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United States Department of the Interior

BUREAU OF RECLAMATION

Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City, Utah 84138-1147



UC-410
ADM-1.10

MEMORANDUM

To: Director, Policy and Program Services
Attention: 84-52000 (AMorgan)

From: Larry Walkoviak *Larry Walkoviak*
Regional Director, Upper Colorado Region

JUN 23 2009

Lorri Gray-Lee *Lorri Gray-Lee*
Regional Director, Lower Colorado Region

JUN 25 2009

Subject: Transmittal of the Basin Study Proposal – Colorado River Basin States

It is our pleasure to transmit the attached Basin Study Proposal developed collaboratively among the seven Colorado River Basin States and the Bureau of Reclamation. The proposed study will analyze the water supply and demand imbalances throughout the Colorado River Basin and those adjacent areas of the Basin States that receive Colorado River water through 2060, assess options for resolving imbalances, and develop recommendations for future consideration to address current and projected imbalances. Paramount to the Basin Study will be an assessment of the potential impacts of climate variability and climate change on both water supplies and demands.

The study will be cost-shared 50-50 between the seven Colorado River Basin States and Reclamation. The study is widely supported across the Basin, as evidenced by the letters of support attached to the proposal.

The Upper and Lower Colorado Regions and the seven Colorado River Basin States fully endorse this Basin Study effort. Should you have questions, please contact Ms. Deborah L. Lawler at 801-524-3685 or by email at dlawler@usbr.gov or Ms. Amber Cunningham at 702-293-8472 or by email at azcunningham@usbr.gov.

Attachment

COLORADO RIVER BASIN WATER SUPPLY AND DEMAND STUDY

A Proposal Submitted for Consideration under the Basin Study Program
June 2009

A. Project Information

1. Title

Colorado River Basin Water Supply and Demand Study

2. Location

The study area for the Colorado River Basin Water Supply and Demand Study (Basin Study) includes the Colorado River Basin as identified in Figure 1 and those adjacent areas of the Basin States that receive Colorado River water.

Figure 1. Study Area of the Colorado River Basin Water Supply and Demand Study



3. Total Study Cost

The total study cost is estimated to be \$2 million, to be cost-shared equally (a 50:50 percent split) between Federal and non-Federal Cost-Share Partners. The non-Federal cost-share contribution will consist of both direct (cash) and in-kind services.

4. Cost-Share Partners

Primary contacts for each of the non-Federal Cost-Share Partners are listed below:

Organization	Primary Contact	Contact Information
Arizona Department of Water Resources	Perri Benemelis	Colorado River Management 3550 North Central Avenue Phoenix, AZ 85012 (602) 771-8408 pfbenemelis@azwater.gov
Central Arizona Project	Tom McCann	Manager, Resource Planning and Analysis P.O. Box 43020 Phoenix, AZ 85080-3020 (623) 869-2343 tmccann@cap-az.com
Colorado River Board of California	Jerry Zimmerman	Executive Director 770 Fairmont Avenue, Suite 100 Glendale, CA 91203 (818) 500-1625 x308 grzimmerman@crb.ca.gov
Colorado River Commission of Nevada	George Caan	Executive Director 555 E. Washington Avenue, Suite 3100 Las Vegas, NV 89101-1065 (702) 486-2670 gcaan@crc.nv.gov
Colorado Water Conservation Board	Randy Seaholm	Chief, Water Supply Protection 1313 Sherman Street, Room 721 Denver, CO 80203 (303) 866-3441 ext. 3233 Randy.seaholm@state.co.us
Metropolitan Water District of Southern California	Bill Hasencamp	Manager, Colorado River Resources 700 N. Alameda Avenue Los Angeles, CA 90012 (213) 217-6520 whasencamp@mwdh2o.com
New Mexico Interstate Stream Commission	John Whipple	Colorado River Program Manager PO Box 25102 Santa Fe, NM 87504-5102 (505) 827-6172 john.whipple@state.nm.us

Six Agency Committee (representing the following agencies)	Bart Fisher	Chairman 770 Fairmont Avenue, Suite 100 Glendale, CA 91203 (818) 500-1625 bart@fisherwireless.com
Coachella Valley Water District	Steve Robbins	General Manager P.O. Box 1058 Coachella, CA 92236 (760) 398-2651 srobbins@cvwd.org
Imperial Irrigation District	Brian Brady	General Manager P.O. Box 937 Imperial, CA 92251 (760) 339-9477 bjbrady@iid.com
Los Angeles Department of Water and Power	James McDaniel	Senior Assistant General Manager, Water Systems P.O. Box 51111 Los Angeles, CA 90051 (213) 367-1022 james.mcdaniel@ladwp.com
Metropolitan Water District of Southern California	Bill Hasencamp	Manager, Colorado River Resources 700 N. Alameda Avenue Los Angeles, CA 90012 (213) 217-6520 whasencamp@mwdh2o.com
Palo Verde Irrigation District	Ed Smith	General Manager 180 West 14 th Avenue Blythe, CA 92225 (760) 922-3144 ed.smith@pvid.org
San Diego County Water Authority	Maureen Stapleton	General Manager 4677 Overland Avenue San Diego, CA 92123 (858) 522-6781 mstapleton@sdcwa.org

Southern Nevada Water Authority	Bill Rinne	Director of Surface Water Resources 100 City Parkway, Suite 700 Las Vegas, NV 89193-9956 (702) 691-5255 Bill.rinne@snwa.com
Upper Colorado River Commission	Don Ostler	Executive Director 355 South, 400 East Salt Lake City, UT 84111 (801) 531-1150 dostler@usbr.gov
Utah Division of Water Resources	Robert King	Chief, Interstate Streams 1594 West, North Temple Street Salt Lake City, UT 84114-6201 (801) 538-7259 robertking@utah.gov
Wyoming State Engineer's Office	John Shields	Interstate Streams Engineer Herschler Building, 4 th East Cheyenne, WY 82002-0370 (307) 777-6151 jshiel@seo.wyo.gov

5. Reclamation Regional Contacts

The Colorado River Basin spans two Reclamation regions, the Upper Colorado Region and Lower Colorado Region. Both regions will be heavily involved in the proposed Basin Study. Primary contacts are listed below:

Region	Primary Contact	Contact Information
Lower Colorado Region	Terry Fulp	Deputy Regional Director Lower Colorado Region Boulder City, NV 89006 (702) 293-8411 tfulp@usbr.gov
Upper Colorado Region	Dave Trueman	Director, Resources Management 125 South State Street Salt Lake City, UT 84138 (801) 524-3759 dtrueman@usbr.gov

6. Supporting Stakeholders

The following Colorado River Basin stakeholders have expressed their support of the proposed Basin Study (see Section C.6 and Attachment 1):

- Arizona Municipal Water Users Association
- Arizona Public Service Company, Four Corners Power Plant
- Black & Veatch Corporation
- Bloomfield Irrigation District
- City of Farmington, New Mexico
- City of Los Angeles, California, Department of Water and Power
- City of Phoenix, Arizona
- Colorado River District
- Denver Board of Water Commissioners
- Environmental Defense Fund
- Hammond Conservancy District
- Imperial Irrigation District
- LaPlata Conservancy District
- Lower Valley Water Users Cooperative Association
- Mohave County Water Authority
- North Gila Valley Irrigation District
- Northern Colorado Water Conservancy District
- Northern Colorado Water Conservancy District, Municipal Subdistrict
- PNM Resources
- San Juan Agricultural Water Users Association
- San Juan Water Commission
- San Diego County Water Authority
- Southern California Water Committee Incorporated
- State of Colorado, Department of Natural Resources, Division of Water Resources
- State of Nevada Office of the Governor
- The Jicarilla Apache Nation
- The Nature Conservancy
- The Navajo Nation, Department of Water Resources
- The Southwestern Water Conservation District
- The State of Arizona, Game and Fish Department
- Trout Unlimited
- Unit "B" Irrigation District
- United States Department of the Interior, Fish and Wildlife Service
- United States Fish and Wildlife Service, Arizona Ecological Services Field Office
- Water Utility Authority, Albuquerque Bernalillo County
- Wellton-Mohawk Irrigation and Drainage District
- Western Water Assessment
- Yuma Irrigation District

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B. Abstract

Spanning parts of the seven states of Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming (Basin States), the Colorado River Basin (Basin) is one of the most critical sources of water in the West. The Colorado River and its tributaries provide water to over 30 million people for municipal use, supplies water used to irrigate nearly 4 million acres of land, and is also the lifeblood for at least 15 Native American tribes, 7 National Wildlife Refuges, 4 National Recreation Areas and 5 National Parks. Hydropower facilities along the Colorado River provide more than 4,200 MW of generating capacity, helping to meet the power needs of the West and offset the use of fossil fuels. The Colorado River is also vital to Mexico to meet both agricultural and municipal water needs.

Water supply and demand imbalances already exist in some geographic areas in the Basin and are projected to increase in both magnitude and spatial extent in the future. Basin-wide inflow has averaged about 16.4 million acre-feet (maf) annually over the past 100 years while water use has averaged 15.3 maf since 2000. Storage capacity of approximately four times the average inflow has provided the ability to meet most demands even over periods of sustained drought, such as is currently being experienced. However, paleoclimatic studies indicate that droughts of greater severity have occurred in the past and climate experts and scientists suggest that such droughts are likely to occur in the future. Furthermore, studies have postulated that the average yield of the Colorado River could be reduced by as much as 30 percent due to climate change. Meanwhile, the Basin States include some of the fastest growing urban and industrial areas in the United States. Demand for water for other uses including the environment, recreation, and Native American water rights settlements also continues to increase. Potential future increases in temperatures in the Basin, as have been observed in most of the Basin over the past 30 to 40 years, would increase evaporation-transpiration from vegetation, leading to further increases in water use and water lost from evaporation from reservoirs. Increasing demands coupled with decreasing supplies will exacerbate imbalances throughout the Basin.

The proposed Basin Study will: analyze water supply and demand imbalances throughout the study area through 2060; assess options for resolving such imbalances; and develop recommendations to address current and projected imbalances. Paramount to the Basin Study will be an assessment of the potential impacts of climate variability and climate change on both water supplies and demands.

A large amount of high-quality data and widely-accepted, credible models exist on the Basin for assessing current and future demands and water supplies, providing the framework for the quantitative assessment of consequences of the potential imbalances.

Reclamation's Upper and Lower Colorado Regions operate and maintain most of the major dams and the associated water delivery and hydropower facilities in the Basin and will be heavily involved in the proposed study. Non-Federal Cost-Share Partners include the water management authorities and irrigation and water districts in each of the Basin States. Broad support for the study exists among stakeholders throughout the Basin and their input and participation will be sought throughout the study. The study is proposed to be conducted over a period of two years beginning at the start of fiscal year 2010 and is estimated to cost \$2 million, with an equal cost-share of 50 percent by the non-Federal Cost-Share Partners.

C. Proposal

1. The extent and consequences of existing or anticipated imbalances in water supply and demand

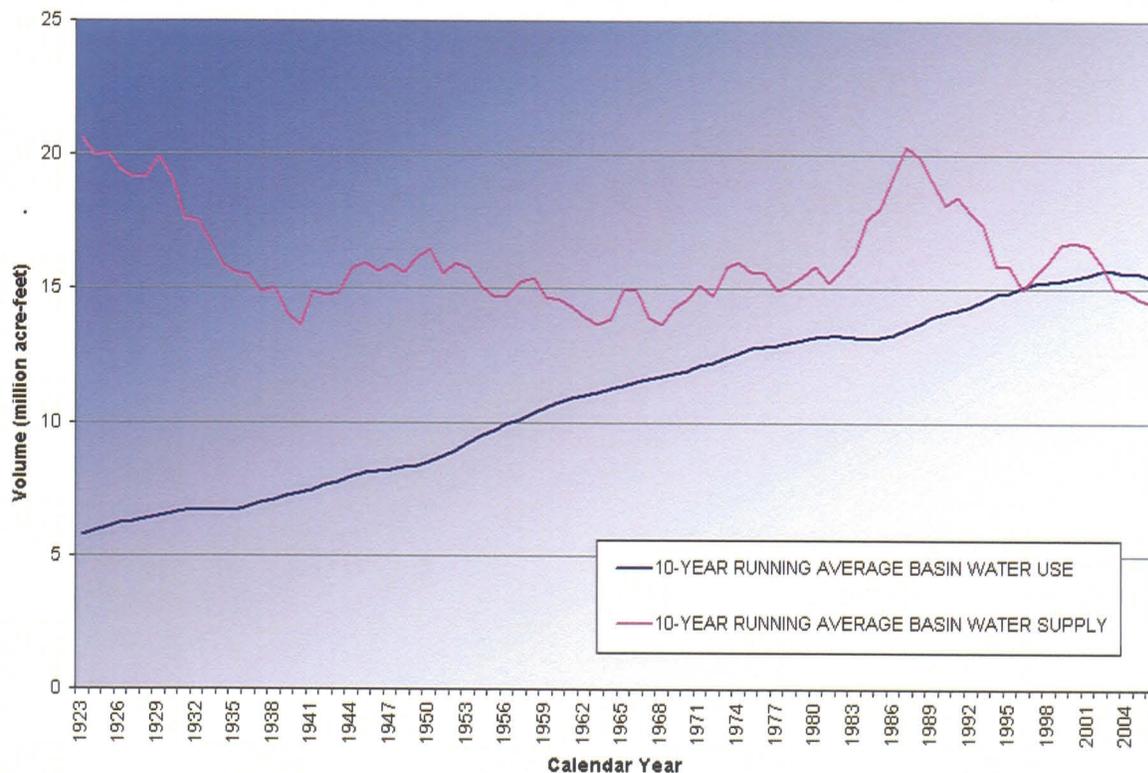
Current Imbalance between Supply and Demand. Today, more than 30 million people in the seven western states of Arizona, California, Nevada (Lower Division States) and Colorado, New Mexico, Utah and Wyoming (Upper Division States), collectively referred to as the Basin States, rely on the Colorado River and its tributaries to provide some, if not all, of their municipal water needs. That same water source irrigates nearly 4 million acres of land in the Colorado River Basin (Basin)—producing some 15 percent of the nation's crops and about 13 percent of its livestock, which combined generate more than \$3 billion a year in agricultural benefits. The Colorado River is also the lifeblood for at least 15 Native American tribes, 7 National Wildlife Refuges, 4 National Recreation Areas and 5 National Parks. Hydropower facilities along the Colorado River provide more than 4,200 MW of capacity providing vitally important electricity to help meet the power needs of the West and offset the use of fossil fuels. The Colorado River is also vital to Mexico. The river supports a thriving agricultural industry in the Mexicali Valley and provides municipal supplies for communities as far away as Tijuana.

Based on historical records from the last 100 years, the natural inflow into the Basin, which represents the Basin-wide water supply, has averaged about 16.4 million acre-feet (maf). This value is comprised of approximately 15.0 maf of natural flow into the Upper Basin and approximately 1.4 maf of natural flow into the Lower Basin. However, recent paleoclimatic studies have indicated that the long-term average natural flow at Lees Ferry may be closer to 14.7 maf. The period from 2000 through 2008 represents the lowest nine-year average natural flow at Lees Ferry in recorded history, averaging 11.7 maf per year. Although a drought of this magnitude is unprecedented in the modern history of the river, the same paleoclimatic studies show that droughts of this severity have occurred in the past.

Based on the inflows over the last century, the Colorado River is over-allocated. The Colorado River Compact of 1922 apportioned 7.5 maf each to the Upper and Lower Division States and the 1944 Treaty with Mexico allotted 1.5 maf to Mexico. Total Basin use for municipal, industrial, agricultural, tribal, recreational and environmental purposes in the United States and Mexico (including system losses such as reservoir evaporation) has averaged 15.3 maf since 2000 and the average Basin use is quickly approaching the average Basin water supply.

Figure 2 presents the 10-year running average of Colorado River water supply and water use over the past century. Since 2003, the 10-year average use has exceeded the 10-year average supply indicating that currently, an overall supply and demand imbalance exists.

Figure 2. Colorado River Basin Historical Supply and Use



Projected Imbalance between Supply and Demand. The Basin States include some of the fastest growing urban and industrial areas in the United States. Nevada, Arizona, and Utah are each ranked among the five fastest growing states in the country. The continued growth and sustainability of the communities and economies of metropolitan areas such as Albuquerque, Denver, Las Vegas, Los Angeles, Phoenix, Salt Lake City and San Diego is tied to future water availability from the Colorado River. Based on a compilation of population projections from various water districts throughout the Basin States, the population dependent on the Colorado River and its tributaries could grow by 25 million over the next 40 years, leading to an increase in water demand of as much as 5 maf annually. Demand for water for other uses including the environment, recreation, and Native American water rights settlements also continues to increase. Potential future increases in temperatures in the Basin, as have been observed in most of the Basin over the past 30 to 40 years, would increase evaporation-transpiration from vegetation, leading to further increases in water use and water lost from evaporation from reservoirs.

How climate change and variability might affect the Basin water supply has been the focus of many scientific studies. Climate experts suggest that droughts of even greater severity may occur in the future. The Southwest, including Nevada, Arizona, Utah, New Mexico and Wyoming which already rank as the five driest states in the nation, is expected to be even drier in the future. Recent studies have postulated that the average yield of the Colorado River could be

reduced by as much as 30 percent due to climate change, a reduction that would be catastrophic to the region without additional water supplies. Increasing demands coupled with decreasing supplies will certainly exacerbate imbalances throughout the Basin.

Consequences of Current and Projected Imbalances between Supply and Demand. Although a shortage to the Lower Division States (i.e., insufficient water available to satisfy annual consumptive use of 7.5 maf) has not been declared to date, some water agencies are experiencing shortages in water deliveries to their customers today. In California, drought conditions, along with increased regulatory restrictions, have caused the Metropolitan Water District of Southern California (Metropolitan) to ration water to its customers in 2009 for the first time in nearly 20 years. These water shortages increase costs to businesses already stressed by the current economic downturn. In addition, to help meet critical water supply needs in the urban areas, programs have been implemented to fallow land in agricultural areas and transfer the conserved water to urban areas. Although this has helped to meet the water needs of the urban areas, it has also reduced the food and fiber production from the region.

Absent the development of additional water supplies, the Upper Basin likely cannot realize full development of its Colorado River Compact apportionment with any level of certainty. Shortages in the Upper Basin are a reality today. Unlike the Lower Basin, which draws its supply from storage in Lake Mead, the Upper Basin is more dependent on annual stream flow to meet its needs. Over the past nine years, average annual Upper Basin water use has decreased by approximately 400,000 acre-feet (a decrease of approximately 11 percent) due in large part to water shortages caused by the current drought.

Currently, Lake Mead is at approximately 43 percent capacity, a water surface elevation of approximately 1,096 feet. If the current drought continues and water levels in Lake Mead fall below 1,025 feet, pursuant to the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (Interim Guidelines), the Central Arizona Project (CAP), which delivers Colorado River water to the Phoenix and Tucson metropolitan areas, would see its supply cut by nearly a third. Under the same circumstance, the Southern Nevada Water Authority's supplies, of which 90 percent come from the Colorado River and serve about 2 million people in the Las Vegas area, would be curtailed by 20,000 acre-feet annually, nearly 7 percent of Nevada's annual apportionment. If Lake Mead drops even further in the next few years, more dire consequences would result. Nevada would be unable to withdraw any water due to its current intake location if water levels in Lake Mead were to fall below 1,000 feet. If water levels continued to decline, the CAP could see its entire 1.5 maf supply disappear.

Summary. Supply and demand imbalances currently exist in the Basin and will grow in the future if the potential effects of climate change and variability are realized and demands continue to increase. A combination of options including conservation and reuse, development of local groundwater supplies, desalination, augmentation and the transfer of water from agricultural to urban uses will likely be needed. The proposed Basin Study will assess these and other options for resolving the projected imbalances in both the Upper and Lower Basins, and develop recommendations to sustain the environment, people and economy of this region.

2. The extent to which Federal involvement is needed due to the nature and complexity of the issues involved

The Colorado River Basin is one of the most highly regulated basins in the country. Federal involvement in the Basin dates back to the 1870s, when John Wesley Powell recommended using major river basins as administrative units in the western United States. Federal geographic and engineering investigations into the potential for irrigated agriculture throughout the Basin and ways and means to divert and convey river water to such areas were conducted over several decades in the late 1880s and early 1900s. These investigations ultimately led to the development of an extensive system of Federal dams and reservoirs, touching almost every aspect of water use in the Basin. Most of these facilities are operated and maintained by Reclamation's Upper and Lower Colorado Regions.

Issues surrounding the Colorado River and its resources are complex. Management of the Colorado River is multi-objective in order to:

- *provide water for agricultural and urban use*

Agricultural products from this region are marketed throughout the United States, and as noted in Section C.1, the fallowing of farmland to supply water to urban areas has reduced the production and distribution of these products.

- *generate hydropower*

Reductions in hydropower production stemming from reduced system water deliveries also affect other parts of the United States because shortfalls need to be made up by other power sources from those areas. Furthermore, the ability to generate hydropower at specific times and magnitudes is often constrained in order to minimize habitat disturbance downstream.

- *provide flood control*

Reservoirs are managed to provide flood control protection in addition to water supply storage. Balancing these different objectives is complex as sufficient reservoir space must be ensured while providing water in storage for future use.

- *provide recreation*

Maintaining recreational infrastructure is challenging and expensive as declining reservoir levels, particularly at Lake Powell and Lake Mead, make boat ramps unusable and often require re-location or abandonment of marinas.

- *provide water for environmental purposes, including enhancement of fish and wildlife habitat and the preservation and recovery of endangered species*

The Federal government is involved in several environmental compliance programs throughout the Basin including the Upper Colorado River Endangered Fish Recovery Program and the San Juan River Basin Recovery Implementation Program, the Glen Canyon Adaptive Management Program, and the Lower Colorado River Multi-Species Conservation Program. The management of these programs will be more difficult under additional pressures stemming from future water supply and demand imbalances.

Reclamation has developed and maintains models capable of representing the operational complexities described above and uses these models to project future river and reservoir conditions in the Basin. Specifically, the Colorado River Simulation System (CRSS) is used by Reclamation, the Basin States and water agencies in their planning processes regarding future water availability.

Additional Federal responsibility stems from the government's role in protecting Native American water rights along the river. These water rights are Native American assets held in trust by the Federal government and, as trustee, the United States is responsible for protecting these rights.

Reclamation (in cooperation with the U.S. Department of Agriculture and the Bureau of Land Management) is involved with the Colorado River Basin Salinity Control Program authorized by the 1974 Colorado River Basin Salinity Control Act. In consultation with water users and the Basin States through the Basin Salinity Control Forum, Reclamation implements projects to reduce the amount of salt in Colorado River water to meet water quality criteria and reduce salinity damages in the Basin. Meeting these criteria will become more difficult and salinity damages will be exacerbated as a result of reduced water supply.

In addition to the complexity of issues discussed above, the Colorado River is an international river. The United States Federal government has both a water quantity and water quality obligation to Mexico in accordance with the 1944 Treaty with Mexico and subsequent agreements between the two countries. In Mexico, the population and water demand continue to grow as in the rest of the region. A cooperative process that includes the International Boundary and Water Commission, Reclamation, the Basin States and Mexico is currently underway to explore conservation opportunities, improvements to system operations, and other water efficiency improvements.

In summary, Reclamation's operation and management of the facilities in the Basin involves a complex interaction among stakeholders that include cities, districts, water users, tribes, the Basin States, Mexico and other Federal agencies. The proposed Basin Study will play an important role in furthering the continued collaboration among these groups that is essential to successfully addressing the complex issues facing the Basin.

3. The existence and quality of data and models available and applicable to the proposed study

High-quality data and widely-accepted, credible models exist for analyzing existing and projected water supplies and demands in the Basin and the potential effects on supply and demand due to climate change and variability. Consequently, no major efforts regarding data collection or model development will be required for the proposed Basin Study.

The tables below describe the data and models in terms of type, source, availability and their interaction. All data and models listed below are high quality and undergo a rigorous peer-review process annually or more often as updates or modification occur.

Table 1. Summary of Available Water Supply Data Relevant to the Proposed Basin Study

<i>Data Type</i>	<i>Source</i>	<i>Availability/Description</i>	<i>Interaction/Applicability</i>
Analysis of Existing Water Supplies			
Historic Streamflow	USGS	Daily for all streamflow gauges in the Basin	Used to compute natural flow
	Reclamation	Monthly natural flow for 29 inflow points Basin-wide from 1906-2007	Used as base data to develop streamflow projections to drive planning model
	Reclamation	Monthly paleo-reconstructed natural flow into Lake Powell from 762-2005	
Historic Precipitation & Temperature	NOAA	Three daily gridded data sets from about 1950-1999; also data from state climatologists	Used to bias-correct climate projections and calibrate hydrologic models that generate streamflow
Snotel & Weather Climate Stations	NRCS, NOAA, NDMC	Available at numerous sites in the Basin	Used for streamflow forecasting and calibration of hydrologic models
Projections of Future Water Supplies			
Downscaled Climate Projections	Reclamation/SCU/LLNL	Daily downscaled and bias-corrected climate driven precipitation and temperature projections to 2099	Used to drive hydrologic models that generate streamflow
	NOAA		
Streamflow Projections	Reclamation	Basin-wide climate-based projections under development in an on-going study due Dec 2009	Used in combination with demand projections to drive planning model
	Reclamation	Basin-wide paleo-based projections	

Note: LLNL = Lawrence Livermore National Laboratory; LCRAS = Lower Colorado River Accounting System; NDMC = National Drought Mitigation Center; NOAA = National Oceanic and Atmospheric Administration; NRCS = Natural Resources Conservation Service; SCU = Santa Clara University; SWSI = Statewide Water Supply Initiative; UCRC = Upper Colorado River Commission; USGS = U.S. Geological Survey

Table 2. Summary of Available Water Demand Data Relevant to the Proposed Basin Study

<i>Data Type</i>	<i>Source</i>	<i>Availability/Description</i>	<i>Interaction/Applicability</i>
Analysis of Existing Water Demands			
Historic Consumptive Use	Reclamation	Basin-wide water use reports available from 1971-2006	Used to develop demand projections and compute natural flows
	By State	e.g. CO's SWSI covers current level of consumptive use state-wide for all sectors	
Crop Irrigation Requirements	Reclamation By State	LCRAS e.g. CO for the San Juan Basin	Used to develop demand projections and compute natural flows
Population	By State	Current population estimates available through U.S. Census Bureau or state demographers	Used to develop demand projections
Projections of Future Water Demands			
Demand Projections	UCRC	Demand projections for Upper Basin to 2060	Used in combination with streamflow projections to drive planning model
	By State	e.g. CO state-wide by type of water-use sector through 2050	
Population Projections	By State	e.g. as prepared by state demographers	Used to develop demand projections primarily for municipal uses

Note: CO = Colorado; LCRAS = Lower Colorado River Accounting System; SWSI = Statewide Water Supply Initiative; UCRC = Upper Colorado River Commission

Table 3 describes the relevant models available for the proposed Basin Study. The interaction with the data listed above is also described.

Table 3. Summary of Available Models Relevant to the Proposed Basin Study

<i>Model Type</i>	<i>Source</i>	<i>Availability/Description</i>	<i>Interaction/Applicability</i>
Planning	Reclamation	CRSS is a basin-wide planning model and widely accepted, used for hydrologic analysis in recent Environmental Impact Statement	Project future water supply conditions given demand and streamflow projections, CRSS will be used to analyze the operational, environmental and recreational impacts of climate change and variability
Shortage Allocation	Reclamation	Allocates a defined amount of shortage to specific users in AZ, CA and NV	Used to distribute shortages to individual users to assess consequences
Hydrologic	University of Washington	VIC solves full water and energy balances; currently being used in an on-going Reclamation study	Used to generate streamflow based on climate driven projections of precipitation and temperature

Note: AZ = Arizona, CA = California, CRSS = Colorado River Simulation System; NV = Nevada; VIC = Variable Infiltration Capacity

In addition, there are many other state or agency models that will be provided by the non-Federal Cost-Share Partners as appropriate to assess supply and demand relationships and quantify imbalances at specific locations with the Basin, e.g. Colorado's Colorado River Decision Support System and Metropolitan's Integrated Resources Planning Model.

Studies dating back decades identified potential supply and demand imbalances in the Basin and some proposed further investigations of these imbalances including identifying options for additional water supplies. These studies include:

- *Upper Colorado Region Comprehensive Framework Study*; Upper Region State-Federal Inter-Agency Group / Pacific Southwest Inter-Agency Committee / Water Resources Council; June 1971
- *Critical Water Problems Facing the Eleven Western States*; Reclamation; April 1975
- *Colorado River Basin Water Problems: How To Reduce Their Impact*; A Report to Congress by the GAO; CED-79-11; May 1979
- *Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability*; National Research Council; 2007
- *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead Final Environmental Impact Statement*; Reclamation; November 2007 (Shortage EIS)
- *Study of Long-Term Augmentation Options for the Water Supply of the Colorado River System*; Colorado River Water Consultants; March 2008

4. The strength of any nexus between the Basin Study and a Reclamation project or activity

The proposed Basin Study is strongly aligned with Reclamation projects in both the Upper and Lower Colorado Regions by virtue of the fact that the United States owns and, through the Secretary and Reclamation, operates the major dams and water delivery facilities throughout the Basin. The Secretary is also vested with the responsibility of managing the mainstream waters of the Lower Colorado River. These responsibilities are carried out consistent with the Law of the River, a longstanding and complex body of federal statutes, court decrees, contracts, regulations and other legal agreements regarding the allocation, appropriation, development, exportation, and management of the waters of the Basin.

Included in the Law of the River are numerous laws authorizing Reclamation projects that will be considered in the proposed Basin Study including the:

- Boulder Canyon Project Act of 1928 which authorized construction of Hoover Dam and the All-American Canal, required that Colorado River water users in the Lower Basin have a contract with the Secretary, and established the responsibilities of the Secretary to

direct, manage, and coordinate the operation of Colorado River dams, and related works in the Lower Basin

- Colorado River Storage Project Act of 1956 which authorized a comprehensive water development plan for the Upper Basin that included the construction of Glen Canyon Dam, Flaming Gorge Dam, Navajo Dam, Curecanti Project (now called the Aspinall Unit, consisting of Blue Mesa, Morrow Point, and Crystal dams) and other facilities
- Colorado River Basin Project Act of 1968 which authorized construction of a number of water development projects throughout the Basin, including the CAP, required the Secretary to develop long-range operating criteria for the major reservoirs and to issue an Annual Operating Plan for mainstream reservoirs, and directed the Secretary to conduct reconnaissance investigations for the purpose of developing a general plan to meet the future water needs of the western United States

Reclamation's Upper and Lower Colorado Regions administer the operation and maintenance of these and other projects and issue annual operating plans in close coordination with the Basin States and other stakeholders.

A key element of the proposed Basin Study will be projections of water supplies and demands throughout the Basin, particularly in light of the potential impacts of drought and climate change and variability. This information will be used to determine how the existing water and power infrastructure and operations of Reclamation projects will perform under these future scenarios. For example, the two largest reservoirs in the Basin, Lake Powell and Lake Mead provide over 50 maf of storage capacity, or about 83 percent of the total storage capacity in the Basin. The annual operation of these reservoirs is currently specified through 2026 under the Interim Guidelines. During the interim period, operation under the Interim Guidelines will provide the opportunity to gain valuable operating experience for the future coordinated management of Lake Powell and Lake Mead. That experience, coupled with options for resolving supply and demand imbalances, will improve the basis for making future operational decisions.

5. The level of Stakeholders interest in and support for the Basin Study

Stakeholders throughout the Basin recognize the need to address current and future water supply and demand imbalances. Interest is broad and includes: agricultural users concerned with preserving the agricultural economy and their water rights; environmental groups concerned about the preservation of aquatic and riparian habitat; purveyors of municipal and industrial water concerned about providing adequate and reliable water resources for customers in their service areas; power users concerned about hydropower generating capacity and the availability of Colorado River water for thermal power generation; and Native American tribes and communities concerned about the preservation of their water rights. Rising concerns about the possibility of severe and persistent drought, climate change and variability, continued growth of urban areas using Colorado River water, and increased water demands for environmental and recreational purposes add urgency to stakeholder interest in Basin-wide planning. Competition and conflict over Colorado River water is occurring now and is expected to increase as the gap between supply and demand widens.

For many years, the Cost-Share Partners and other stakeholders within the Basin have been working to plan and implement actions to improve management and use of water throughout the Basin as evidenced by the recent public process that led to the development of the Interim Guidelines. There is broad support for the proposed Basin Study among Colorado River water users and other stakeholders throughout the Basin. Attachment 1 contains the letters of support from various entities that were received as of June 26, 2009. Additional letters of support are anticipated and will be forwarded upon receipt.

A more inclusive list of potentially interested stakeholders will be prepared based on interest in other recent planning efforts in the Basin and an organization plan will be developed for working with and allowing input from these and other interested parties throughout the study. All input received will be carefully considered and incorporated in the study as appropriate. The plan will include meetings where stakeholders will be provided information about the study and be invited and encouraged to provide input. Reclamation will also create a website to keep stakeholders informed on the status of the Basin Study and provide opportunity for their input. Working groups may also be formed to assist in different aspects of the study.

6. Whether the non-Federal cost-share contribution exceeds the required 50 percent

The non-Federal cost-share contribution, consisting of both direct (cash) and in-kind services, will match the Federal cost-share contribution (a 50:50 percent split) of the proposed Basin Study cost. Attachment 2 contains letters from the non-Federal Cost-Share Partners.

D. Study Outline and Schedule

1. Study Purpose

The purpose of the proposed Basin Study is to analyze water supply and demand imbalances throughout the study area through 2060, to assess options for resolving such imbalances, and to develop recommendations that will address current and projected imbalances. Options to resolve such imbalances in both the Upper and Lower Basins will be evaluated. Paramount to the Basin Study will be an assessment of the potential impacts of climate variability and climate change on both water supplies and demands.

2. Cost-Share Partners

Reclamation and the non-Federal Cost-Share Partners will develop a Memorandum of Agreement (MOA) and a Plan of Study, clearly defining the scope and goals of the study, cost-sharing, study phases and specific study tasks, and the roles and responsibilities of all parties. A management team, project manager(s), and appropriate staff and participants will also be identified.

3. Study Outline

Table 4 provides an outline of the proposed Basin Study, briefly describing the major tasks envisioned and providing an estimated cost for each.

Table 4. Summary of Tasks and Costs Associated with the Proposed Basin Study

Proposed Basin Study Tasks	Estimated Cost
1. Water Supply Assessment. Assess the quantity and location of existing and future water supplies throughout the Basin, including the potential effects of climate variability and climate change.	\$250,000
2. Water Demand Assessment. Assess the quantity and location of existing and future water demands, including the potential effects of climate variability and climate change.	\$350,000
3. System Reliability Analysis. Use CRSS and other models as appropriate to analyze supply and demand relationships and quantify imbalances in specific locations within the study area. Quantify current and potential future locations, magnitudes, probabilities, and timing of shortfalls.	\$400,000
4. Development and Evaluation of Opportunities for Balancing Supply and Demand. Formulate and evaluate potential strategies to balance supply and demand, including better management of existing supplies and development of new supplies (i.e., brackish water desalination; water conservation, reclamation, and reuse; and conjunctive use of surface and groundwater), augmentation within the study area (e.g., ocean water desalting, weather modification), and augmentation from outside the study area (e.g., importation through mutually cooperative ventures with entities outside the study area). Evaluate effectiveness of strategies in addressing imbalance using CRSS and other models as appropriate.	\$475,000
5. Findings and Recommendations. Formulate findings and recommendations, including analyses for prioritized conservation measures, operational improvements, and augmentation measures within and outside the study area. Prepare a study report documenting technical details.	\$250,000
6. Stakeholder Involvement. Cultivate stakeholder participation and input throughout the study. This will include conducting meetings with stakeholders and the general public at key stages of the study as shown in the study schedule, and providing up-to-date information and links to pertinent documents on Reclamation’s public website.	\$75,000
7. Study Management. Coordinate study activities performed by participants, track costs, and write progress reports during the study. Develop a detailed Plan of Study and MOA to clearly define the study scope, tasks, organization, budget and cost-share.	\$200,000
Total Cost	\$2,000,000

4. Study Schedule

The Cost-Share Partners propose to conduct the Basin Study over a period of two years beginning at the start of fiscal year 2010. The proposed Basin Study schedule is provided in Figure 3. Major Basin Study milestones are listed in Table 5.