now less than 15 maf per year. Figure IV-I was included within the UCRC study. Figure IV-I is significant because it shows a water supply to the Upper Basin of less than 7.5 maf/year with no delivery to Mexico.

FIGURE VI-1: Virgin Flow, Colorado at Lee Ferry

The debate over the CAP included considerable discussion on the need to augment the supplies of the Colorado River from sources such as northern California, the Snake River/Columbia River drainage and even as far away as Alaska’s Yukon River. Figure IV-2 was included in the Congressional record. It shows a lengthy pipeline from the Snake River to Lake Mead.

The Congressional debate over the CAP was lengthy and complicated with numerous plots and subplots. It involved all of the Basin States, Indian tribes and environmental groups, and the fate of Marble Canyon Dam and the coal-fired Navajo Generating Station near Page, Arizona. If readers want more information I recommend Rich Johnson’s book or the numerous records of the Congressional hearings.


128 Johnson, page 150 and 162. The CRWCD library includes a 1965 appraisal study of a pipeline from the Snake River in Idaho to Hoover Dam prepared by the Metropolitan Water District.
On September 30, 1968, Congress passed the Colorado River Basin Project Act\textsuperscript{129} (1968 CRBPA). The 1968 CRBPA was the result of years of legislative debate, negotiations and compromise. There are numerous significant provisions within the legislation that must be specifically mentioned because of their importance to the situation on the river today.

Section 202 declares that “the satisfaction of the requirements of the Mexican Water Treaty from the Colorado River constitutes a national obligation.” It contemplated that once an augmentation plan was in place and delivering two and one half million acre feet of water to the Colorado River below Lee Ferry, the Basin States would be relieved of their obligations of the 1944 Mexican Water Treaty.

Comment: Importation from the Columbia River Basin has not happened and with the ESA issues it is unlikely to ever happen. But the Lower Basin has not forgotten about augmentation. At the Colorado River District water seminar in September 2006, CAP Chief Engineer Larry Dozier suggested that the Federal Government should build an enormous nuclear powered desalinization plant in Mexico on the Gulf of California. The states are also continuing to pursue cloud seeding to enhance the snowpack, primarily in the Upper Basin. There are many unanswered technical and legal issues with regional cloud seeding. The March/April 2007 edition of “Southwest Hydrology” is devoted to cloud seeding issues.

\textsuperscript{129} 82 Stat. 885. (1968)
FIGURE IV - 2: Snake - Colorado Project
Section 301 (a) authorized the Secretary to construct, operate and maintain the CAP. It also limits any use of the Granite Reef Aqueduct in excess of 2,500 cfs to only those times when Lake Powell is full, spilling or making equalization releases pursuant to 602 (a) (3).

Comment: During the current seven-state negotiations Arizona officials suggested that the other states agree to repeal this provision. The other states did not take the offer at which point the CAP representatives said “it really doesn’t matter because we ignore it anyway.”

Section 301 (b) subordinates the water supply of the CAP to existing perfected uses during times of shortage. As a practical matter, this means that when there is a shortage of less than 1.8 maf/year California’s 4.4 maf apportionment is still fully satisfied.

Comment: This provision has a major bearing on the Secretary’s current efforts to develop shortage criteria. Subordination was the political price Arizona paid to get California’s support for the CAP. Today, the subordination is a major concern for Arizona. I suggest the reader look at the CAP website; cap.-az.com, under “public critical issues” see “restoration of the CAP priority.” My reading of the CAP statement is simple; “we made the deal in 1968 to get the project authorized, now we don’t like it and we’re going to do whatever we can to change it.”

Section 501 (a) and (b) authorized and directed the Secretary to “proceed as nearly as practicable with the construction of the Animas La-Plata, Dolores, Dallas Creek, West Divide and San Miguel Projects” concurrently with the construction of the CAP.

Comment: The River District minutes and River District and CWCB testimony is clear. Colorado was concerned that much of the water supply for the CAP was contingent upon the Upper Basin not using its full apportionment for quite some time. This provision was included to guard against Arizona and CAP officials opposing Upper Basin development in order to protect the CAP supplies. A situation that may, in fact, exist today. Of the five projects mentioned, Dolores and Dallas Creek have been completed, a downsized Animas La Plata is under construction and West Divide and San Miguel are considered economically unfeasible by Reclamation.

Section 601 (b) requires the Secretary to make reports as to the annual consumptive use and losses of water from the Colorado River system after each successive five-year period starting on October 1, 1970.

Section 602 (a) is one of the most important provisions of the Act. It provides Congressional direction to the Secretary on the operation of Glen Canyon Dam and Hoover Dam. This section is important enough to include verbatim:

“Section 602 (a) In order to comply with and carry out the provisions of the Colorado River Compact, the Upper Colorado River Basin Compact, and the Mexican Water Treaty, the Secretary shall propose criteria for the coordinated long-range operation of the of the

Granite Reef Aqueduct is the main supply canal which runs from Park to the Phoenix area. It is now named the Rhodes-Hayden Aqueduct.
reservoirs constructed and operated under the authority of the Colorado River Storage Project Act, the Boulder Canyon Project Act, and the Boulder Canyon Project Adjustment Act. To effect in part the purposes expressed in this paragraph, the criteria shall make provision for the storage of water in storage units of the Colorado River storage project and releases of water from Lake Powell in the following listed order of priority:

(1) releases to supply one-half the deficiency described in article III (c) of the Colorado River Compact, if any such deficiency exists and is chargeable to the States of the Upper Division, but in any event such releases, if any, shall not be required in any year that the Secretary makes the determination and issues the proclamation specified in section 202 of this Act;

(2) releases to comply with article III (d) of the Colorado River Compact, less such quantities of water delivered into the Colorado River below Lee Ferry to the credit of the States of the Upper Division from other sources; and

(3) storage of water not required for the releases specified in clauses (1) and (2) of this subsection to the extent that the Secretary, after consultation with the Upper Colorado River Commission and representatives of the three Lower Division States and taking into consideration all relevant factors (including, but not limited to, historic stream-flows, the most critical period of record, and probabilities of water supply), shall find this to be reasonably necessary to assure deliveries under clauses (1) and (2) without impairment of annual consumptive uses in the upper basin pursuant to the Colorado River Compact: Provided, That water not so required to be stored shall be released from Lake Powell: (i) to the extent it can be reasonably applied in the States of the Lower Division to the uses specified in article III (e) of the Colorado River Compact, but no such releases shall be made when the active storage in Lake Powell is less than the active storage in Lake Mead, (ii) to maintain, as nearly as practicable, active storage in Lake Mead equal to the active storage in Lake Powell, and (iii) to avoid anticipated spills from Lake Powell.”

Paragraph (3) has led to the concept of what is commonly referred to as the 602 (a) storage “trigger.” My explanation of the 602 (a) storage trigger is based on the concept of risk. When there is less than this amount of storage in the CRSP reservoirs, the Upper Basin is at an unacceptable level of risk. The risk is that sometime in the next 10 year period the Upper Basin will not be able to meet its obligations under Article III (c) and (d) of the 1922 Compact, resulting in an impairment of annual consumptive uses. This situation is commonly referred to as a 1922 Compact “call.” If CRSP storage levels are above 602 (a) and the active capacity of Lake Mead is less than Lake
Powell, then the Upper Basin is not at risk and therefore the Secretary can release extra water from Lake Powell in order to equalize storage in Mead and Powell. These extra releases are referred to as “equalization” releases. The importance of these equalization releases and issues surrounding the minimum release will be explored in later chapters.

In even simpler terms, the 602 (a) trigger is the Upper Basin compact insurance policy. The more water we have in storage, the more insurance we have. However, under Article III (e) of the 1922 Compact the Upper Basin cannot withhold water from the Lower Basin that cannot be “reasonably used.” In setting a 602 (a) level, the Secretary has to balance the Upper Basin’s need for insurance water against the Lower Basin’s rights under Article III (e).
CHAPTER V
THE DEVELOPMENT OF THE COLORADO RIVER
AND THE LAW OF THE RIVER 1969 TO PRESENT

Introduction

After the passage of the 1968 CRBPA, Arizona partied. Its dream of moving Colorado River water from the mainstem to central Arizona was about to become a reality.

The authorization of the CAP may have happened at the very last moment possible. The nation was changing rapidly in 1968. It was the year of the Vietnam War Tet offensive. The year President Johnson signed the Civil Rights Act. Martin Luther King and Bobby Kennedy were assassinated. There were riots outside the Democratic National Convention in Chicago. On December 24, 1968 Apollo 8 first orbited the moon.

The nation’s political appetite for large federally subsidized water projects was waning. From the late 60s through the mid 70s, Congress would pass or strengthen a number of federal environmental laws, including the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Clean Water Act, the Wild and Scenic Rivers Act and the Safe Drinking Water Act. In 1970, by executive order, President Nixon created the Environmental Protection Agency or EPA.131

Sometime in the late 1960s, Mother Nature also made another shift. The generally dry period in the Colorado River Basin that began about 1930 was about to end. For the next 25 to 30 years, the Basin generally saw abundant moisture. There would be dry years, 1977 and 1981 for example, but overall, the period was wet. Water supplies were ample. This phase shift occurred about the same time the entire Colorado River Basin experienced explosive growth. This pluvial may have given us a false sense of security and certainty for our water supplies. It would come to a sudden end in 2000 with the new millennium.

The Colorado River Basin Salinity Control Act

With additional development water quality on the Colorado below Hoover Dam became an issue. The Colorado River Basin Salinity Control Act (CRBSCA) passed Congress in 1976.132 The CRBSCA was passed to address the problems created by the loading and concentration of salts in the Colorado River. Salts enter the river through both natural and manmade sources. The numerous hot springs along the Colorado River near Glenwood Springs are natural. Irrigation return flows are the primary source of manmade salt loading.

131 The Presidential message notifying Congress of the organization of the EPA is House Document 9-36, July 9, 1970. The National Oceanic and Atmospheric Administration (NOAA) was created at the same time.

Title I of CRBSCA deals with measures downstream of the Imperial Dam. The primary objective of Title I is to comply with minute 242 of the 1944 Mexican Water Treaty. Minute 242 commits the United States to maintain the salinity of the water being delivered to Mexico at no more than 115 ± 30 ppm greater than the salinity of the water at Imperial Dam.

Title II of CRBSCA addresses measures upstream of the Imperial Dam. Its primary purpose is to reduce salinity levels to water users on the Lower Colorado River within the United States.

Over the years, a number of salinity control projects authorized under the CRBSCA and administered by the Bureau of Reclamation have been completed in western Colorado. These projects include both the lining of canals and piping of laterals and on-farm improvements.

**Endangered Species Recovery Efforts and Other Environmental Programs**

The realities of the impact of the ESA on the Colorado River Basin surfaced in the late 1970s. The first major legal case was the Tellico Dam decision.\(^{133}\) It is also known as the Snail Darter decision. In the Colorado River Basin, there are a number of species listed under the ESA. The primary species of concern for water projects are the humpback chub, bonytail chub, razorback sucker and Colorado pikeminnow. The pikeminnow was formally known as the Colorado squawfish.

In the mid 1980s after the Colorado water community realized that Congress was unlikely to repeal or substantially modify the ESA, members of the Colorado Water Congress formed a special project to develop a programmatic approach to recovering the listed fishes. The programmatic approach was endorsed by the federal agencies, states and environmental groups. The effort led to the formation of the Upper Colorado River Basin Endangered Fish Recovery Program (Upper Basin Program) in 1988. The Upper Basin Program takes a programmatic approach to the recovery of the four fish species.

The goals of the Program are to recover the fish while allowing the participating states, Colorado, Utah and Wyoming to develop their available compact waters. There are similar programs for the San Juan River Basin and in the Lower Basin. The Lower Basin effort is broader. It involves terrestrial species as well. The Lower Basin program is referred to as the Lower Basin Multi-Species Conservation Program.\(^{134}\)

From a water agency perspective the Upper Basin Program has been very successful. However, there are some realities that need to be disclosed.

1. The Upper Basin Program is very manpower and resource intensive.

2. The Upper Basin Program is heavily reliant on water from Reclamation Projects. Flaming Gorge Reservoir, Ruedi Reservoir, Blue Mesa Reservoir and Green

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\(^{134}\) More information on these programs can be found on their websites. The Upper Basin program at [www.fws.gov/coloradoriver](http://www.fws.gov/coloradoriver) recovery, the San Juan Program at [www.fws.gov/southwest/sjrip](http://www.fws.gov/southwest/sjrip) and the Lower Basin Program at [www.sci.sdsu.edu/salton/lowercoloradorivermscp](http://www.sci.sdsu.edu/salton/lowercoloradorivermscp).
Mountain Reservoir provide a substantial amount of storage water and/or have been reoperated to benefit the fish. The same is true for Navajo Reservoir in the San Juan Program.

3. Major portions of the annual operating budgets and the capital budgets for both the Upper Basin and San Juan Programs are derived from the sale of CRSP hydroelectric power. If Lake Powell drops below the minimum elevation necessary to produce hydroelectric power, the Upper Basin Program and the water projects that rely on the program would be in serious trouble.

4. The Upper Basin Program only provides certainty for Upper Basin water uses to the extent it is successful. We must make continued progress toward recovery of the listed fish species or all bets are off.

Glen Canyon Dam is facing a separate and challenging set of environmental issues. There are both ESA issues and general river and riparian area habitat issues in the Grand Canyon below Glen Canyon Dam. The Grand Canyon Protection Act passed by Congress in 1992 set up an Adaptive Management Program or AMP. The AMP is a multi-disciplinary and multi-agency program to address environmental issues through the Grand Canyon.

In late 2006, Reclamation initiated the preparation of an EIS on what is being referred to as the Long-Term Experimental Plan (LTEP). The website states that the “proposed plan would implement a structured, long term program of experimental operations (including dam operations, potential modifications to Glen Canyon Dam intake structures, and their potential management actions, such as removal of non-native fish species) in the Colorado River below Glen Canyon Dam.”

Growth and Water Use in the Colorado River Basin

Initially, the growth in water demands was the result of the reclamation of lands for irrigated agriculture. However, since about 1960 and especially since the late 1980s, population growth throughout the Colorado River Basin has been explosive. This growth is driving both new water use and changes in existing uses. In 1960 when Arizona was fighting with California over water rights for the CAP, it had a population of just over 1.3 million people. By 2000, its population had reached 5.13 million people and by 2030 Arizona is projected to have reached a staggering 10.7 million people!137

Arizona’s water use presents a different picture. In 1971, the first year for which data on water are available from the Consumptive Uses and Losses Report, Arizona used 4,756,000 af.138

136 See www.usbr.gov/ud/frm/amp/background.
137 All of the population data was obtained from the U.S. Census Bureau website.
138 All of the consumptive use data is from the Consumptive Uses and Losses Report available on the USBR website.
In 2000, the last year for which published data are available, Arizona used 4,791,000 af, virtually the same as 1971. The water use figures include mainstem uses, tributary uses and groundwater uses. The Consumptive Uses and Losses Report includes a qualification that within Arizona, Interior cannot distinguish between tributary surface water uses and groundwater withdrawals.

The point is that in the Colorado River Basin, states where there is considerable agricultural uses, all of the states except Nevada, there is not necessarily a correlation between population growth and increases in water use. Much of the new growth has been and will continue to be served by the conversion of agricultural supplies to municipal uses.

For example, in Colorado, two transmountain diversion projects, the Colorado-Big Thompson Project (C-BT) and the Twin Lakes-Independence Pass Tunnel Project were at one time almost entirely used for agricultural purposes. Today the C-BT Project is approaching 65% municipal and industrial on a share ownership basis and the Twin Lakes Project is about 95% municipal.

Nevada is an exception. Nevada has a little bit of irrigation in the Muddy River and Virgin River Basins, but this water is not readily accessible by Las Vegas, therefore there has been a direct correlation between population growth in the Las Vegas area and Nevada’s mainstem water use.139

The following table shows historical and projected populations for California, Nevada, Arizona and Colorado (in millions).

<table>
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<td>29.76</td>
<td>33.87</td>
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<tr>
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<td>.80</td>
<td>1.20</td>
<td>2.00</td>
<td>4.28</td>
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<tr>
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<td>1.75</td>
<td>2.21</td>
<td>2.89</td>
<td>3.29</td>
<td>4.30</td>
<td>5.79</td>
</tr>
</tbody>
</table>

The following graph (Figure V-1) shows Arizona’s tributary water uses which, as previously mentioned, includes groundwater overdrafts on the Gila River system. The graph clearly shows the impact of Arizona’s legislative efforts to reduce groundwater uses which began in 1980.

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139 One of the great ironies is that under the Arizona v. California ruling, if Las Vegas builds an expensive pipeline to convey retired agricultural water from the Virgin and Muddy Rivers to Las Vegas it is tributary water, but if Las Vegas tries to convey this water down these rivers to Lake Mead and pick it up at its pumping plant, then it is mainstem water and counts as a part of Nevada’s 300K apportionment. The Seven States agreement gives Nevada access to pre-compact agricultural water in the Virgin Basin.
In contrast, Figure V-2 is a graph showing Arizona’s mainstem consumptive use. Pumping by the CAP began in 1986. One can see that Arizona reached its full 2.8 maf normal year mainstem apportionment in 2002. In the late 1990s, Arizona developed a groundwater bank. A portion of the CAP mainstem diversions are stored or banked in groundwater basins in central Arizona and are available for future use.
FIGURE V-2

Arizona Mainstem Consumptive Uses 1970-2004

Acre Feet X 1000

Year

Figure V-3 is a graph showing Nevada’s mainstem consumptive use. Almost all of Nevada’s mainstem apportionment is used for municipal uses in the Las Vegas area and Laughlin. As you can see, Nevada has reached its normal year apportionment of 300,000 af per year. The drop below 300,000 af in 2004 is the result of the aggressive conservation program implemented by the Southern Nevada Water Authority.
Figure V-4 is a graph showing California’s mainstem consumptive uses from 1971-2004. The graph clearly shows the impact of the recent drought. In 2003 and 2004, California had no choice but to reduce its uses to its normal year apportionment of 4.4 maf for the first time ever. In 1982 and 1983 when California uses were at or less than 4.4 maf, it was because of very wet conditions and reduced demands.
Figure V-5 shows Colorado’s consumptive uses and total Upper Basin consumptive uses for 1970 to 2004. The numbers do not include CRSP reservoir evaporation. From 1971 to about 1988 there was a clear upward trend, but from 1988 to 2004, depletions for both Colorado and the Upper Basin have been relatively flat.
Operation of Glen Canyon Dam

Pursuant to the 1968 CRBPA, Glen Canyon Dam, Hoover Dam and other major Reclamation reservoirs are operated pursuant to the “Criteria for Coordinated Long Range Operation of Colorado River Reservoirs.” These criteria were last reviewed and amended on March 21, 2005. ¹⁴⁰

For the most part, the criteria simply restates portions of Section 602 (a) of the 1968 CRBPA and relevant portions of the decree in Arizona v. California. ¹⁴¹ The criteria goes beyond Section 602 (a) for one critical decision. The criteria defines a minimum objective release of 8.23 maf per year. This minimum release is made if either the active storage in Upper Basin reservoirs is less than the 602 (a) trigger or if Lake Powell active storage is less than Lake Mead active storage.

The 8.23 maf per year release can be derived as follows:

7.5 maf - which happens to be 75 maf divided by 10 (Article III (d) of the 1922 Compact).

plus .75 maf - which happens to be the Mexican Treaty obligation of 1.5 maf/year divided by 2.

less .02 maf - which is the approximate flow of the Para River - an Upper Basin tributary that enters the Colorado above Lee Ferry, but below Glen Canyon Dam.

equals 8.23 maf

The criteria includes an additional comment: “Releases from Lake Powell pursuant to these criteria shall not prejudice the position of either the upper or lower basin interests with respect to required deliveries at Lee Ferry pursuant to the Colorado River Compact.”

Figure V-6 is a graph showing storage in Lake Powell from late 1963 when the gates closed through today. Until about 1980 when Lake Powell first filled, operations were controlled by the filling criteria. Since 1981, there have been two periods when the reservoir was full, 1982-1987 and 1995-2000 and two periods when reservoir levels were low, 1988-1994 and 2001 to the present.

Figure V-7 is a bar graph showing releases from Glen Canyon Dam from 1980-2006. During the two wet periods, releases were well in excess of 8.23 maf/year. But during the dry periods, releases were 8.23 maf/year.

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¹⁴⁰ Copies of the criteria can be viewed or obtained from the Bureau of Reclamation website, www.usbr.gov.us.

FIGURE V-6

Historic Flows at Lee Ferry 1981 - 2006

Source: UCRC Annual Reports

FIGURE V-7

Historic Flows at Lee Ferry 1981 - 2006

Source: UCRC Annual Reports
California 4.4 Plan and the Development of the Interim Surplus Guidelines

As shown by Figure V-2, the phased completion of the CAP brought a new reality to the lower river. Prior to the CAP, Arizona’s mainstem uses were only in the range of 1.0 to 1.2 maf per year. California has contracts totaling 5.3 maf, but a normal year apportionment of only 4.4 maf per year. California was using (and legally) Arizona’s unused apportionment. After the completion of the CAP, there is no unused apportionment for California to use to satisfy its contract demands in excess of 4.4 maf. Only in years when there is surplus water is there enough water to meet California’s full contract demands. To further complicate matters, agricultural uses in California have priority for the first 3.85 maf of mainstem water leaving MWD with a safe supply of only 550,000 af/year.

In the early 1990s, basin and federal officials recognized that it was in everyone’s best interests to have a plan in place that would move California toward being able to survive on its normal year apportionment of 4.4 maf per year. Thus, it was named the 4.4 Plan.

There are four sources of water for the Southern California coastal plain, a region that includes Los Angeles, San Diego and about 20 million people:

- Local sources, including groundwater.
- The Owens Valley Aqueduct, built by Los Angeles in the early 1900s.
- The Colorado River Aqueduct.
- California State Water Project.\textsuperscript{142}

There are ongoing problems with all four sources. The local supplies have been fully used for over 100 years. Los Angeles has had to limit its diversions from the Owen Valley to restore environmental impacts. The State Water Project takes water from northern California through the San this project. The State Water Project is also prone to drought. Finally, the Colorado River Aqueduct has junior rights. Its firm supply is only about 550,000 af/year or less than ½ of its capacity.

Related to the 4.4 Plan, the Secretary needed to develop surplus guidelines for the operation of Lake Mead as required by the 1964 decree. When is the water supply sufficient to satisfy all needs v. when is there still a surplus, but not enough to satisfy all surplus needs? When there is a limited surplus, who gets it?

\textsuperscript{142}The California State Water Project (SWP) is actually the Metropolitan Water District’s largest water source. The SWP delivers water from northern California to the Metropolitan Water District and numerous other California agencies. I refer the reader to www.publicaffairs.water.ca.gov/swp.
After a decade or so of meetings, studies, lawsuits, environmental impact statements and various threats from four different Secretaries, a series of agreements was completed in 2003. The package includes:

1. Formal Interim Surplus Guidelines (ISGs) for the operation of Lake Mead: The amount of available surplus is tied to storage level triggers in Mead. The ISGs were signed by Secretary Babbit in 2000, but suspended by Secretary Norton in late 2002 because California was not making sufficient progress on the 4.4 Plan.

2. Quantification Settlement Agreement (QSA): Which quantifies the amount of water Imperial Irrigation District and Coachella Valley Irrigation District can take under their senior rights. The QSA is needed to implement agricultural transfers from IID to San Diego and MWD.

3. A California 4.4 Plan: This plan is a road map on how MWD firms up its Colorado River supplies. It primarily does this through agricultural transfers and land fallowing including the agreement between Imperial Irrigation District and San Diego.

Shortage Criteria for the Operation of Hoover Dam

On October 16, 2003, Secretary Norton joined water basin officials at Hoover Dam to celebrate the completion of the 4.4 Plan. The plan contemplated that California would have about 16 years to “ramp down” and the EIS on the Interim Surplus Guidelines suggested that there was better than a 50% chance that California and Nevada would have access to surplus water for at least the next decade. Mother Nature however, didn’t read the plan or the EIS. The Upper Basin was already four years into a drought period, one that continues today.

By 2004, hydrology, caution and decent water supplies available from the California State Water Project would result in a decision by the California agencies to reduce their take of mainstem water to 4.4 maf. By this time, the Basin States and federal agencies all realized that shortage criteria were needed, and possibly soon.

Further, the drought triggered an evaluation of different management strategies for the operation Lake Powell and Lake Mead. The Shortage Criteria DEIS examines different alternatives and a no-action alternative. The four action alternatives are:

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143See remarks by Secretary Gail Norton doi.gov/secretary/speeches/hoover.html.

144USDOI, Interim Surplus Guidelines FEIS, December 2000, Table 3.4.3.

145The May 1st forecast for April-July inflow to Lake Powell is 50%. 2007 is shaping up to be another below average year. Since 2000, only 2005 has been an above average year.

146See Footnote #2.
1. Seven Basin States Alternative: This alternative was developed by the Basin States. It would include shortages of 400K, 500K and 600K triggered by storage elevations in Lake Mead. It includes a number of conservation and management strategies, the conjunctive management proposal shown on Figure V-8 and contemplates the use of Lake Mead to store intentionally created surplus (ISC) water.

2. Conservation Before Shortage Alternative: This alternative was developed by a consortium of environmental groups. It is similar to the States’ proposal, but triggers smaller shortages sooner and makes water potentially available to address environmental issues in the Colorado River Delta.

3. Water Supply Alternative: This alternative would maximize reservoir drawdowns before any shortages are required. The tradeoff is that if a shortage is necessary, it’s going to be big.

4. Reservoir Storage Alternative: It maximizes keeping water in storage by triggering more frequent shortages. It primarily benefits recreation and power generation.

Figure V-8 shows the Lake Mead elevation triggers for the Interim Surplus Guidelines (ISGs) and the Seven States proposed triggers for shortages and proposed coordinated operations of Lakes Mead and Powell.
For the Upper Basin, the significance of the proposed coordinated reservoir operations is that in order to protect minimum power elevation at Lake Powell, deliveries can be reduced from 8.23 maf/year to 7.48 maf/year. The precedent of reducing deliveries from 8.23 maf/year to 7.48 maf/year is very significant. The Lower Basin benefits from the proposed coordinated operations because when Lake Mead drops below an elevation of 1,075' and Lake Powell is above 3,575', releases from Lake Powell can be increased from 8.23 maf/year to 9.0 maf/year.
A few weeks after Congress passed the 1928 Act, Congress passed a joint resolution authorizing and directing the Secretary of the Interior to appoint a board of five nationally recognized engineers and geologists to study and report on the proposed Boulder Dam alternatives.\textsuperscript{147}

The commission was chaired by Major General William L. Sibert of the U.S. Army Engineers. The Sibert Commission studied the geology, safety, economic and engineering feasibility and hydrology of the proposed sites. In November 1928, the commission issued its report. In addition to recommending the Black Canyon dam site, the report addressed the water supply of the Colorado River.

The report was highly critical of the hydrology and by implication critical of the assumptions made by the negotiators of the 1922 Compact. The commission reported:\textsuperscript{148}

“A record of gauge heights for the River at Yuma is continuous from April 1878, but no actual current meter gaugings were made at the station until 1902. In 1902 the Hydrographic Branch of the United States Geological Survey established a gauging station at Yuma which was maintained until the close of 1906, when the station was taken over by the United States Reclamation Service in connection with the operation of the Yuma irrigation district.

In 1909 the Yuma gaugings were estimated by an engineer of the United States Geological Survey as probably too large, varying from nothing to 15 percent, and he suggested improved methods, which were, however, not adopted until 1918 and the best modern methods were not installed until January 1926. The opinion was also expressed to the board by officials at Yuma in charge of the gauging work that the measurements made prior to 1926 were too high an estimate.”

The report went on to draw the following conclusion:

“One of the most important facts shown by these estimates is the existence of a long dry period in the Colorado River flow prior to 1906. This low period is clearly shown by an inspection of the Yuma gauge record for that period. Further investigation of this matter has

\textsuperscript{147}5 Stat. 1011. (1928).

\textsuperscript{148}House Document 717, 80\textsuperscript{th} Congress, Second Session pages A197-198.
Further studies using paleohydrology techniques have verified that indeed 1878 to 2006 was a very dry period. The paleohydrology will be discussed later in this chapter.\textsuperscript{149}

The Siebert Report would begin a trend that continues today. Almost every new and updated study of the hydrology of the Colorado River reduces or raises additional serious questions about the water supply available from the Colorado River. While I was drafting this paper, the National Research Council of the National Academy of Sciences issued yet another study; “Colorado River Basin Water Management: Evaluating and Adjusting to Hydrologic Variability,” (NRC Report on Colorado River Hydrology). The “Report in Brief” makes the following conclusion on page 150:

“The preponderance of scientific evidence suggests that warmer future temperatures will reduce future Colorado River stream flow and water supplies.”\textsuperscript{150}

Over the years, a number of different studies have estimated natural flow at Lee Ferry and a few studies have estimated the natural flow at the mouth of the river at Yuma. Reconstructing flows for the river at Yuma are much more difficult because the Gila River System is normally dry below Phoenix, making an estimate of natural losses on the Gila as that stream crosses the desert is very difficult.

The following table shows the evolution of the natural flows at both Lee Ferry and where available, Yuma from a number of different sources:

\textsuperscript{149}Further studies using paleohydrology techniques have verified that indeed 1878 to 2006 was a very dry period. The paleohydrology will be discussed later in this chapter.

\textsuperscript{150}For a copy of this report see http://books.nap.edu/catalog/11857.html.
Table VI-1 Natural Flow Estimates

<table>
<thead>
<tr>
<th>Study or Effort</th>
<th>Time Period</th>
<th>Natural Flow at Lee Ferry</th>
<th>Natural Flow at Yuma</th>
</tr>
</thead>
<tbody>
<tr>
<td>1922 Compact Negotiations</td>
<td>1903-1992 (Yuma)</td>
<td>17-18 maf</td>
<td>20-22 maf</td>
</tr>
<tr>
<td>1928 Siebert Commission†</td>
<td>1878-1926 (Yuma)</td>
<td>15.3 to 16.2 maf</td>
<td>18-20 maf</td>
</tr>
<tr>
<td>HD 419 (1947) USBR</td>
<td>1897-1943</td>
<td>16.27 maf²</td>
<td>17.72 maf³</td>
</tr>
<tr>
<td>UCRC Engineering Committee 11/29/48</td>
<td>1914-1945</td>
<td>15.64 maf⁴</td>
<td>N/A</td>
</tr>
<tr>
<td>Tipton &amp; Kalmbach for UCRC, July 1995</td>
<td>1896-1965</td>
<td>14.9 maf⁵</td>
<td>N/A</td>
</tr>
<tr>
<td>USBR CAP Senate Hearings 1967</td>
<td>1914-1958</td>
<td>15.07 maf⁶</td>
<td>16.03 maf⁷</td>
</tr>
<tr>
<td>UCRC 2004 Annual Report</td>
<td>1896-2004</td>
<td>14.8 maf⁸</td>
<td>N/A</td>
</tr>
<tr>
<td>USBR Natural Flow Data Base</td>
<td>1906-2000</td>
<td>15.28 maf⁹</td>
<td>N/A</td>
</tr>
<tr>
<td>USBR Natural Flow Data Base</td>
<td>1931-1977</td>
<td>13.59 maf¹⁰</td>
<td>N/A</td>
</tr>
<tr>
<td>Kanzer &amp; Kuhn</td>
<td>1906-1990</td>
<td>N/A</td>
<td>17.32 maf¹¹</td>
</tr>
</tbody>
</table>

†The Siebert Commission Report did not actually present any numbers, but it concluded that previous estimates were too high by 10%.

²House Document 419, Table CXL, page 281.

³id., page 284.


⁵I’ve shown an unlabeled graph from the 1965 report as Figure VI-I.


⁷id., page 208. It is not clear from the testimony or chart whether this includes the Gila. I suspect it does not.


⁹I used the same USBR Lee Ferry natural flow estimates that were used for the pending review of the Hydrologic Determination. The USBR natural flow data base is slightly different than the UCRC, especially for the 1950s.

¹⁰id.
The Paleohydrologic Record

Our gage record is relatively recent. There was no gage at Lee Ferry until 1921. In the Upper Basin the longest serving mainstem gages are the Green River at Green River, Utah which has been in place since 1894 and the Colorado River near Cisco, Utah gage, 1913 to present.

As noted by a number of hydrologists, our stream flow records and thus reconstructed natural flows before 1930 are relatively crude. Reclamation and others have used a number of methods, primarily statistical correlations, to reconstruct the record. The limited gage records are not the only problem. Knowing the amounts of lands under irrigation and crops being irrigated is also necessary to reconstruct natural flows. These records are also less reliable, the farther we go back. The bottom line is that we must recognize that much of the so-called gage record is actually a synthetic record with considerable uncertainty.

In March 1976 Charles Stockton and Gordon Jacoby published “Long-Term Surface-Water Supply and Stream Flow Trends in the Upper Colorado River Basin.” The Stockton and Jacoby report was one of a number of studies funded by the National Science Foundation. The effort was called the Lake Powell Research Project.

Stockton and Jacoby used dendrochronology to reconstruct a longer term (1512 to 1961) hydrograph of the Colorado River at Lee Ferry. The report concluded that the long term natural flow at Lee Ferry was only 13.5 maf + .5 maf. The Stockton and Jacoby reconstructions were used for the Severe and Sustained Drought on the Colorado River Project. The results of this project were published by the Water Resources Bulletin, Journal of the American Water Resources Association, October 1995.

After the Stockton Jacoby report there have been a number of additional tree ring based reconstructions. Most recently, in 2006 Connie Woodhouse, Stephen Gray and David Meko published “Updated Stream Flow Reconstruction for the Upper Colorado River Basin” in 2006.

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11This estimate is based on a correlation between the Little Colorado River natural flows from the Reclamation natural flow data base and the Gila River natural flows from HD 419 to determine natural Gila flows at Yuma. The Gila flows at Yuma are added to the Colorado River natural flows at Imperial Dam from the Reclamation natural flow data base.

151Tipton & Kalmbach, page 9.

152Dendrochronology uses tree rings to amke statistical correlation with stream flows. A detailed discussion is found on pages 11-17 of the Stockton and Jacoby report. The bottom line is that the statistical methods used in dendrochronology are no different and probably as sophisticated as the methods used to recreate the USBR natural flow data base.

153Unfortunately, the report was published during a very wet period and did not receive the attention it deserved by policy makers. Copies of the journal can be obtained from Hydrosphere Inc. www.hydrosphere.com

154The paper was published by Water Resources Research, Volume 42, January 2006.
The NRC Report on Colorado River Hydrology report has a good discussion on uncertainties in stream flow reconstructions. The report concludes that despite the differences, all of the reconstructions share important and common conclusions:

1. The long term average natural flow at Lee Ferry is less than the USBR 1905-2000 natural flow data base. The means are in the 13.0 maf/year to 14.7 maf/year range.

2. The early 1900s were indeed one of the wettest periods on record. The 1970 to 1995 period was also relatively wet.

3. The reconstructions verify the conclusion of the Siebert Report, the 1870-1900 period was indeed quite dry. It was most likely much drier than the 1930-1960s period.

4. There are drought periods in the late 1500s, late 1600s, late 1700s and mid and late 1800s that are most likely more severe than the 1930-1960s dry period.

Figure VI-1 shows a 25 year smoothed or filtered average of the Lees-B reconstruction of the 2006 Woodhouse paper. I like using a 25 year smoothed average because of its relevance to reservoir operations and the 1922 Compact. Because of the large amount of storage in Lake Powell and Lake Mead and the 10 year commitment under Article III (d) of the 1922 Compact, the 25 year filtered average approximates Mead and Powell operations and can be used to flag periods where the Upper Basin could have problems meeting its downstream commitments and periods of extended shortages in the Lower Basin.

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155 National Academy of Sciences, pages 75-76.

156 For this paper, the 25 year smoothed or filtered average is the average of the current and previous 24 years.
As you can see by Figure VI-1, there are a number of 25 year valleys when the flow dropped to 13 maf or less. 13 maf/year is an important trigger, even at today’s level of demands, a 25 year period with a natural flow of only 13 maf/year will draw down system storage and stress the system in a major way. The lowest 25 year periods in the 1900s are all greater than 13 maf/year.

Global Warming, Climate Change and the Colorado River Future Hydrology

Author’s Note: Global warming and climate change have become a political and public policy hot potato. My observation is that it has become too polarized. For some it is cause-celeb, and for others, it is a hoax. The NRC Report on Colorado River Hydrology concludes that it is a real issue and concern. Within the Colorado River Basin, we need to begin to consider the potential consequences now. Water decisions, both for projects and operational criteria are long lasting. It may be too late before we know whether the science is right or wrong, so we need to expand our planning
horizon to seriously consider the issues raised and a broad range of possible futures. We need to consider how to avoid unacceptable outcomes, not just plan for the most probable or most politically popular.

The idea that global warming could reduce the stream flows in the Colorado River is not new. John Carlson mentions it in his 1986 paper. According to Western Water Assessment, there have been at least ten studies of the Colorado River since 1979.\textsuperscript{157}

Most recently a number of professional journals have addressed the matter. The January/February 2007 edition of “Southwest Hydrology Magazine” has a cover titled “Inconvenient Hydrology.” The edition includes articles on climate change and the Colorado River. The AWRA Journal “Water Resources Impact” dedicated its July 2004 and September 2006 editions to climate change issues.

**Increasing Temperatures**

There seems to be no debate in the science community that temperatures in the Colorado River Basin have increased by at least $2\frac{1}{2}$\textdegree{} F ($1.5$\textdegree{} C) over the last century. Figure VI-2 shows the annual average surface temperature for the Colorado River Basin. The graph also shows actual and modeled Colorado River Basin stream flows. The modeled stream flows are based on the Hoerling and Eischeid study. The Hoerling and Eischeid study suggests a drier future than other studies.

\textsuperscript{157}Western Water Assessment is a joint program of NOAA and the University of Colorado. See www.Colorado.edu.
Colorado State Climatologist Nolan Doesken and NOAA scientist Klaus Wolter recently released a study of temperatures within Colorado.\textsuperscript{158} Doesken and Wolter conclude that there have been statistically significant increases in temperatures in Colorado, especially in the spring months and most prominently in the north central mountains.

In February 2007, the International Panel of Climate Change (IPCC) released its 2007 “Supplement for Policy Makers” (SPM). The SPM concludes that it is almost a certainty the worldwide temperatures will continue to rise well into the 21\textsuperscript{st} century.\textsuperscript{159}

**Precipitation Changes**

There is much less certainty over future changes in precipitation. The modeling results generally forecast little annual change in precipitation in the entire region. Over the next 10 to 40 years, modeling suggests a slight increase in annual precipitation in Northwest, slight decreases in precipitation in the Southwest and virtually no change in the Upper Colorado River Basin.\textsuperscript{160} In a

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\textsuperscript{158}A copy of the study is available on the Western Water Assessment web site [www.colorado.edu](http://www.colorado.edu).

\textsuperscript{159}The SPM can be viewed at [www.ipcc.ch/](http://www.ipcc.ch/). The Supplement presents different greenhouse gas forcing scenarios.

\textsuperscript{160}NRC Report on Colorado River Hydrology.
In his presentation to the Colorado Water Congress at the January 2007, Brad Udall pointed out that currently the GCMs do not handle precipitation changes as well as temperature changes, especially in the Southwest. The summer monsoon which primarily impacts Arizona, New Mexico, southern Utah and the Colorado Front Range and Southwest Colorado is a very difficult challenge for the current models.

**Stream Flow Changes**

There are a number of climate change factors that will influence future stream flows; changes in the seasonality and amount of precipitation, changes in timing of the runoff, changes in system evaporation, changes in sublimation of the snowpack (wind losses, dust, etc.), changes in evapotranspiration of natural basin vegetation and changes in system demands for irrigation, lawn watering, power plant cooling and other outdoor uses.

Recently, there have been several studies that paint a bleak picture for future Colorado River flows. Writing in the January/February 2007 edition of “Southwest Hydrology,” Greg Garfin put it this way: “the basic message of these studies is that the certainty of the temperature increases trumps the uncertainty of precipitation changes.”

I will highlight three of the recent studies. The first is by Martin Hoerling of NOAA and John Eischeid of the University of Colorado, CIRES. The study is called “Past Peak Water in the Southwest.” A summary version is included in the January/February Southwest Hydrology magazine. Using a suite of climate model simulations from the same tools that are being used for the preparation of the 2007 IPCC report (AR4), Hoerling and Eischeid found that the stream flow is strongly correlated with the annual Palmer Drought Severity Index or PDSI.

Hoerling and Eischeid conclude that “the Southwest appears to be entering a new drought era” and “even several of the wetter runs yield increasing drought due to the overwhelming effect of the heat-related moisture loss.” They show a dramatic decrease in the natural flow of the Colorado River at Lee Ferry yielding only an average of 10 maf for the next 25 years and 7 maf/year during 2035-2060.


163id. pages 18-19, 35.

164The PDSI developed by Palmer in 1965 is an index that calculates the cumulative effects of precipitation and temperature on surface moisture balance. The index ranges from -4 (extreme drought) to +4 (extreme wet).
A second study of interest is “Global patterns and trends in stream flow and water availability in a changing climate” by Millly, Dunne and Vecchia.\textsuperscript{165} Milly et al. used an ensemble of 12 climate models that exhibited “qualitative and statistically significant skill in simulating actual stream flow changes observed in the 20\textsuperscript{th} century.” In simpler terms, the models performed well at simulating actual observed changes.

Figure VI-3

The study was worldwide in scope. Figure VI-3 shows relative changes in runoff in the 21\textsuperscript{st} century. The Southwestern United States, and the Colorado River Basin in particular, show a general reduction in stream flows in the 10\% to 30\% range.

\textsuperscript{165}Published in the November 2005 edition of Nature.
Finally, the previously mentioned Christensen and Lettenmaier 2006 study shows a reduction in stream flows, but not as drastic as suggested by either Hoerling or Milly. Christensen and Lettenmaier suggest stream flow reductions in the single digits up to perhaps 11%. They also included reservoir storage in their study. The small reductions in stream flows result in much more dramatic reductions in average storage levels. Given the close balance between existing supplies and demands, a large decrease in storage caused by a modest reduction in stream flows is not unexpected.

I’m concerned with one of the Lettenmaier assumptions. Specifically, the study assumes that Upper Basin demands will remain constant. I would expect that even with no new project development, expanded use by existing projects with unused capacity (Dillon Reservoir for example), and increasing demands for existing irrigation and lawn watering will increase Upper Basin demands by 6% or more. While not a reduction in “natural stream flows,” the increased Upper Basin demands will further reduce reservoir levels and Lower Basin shortages beyond those shown by Lettenmaier.166

Transition to a More Arid Climate in Southwestern North America

In March 2007, Richard Seager of the Lamont Doherty Earth Observatory of Columbia University released a study titled “Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America.”167 The study abstract makes the following conclusion:

“There is a broad consensus amongst climate models that this region will dry significantly in the 21st century and that the transition to a more arid climate should already be underway. If these models are correct, the levels of aridity of the recent multi year drought, or the Dust Bowl and 1950s droughts, will, within the coming years to decades, become the new climatology for the American Southwest.”

In simpler terms, the flows we’ve experienced from 2000 to 2007 may now be the normal, not the exception. It should be noted that the Colorado River Basin drains areas in northern Utah, Wyoming and northern Colorado where the Seager study suggests very little change in precipitation and even small increases in precipitation. The Seager study does not quantify stream flow changes.

The Seager results are consistent with both Milly and Hoerling. Seager suggests that the Colorado River Basin will experience more frequent dry conditions and that the impacts of this drying will not be uniform. The primary impacts will be in the more southern tributaries.

166See “Climate Change Through the Eye of Water Managers,” Betsy Woodhouse, Southwest Hydrology Magazine, January /February 2007, page 22. The discussion on Waage efforts at Denver Water. It should also be noted that Lettenmaier developed a separate model for shortages. His model results are not as robust as the USBR Colorado River model.

Climate Change Summary

The conclusion of the National Research Council “Report in Brief on Colorado River Basin Water Management” is worth repeating in full.

“Temperature records across the Colorado River basin and the western United States document a warming trend over the past century. These temperature records, along with climate model projections, suggest that temperatures across the region will continue to rise in the foreseeable future. Higher temperatures will result in less upper basin precipitation falling and being stored as snow, increased evaporative losses, and will shift the timing of peak spring snow-melt to earlier in the year. There is less consensus regarding future trends in precipitation. However, based on analysis of many climate model simulations, the preponderance of scientific evidence suggests that warmer future temperatures will reduce future Colorado River stream-flow and water supplies. Reduced stream-flow would also contribute to increasing severity, frequency, and duration of future droughts.” (Emphasis added).

The potential implications of this conclusion by the National Academies of Sciences are intriguing. The Bureau of Reclamation, state water policy agencies and public water providers are all aware of climate change. However, there are a number of outstanding policy questions.

• There is likely to be a stark difference in impacts within the Basin, with the southern most tributaries experiencing the biggest impacts due to climate change. How will the institutions and the Law of the River adapt to both an overall reduction in Basin yield and the differential impacts within the Basin?

• Will the water management community change the way it has historically done business? Specifically, if the basic planning assumption that “the future will resemble the past” is no longer valid, what are the alternatives?

• Will the water management community speak out on climate change? Will the impacts to our nation’s water resources be considered serious enough for water policy bodies to take on a leadership role on climate change?

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168 By water management community, I mean the federal agencies, state agencies, public utilities, water districts, and water professionals (engineers, attorneys, etc.) that are responsible for the operation of our water systems and natural water courses.
• How do we continue to improve the communications and cooperation among water policy makers (board members and legislators), water management professionals and the science community? Will the water management agencies actively participate in setting priorities for and assuring the funding of climate change hydrologic studies?

• In recent years, NOAA has made outreach efforts to bring in the water and other natural resource agencies into the design of their products and services. These efforts need to continue and new methods of evaluating hydrologic risk need to be developed.
CHAPTER VII

DISPUTES, DIFFERENCES OF OPINION AND
UNANSWERED QUESTIONS - COLORADO RIVER INTERSTATE ISSUES

There are a number of unresolved disputes, differences of opinion and many unanswered questions regarding the Law of the River and the operation of the major projects in both the Upper Basin and Lower Basin. These disputes, differences of opinion and unanswered questions are all interrelated and in most cases impact almost all users of Colorado River Basin water.

The reader needs to recognize many of these issues have never been addressed by the courts. A fundamental policy question facing all parties, especially the States, is whether or not to continue the process of trying to resolve the issues through negotiations and compromise or through legal action.

**Issue:** Does the Upper Basin have to give up or forego some of its 7.5 maf/year apportionment in order to meet its delivery obligations under Articles III (c) and III (d) of the 1922 Compact?

As previously mentioned, Article III (a) of the 1922 Compact apportions to each basin 7.5 maf of beneficial consumptive use per year. The 1922 Compact also places fixed obligations on the Upper Basin at Lee Ferry. Article III (d) requires the States of the Upper Division to not cause the flow at Lee Ferry to be depleted below 75 maf every consecutive ten years. Technically speaking, this is not a delivery obligation because nature could cause the flow to drop below 75 maf (without post 1922 depletions).

Article III (c) requires the Upper Basin to deliver at Lee Ferry its 50% share of a deficiency in the Mexican Treaty obligation in addition to the Article III (d) requirements. The 1922 Compact contemplates that the Mexican Treaty obligation is to met first with surplus waters over and above the Article III (a) and (b) apportionments (16 maf). If the surplus is not sufficient then the Upper Basin and Lower Basin share the deficiency equally.

The basic question is then what happens if there is not sufficient water for the Upper Basin to consume 7.5 maf under paragraph III (a) and meet the provisions of III (c) and III (d)? It is now well understood that in dry periods there is not, and probably never was, enough water to meet all three paragraphs.

Unfortunately for the Upper Basin, the answer appears to be that the Lee Ferry obligations trump the Upper Basin’s 7.5 maf/year. The courts however, have not conclusively addressed this matter. I base this conclusion on the view of legal scholars such as Carlson, Tipton and Hundley and the language of the 1968 CRBPA.
Carlson discusses the issue on pages 51-56 of his 1986 paper. Carlson outlines what he believed were the reasons that Article III (d) was included in the compact. In his footnotes Carlson notes that “perhaps the most damaging to the Upper Basin’s position is the second part of Herbert Hoover’s answer to the fifth of 26 written questions submitted to him in 1923 by Congressman Carl Hayden:” The question and answer are as follows:169

“Question 5. Why is the basis of division changed from the “Colorado River system” to the “river at Lee Ferry” in paragraph (d) of Article III, the period of time extended to 10 years and the number of acre-feet multiplied by 10:

(Answer)

(b) The agreement as to the flow of 75,000,000 acre-feet at Lee Ferry during each 10-year period fixes a definite quantity of water which must pass at that point. Under III (a) each basin is entitled to the use of 7,500,000 acre-feet annually. Judging by past records, there will always be sufficient flow in the river to supply these quantities, but in the improbable event of a deficiency, the lower basin has the first call on the water up to a total of 75,000,000 acre-feet each 10 years. While there was in the commission a firm belief that no such shortage will ever occur, still this provision was adopted as a matter of caution. The period of 10 years was fixed as a basis of measurement, as being long enough to allow equalization between years of high and low flow, and as representing a basis fair to both divisions.”

Thus, the impartial federal representative to the compact negotiations believed that the Lower Basin has the first call or senior rights on the water up to the use of 75 maf each ten years.170

The 1968 CRBPA in Section 602 (a) (1) lists the first priority for releases from Lake Powell as “releases to supply one-half the deficiency described in Article III (c) of the Colorado River Compact, if any such deficiency exists...” Section 602 (a) (2) lists the second priority as “releases to comply with Article III (d) of the Colorado River Compact.”

169Carlson and Boles footnote #105, page 13 (of the footnotes).

170The Hoover answer was referred to on several occasions during the Congressional hearings in 1948 and by Breitestein in his 1944 report to the CWCB.

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As a practical matter, the priorities for the available water in the Upper Basin are as follows:

1. Water rights perfected by use prior to November 24, 1922.

2. Upper Basin’s Mexican Treaty Obligation under Article III (c).

3. Upper Basin’s 75 maf every ten years obligation under Article III (d).

4. Upper Basin’s post-1922 Compact depletions.

This means that if in the future the available yield of the Colorado River is reduced, then the post-1922 Compact water rights are at the most risk.

**Issue**: When is there a deficiency, and thus an Upper Basin delivery requirement under Article III (c) of the 1922 Compact (Mexican Treaty obligation)?

When a deficiency exists, the Upper Basin clearly has an obligation to deliver water to Mexico. However, the questions of when such a deficiency exists and how to quantify the amount of a deficiency are unresolved.

An ultimate resolution of these questions may be the most difficult task facing the 1922 Compact parties. A full discussion of the legal and hydrologic issues related to the Mexican Treaty obligation is far beyond the scope of this paper, but I will try to provide the highlights and discuss the ramifications for water use in the Upper Basin.

Article III (c) defines surplus as “over and above the aggregate of the quantities specified in paragraphs (a) and (b).” The plain meaning of this is the surplus is the amount of water over and above 16 maf per year.

The fact that paragraphs III (a) and III (b) add up to 16 maf is clear, but there are a number of related unanswered questions:

- The Upper Basin is not currently consuming 7.5 maf per year as contemplated by Article III (a). The Upper Basin is currently using only about 4.5 maf per year. Assuming the Lower Basin is consuming its full amount under Articles III (a) and (b) or 8.5 maf per year, is the surplus over 13 maf per year (8.5 + 4.5) or is it still 16 maf per year?

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171 There is an argument that prior perfected rights are those perfected by use prior to June 25, 1929, the date the Colorado River Compact was declared effective by President Hoover, but I’ll use the date of the signing of the compact.

172 Based on the Secretary of the Interior’s Consumptive Uses and Losses Reports, the Lower Basin is consuming considerably more than 8.5 maf/year.
The plain language of the 1922 Compact does not say the aggregate of the quantities specified in paragraph (a) or (b) or the amounts being currently consumed, whichever is less, but was that the intent? The Upper Basin has always argued that the first priority of its unused Article III (a) apportionment should be its obligations to Mexico, not uses in the Lower Basin beyond 8.5 maf per year.

- Are consumptive uses measured at the point of uses or as depletions to the river at the border with Mexico? For Arizona, this is a major issue. As measured at the points of use, Arizona’s use of the Gila River exceeds 2 maf per year on average, but the Gila’s contribution to the natural flow of the Colorado River at the border with Mexico is only 1 maf per year. It should be noted that to a lesser extent, the same concept applies at Lee Ferry. The 1948 Compact defines consumptive use as manmade depletions at Lee Ferry, not the aggregate of the total depletions at the upstream points of use. The UCRC Engineering Advisory Committee believed that the Upper Basin could use beyond 7.5 maf per year by defining the depletion as the impact to natural flow at Lee Ferry.

- Are consumptive uses on the Lower Basin tributaries included within the 8.5 maf per year apportioned to the Lower Basin under Articles III (a) and III (b)?

The plain language of Article II (a) is that the Colorado River System includes the Colorado River and all of its tributaries in the Upper and Lower Basins. Arizona and possibly Nevada may argue that the 1928 Act changed or amended the 1922 Compact and exempted the Gila River from being included within the Lower Basin apportionment under Articles III (a) and III (b). However, legal scholars dismiss this as wishful thinking. In private correspondence, Jim Lochhead, former Upper Colorado River Compact Commissioner for Colorado, and still very active in Colorado River interstate matters and John Carlson in his 1986 paper have both pointed out that although *dicta*, the Supreme Court noted that “inclusion of the tributaries in the Compact was natural in view of the upper States’ strong feeling the Lower Basin tributaries should be made to share the burden of any obligation to deliver water to Mexico which a future treaty might impose.”

The Lower Basin tributary obligation to Mexico issues quickly become very complicated and convoluted. In the Consumptive Uses and Losses Reports, the Reclamation authors note that it is impossible to distinguish between tributary surface water use and groundwater overdrafts on the Gila River System in Arizona. Are

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173 For Article III (b), the question actually is “has the Lower Basin increased its uses (post compact) on the tributaries by greater than 1 maf per year?”


175 For example see page 17 of the 1976-1980 Consumptive Uses and Losses Report - “For the purpose of this report, groundwater overdraft has not been taken into account in the computation of tributary consumptive use.”
these overdrafts of groundwater tributary or non-tributary to the Colorado River system?

As a practical matter, it may be that uses on the Lower Basin tributaries are considered when determining whether or not a surplus exists, but asking for water from the tributaries results in a “futile” call. The only way to actually deliver water to Mexico may be from the mainstem of the Colorado.

• Is the Mexican Treaty obligation administered on a real time annual basis, an average year basis or a time-delayed basis? The 1922 Compact and other features of the law of the river are completely silent on this issue, yet it is a major administrative issue. The natural flow of the Colorado River (as measured at Lee Ferry or Yuma) varies considerably from year to year. Two recent examples are 2004 and 2005. The 2004 year was dry throughout the Basin. It is almost a certainty that the natural flow at Yuma in 2004 was less than 16 maf per year and most likely less than 13 maf per year.\textsuperscript{176} Thus in 2004, there was no surplus. In contrast, in 2005 it is just as probable that the natural flow at Yuma exceeded 20.0 maf per year,\textsuperscript{177} thus there was a large surplus, no deficiency. However, there is no generally accepted basinwide accounting of consumptive uses and thus no official estimate of the natural flow of the Colorado River at the border with Mexico.

As a practical matter, it seems almost impossible to strictly administer the Mexican Treaty obligation on a real time basis. Even with detailed system accounting, it would likely take several years for a Secretary of the Interior to make any definitive conclusion about whether a surplus or deficiency exists in any given water year. Two practical alternatives exist; use an average or running average basis or use annual deliveries with a built-in correction within a two or three year window. It could be that the Upper Basin delivers an amount based on an initial estimate (by the Secretary) which is then adjusted for the actual delivery requirements within this window. This is similar to current practice of mainstem decree accounting in the Lower Basin.

• If there is a surplus does it matter where the surplus is physically located? Again, the 1922 Compact is silent on this issue. I’ve heard representatives of the Lower Basin argue that if there is a surplus in any given year, then it is probably in the Upper Basin where the snow and the surplus runoff is located. Therefore, delivery of the surplus would be made from surplus flows in the Upper Basin. I’ve not read any legal analysis of this argument, but there is no question if the Mexican Treaty obligation is ever the subject of interstate litigation, one, if not all, of the Lower Basin States will raise it.

\textsuperscript{176}See 57\textsuperscript{th} Annual Report of the Upper Colorado River Commission, Table 3, the estimated virgin flow at Lee Ferry for 2004 was 10.9 maf. In the Lower Basin it was a very dry year with very little storable water on the Salt River System. Total tributary gains in the Lower Basin were probably <1.0 maf.

\textsuperscript{177}Id. Table 3 - for 2005, the estimated virgin flow was 17.7 maf plus on the Lower Basin, it was a record high year. Total natural virgin flow at Yuma probably exceeded 22 maf.
• When a deficiency does exist, is the Upper Basin obligated to make up for conveyance losses incurred from the delivery point of water at Lee Ferry to the Mexican border? The Lower Basin has always taken the position that the Upper Basin’s obligation includes covering transit losses. The Upper Basin counters that neither the 1922 Compact or 1968 CRBPA (section 602) require or even mention transit losses. Randy Seaholm of the CWCB staff estimates that transit losses are in the range of 50,000 to 75,000 af per year. On an annual basis, this may seem small, but over an extended period of time, it could have a real impact on storage levels in Lake Powell.

**Implication of Climate Change on the Mexican Treaty Obligation Issues**

Unfortunately for the Upper Basin, a future where there is less water in the Colorado River diminishes its argument that it is currently delivering more water than is necessary (750,000 af annually) to meet its Mexican Treaty obligations. If the average natural flow of the Colorado River at Yuma is below 16 maf, and it is probably headed in that direction, then other than to take advantage of infrequent wet years (like 2005), the incentive to challenge the matter is diminished. When this is balanced with the possibility that the Court could rule that in years when there is a deficiency the Upper Basin must also provide transit losses, the end result of a decision by the Upper Basin to challenge the matter could be a loss of yield during critical dry periods!

**Issue**: Is evaporation on the Lower Basin mainstem reservoirs considered a beneficial consumptive use under the 1922 Compact and, if so, is it charged against the Lower Basin’s 7.5 maf per year apportionment under Article III (a)?

The question of whether or not reservoir evaporation is a beneficial consumptive use under the 1928 Act was argued in the fourth *Arizona v. California* case. The Special Master determined that based on the language of the 1928 Act itself, evaporation is not chargeable against the Congressional mainstem apportionments made by the 1928 Act. For mainstem uses, consumptive use is defined as diversions less return flows.\(^{178}\)

However, the 1963 *Arizona v. California* decision does not settle the issue as to whether or not evaporation is a beneficial consumptive use under the 1922 Compact.

From my perspective, this is a major issue that, with declining river hydrology, may actually involve more water that than the issue of the Lower Basin tributary obligation to the Mexican Treaty.

There are three major reservoirs on the lower river; Lake Mead, Lake Mojave and Lake Havasu. Plus there are evaporation losses in the expanded river pools behind the Imperial Irrigation District diversion dam and the Headgate Rock diversion dam.

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\(^{178}\)364 U.S. 940 (1961), page 313. Ironically, it was Arizona that argued that California’s 4.4 maf apportionment included mainstem reservoir evaporation. Today, Arizona is probably happy that it lost that argument.
The consumptive uses and losses reports for 1971 to 2000 put lower mainstem evaporation losses in the range of 900,000 to 1,200,000 af per year.

In the Upper Basin, the issue is settled. Pursuant to the 1948 Compact evaporation on the CRSP reservoirs is considered a beneficial consumptive use and charged to individual states pursuant to specific provisions in the 1948 Compact.

In the Lower Basin, the issue remains unresolved. Resolution is extremely important because in dry periods, the Lower Basin may be able to show that its total beneficial consumptive uses are less than 8.5 maf if the tributary contribution is measured as depletions to the mainstem and if mainstem reservoir evaporation is not considered a beneficial consumptive use.

The argument in favor of including evaporation is that it is clearly a manmade depletion and it is a legitimate water cost of building a reservoir. Equity between the Upper Basin and Lower Basin may also be an argument.

There are two arguments against it. First is the decision in Arizona v. California on the 1928 Act. Did Congress effectively amend the 1922 Compact with the 1928 Act? The second is more subtle. In his 1944 report, CWCB attorney Jean Breitenstein noted the Upper Basin was reluctant to push that issue because Article VIII of the 1922 Compact includes the following provision: “Whenever storage capacity of 5,000,000 acre-feet shall have been provided on the main Colorado River within or for the benefit of the Lower Basin, then claims of such rights, if any, by appropriators of users of water in the Lower Basin against appropriators or users of water in the Upper Basin shall attach to and be satisfied with water that may be stored not in conflict with Article III.”

Breitenstein was concerned that the Lower Basin might win an argument that Lake Mead benefitted both the Upper Basin and Lower Basin because the construction of Lake Mead (to a capacity of >5,000,000 af) forever relieved all Upper Basin pre-1922 appropriations against pre-1922 Lower Basin appropriations. If under the 1922 Compact, Lake Mead benefitted both Basins, then either the evaporation should be shared or not charged against either Basin. Excluding Lake Mead, lower mainstem evaporation is in the range of 250,000 af per year.

Even if the Lake Mead evaporation argument was valid, the same argument does not apply to Lake Havasu and the pools behind the diversion dams. Havasu is a pumping and desilting forebay for the Colorado River Aqueduct and now the CAP pumping plant. Lake Mohave is somewhat unique. It was constructed to assist with deliveries to Mexico. So, the Lower Basin may argue that it is not responsible for the evaporation of Lake Mohave. However, the operation of Mohave also benefits power use and water deliveries to mainstem users as well.

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179 Breitenstein, pages 96-97.
**Issue**: At current demand levels, the three lower basin states cannot live on 8.23 maf/year alone.

Under current operations, Reclamation operates Glen Canyon Dam to make a minimum objective annual release of 8.23 maf/year. Tributary inflow between Glen Canyon Dam and Lake Mead contributes another 750,000 af per year.\(^{180}\) Thus, inflow to Lake Mead is approximately 9 maf/year (plus the wet cycle releases from Glen Canyon Dam in excess of the minimum release).

There are three basic outflow demands on Lake Mead; net pumping from Lake Mead by the Southern Nevada Water Authority (SNWSA), evaporation and releases to downstream requirements. Reclamation modeling includes inflows to and outflow from bank storage as well. The bank storage impacts are relatively small and the modeling treatment simplified.\(^{181}\)

The bottom line is that under normal conditions, outflows from Lake Mead are in the range of 10.0 to 10.5 maf/year. Thus, the demand (or outflow) on Lake Mead exceeds its supply (or inflow) by 1.0 to 1.5 maf/year. Unless tributary inflows are exceptionally high or Glen Canyon is releasing more than 8.23 maf/year, Lake Mead will lose storage.\(^{182}\)

There are only two ways to make outflows equal or exceed inflows: increase the releases from Lake Powell and/or reduce outflows by reducing deliveries to Lake Mead users (imposing a shortage). Figure VII-1 shows the basic problem:

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\(^{180}\)There are various estimates for inflow between Lake Powell and Lake Mead. The USBR 24 month study estimates for 2007 is 824,000 af. Tipton estimated long term dry period (1931-1965) inflow at 700,000 af. I’ll use 750,000 af/year. It makes the math easier.

\(^{181}\)Bank storage is the amount of water in the ground adjacent to the reservoir. As the reservoir fill, water goes into bank storage. As the reservoir is drawn down, it returns back to the reservoir.

\(^{182}\)According to the February 2007 USBR 24 month study, in 2006 inflow were 8,229 kaf from Glen Canyon plus 702 kaf from side tributaries for a total of 8,931 kaf. Outflows were 287K for Southern Nevada Water Authority, 668K for evaporation and 9,395K for downstream releases for a total of 10,350K. Outflow exceeded inflow by 1,419 kaf. For 2007, the estimate is that outflows will exceed inflows by 1,180 kaf.
If releases from Glen Canyon Dam remain at the 8.23 maf/year levels for an extended period of time, then the Secretary of the Interior will have no choice but to reduce Lake Mead outflows through reductions in downstream deliveries and pumping from Lake Mead of about 1.0 maf per year. The only question is at what elevation to stop the drawdown. Based on the Seven States proposal, that elevation will probably be in the 1,000’ range. At the lower elevation, 1,000’ (or less), evaporation losses are reduced, but there is also less water in storage if low flow conditions persist and a greater risk of a very large shortage in the future. There are also major impacts to hydroelectric power generation and recreation on Lake Mead.

At the higher levels, 1,000’ (or greater), there is slightly more storage available, evaporation is higher, impacts to hydropower generation and Lake Mead recreation are less, but still significant.
The shortage criteria proposed by the Seven States ramps up the shortages based on Lake Mead elevations. If the projected December 31 elevation of Lake Mead is between 1,075' and 1,050' there is a 400,000 af shortage. At 1,050' the shortage is increased to 500,000 af and at 1,025' it is increased to 600,000 af. If shortages are required greater than 600,000 af then the Seven States proposal calls for further consultation.

The shortage criteria DEIS includes several critical assumptions:

- Upper Basin depletions remain relatively low. The DEIS assumes that Upper Basin depletions (2008) are currently at 4.54 maf/year and will ramp up to 5.3 maf/year by 2030.\(^{183}\)

- The Colorado River Basin hydrology remains unchanged. The DEIS included a hydrologic appendix that expanded the analysis beyond the 1905-2004 record. The appendix includes a look at the Colorado River Basin hydrology based on two synthetic and two paleohydrology based records. However, the four alternative hydrology runs are not all that different than the 1905-2004 record. The paleohydrology trace has a mean natural flow of 14.6 maf/year at Lee Ferry, only .4 maf less than the mean of the 1905-2004 record.\(^{184}\)

- For modeling purposes, the assumption is that there will also be a 16.67% reduction in deliveries to Mexico. However, the Secretary of the Interior has no authority to unilaterally reduce deliveries to Mexico. This must be done in consultation and perhaps with approval of the Secretary of State.

**Impacts of Climate Change on Proposed Shortage Criteria**

The Shortage Criteria DEIS does not include any discussion of the impacts of climate change on future river flows. The technical data necessary to make these kinds of analyses may not be available. Which of the many different studies would Reclamation use? Does it simply reduce the 1905-2004 record by a fixed amount, 10%, 15% or 20%, or does it generate synthetic flow using GCMs? These are difficult questions.

The impact on the Lower Basin shortages can be assumed without modeling. Reduced flows mean the Lower Basin will see longer periods of time without equalization releases from Lake Powell and when spills do occur, the magnitude of the spills will be smaller. The information provided in the DEIS does not display the average length of time minimum releases are made at 8.23 maf/year. Nor does it display the average number of consecutive years with shortages. The information

\(^{183}\)USDOI DEIS Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Reservoir Operations for Lake Powell and Lake Mead. Appendix C.

\(^{184}\)id., Appendix N.
displayed in numerous graphs is the probability of a shortage (or other occurrence such as Lake Powell dropping below minimum power head).

From a water policy perspective, the Lower Basin will have to adopt different strategies to live with long extended periods of shortage. Agricultural land fallowing and the withdrawal of water from groundwater banks may be adequate to survive a three to five year period of shortages in the range of 400,000 to 600,000 af per year. However, these same strategies will not be adequate to survive 20 year consecutive years of shortages in the range of 800,000 to one million af per year.

The impacts of climate change on Lower Basin shortages will be aggravated by the impact on local water supplies. For example, in the Phoenix area, there are two primary sources of surface water; water imported from the Colorado River via the CAP and water diverted by the Salt River Project from the Salt River and Verde River watersheds. Climate change may well have a double barreled impact to water supplies to the Phoenix area. Because the CAP is one of the most junior users on the mainstem, it bears the major impact of reductions in deliveries from Lake Mead. If climate change results in more frequent and greater shortages, then the CAP will not be able to meet its anticipated deliveries of municipal water to the Phoenix and Tucson areas.

Increased shortages on the CAP will be accompanied by less surface water available for diversion by the Salt River Project. According to Dr. Robert Balling, a climate scientist from Arizona State University in Tempe, scientists have an 85% confidence level that increasing temperatures will reduce surface water in the Salt River and Verde River systems.185

The amount of lost yield on the Salt and Verde systems varies based on the model used, future greenhouse gas assumptions and assumptions concerning vegetative changes in the watershed. However, losses in the range of 10% to 30% are a common model output.186 Since the Salt River Project diverts on average about 1 maf of surface water per year, losses in the 100,000 to 300,000 af are possible.

If the Secretary of the Interior has to impose a 1 maf shortage on Arizona, Nevada and Mexico in order to live through an extended period of 8.23 maf/year releases from Lake Powell, then Arizona’s total water impact could be in the 900,000 to 1,100,000 a.f per year.187

In order to live with a shortage of this magnitude, the CAP and its municipal customers would have to either expand groundwater use or purchase large amounts of senior Indian agricultural or

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186 id.
187 My assumptions are that Mexico would bear 17%, Nevada 3% and Arizona 80%. I’ve also assumed the Salt River Project diverts 1 maf/year/ The USBR website on the other SRP states that it delivers “more than 1 maf/year.”
mainstem agricultural uses.\textsuperscript{188}

A similar situation may exist for the Metropolitan Water District of Southern California (MWD). California has been a leader in addressing global climate change issues. One of its primary concerns is the future reliability of water available to the California State Water Project.

There are three problems. The State Water Project watershed in the Sierra Nevada Mountains is expected to see more rain and less snow, rising sea levels could result in seawater intrusion into the Bay Delta contaminating the fresh water supply to the State Water Project with seawater and finally for a large system, it has very little storage.

California and MWD already have a jump on Arizona. Because of the 4.4 Plan, actions are already underway to firm up the yield of the Colorado River Aqueduct.

Southern Nevada is in a different situation. The Southern Nevada Water Authority is solely reliant on Colorado River water, and except for a small amount of agriculture in the Virgin and Muddy River Basins, it has no agriculture to turn to. This is the reason that Southern Nevada has been forced to pursue groundwater from several hundred miles away in east central Nevada.

**The Importance of the 602 (a) Storage Level Trigger**

As previously mentioned, the 1968 CRBPA established a trigger mechanism for moving surplus Upper Basin water to the Lower Basin. This trigger is referred to as the 602 (a) storage level. If Lake Powell storage is above the 602 (a) level and active storage in Lake Powell is more than active storage in Lake Mead, the Secretary makes additional releases beyond the minimum objective release of 8.23 maf/year from Glen Canyon to equalize active storage levels in Mead and Powell.

As discussed in the previous section, to avoid shortages in the Lower Basin, the additional releases need to average about 1maf per year. To meet current demands in the Lower Basin and keep a full supply to the Colorado River Aqueduct, the additional releases would need to average about 1.5 maf per year.

From the Upper Basin perspective, 602 (a) needs to be high enough to keep sufficient water in storage to avoid a future curtailment caused by the Upper Basin’s failure to meet its Article III (c) and III (d) obligations under the 1922 Compact. As Upper Basin depletions rise, 602 (a) must go up and if the critical low flow period is drier, then 602 (a) again must go up.

Reclamation has developed a formula to determine the 602 (a) level. The formula is as follows:

\textsuperscript{188}Expanding groundwater use, which has been overdrafted for decades, may not be legally or physically possible. Assuming an annual price of $300 per af, purchasing 500,000 af/year would be $150 million per year.
There are numerous contracts for Navajo Reservoir water and a few small ones for Blue Mesa water. There is currently a contract request pending for a large contract (175,000 to 450,000 af/year) from Flaming Gorge Reservoir.

\[
\text{602 (a) storage} = [(\text{U B. Dep.} + \text{U. B. Evap.}) \times (1 - \text{Allowable Shortage})/100 + \text{Minimum Release - Critical Period Inflow}] \times \text{Critical Period Length} + \text{Minimum Storage for Power (Optional)}.
\]

The details of this formula (or algorithm) is shown in Appendix C. Appendix C was provided by Reclamation. The appendix was attached to the Environmental Assessment prepared by Reclamation to approve the 14.85 maf 602 (a) level that was a part of the Interim Surplus Guidelines. It included in Appendix A of the Shortage Criteria DEIS.

The formula raises the following questions:

1. What is the allowable shortage? For the 1988 Hydrologic Determination, a 6% shortage was considered acceptable. Is this shortage also appropriate for the 602 (a) determination?

2. Is the minimum release 8.23 maf/year, 7.5 maf/year, or something in between or greater than 8.23 maf/year?

3. What is the critical hydrologic period? To date, the assumption is that it is 1953 to 1964 which had an estimated natural flow at Lee Ferry of 12.18 maf/year. By the time the current period (2000-2007) ends, it may well be more severe than the 1953 to 1964 period and there are many periods in the paleohydrology record that are much more severe.

4. Should the minimum power pool(s) be included in the calculation? The Upper Basin believes it is appropriate to add minimum power levels. The Lower Basin does not.

5. Does 602 (a) include only Lake Powell, or does it also include Navajo, Blue Mesa, and Flaming Gorge? If it includes the latter three, does Reclamation exclude the capacity needed to meet its water contract delivery obligations from storage water considered 602 (a) purposes?\(^\text{189}\)

Figure VII-2 shows the active storage capacity necessary to satisfy 602 (a) using three different critical periods and at three different Upper Basin depletion levels, 4.25 maf/year, 4.75 maf/year, and 5.25 maf/year under the following common assumptions:

- 350,000 af per year average evaporation (derived from the proposed 2007 Hydrologic Determination).

\(^\text{189}\)There are numerous contracts for Navajo Reservoir water and a few small ones for Blue Mesa water. There is currently a contract request pending for a large contract (175,000 to 450,000 af/year) from Flaming Gorge Reservoir.
• 6% shortage (same as proposed 2007 Hydrologic Determination).
• no minimum power pools.

The three critical periods are:

2. A hypothetical 2000-2011 period with an average flow of 11.1 maf/year (the estimated 2000-2007 mean).\textsuperscript{190}
3. An 1878-2002 25 year period from the Woodhouse reconstruction (Lees B) with an average natural flow of 12.36 maf/year.\textsuperscript{191}

\textsuperscript{190}If the 50\% May 1, 2007 Lake Powell forecast holds, we are already eight years into a drought that is averaging about 11.1 maf/year.

\textsuperscript{191}The 2006 Woodhouse report developed four different reconstructions, Lees A, B, C and D. Each used slightly different statistical approaches.
As you can see, the calculation for 602 (a) storage varies considerably. At one extreme, using a 6% shortage and 350,000 af per year of CRSP evaporation, relatively low estimates of Upper Basin depletions, and the 1953 to 1964 drought as the critical period, application of the 602 (a) algorithm results in a very low amount of necessary storage, about 4.6 maf. At this level, just about anytime Lake Mead storage dropped below Lake Powell, it would require an equalization release.

192The low evaporation levels are based on the reality that during critically dry periods, CRSP reservoirs are very low. The 6% shortage recognizes that during very dry periods, the amount of physical water available at the upstream diversion points is at least 6% less than the demands. An estimate of 4,250 maf of upstream depletions may seem low, but it is more than the recent 5 year average as computed by Reclamation in the Consumptive Uses and Losses Report.
However, using those same assumptions and an 11.1 maf/year average flow during the critical period, 602 (a) goes up to 17.7 maf. Increasing depletions to 4.75 maf/year, 602 (a) goes up to 23.3 maf. At this level, equalization releases would be very rare. They would probably only occur during wetter periods, like the early 1980s and mid 1990s, when the operation of Glen Canyon Dam would be primarily driven by the avoidance of spills rather than equalization.

The most important factor in determining the 602 (a) trigger is clearly the critical hydrologic period. There are two variables in the critical period, the length of the period and natural flow during the period.

**How Will Climate Change Impact the Calculation of 602 (a)?**

The answer to this question is very simple. The drier and longer the critical period, the more storage is necessary for 602 (a). A 12 year - 10.6 maf/year period is well within the predicted range of all of the studies that have looked at impacts of climate change on Colorado River flows. Hoerling suggest a 10 maf/year natural flow through 2025. 10.6 maf/year is about half - between 10 maf/year and the current 2000-2007 period. At the current levels of development (4.25 maf/year) a 12 year, 10.6 maf/year critical period would require 23.8 maf of storage for 602 (a).

For all practical purposes, this means that if in the future, stream flows are reduced, all of the available CRSP storage will be needed to protect the Upper Basin.\(^{193}\)

Although very rare, there are also 12 year periods in the paleohydrology record with average natural flow estimates at or less than 10.6 maf. It should be noted that periods with lengths other than 12 years, such as 14 or 15 year periods, may be more critical than 12 years. For example, based on the Woodhouse reconstruction, Lees-B, there are a number of 15 year periods that would require over 20 maf for 602 (a) and several that would require over 30 maf at today’s level of depletions.\(^{194}\) Depending on what actually happens in 2007 and 2008, we may already be in a 9 year period more critical than the 1953-1964 12 year period.

It is my opinion that the calculation of the 602 (a) trigger is the most important reservoir operation policy decision that has received the least policy level discussion. Although an algorithm has been developed for modeling purposes, the Secretary of the Interior has never issued formal criteria for the calculation of 602 (a).\(^{195}\)

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\(^{193}\)Even though Lake Powell has an active storage capacity of greater than 24 maf and the other three CRSP units provide another 6 maf of storage, for dam safety reasons Reclamation will not operate these large reservoirs at full capacities for more than a few months at a time. At high levels avoiding a future uncontrolled spill drives reservoir operations, not equalization.

\(^{194}\)For example, the 15 year period ending in 1508 would require over 36 maf of 602 (a) storage.

\(^{195}\)Interim Surplus Guidelines include an interim 602 (a) of 14.85 maf. The Secretary did formally adopt this interim number which is based on negotiations, not hydrology. The proposed Seven State shortage criteria fixes (by negotiation) 602 (a) levels described in the DEIS Appendix A. The negotiated 602 (a) levels are for Lake Powell only.
During the discussions among the seven states over shortage criteria, the State of Arizona issued a “briefing paper” on 602 (a). The Arizona paper raised a number of technical and policy issues. Arizona pressed its case that the storage available in CRSP reservoirs above minimum outlet works, but below the elevation for minimum power generation should be included in determining 602 (a). Whether or not to drawdown CRSP reservoirs below minimum power is a policy issue. The generally accepted view is that water use trumps power.

Arizona also noted that Upper Basin depletions are overstated and that the 602 (a) calculation needs to be calculate annually under the assumption that the amount of storage needs several years into a 12 year dry period is less than the amount needed at the beginning.

Arizona’s arguments on 602 (a) though interesting, are overwhelmed by the impact of future lower flows on the Colorado River. Unless the Basin sees relatively wet conditions in the next several years, the 2000 to 20?? dry period will very likely replace the 1953-1964 dry period as the critical period.

Recognizing the conclusions and warnings in the recent National Academies of Sciences report, I would strongly recommend the Upper Basin to insist the Secretary be very conservative in the calculation of 602 (a).

The proposed conjunctive management operation of Lake Mead and Lake Powell disclosed in the Shortage Criteria DEIS only changes operations at very low reservoir levels. For most years, equalization levels are still extremely important. Table A-9 of Appendix A - Modeling Assumptions, displays equalization levels assumed for the EIS. The equalization levels shown on Table A-9 were negotiated by the seven states as part of the states proposal. If the Secretary adopts this part of the states proposal, equalization levels will be fixed through 2026.

**Environmental Issues and Disputes**

I’ve summarized the endangered species, salinity and Grand Canyon ecosystem issues in previous chapters. The other prominent environmental issue facing the Colorado River Basin as a whole is the question of flow through the Colorado River Delta in Mexico. Environmental groups and other non-governmental organizations (NGOs) have proposed an alternative under consideration by the Secretary for the shortage criteria. This alternative includes the potential use of water to maintain periodic flows in the Colorado River through the delta. The details of the conservation before shortage alternative are in Appendix K of the Shortage Criteria DEIS.

In the recent years, environmental issues in Mexico have become a major concern of NGOs in both the United States and Mexico. Except for when Lake Mead is making flood control releases, all of the water of the Colorado river system is diverted and not a drop of river water actually flows into the Gulf of California. Thus, there have been proposals to restore a small amount of flow through the channel. There are many problems to overcome including how to legally protect flows in the Colorado River channel through Mexico.
A related problem is maintaining water for the Santa Clara Slough. Currently, groundwater that is pumped by the Welton-Mohawk Irrigation and Drainage District is transported through the Santa Clara Slough into the Republic of Mexico where it has created a large brackish wetland. The wetlands are called the Cienaga de Santa Clara.

The groundwater is pumped by the drainage district in order to maintain the groundwater levels at least 8' below the surface and below the root zone so that crops will grow. The 100,000 af (or so) of water that is annually delivered into the Santa Clara Slough does not count toward Mexico’s 1.5 maf of 1944 Treaty water.

The 1974 CRBSCA authorized the construction of a large desalting plant to reduce the salinity of the pumped water so that it could be delivered to Mexico as river water and count against the 1.5 maf delivery requirement. However, since its construction the Yuma Desalter has not been operated. The environmental concern is that if the plant were to be operated the brine discharge from the desalter would be many times saltier than the current Santa Clara Slough water and there would be much less water. This would have serious impacts on the Cienaga de Santa Clara.

Another major issue facing the Lower Basin is the future of the Salton Sea. The Salton Sea is currently maintained by about 1 maf/year of agricultural return flows and drainage water from the Imperial Irrigation District (IID). Impacts of the implementation of the California 4.4 Plan on the Salton Sea is currently the subject of a comprehensive environmental effort.

**Impact of Climate Change on the Environmental Issues**

As the frequency of shortages increases in the future, the competition between water for human uses and environmental uses will become more intense. Without shortages, 100,000 af/year of water in the Santa Clara Slough is not a major problem. However, with routine shortages, the CAP and SNWA will put intense pressure on Reclamation to operate the Yuma Desalter to reduce deliveries to Mexico from Lake Mead. This would reduce the shortages and increase their water supplies. The CAP and NGOs have already worked out a pilot project that will look at the impacts on the wetlands if the Yuma Desalter is operated at 15 to 25% capacity level.

Similarly, the 1 maf of IID return flows into the Salton Sea is probably the largest remaining block of water in the system available for future use. Collecting, treating and using these return flows will be very expensive, but if it is the only option available, it will have to be pursued. This approach may require the importation of seawater or the bifurcation of the sea to manage salinity levels.

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196 For a more detailed description of the Welton-Mohawk Project see [www.usbr.gov/lc](http://www.usbr.gov/lc).

197 A great deal more information on the Yuma Desalter can be found on the Reclamation website. [www.usbr.gov/16](http://www.usbr.gov/16).

198 I recommend the reader visit [www.saltonsea.ca.gov](http://www.saltonsea.ca.gov).
Remedies - What Options do States or Other Parties Have to Make Changes?

If one of the seven Basin States decides that it can no longer live with the 1922 Compact or other provisions of the law of the river, what are its options? I believe there are four basic options:

1. Amend the 1922 Compact pursuant to Article VI of the Compact.
2. A Congressionally mandated change in the 1922 Compact through federal legislation.
3. Litigation.
4. Continued negotiations and dialogue among the basin states and the federal government.

Article VI provides an internal method of addressing any claim or controversy that might arise between two or more of the signatory states. It provides that the governors of the states affected appoint commissioners. The commissioners must first reach an agreement which then would have to be ratified by each of the affected states.

As a practical matter, it is very unlikely that Article VI could ever be used to address the most controversial issues. Each state has two chances to say “no,” its commissioner and then the legislature.

Asking Congress to amend the 1922 Compact is also unlikely to succeed. The idea that Congress has the power to unilaterally amend an interstate compact is one that makes the attorneys working for the States’ Attorney General offices bristle and bare their teeth. John Carlson, in his 1986 paper, makes a reasonably strong, but not bulletproof argument for it. If Congress were to try, an unhappy state would certainly challenge it in court and the outcome would be uncertain.

However, I believe that it is more likely that Congress would never seriously consider such legislation. It is highly unlikely that legislation could succeed, especially in the U.S. Senate where there are six Lower Basin senators and eight Upper Basin senators. The practical reality is that unless there is a strong consensus, the other 86 senators are unlikely to want to set a precedent that the Senate would take sides on what is a regional non-partisan resource issue.

I do believe that it is conceivable that Congress might consider federal incentives to bring individual states to the table or keep them at the negotiating table. Federal aid on environmental or conservation projects is an appropriate example.

The third mechanism to force change is litigation. In the 1950s, Arizona determined that it was necessary to litigate in order to confirm a water supply for the CAP. It is possible, some even say probable, that in the future, Arizona or some other state may decide that it has no choice but to pursue interstate litigation.
It is well beyond my expertise and the scope of this paper to analyze the legal issues and strategies associated with interstate compact litigation. Again, I call the reader’s attention to John Carlson’s 1986 paper where he discusses the pros and cons and the legal theories from the perspective of Colorado attempting to obtain additional Colorado River water.

From a policy viewpoint, a decision by any of the Basin States to initiate Supreme Court litigation is a major policy decision with potentially huge implications for the entire region. Based on the history of the 1952 *Arizona v. California* case and most recently Colorado’s litigation with Kansas involving the Arkansas River, a Supreme Court case involving the 1922 Colorado River Compact would likely:

1. Take ten to twenty years for resolution.

2. Involve considerable expense to each state for attorneys, engineers, research and the costs of a special master.

3. During the litigation it is possible, if not probable, that federal actions on major project permits, mainstem reservoir operating criteria, Indian water rights settlements and even the continued federal funding of water-related conservation programs would be on hold.

4. The U.S. Supreme Court would ultimately make a decision, but the losing party or parties would still have ample opportunity to frustrate, delay or challenge in other venues the winning party or parties. The CAP subordination in the 1968 CRBPA is a good example.

5. A U.S. Supreme Court decision would almost certainly not be a solution to the water problems facing the Basin. At the end of the day, both the winners and losers of a court case would still have to cooperate on practical solutions.

Recognizing that Supreme Court litigation may be too risky, states and other parties might consider litigation at the Federal District Court level involving such issues as the operation of mainstem reservoirs under the 1968 CRPBA or specific project issues under NEPA, the Clean Water Act or even the Endangered Species Act.

Historically, the individual states have generally stayed out of each other’s way on intrastate Federal permitting and state specific federal legislation. However, there are troubling signs that era could be ending. Recently, Arizona has raised concerns with Federal legislation being proposed to approve a proposed water rights settlement between New Mexico and the Navajo Nation. Before that action, the Colorado Water Conservation Board (CWCB) wrote a letter to the Bureau of Land Management (BLM) raising questions concerning the SNWA’s efforts to obtain a BLM right-of-way for a pipeline to convey agricultural water from the Virgin River Basin to Las Vegas.\(^{199}\)

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\(^{199}\)This issue has been temporarily resolved by the proposed Seven States agreement.
The final, and perhaps least risky remedy, is for the seven Basin States and Federal Government to continue discussions and dialogue. The success of the Interim Surplus Guidelines and the success, to date, of the Seven State proposal for shortage criteria are good signs. However, the reality may be that these examples are the low hanging fruit.

The underlying assumption has been that the shortage criteria will be used relatively infrequently and that some day conditions in the Basin will return to “normal.” If in the future, as the science suggests, shortages become the “normal,” then the negotiations and dialogue will be much more challenging. Unless the states are willing be to more candid on the issues and posture less, negotiating an umbrella agreement that recognizes the reality of overall less water in the Basin is going to be a major challenge.

I can see at least three major flashpoints that, if negotiations are not successful, litigation may be likely:

1. If in the future, shortages are common and the SNWA is frustrated or stopped in its efforts to obtain in-state groundwater sources.\(^{200}\)

2. If in the future, shortages are common, the Salt River Project yield is diminished and the CAP experiences routine shortages to its major municipal users in central Arizona. At that point, Arizona will have to either purchase very expensive Indian water or litigate or both. Arizona’s history points toward litigation.

3. Uncertainty over a firm water supply for a new large transmountain diversion forces Colorado to challenge the Upper Basin delivery obligations to the Mexican Treaty.

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\(^{200}\)During preparation of this paper, the Nevada State Engineer made a decision on SNWA’s claims in north central Nevada. The State Engineer gave the SNWA about 50% of the water it was seeking.
At the January 2007 IBCC meeting, I raised a number of major Colorado River policy issues:

1. How much Colorado River water can Colorado reasonably develop?

2. Does Colorado develop its remaining Colorado River water on a “firm” yield basis or an “average” yield basis?

   Subsets of this question are:

   a. How will Colorado administer a curtailment caused by a delivery obligation under the 1922 Compact?

   b. Given the 10 year obligation under Article III (d) of the 1922 Compact, how can Colorado develop new junior projects without injuring post 1922 seniors?

   c. If Colorado over develops its Colorado River Compact entitlement and a curtailment occurs, which water users are at risk?

3. Is the prior appropriation doctrine the appropriate policy mechanism for Colorado to develop its remaining compact entitlement?

   a. If not, should the remaining water be allocated among the four major sub-basins, each represented by a Roundtable, and the Front Range?

   b. If not, what legal mechanism could be used to implement an intrabasin compact?

   c. If the prior appropriation doctrine is the appropriate policy mechanism to develop the State’s remaining compact entitlement, what other policy reasons are there for intrastate compact among the Colorado River Basins and the Front Range?

The Colorado Water Conservation Board (CWCB) has proposed funding a comprehensive study of Colorado River issues. The 2007 CWCB construction fund authorization included $500,000 for this Colorado River study. The scope of work as contemplated by the IBCC, will include addressing the questions presented in 1 and 2 above. Question 3 is a policy question facing the Roundtables.
How Much Water Can Colorado Reasonably Develop?

How much Colorado River water can Colorado reasonably develop may be the most fundamental question facing policy makers. Given the legal and hydrologic uncertainties, there is not going to be a single definitive answer. The answer will most likely be a complicated range of answers based on different assumptions. The range will have to include a careful analysis of related risk.

The question of water availability is critical to the State of Colorado because the basic assumption is that among the state’s four major river basins; the Platte, the Colorado, the Arkansas and the Rio Grande, ONLY the Colorado River Basin has water left to develop.201

There are a number of different estimates:

1. **The Nameplate Estimate:** Under the 1922 the 1948 Compacts, the Upper Basin can put to beneficial consumptive use, 7.5 maf per year and Colorado can put to beneficial consumptive use 51.75% of the Upper Basin’s apportionment (less Arizona’s 50,000 af). Therefore Colorado can consumptively use:

   \[ 0.5175 \times (7,500,000 - 50,000) = 3,855,375 \text{ af/year} \]

   This estimate assumes either:

   a. There is sufficient physical water available in the Colorado River System so that the Upper Basin can meet its delivery obligations under Article III of the 1922 Compact and consumptively use 7.5 maf per year; or

   b. The Upper Basin’s obligations under Article III (c) and (d) are subordinate to its ability to beneficially consume 7.5 maf/year under Article III (a).

   By the 1950s, Colorado and the other Upper Basin States already recognized that there was not sufficient water to meet all of the Article III provisions and although carefully preserving its legal argument, III (c) and III (d) obligations were very likely senior to its III (a) apportionment.

   It can be argued that by 1962, Congress, including Colorado’s Congressional delegation, recognized that the Upper Basin could develop less than 7.5 maf per year. In 1962, under Public Law 87-483, Congress authorized the Navajo Indian Irrigation Project and the San Juan-Chama Project. Section 11(a) of the legislation included the following provision:

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201 The South Platte River Basin is recommending the CWCB approve a SB-179 funded study of the water available for appropriation in the South Platte River Basin. It is likely that some wet year water remains available for development, but how (or if) it can be developed is the question. Just like the Front Range Roundtables have an interest in the Colorado River study, the West Slope and Arkansas Roundtables should be involved with the South Platte study.
“No long-term contract, except contracts for the benefit of the lands and for the purposes specified in sections 2 and 8 of this Act, shall be entered into for the delivery of water stored in Navajo Reservoir or any other waters of the San Juan River and its tributaries, as aforesaid, until the Secretary has determined by hydrologic investigations that sufficient water to fulfill said contract is reasonably likely to be available for use in the State of New Mexico during the term thereof under the allocations made in articles III and XIV of the Upper Colorado River Basin Compact, and has submitted such determination to the Congress of the United States and the Congress has approved such contracts.”

Had Congress believed the Upper Basin could consume 7.5 maf/year, then there would be no reason for the Secretary to conduct any “hydrologic investigations.” The answer as to how much water would be available for use in New Mexico would be:

\[0.1125 \times (7,500,000 - 50,000) = 838,125 \text{ af/year}.
\]

The “hydrologic investigations” became formally known as a “Hydrologic Determination.”

2. **1988 Hydrologic Determination:** Note: As this paper is being prepared, the Secretary of the Interior has under consideration, approval of a revised 2007 Hydrologic Determination.

The 1988 Hydrologic Determination was formally approved by Acting Secretary Robert Broadbent on February 2, 1989. The 1988 Determination found that there was 6.0 maf per year of reasonably available water for use in the Upper Basin. Colorado’s share of 6.0 maf is:

\[0.5175 \times (6,000,000 - 50,000) = 3,079,125 \text{ af/year}.
\]

The 1988 Determination was an update of a 1984 Determination which found 5.8 maf/year was reasonably available for use in the Upper Basin. New Mexico asked Interior to update the 1984 report so additional contracts for Navajo Reservoir water could be made available to New Mexico users.

There are a number of previous important aspects of the 1988 Hydrologic Determination that need to be amplified:
a. Under the 1962 statute, the Hydrologic Determination only applies to New Mexico and to contracts for Navajo Reservoir water within New Mexico. Technically, it does not apply to federal contracts or water uses in any of the other Basin States.

b. The other Upper Basin States consider the hydrologic determinations relevant because it is similar to a firm yield calculation. Although similar to a firm yield calculation, the legislation specifically use the wording “reasonably likely to be available.” Thus, the Secretary has broad discretion on what is meant by “reasonably likely.” It is probably a lower standard than a firm yield standard. In fact, in the 1988 Hydrologic Determination the Secretary assumed that during the 1953-1977 critical period, a 6% shortage over the period is acceptable. The rationale for this is that during the critically dry period, the physical water available for upstream use is limited.

c. In addition to the 6% shortage criteria, in the 1988 Hydrologic Determination, it made a number of other critical, and possibly controversial assumptions.

• 1953-1977 is the critical hydrologic period. Note: this critical period overlaps, but it is different than the 1953-1964 critical period used in the calculation of the 602 (a) storage trigger.\(^\text{202}\)

• The Secretary assumed that the Upper Basin obligation to the Lower Basin is 8.25 maf/year; 7.5 maf/year for the Lower Basin and .75 maf/year for the Mexican Treaty obligation.\(^\text{203}\) The 1988 Determination included a disclaimer on interpreting the law of the river, but as a practical matter, the modeling has to include a release from Glen Canyon Dam.

This, of course, is a very controversial assumption. If the Secretary had assumed an annual delivery of less than 8.25 maf/year, even in the occasional wet years, then the Upper Basin would have more than 6.0 maf/year. If the Secretary had assumed an annual delivery of more than 8.25 maf/year (to include transit losses), the Upper Basin would have had less than 6.0 maf/year.

• The Secretary also assumed that in the operation of the CRSP reservoirs, minimum power pools would be protected, and that over the critical period CRSP evaporation was the same as average evaporation over the entire study period, 560,000 a.f/year.

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\(^{202}\) The 1953-1977 period is more critical than 1953-1964 because due to the modeling there actually more storage in Powell at the end of 1952 than the 602 (a) amount needed to cover 1953-1964.

\(^{203}\) Recall that with an 8.25 maf/year Upper Basin Deliveries the release from Glen Canyon Dam is 8.23 maf/year with the Paria River providing another .02 maf/year.
3. **2007 Hydrologic Determination:** In 2006, New Mexico again asked the Secretary to update the 1988 Determination. New Mexico needs additional water capacity (beyond 11.25% of 6.0 maf) in order to comply with the water rights settlement it has negotiated with the Navajo Nation. The Navajo Nation settlement includes a municipal pipeline that will convey 20,000 af of water from the San Juan River south through the Navajo Reservation to Gallup, New Mexico. Because New Mexico only gets 11.25% of the Upper Basin allotment, in order to provide New Mexico with an additional 20,000 af, the Upper Basin’s yield must increase by about 200,000 af.

The hydrologic analysis to support the 2007 Determination was conducted by the Upper Colorado River Region of the Bureau of Reclamation. Rather than use Reclamation’s Colorado River model (CRSS), Reclamation prepared a simple spreadsheet model. This spreadsheet was then used to look at a number of different alternatives.

Perhaps the major difference between the proposed 2007 Determination and the 1988 Determination is how the modeling handles CRSP reservoir evaporation. For the 2007 version, evaporation is calculated based on actual reservoir content, therefore, during the 1953-1977 critical period CRSP evaporation is much lower than average. In fact, it averages only 267,000 af per year (as opposed to over 500,000 af per year in the 1988 Determination). There are four individual years when total Upper Basin storage is zero and evaporation is reduced to the amount caused by the dead pools, 133,000 af/year.

Although for the 2007 Determination, Reclamation actually looked at over 20 different model runs that varied based on demand levels, protection of the power pools, use of the power pools and different levels of shortages, the major difference is the treatment of evaporation. Assuming the same basic assumptions that a 6% shortage is acceptable and using the same 1953-1977 critical period, Reclamation has recommended that the Secretary can conclude that the Upper Basin States can reasonably develop 5.76 maf per year- EXCLUDING CRSP evaporation. The net effect of this is to provide the Upper Basin with over 200,000 af per year of additional consumptive use.

Using this methodology, Colorado’s share of the Upper Basin’s 5.76 maf/year is:

\[0.5175 \times (5,760,000 - 50,000) = 2,955,000 \text{ af}\]

There are a number of controversies related to the 2007 Determination:

- It uses the same critical period 1953 to 1977. It does not utilize the available paleohydrology record and it completely ignores the conclusions and warnings of the recent National Academies of Sciences Report on the Colorado River.
• The spreadsheet model uses all available upstream storage, not just CRSP storage. The model draws on all (Federal and non-federal) sources of storage to meet both Upper Basin in-basin demands and the Upper Basin deliveries at Lee Ferry. At the 5.76 maf/year demand level, the model shows that all Upper Basin storage would be completely depleted in four separate years, 1964, 1967, 1968 and 1977. This is unrealistic, major water suppliers such as Denver Water, can never allow storage to be depleted to zero.

• The 2007 Determination assumes that shortages are acceptable (up to 6% over the 25 year period), but in individual years, the shortage can be as much as 2.5 to 3 maf/year. The May 7, 2006 memo from Randy Seaholm to the CWCB is attached as Appendix D. The appendix is the spreadsheet results from runs of study No. 18, an assumed Upper Basin use of 5.76 maf/year. It should also be noted that there are no deliveries from Glen Canyon Dam in excess of 8.23 maf/year for a 53 year period from 1931-1983.

Alternative Hydrologic Determinations

Using the same spreadsheet model that Reclamation developed for the 2007 Determination, I have used the estimated natural flows at Lee Ferry for the period of 1800-1904 from the Woodhouse reconstruction “Lees-B.” The 1800-1904 period is considerably drier than 1905-2000. The average natural flow at Lee Ferry is 14.23 maf/year as opposed to 15.28 maf/year.

The critical period for the 1800s is now 1871-1904. Based on this hydrology and on similar assumptions, a 6% shortage and protect power pools or no shortage but do not protect power pools, the Upper Basin yield could be as low as 5.25 maf/year plus CRSP evaporation.

At the 5.25 maf/year level Colorado’s share is:

\[ .5175 \times (5,250,000 - 50,000) = 2,691,000 \text{ af plus CRSP evaporation.} \]

From 2004 through mid 2006, the River District provided financial support for Julia Keedy, a graduate student and water research assistant at Colorado State University. A summary of Keedy’s research and Masters thesis was published in the December 2006 edition of Colorado Water, newsletter of the Water Center of Colorado State University. Keedy’s research looked at the Colorado River system under historical hydrology, paleohydrology and stochastic methods. Using the Reclamation CRSS model, Julia estimates that the long term firm yield of the Upper Basin is 5.7 maf/year including CRSP evaporation.205

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204My decision to use “Lees B” is similar to the Academy of Sciences report. It has the largest value for R².

205Presentation to the CRWCD Board of Directors on July 16, 2006.
Assuming 350,000 to 400,000 af/year of CRSP evaporation during the critical periods, her results are very similar to the Reclamation spreadsheet model using the 1871-1904 hydrology. Subtracting 400,000 af of CRSP evaporation from a total yield of 5.7 maf gives the Upper Basin a usable firm yield of about 5.3 maf/year.

**Impact of Climate Change on the Hydrologic Determination**

One of the biggest potential problems with the 2007 update of the Hydrologic Determination is that it ignores all of the science that concludes that the future is likely to be drier than the past and it ignores the current 2000-2007 drought period.

If the 2000 to 2007 dry period is extended for five more years with an assumed natural inflow to Lake Powell of 11,100,000 af/year (= 75% of normal), then the Upper Basin’s yield drops to about 5,200,000 to 5,300,000 af/year using the same assumptions as the proposed 2007 update. Appendix E shows the model results with a 2000-2012 update. Colorado’s share would be about 2.7 maf/year.

**Bottom Line:** Using a continuation of the 2000 to 2007 dry period through 2011, and assuming a continued release of 8.25 maf/year to the Lower Basin, Colorado’s reasonable yield from the Colorado River is approximately 2,700,000 af/year.

If Colorado River flow continues to decline beyond the levels seen in 2000 through 2007, then even 2.7 maf/year may be an optimistic estimate. If climate change drops the critical period (not the average flow) below about 10.7 maf/year, it could be argued that Colorado is already using its full entitlement.

**How Much Water is Colorado Currently Using?**

According to the Consumptive Uses and Losses Report, Colorado’s average use from 1988-2004 was 2,108,000 af/year. This figure does not include Colorado’s share of CRSP evaporation.

During this 16 year period, the two highest years of use were 1989 with 2,406,000 af and 2000 with 2,377,000 af. The lowest two years were 1995 with 1,711,000 af and 1999 with 1,780,000 af. Colorado’s depletions from 1970-2004 are shown on Figure V-5.

How good are the data? The CWCB staff believes that there may be problems with the data.

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206 Julia did not use Lees B, she used a trace which has a slightly higher average natural flow at Lee Ferry (14.9 maf/year vs. 14.5 maf/year).

207 I’ve chosen 1988 to 2004 because during this period, Colorado’s uses appear to be flat. If anything, there is a slight downward, but statistically insignificant trend.
Appendix F is a July 10, 2006 memo from Ray Alvarado to the CWCB identifying problems with the use of the modified Blaney-Criddle methodology to determine the consumptive use of pasture grasses grown at elevations of greater than 6,500 feet. Figure 2 of the memo shows that in some years, there could be 100,000 to 200,000 af/year of difference. The USBR Consumptive Uses and Losses Report is underestimating consumptive use by this amount.

However, it is not a simple matter just to add in additional uses. The natural flows are calculated as observed flow plus depletions, so Reclamation may also underestimate natural flows, and under the 1948 Compact Colorado would get 51.75% of any additional natural flows (especially in the critical period). Hopefully, the Colorado River study being proposed by the CWCB will address this issue in some detail.

Though imperfect, the Consumptive Uses and Losses Report is still the best comprehensive source of information.

When considering how much water Colorado has for development, projects currently underutilized and projects under construction must be considered. The underutilized projects include Denver’s Dillon Reservoir/Roberts Tunnel, Northern’s Windy Gap Project and a number of West Slope reservoirs and projects; Green Mountain, Ruedi, Wolford Reservoirs and the Dallas Creek Project. The Animas-La Plata Project is currently under construction. Additionally, there are a number of projects where the owners believe that additional diversions will happen in the future. Those projects include Twin Lakes, the Fryingpan-Arkansas Project, and Denver’s Moffat System Project. When these additional depletions are added in it could result in another 150,000 to 200,000 af of annual depletions. The biggest unknown is probably the consumptive uses associated with the Animas-La Plata Project. The project is permitted for an additional depletion of 57,000 af per year, but it is unlikely that it will reach that level of depletions for many years, if ever.

Considering existing infrastructure, Colorado has the capability of diverting about 2.3 maf/year on average to 2.6 maf/year maximum.

**How Will Climate Change Impact Future Depletions on Existing Projects?**

I believe the answer to this question is relatively straightforward. As growing seasons lengthen and temperatures increase, existing projects and existing development will consume more water. Denver Water has determined that it could see a 6% increase in demands. These results are entirely consistent with the CWCB concerns with the modified Blaney-Criddle methodology. Applying a 6% increase to existing uses means that Colorado’s current usage, with no additional projects, is in the range of 2.45 maf/year average to 2.75/year maximum.

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201 The technical problem is that the modified Blaney-Criddle method uses an average daily temperature. At higher elevations the average daily temperature understates the daily high temperature which is important to evapotranspiration. Of course, there is nothing magical about 6,500’ as the elevation increases, so does the typical diurnal. Climate change could aggravate this problem.

202 See footnote 166.
How will Colorado Administer a Compact Call?

The question of how Colorado will administer a compact call on the Colorado River system is a risk issue. The question addresses the underlying reliability or certainty of post 1922-water rights. The risk of a 1922 Compact call is real, but probably not eminent. It is likely that before a call were to occur most of the difficult legal issues identified in the previous chapter will have to be resolved. Resolution of these issues could take ten to twenty years. However, with the impacts of declining hydrology and within the lifetime of the project-related decisions that we are addressing today, a compact call is a real possibility. Therefore, I believe it is important that Colorado begin addressing call related issues today.

The State of Colorado has considerable experience with the administration of interstate compacts. On the Rio Grande and Arkansas River systems, compact administration is routine. The Colorado River system may present new and different challenges to those presented in the Rio Grande and Arkansas systems. The Upper Basin’s obligation under the 1922 Compact is a ten year moving average, not an annual delivery. This means that what juniors do in the earlier years affects seniors once a call is placed. The payback provision of the 1948 Compact puts an additional burden on the State of Colorado if it uses are greater than 51.75% of the Upper Basin’s share during any of the previous ten years.

At the January 2007 IBCC meeting, Jeris Danielson stated that when he was State Engineer, he believed there were two basic options administering a call under the 1922 Compact:

1. using the priority system on a Colorado River basin-wide basis; or

2. asking each major basin to deliver a certain percentage of a call based on the natural flow in each basin, then using the appropriation doctrine or alternative mechanism within each basin.

There are other suggestions as well.

3. Denver Water staff suggested reducing all post 1922 water rights in a proportionate manner. All rights would be reduced equally based on actual consumptive use.

What entity makes this fundamental decision, the State Engineer, the Colorado Legislature, the Supreme Court, or is it a possible subject for intrastate compacts among the Roundtables? How does Colorado decide we’ve reached a limit?

The ten year commitment raises a number of new and very challenging issues:

- How does Colorado address water in reservoirs that was stored in the years prior to a call? Should water stored in previous years by juniors be delivered before impacting seniors during the call year?
• How does Colorado address Colorado River water stored on the East Slope that cannot be put back into the Colorado River system? For example, Denver Water’s Dillon system is senior in priority to the Fryingpan-Arkansas Project, yet water stored in Dillon (during the call year or in previous years) is physically available to release for a call, but water stored in Turquoise or Pueblo Reservoirs are not.

• How do we protect uses that cannot be curtailed such as municipal indoor use and thermal power plant cooling water? A common assumption has been that the State of Colorado could redistribute (at a price) the pre-1922 Compact consumptive uses. Under the 1922 Compact is it legal to augment post-1922 depletions with pre-1922 depletions? On the West Slope, much of the pre-1922 depletions are associated with water rights held by the United States that may be appurtenant to the underlying lands.

• At some point in the future, will new junior uses have to augment their depletions impacts to seniors on a full ten year basis?

• Should Colorado consider curtailing uses in advance (in anticipation of a call) in order to insure protection of seniors? Does Colorado adopt a strategy similar to the 602 (a) trigger where juniors can only divert when CRSP storage is above 602 (a). This is similar to the situation on the Rio Grande where juniors in Colorado can only divert when Elephant Butte Reservoir in New Mexico is spilling.

• There are some compact matters addressed in existing decrees. For example, the Blue River Decrees which adjudicates the water rights for the C-BT Project and incorporates SD-80, already address compact related curtailments on the Blue River and Upper Colorado River. The decree makes C-BT uses senior to Denver and Colorado Springs and within the C-BT gives Green Mountain priority over East Slope uses.

• Is it possible that the only acceptable strategy is to avoid a 1922 Compact call? If so, how do we accomplish this and what is the cost? How much wet year water is left on the table if Colorado uses this approach?

The administration of a 1922 Compact call is going to be very complicated. Many new issues will surface as the process proceeds. I recommend that each of the Colorado River Basin Roundtables begin discussing the basics of this issue. At the January 2007 IBCC meeting, CWCB member Eric Wilkinson stated that the CWCB believes that compact administration options is an essential part of the proposed CWCB study. How will the study address the specifics of the issue? What role will the Roundtables have in guiding the issue? These questions all need to be resolved.
How Much Colorado River Water Does Colorado Have Left to Develop?

The following table shows Colorado’s potential water remaining based on risk. I present this table as an example. The numbers are mine. Others may disagree with my assumptions, but I believe the concept of tying risk to remaining development is what is important. This table displays the concept.

**Table VII-1: Risk Factors**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Remaining to be Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little or No Risk</td>
<td>0 to 150,000 af/year</td>
</tr>
<tr>
<td>Moderate Risk</td>
<td>150,000 to 300,000 a.f/year</td>
</tr>
<tr>
<td>High Risk</td>
<td>300,000 to 600,000 af/year</td>
</tr>
<tr>
<td>Extremely High Risk</td>
<td>600,000 to ? af/year</td>
</tr>
</tbody>
</table>

**TABLE NOTES**

1. Little or no risk assumes that climate change will impact future Colorado River flows by a moderate amount, perhaps 10% or more. It also assumes that existing users will accept little or no risk of future curtailment and that the Upper Basin will continue delivery of 8.25 maf/year at Lee Ferry, as modified by the coordinated reservoir operations. Under this scenario Colorado’s current projects could consume about 2.45 maf/year with supply about 2.5 maf/year + .1 maf (or less).

2. Moderate risk assumes that climate change will impact flows but only in the range of 5% to 10% and that the Upper Basin will continue delivery of 8.25 maf/year at Lee Ferry, as modified by the coordinated reservoir operations. Colorado’s current infrastructure can consume about 2.45 maf/year, and supplies are in the 2.7 maf/range + .1 maf. There would be a chance of compact curtailment, but the impact of a curtailment would be manageable and the risk acceptable to existing users.

3. High risk assumes that climate change has no impacts on future stream flows and only a moderate impact on consumptive uses. It assumes that uses are about 2.4 maf/year and supplies up to 2.9 maf/year + .1 maf. It also assumes no change or small changes in Upper Basin deliveries of 8.25 maf per year to the Lower Basin. The chances of a future compact curtailment are high, curtailments would be relatively rare, but when they occurred the impacts could be significant.

4. Extremely high risk assumes no impacts in flows or consumptive uses due to climate change or that Colorado is not concerned with the impact of a call. It also assumes that at some point, in the future, the Secretary of the Interior or the Supreme Court reduces the Upper Basin’s 8.25 maf/year delivery to the Lower Basin. Current uses
are in the 2.3 to 2.4 maf/year range, but supplies are 3.0 maf/year or more. Chances of a compact curtailment are also very high. It is possible that a curtailment could cut back all post 1922 water rights for several years. Chances of litigation under this scenario are also very high.

**Is the Prior Appropriation Doctrine the Appropriate Policy Mechanism for Colorado to Develop Its Remaining 1922 and 1948 Compacts Entitlement?**

This question may be the most fundamental question facing the Roundtables, IBCC and the State. There are a number of proposals on the table for development of major projects. Some of these projects have proponents, others are just concepts:

1. The “Northern or Yampa Straw” which would divert up to 300,000 af per year from the Yampa River to the Front Range.

2. The “Aaron Million or Flaming Gorge Straw” which would divert from 175,000 to 450,000 af per year from Flaming Gorge Reservoir then pump it to the Front Range via I-80 and I-25.\(^{210}\)

3. The “Big Straw” which would pump up to 500,000 af per year through one of three basic routes from the Colorado River below Grand Junction to the Front Range.

4. The “Blue Mesa Straw” which would pump up to 300,000 af per year from Blue Mesa Reservoir to the Front Range.

All of these projects have two things in common. Each will cost billions of dollars and each has the potential to divert what might be all of Colorado’s remaining Colorado River water to the Front Range. Depending on one’s perspective, “might” could be replaced with “probably.”

Without answering major unresolved legal and scientific questions such as the Upper Basin’s Mexican Treaty obligation and the impact of climate change on Colorado River flows, can we seriously consider these kinds of projects? Would the citizens of Colorado ever vote to raise their taxes or allocate existing state revenues to subsidize one of these multi-billion dollar projects without answering these basic questions? Could project proponents ever finance one of these projects through revenue-based bonds without answering these basic questions?

Can we get statewide support for one of these major projects without addressing the future needs of all of the Colorado River Basin Roundtables? Or do we need to do what Delph Carpenter proposed in 1922, protect the future legitimate needs of all impacted parties?

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\(^{210}\)Initially, Mr. Million indicated that his project would divert 300,000 to 450,000 af/year, but Reclamation has determined it may have only about 175,000 af/year available.
I believe that we need to take a careful look at the issues of risk. Are there alternatives to these major straws that might provide for the needs of each of the Roundtable basins and the Front Range at a more reasonable risk? Is the prior appropriation doctrine the appropriate mechanism to allocate the remaining Colorado River water? If not, what are the alternatives? How do we legally implement these alternatives? Could the solution be an umbrella interstate compact among the four Colorado River Basins and the Front Range?

**Concluding Remarks and Challenges**

The goal of this paper is to educate HB-1177 Roundtable members and encourage a transparent discussion of the Colorado River water issues facing the State of Colorado. I would encourage Roundtable members to consider the issues I’ve raised, but also recognize that there are different views on the subject matter.

The study of the Colorado River yield is going to be an important tool for both the Roundtables and the entire state and may provide some of the answers. I would recommend each Roundtable actively participate in both the scoping and the actual conduct of the study. Many of the study conclusions will not be simple or straightforward. It is important that we get it right and that we have confidence in the study. Confidence in the study results will allow the HB-1177 process to move forward in a manner that can benefit each basin, the West Slope and the entire State of Colorado.

If individual Roundtable members have questions or additional thoughts I can be reached at ekuhn@crwcd.org or at (970) 945-8522.
Glen Canyon Dam Flushing Flows (USBR Website)
APPENDICES

Appendix A: November 24, 1922 Colorado River Compact


Appendix C: 602 (a) Formula (Source: Short Criteria DEIS, Appendix A)

Appendix D: May 7, 2006 Memo from Randy Seaholm, CWCB Staff to the CWCB (Subject: Upper Colorado River Basin Hydrologic Determination)

Appendix E: Upper Basin Yield Mass Balance Analysis Modified to show a 2000-2012 Period with 11.1 MAF year, Natural Inflow to Lake Powell (Source E. Kuhn)

Appendix F: July 10, 2006 Memo from Ray Alvarado, CWCB Staff to the CWCB (Subject: Consumptive Use & Losses and High-Altitude Crop Coefficients)
References


12. Minutes of the first eighteen sessions of the Colorado River Compact Commission, November 1922.


