glen canyon institute
Restore Glen Canyon

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August 26, 2005

Mr. Robert Johnson
Regional Director
Bureau of Reclamation, Lower Colorado Region
Attn: BCOO – 1000
PO Box 61470
Boulder, City, NV 89006-1470

Dear Mr. Johnson:

The Glen Canyon Institute (GCI) provides you our comments on the development of management strategies for Lakes Powell and Mead under low reservoir (drought) conditions. The proposed actions by Reclamation will form the basis of *Shortage Criteria* that will guide your Colorado River management actions.

CONTEXT OF THE ISSUE

Total Colorado River system reservoir storage has decreased over 40% over the last 5 years. Climatic studies of the Southwestern United States suggest that the drought will likely continue for years to come. Increased flows, similar to those that have occurred in 2005 may occur periodically but certainly will not provide hydrologic conditions that existed during the filling period for the Colorado River Basin reservoirs. Lower water conditions coupled with increased water demand stemming from the large population influx into the region requires that a new approach be developed for Colorado River management. The Bureau of Reclamations' own hydrologic modeling predicts that it could take anywhere from 10 to 20 yeas for the reservoir system to fully recover under today's conditions. This does not take into account the anticipated development and continued depletion of Upper Colorado River Basin water supplies or the increased use in the Lower Colorado River Basin.

The Glen Canyon Institute is dedicated to evaluating and protecting the unique ecological, cultural and social environments of the Colorado River Basin, especially Glen and Grand Canyon. Our efforts are focused on developing dialogue and action on restoring the ecological integrity of the Colorado River system. Our goal is to do this based on science. We desire to develop solutions to the water, power and environmental concerns of the Colorado rather than continuing the business as usual approach of hydrologic management of the last 40 years. The issues facing the river system today are far more complex than those that the early management of the Colorado River was developed around.

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Dedicated to restoring a free-flowing Colorado River through Glen and Grand Canyons.
450 South 900 East Suite 160 Salt Lake City, UT 84102 tel: 801.363.4450 fax: 801.363.4451 www.glencanyon.org

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AN INTEGRATED APPROACH AND NEED FOR A BASIN-WIDE EIS

Development of shortage criteria for the management of Glen Canyon and Hoover Dam is a step that should have been taken in 1970 when the Long-Range Operating Criteria were developed and implemented. Now we are 35 years down the road and find ourselves facing political, legal, social, hydrologic and environmental pressures that require a *system-based* rather than a *reservoir-specific* approach. The Colorado River Basin is a hydrologically controlled plumbing system that is composed of over 60 dams, reservoirs and diversions. Reservoirs Powell and Mead are the largest managed bodies of water on the system and are comparatively easily managed by the turning of knobs to release water. The hard part is to find an agreed upon, state and federal approach, to who gets what water then. What is clear is that the assumptions utilized when the 1922 Compact was negotiated and signed were in error. That error has been carried forward to today where we are today trying to fill the coffers of all states demand with a limited supply of water. The cumulative effect of those 1922 decisions should not continue to dictate water management in a far more complicated and water intense society.

What is needed today is to look for *solutions to the water issues* of the Colorado River Basin which demands an integrated, Basin wide approach to evaluating how the entire Colorado River system can be better managed to meet water, cultural, environmental, social and tribal water needs. The Glen Canyon Institute calls for the development of a *Colorado River Basin Environmental Impact Statement* in order to develop solutions for the future. 1 2

The Glen Canyon Institute believes that the Bureau of Reclamation can provide the leadership and vision to initiate a Basin-Wide EIS in order to form a solid and coordinated basis for the future management of the Colorado River. The American people depend upon our government leaders to provide leadership and vision.

RECOMMENDATIONS FOR CONSIDERATION

The Glen Canyon Institute believes that there are specific areas that the Bureau of Reclamation should evaluate and address in the development of the Colorado River Shortage Criteria. No one of these recommendations will by itself solve the water issues. Rather, the Institute advocates that a suite of these elements be integrated into a management portfolio that will provide options for water and resource managers.

Utilize Underground Storage

Combined Lake Powell and Lake Mead loose to seasonal evaporation more than 17% of the annual water that flows into them. Aquifer storage efforts are ongoing in Arizona and California. Many of these aquifers are located adjacent to or in close proximity to the existing Central Arizona and California Aqueducts. By some estimates over 50 million acre feet of storage may exist in these two states alone. It is far more cost and water efficient to utilize these aquifers to store water rather than the large surface reservoirs of the Colorado River Basin. 3

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Develop Specific Conservation Strategies Tied to Hydrologic Predictions

Managing water in the existing reservoir dominated plumbing system requires a more conservation specific approach. The Glen Canyon Institute believes that developing a set of conservation focused water management thresholds (triggers), rather than an upper basin, lower basin centric approach makes is necessary. This approach has been recently proposed by conservation groups as an option for management. Specifically, the approach calls for using elevations of Lake Mead to dictate actions dependent upon Reclamation's 24-month study projections on January 1st of each year: 4

- *Conservation Triggers*
  - i. Elevation of Lake Mead drops below 1,100 feet
    Secretary of the Interior will require conservation of 200,000 acre-feet of water in order to maintain reservoir elevations. This water may come from conservation agreements, forbearance agreements, or other approaches that includes the country of Mexico.
  - ii. Elevation of Lake Mead drops below 1,075 feet
    Secretary of the Interior will require conservation of 400,000 acre-feet of water in order to maintain reservoir elevations. This water may come from conservation agreements, forbearance agreements, or other approaches that includes the country of Mexico.
  - iii. Elevation of Lake Mead drops below 1,050 feet
    Secretary of the Interior will require conservation of 600,000 acre-feet of water in order to maintain reservoir elevations. This water may come from conservation agreements, forbearance agreements, or other approaches that includes the country of Mexico.

This conservation oriented approach will by necessity, force management actions to be focused primarily at Lake Mead. Glen Canyon Dam and Lake Powell will be used to support maintaining Lake Mead elevations. Water released to support Lake Mead elevations will be credited back to Upper Basin users in the form of forbearance agreements, rebates or other appropriate vehicles to ensure credit.

In years of drought, water allotments for all seven basin states should be reduced by the same percentage based on the projected water deficit for each year of drought. Simplicity and equitability can minimize stakeholder conflict.

Sediment Management in Grand Canyon

Glen Canyon Dam is trapping millions of tons of sediment in Lake Powell. This sediment historically supported the ecosystem of the Grand Canyon and the entire lower Colorado River Basin, including the Colorado River delta and the Sea of Cortez. Loss of sediment in the system is causing an ecological collapse that cannot be mitigated away by periodic high flow releases from Glen Canyon Dam. These efforts, while noble in nature, are nothing more than Band-Aids in the solution of the problem. 5

The sediment behind Glen Canyon Dam must be allowed to be moved downstream if there is any hope of saving what is left of the native fish assemblage and habitats in the

Grand Canyon. Reoperation and retrofitting of Glen Canyon would allow for sediment to be mobilized into the Grand Canyon and lower Colorado River system.

Endangered Species Protection and Habitat Restoration
The primary mandate of the Grand Canyon Protection Act of 1992 (section 1804) pledges that: *"The Secretary shall operate Glen Canyon Dam...to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use"*. This commitment was reiterated in the 1996 Record of Decision for the Glen Canyon Dam Operations EIS.

The operation of Glen Canyon Dam has caused four of the Grand Canyon's eight native fish species to go extinct. Two of the remaining four native fish species are now showing negative population dynamics and may indeed be petitioned to be added to the Endangered Species list over the next several years. Native reptiles, birds, mammals and plants depend upon an intact ecosystem in the Grand Canyon, an ecosystem that is dependent upon sediment and more normal flows in the Colorado River.

Flow Conditions in the Grand Canyon.
Based on knowledge of the requisite conditions for flow conditions in the Colorado River, minimum flows at Glen Canyon Dam should be no less than 8,000 cfs in order to keep important native fish habitats wetted during critical life history stages. Reduced reservoir levels in Lake Mead will allow the lower Grand Canyon to become more ecologically functional and provide additional areas for recreation and economic opportunity for the Hualapai people. 6

SUMMARY

Water management in the Colorado River basin have since 1922 been based on incorrect assumptions and a political hierarchy that does not allow for integration of innovative approaches. Maintaining the Status Quo has become more important than addressing the inherent problems of the Colorado River system. The drought and the development of the Shortage Criteria provide an opportunity for the government, states and public to cooperatively work towards solutions for the Colorado River management. Solutions that must look at a portfolio of system-based solutions that cumulatively can achieve the desired goals of water efficiency, water deliveries and ecological restoration.

The Glen Canyon Institute strongly believes that one solution that needs to be evaluated is the *reoperation of Glen Canyon Dam*, permanently reduce the water levels in Lake Powell and restore Glen Canyon. This approach will provide water to Lake Mead to ensure adequate levels of water for power generation and water delivery to the lower basin. Administrative actions can be implemented to ensure that the upper basin states are not cheated out of their 1922 Compact water. New allocation guidelines should be developed that reflect the actual amount of water available to be distributed to the seven states and Mexico. 7

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Glen Canyon Dam has outlived its usefulness for providing the dowry for the upper basin states. Reevaluation of the role of Glen Canyon Dam, within the context of a system-wide Colorado River Basin EIS, could serve as the vehicle to develop solutions for the future management of the river that would allow all users to be kept whole while providing the benefits of restoring Glen Canyon, meeting the needs of the Endangered Species Act, preserving and restoring Grand Canyon, and invigorating new and innovative approaches to developing an integrative water and ecosystem management approach to the Colorado River Basin.

Thank you for considering our comments.

Sincerely,

David L. Wegner
Board of Trustees
Glen Canyon Institute

cc. Mr. Rick Gold
Upper Colorado Regional Director

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August 31, 2005

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Regional Director
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Salt Lake City, UT 84318-1147

Re: Comments on content, format, mechanisms, and analysis to be considered during the development of management strategies for Lake Powell and Lake Mead under low reservoir conditions

Dear Sir or Madam:

Thank you for the opportunity to comment on the recent Federal Register Notice on the above-mentioned topic.

Management strategies for low reservoir operations of Lake Mead and Powell should include the effects of climate variability and long-term trends in climate. In addition, there are significant uncertainties on the management of the system due to potential changes in demand and new interpretations of the Law of the River. Specifically, we suggest the following be included in Reclamation's analysis of management strategies:

- Long-term Climate Variability
- Intra-seasonal Climate Variability
- Inter-annual Climate Variability
- Climate Change Trends
- Demand Efficiencies and Law of the River Ramifications

Details on each of these topics are below.

Long-term Climate Variability

The Colorado River basin streamflow gage record unfortunately extends back only 100 years. Dendrochronology, a subfield of paleoclimatology, has produced streamflow reconstructions for the basin going back over 450 years with the first reconstruction completed in 1976, and several new reconstructions have been created since 1995 (e.g. Woodhouse, Gray, Meko, 2005,in preparation). While there is some difference between these reconstructions – and research is proceeding to explain these differences -- these data suggest that droughts more persistent and

more severe than any in the 20th and 21st centuries have occurred over the past centuries. These records also indicate that the frequency of extreme drought events has also varied, and that the past has included periods of time with a higher frequency of extreme events than what is documented in the short instrumental records of the past 100 years. We strongly encourage the use of this information in studying the potential risks of low flow conditions and how best to optimize reservoir operations. 1

Intra-seasonal Climate Variability

Intra-seasonal climate variability deals with sub-seasonal changes in climate ranging from two weeks to less than a complete season. NOAA is producing "Week Two" experimental forecasts which substantially improve on NOAA's operational forecasts out to 14 days. These forecasts have the potential ability in some situations to allow for improved water management in the Lower Basin where operational constraints sometimes force unwanted releases. For example, it may have been possible to capture flood control releases from the Gila and Bill Williams in mainstem reservoirs during the winter of 2004-2005 using these forecasts. These forecasts should be of use under all reservoir conditions, but would be especially useful during low reservoir levels. We urge Reclamation to see if these forecasts may be valuable in reservoir management. 2

Inter-annual Climate Variability

Climate variability occurs on numerous time scales from sub-seasonal to inter-annual to even decadal. The El Niño/Southern Oscillation (ENSO), which influences winter storm tracks and precipitation, is a major factor in inter-annual variability. The impacts of ENSO over the western United States are predictable to some extent, and there is a relatively strong ENSO signal in the Lower Basin. Western Water Assessment researchers are investigating the ENSO signal in the Upper Basin to determine the potential for predictability. We urge Reclamation to consider if NOAA Climate Prediction Center seasonal forecasts and other experimental forecasts may be useful in some years to optimize reservoir management. 3

Climate change and long-term trends

Spring runoff, as well as other indicators, shows a trend toward earlier onset of spring in many areas of the West, although the Colorado River with its higher elevations appears to be lagging the Sierra and the Pacific Northwest (Dettinger, et al., 2001, Mote, et al., 2005). These indicators are consistent with an observed increase in spring temperature over western North America of 1-3° C (2-4.5° F) since the late 1970s.

Several modeling studies have projected the impacts of climate change on Colorado River water resources. In a study funded by USBR, Ryan (1996) estimated that the "best guess" scenario for the Gunnison River Basin is "warmer temperatures, less snowfall, more summer thunderstorms, and slightly reduced streamflow (5% reduction)." In a study of the Colorado Basin, Christensen, et al. (2004) found an increase in temperatures, especially in the late spring, and decreases in average precipitation. Nash and Gleick (1993) found that the Colorado reservoir system is highly sensitive to changes in runoff, and that violations in the Colorado Compact would potentially occur if runoff decreased by only 5%. Thus, even a small percentage decrease in average flows could jeopardize the potential to meet reservoir goals.

While we do not believe that these model runs should be accepted without challenge, these studies suggest that changes in timing and amount of runoff may be likely, and that even small changes in mean flow may have wide repercussions for the basin. We urge Reclamation to consider how climate change might affect reservoir operations in the Colorado River basin. 4

Demand Efficiencies and Law of the River Ramifications

Current research and modeling activities supported by Reclamation are proving extremely useful in evaluating proposals for modified reservoir management regimes. As stated throughout this letter, one way to increase the value of these already impressive efforts is through the more sophisticated consideration of past and future climate regimes and the nature of climate variability involving ***supply-side*** issues. There are two other areas, however, that we believe should be included in these analyses because of their potential to have a very large impact on reservoir operations: (1) demand-related issues, and (2) uncertainties over the Law of the River.

In a fully allocated system of the size of the Colorado River, small changes in demand (just like small changes in supply) have the ability to substantially impact the system. Many astute observers have commented that there is ample room in this system for improved efficiencies. We therefore urge Reclamation to consider how decreased demands through improved efficiencies would impact the reservoirs.

Finally, ambiguities in the Law of the River (e.g., use of tributaries) may obscure large and serious impacts to the supply of water. Any study of reservoir management is usually predicated on current – and often buried -- interpretations of the Law of the River. Where such interpretations have such serious impacts, we urge that these interpretations and their impacts be made clear – it is pointless to conduct studies on Law of the River foundations that are in dispute and potentially subject to change.

Concluding Comments

The NOAA-University of Colorado Western Water Assessment is willing to work with Reclamation to assess any of the issues addressed in this letter so that Lakes Powell and Mead can be operated most efficiently during low reservoir conditions.

Sincerely,

Brad Udall
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References:

Cayan, D.R., S. Kammerdiener, M.D. Dettinger, J. M. Caprio, and D.H. Peterson, 2001: Changes in the onset of spring in the Western United States., Bull. Am. Met. Soc., (82) 399-415.

Christensen, N. S., A. W. Wood, N. Voisin, D. P. Lettenmaier, and R. N. Palmer, 2004: The effects of climate change on the hydrology and water resources of the Colorado River Basin. Climatic Change (62) 337-363.

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Woodhouse, C. A., 2003: A 431-year reconstruction of western Colorado snowpack from tree rings. Journal of Climate (16) 1551-1561.

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RECLAMATION

Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

— *Comment Card* —

COMMENTS DUE BY WEDNESDAY, NOVEMBER 30, 2005

PLEASE PRINT

Date: 11/1/05

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☑ Yes, I would like to be added to your mailing list: E-Mail ☑ US Mail ☑

The Bureau of Reclamation is seeking public input on the Development of Lower Basin Shortage Guidelines and Coordinated Management Strategies for Lake Powell and Lake Mead Under Low Reservoir Conditions. Your input on the scope of the project is greatly appreciated. Please write legibly.

Please submit your comments to a project representative or fold this form in half, seal with tape and mail to: Regional Director, Bureau of Reclamation, Lower Colorado Region, Attention: BCOO-1000, P.O. Box 61470, Boulder City, NV 89006-1470.

Comments must be received by November 30, 2005.

G-2000

James Wechsler, Sierra Club

1. We* believe a full NEPA analysis is called for, with complete analyses of costs, benefits, and environmental implications of each alternative. 1

2. Shortage Criteria should be crafted for the long haul and should be implemented as a permanent policy. The recent drought is likely only a preview of what is to come given what we have learned from the long-term record of Colorado River flows, and given the probability of climate change to reduce flows over the next several decades. 2

3. We have a proposal for managing shortages, called Conservation Before Shortage (CBS). Benefits of Conservation Before Shortage include: 3

A - Reduced need for new water projects. Introducing flexibility into Colorado River management will allow those who are willing and able to reduce their water use to be compensated for doing so, and avoid the need to impose reductions in water use on those who cannot. By eliminating the potential for water shortages where they cannot easily be accommodated, this policy will limit the need for costly new water projects.

B - Protection of the environment. Fish, wildlife, and natural areas on the Colorado River do not, for the most part, have their own water rights. As such, they are "last in line" for water, and are the most vulnerable of all water users to drought. "Conservation Before Shortage" reduces overall water consumption in dry years, decreasing the risk of shortages that could disproportionately impact environmental uses in the future. Also, by increasing protection against shortage for water users that have inflexible demands, it will allow some water to remain in the river for the wildlife that needs it to survive while still meeting critical human needs.

C - Improved power production. _Consistent maintenance of reservoir storage and power head above baseline conditions in average to low flow conditions will result in increased power production and improved power revenues, as well as elimination of the risk that elevations at Lake Mead will drop below minimum power head, improving the reliability of power production.

D - Increased certainty for water users: _"Conservation Before Shortage" will significantly reduce the likelihood of involuntary and uncompensated shortages in the Lower Basin at levels above 500,000 acre-feet (the approximate level at which a shortage exceeds the ability of the Arizona Water Bank to readily buffer the shortage).

CBS offers an active, anticipatory approach that protects Colorado River water users and the environment from abrupt reductions in the amount of water available.

It's hard to reach consensus when someone has to lose. The current deadlock between the states reflects a zero-sum approach to river management, where one state or one water user is expected to shoulder the full burden of a drought by suffering a large, uncompensated shortage while other users are unaffected. CBS suggests a more cooperative, evenhanded approach to coping with drought.

CBS would create a predictable, rational system for water users, and distribute the costs between water and power users and the federal government.

CBS would include Mexican water users in the solution, thereby reducing the need for conservation among US water users.

* Defenders of Wildlife, Environmental Defense, National Wildlife Federation, Pacific Institute, Sierra Club, Sonoran Institute

Defenders of Wildlife · Environmental Defense · National Wildlife Federation
Pacific Institute · Sierra Club · Sonoran Institute

July 18, 2005

Honorable Gale A. Norton, Secretary
Department of the Interior
1849 C Street, NW
Washington DC 20240

Re: Development of Lower Basin Shortage Guidelines

Dear Secretary Norton:

Last year, you asked the Colorado River basin states to recommend approaches regarding proactive drought management actions in the basin. Last month, the Bureau of Reclamation published a notice to solicit comments and hold public meetings on the development of Lower Basin shortage guidelines (70 Fed.Reg. 34794). Defenders of Wildlife, Environmental Defense, National Wildlife Federation, Pacific Institute, Sierra Club, and Sonoran Institute respectfully submit the attached "Conservation Before Shortage" policy proposal in response to these requests.

We believe that it is preferable for water users to voluntarily engage in predictable, small-scale reductions in use – and receive compensation for those reductions – rather than face large-scale, involuntary, and uncompensated disruptions in water deliveries that could cut into municipal and agricultural water supplies and create unmitigated economic impacts. Our "Conservation Before Shortage" proposal would dramatically reduce the risk of large-scale, involuntary shortages to Lower Basin users and to Mexico, by implementing a series of increasing conservation targets linked to the declining elevation of Lake Mead. The required amount of water would be conserved by offering to pay Colorado River water users, located anywhere in the Lower Colorado River basin or in Mexico, to voluntarily forbear water use.

Funds to pay for forbearance would come from federal appropriations as well as a surcharge applied to all Lower Basin water users and consumers of power generated at the Hoover Dam. One of the more significant corollary benefits of the conservation program described in the "Conservation Before Shortage" proposal, beyond the primary benefit of protecting water users from involuntary and uncompensated shortages, would be the preservation of power production at Hoover Dam at higher levels and for longer durations than would otherwise occur.

CONSERVATION BEFORE SHORTAGE BENEFITS

- *Reduced need for new water projects.* The introduction of flexibility into Colorado River management will allow those who are willing and able to reduce their water use to be compensated for doing so, and will avoid the need to impose reductions in water use on those who cannot. By eliminating the potential for water shortages where they cannot easily be accommodated, this policy will limit the need for costly new water projects to protect water users that cannot tolerate interruptions in water supplies.
- *Protection of the environment.* Fish, wildlife, and natural areas on the Colorado River do not, for the most part, have their own water rights. As such, they are "last in line" for water, and are the most vulnerable of all water users to drought. "Conservation Before Shortage" reduces overall water consumption in dry years, decreasing the risk of shortages that could disproportionately impact environmental uses in the future. Also, by increasing protection against shortage for water users that have inflexible demands, it will allow some water to

remain in the river for the wildlife that needs it to survive while still meeting critical human needs.

- *Improved power production.* Consistent maintenance of reservoir storage and power head above baseline conditions in average to low flow conditions, resulting in increased power production and improved power revenues, as well as elimination of the risk that elevations at Lake Mead will drop below minimum power head, improving the reliability of power production.
- *Increased certainty for water users.* Significant reduction in the likelihood of involuntary and uncompensated shortages in the Lower Basin at levels above 500,000 acre-feet (the approximate level at which a shortage exceeds the ability of the Arizona Water Bank to readily buffer the shortage).
- *Reduces risk of involuntary shortage.* In the past, the established priority system on the Colorado River has prompted those most at risk of shortage to limit their exposure by promoting actions that could have devastated invaluable ecological resources. Minimizing this risk will benefit all Colorado River stakeholders.

We look forward to working with Reclamation on the development of shortage guidelines. Please do not hesitate to contact any of us if you would like any additional information on the Conservation Before Shortage proposal.

Sincerely,

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attachment – "Conservation Before Shortage" proposal

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Bureau of Reclamation staff

Members of the Colorado River
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Colorado River Tribes

Colorado River NGOs

Conservation Before Shortage

Proposed Shortage Criteria for
Colorado River Operations

I. Background/Context

The effects of a multi-year drought have had a tremendous impact on storage in the Colorado River basin. Although above-average precipitation in the Lower Basin has led to small recoveries in system storage over the winter of 2004-2005, total system storage on the Colorado River has decreased by more than 40% over the past several years. As a result, there is a real possibility that the Secretary of the Interior will declare an actual shortage on the lower Colorado River in the near future. A shortage declaration would reduce deliveries to the Central Arizona Project (CAP) and to southern Nevada (which are among the first in line for cuts in the event of a shortage).

The surface elevation of Lake Mead dropped more than 80 feet from the end of 2000 through the end of 2004; Lake Powell dropped by more than 115 feet in this period. The Bureau of Reclamation's (Reclamation's) Riverware model of the Colorado, based on historic flow records, projects that reservoir levels at Lake Powell could head quickly towards the minimum power pool if the drought continues, and reservoir levels at Lake Mead could fall below the elevation of southern Nevada's upper intakes or remain in a long-term decline that will be difficult to reverse until Powell begins to re-fill. In addition, the model predicts that even if precipitation levels returned to average today, it could take 10-20 years for the Colorado River reservoir system to recover fully (during which time continued development of water supplies in the Upper Basin will further shrink available supplies). As a result, it is time to begin a long-delayed discussion about the method for defining, mitigating, and sharing shortages on the Colorado River.

Although the Secretary of the Department of the Interior (Secretary) has the authority to declare a shortage on the Colorado River, thereby reducing deliveries to some Lower Colorado River contractors, to date no criteria exist for determining when such a shortage will be declared. In June 2005, the Department of the Interior (DOI) noticed its intent to begin a public scoping process for the development of "Lower Basin Shortage Guidelines," (70 Fed.Reg. 34794). In 2004, DOI initiated a series of technical meetings with the Colorado Basin states to discuss drought issues, and the seven Basin states met frequently among themselves throughout the winter of 2004-2005 to discuss potential shortage criteria. Non-governmental organizations (NGOs) were not invited to participate in these discussions; however, several NGOs with interest and expertise in Colorado River issues began meeting over the winter to develop an alternative shortage proposal. These organizations met with Reclamation staff to review the results of technical modeling runs developed in support of the states' discussions, and Reclamation has provided additional modeling data to these interested NGOs in response to their inquiries and to evaluate potential shortage criteria.

These meetings led to the development of this document, which proposes an approach to the management of shortages in the Lower Colorado through the implementation of a tiered conservation program that is tied to the surface elevation of Lake Mead.

II. Rationale for this Proposal

The basic rationale behind this "Conservation Before Shortage" proposal is that shortage criteria should attempt to maximize the reliability and predictability of water deliveries on the Lower Colorado by introducing increased flexibility into the management of river resources when shortage conditions are imminent.

Principles:

- It is desirable to protect the elevation of Lake Mead at 1050 feet (the current minimum power pool) to the extent feasible without implementing shortages that would involuntarily curtail deliveries to Lower Basin users.
- It is desirable to protect the elevation of Lake Mead at no less than 1000 feet under any condition in order to protect Southern Nevada Water Authority's lower intake structures, as well as the new minimum power pool if proposed low-pressure turbines are installed at Hoover Dam.
- It is desirable to avoid shortages in the Lower Basin above 500,000 acre-feet whenever possible (the approximate level at which shortages would cut into CAP's deliveries beyond those currently utilized for water banking).
- It is preferable for Lower Basin water users to voluntarily engage in predictable, small-scale reductions in use – and receive compensation for those reductions – rather than face large-scale, involuntary, and uncompensated disruptions in water deliveries that could cut into municipal and agricultural water supplies and create unmitigated economic impacts.
- Minimizing large, forced disruptions to normal deliveries as a result of shortage declarations will minimize the threat of unmitigated environmental impacts in the Lower Colorado River and Delta as a result of significantly decreased deliveries to low-priority users and corresponding return flows that support environmental values.
- Market-based programs, with low transaction costs and appropriate mitigation of third-party impacts, can offer a reasonable mechanism for minimizing the risk and impacts of shortage.[1]
- Users of Colorado River water in Mexico may wish to participate in short-term conservation agreements, to reduce the probability of larger, uncompensated future reductions due to a declaration of shortage under the 1944 Treaty with Mexico.
- Water can be obtained from agricultural users in the United States, and could be obtained in Mexico with an appropriate agreement,[2] through the use of voluntary, market-based forbearance programs. Economic studies of Lower Basin agricultural use, as well as recent leases of water from farmers in this area, suggest that there is a large volume of water in the basin that could be obtained for $20 - 100 per acre-foot (see Figure 9).

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[1] Some 4.5 million acre-feet of Colorado River water are used to irrigate crops in the Lower Basin states, and more than 1 million acre-feet are used to irrigate crops in Mexico. Conservation of between 200,000 and 600,000 acre-feet through the use of part-year fallowing programs, dry year options, or other similar arrangements would constitute only 4-11% of total Lower Basin agricultural use in the United States and Mexico. (However, as even small-scale reductions in agricultural water use may have third-party impacts, some portion of funds accrued for the purchase of water should be set aside to support community economic development in affected areas.) Conversely, without these small-scale reductions, water users would likely be faced with the need to curtail large amounts of water quite abruptly, with significant economic consequences. (Shortages of nearly 2 million acre-feet in a single year are predicted by Reclamation's model when the 1000 feet elevation is protected at Lake Mead without conservation measures).

[2] Such an agreement would likely require a new Minute to the 1944 Treaty with Mexico. Fallowing agreements in Mexico would have to be administered by the appropriate authorities.

III. Conservation Before Shortage Policy

The "Conservation Before Shortage" policy essentially consists of two sets of criteria tied to projected elevations at Lake Mead on January 1 of a given year, according to the Bureau of Reclamation's August 24-month study. These criteria consist of three "conservation triggers," which impose progressively increasing conservation goals as lake levels drop from 1100 feet to 1050 feet, and a "shortage trigger," which imposes involuntary shortages in the Lower Basin as are necessary to accomplish absolute protection of Lake Mead at a minimum elevation of 1000 feet.

(A) Normal Conditions

In years when the 24-month study projects the elevation of Lake Mead on January 1 will be at or above 1100 feet, the Secretary of the Interior (Secretary) shall determine a Normal or Surplus (as defined by the Interim Surplus Guidelines) year.

(B) Conservation Triggers

First Conservation Trigger: Below 1100 Feet at Lake Mead

In years when the 24-month study projects the elevation of Lake Mead on January 1 will be at or above 1075 feet but below 1100 feet, the Secretary will seek to conserve 200,000 acre-feet of water. On behalf of the Secretary, Reclamation will preferentially seek to achieve this 200,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

Second Conservation Trigger: Below 1075 Feet at Lake Mead

In years when the 24-month study projects that the elevation of Lake Mead on January 1 will be at or above 1050 feet but below 1075 feet, the Secretary will seek to conserve 400,000 acre-feet of water. Reclamation will preferentially seek to achieve this 400,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

Third Conservation Trigger: Below 1050 Feet at Lake Mead

In years when the 24-month study projects that the elevation of Lake Mead on January 1 will be below 1050 feet (minimum power pool absent the installation of low-pressure turbines), the Secretary will seek to conserve 600,000 acre-feet of water. Reclamation will preferentially seek to achieve this 600,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek

forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

(C) Shortage Trigger

Absolute Protection of Lake Mead Elevation 1000 Feet

The Secretary shall not permit the elevation of Lake Mead to drop below elevation 1000 feet (minimum low-pressure power pool and Southern Nevada Water Authority intakes) at any time. Shortages to Colorado River contractors shall be implemented in the Lower Basin and in Mexico[3] to the extent necessary to prevent such declines.

(D) Funding Mechanisms

In recognition of the federal government's continuing national obligation to replace the MODE bypass flow to Mexico, 43 U.S.C. § 1571(c), the federal government will assume responsibility for the cost of all conservation agreements up to the volume of the bypass flow that the Secretary has not otherwise replaced in the year that a conservation trigger becomes effective. Given the national interest in minimizing both environmental impacts and economic disruptions resulting from the involuntary curtailment of deliveries to Colorado River users, the federal government would also assume responsibility for half of the cost of any additional agreements required to generate conserved water for the "Conservation Before Shortage" policy, pursuant to the Secretary's authority under the Reclamation States Emergency Drought Relief Act of 1991 (Drought Relief Act),[4] conservation authorities in the Farm Bill, or other appropriate authority that may be granted by Congress.

To the extent that conservation of water is required beyond that to be funded by the federal government in the manner described above, conservation activities would be funded through one or both of the following:

Power Pool Protection Fund

The priority of water used for power generation is considered to be tertiary to that of irrigation and domestic use under the Law of the River. As a result, Hoover and Glen Canyon Dams are operated to maintain deliveries to water users regardless of the impact of declining reservoir levels on power production. However, one of the more significant corollary benefits of the conservation program described in this proposal, beyond the primary benefit of protecting water users from involuntary and uncompensated shortages, would be the preservation of power production at Hoover Dam at higher levels and for longer durations by reducing deliveries for irrigation, domestic use, and underground storage in a manner that would not otherwise occur under current practices.

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[3] In the event that a shortage is declared and is also considered to be an extraordinary drought under the 1944 Treaty, deliveries to Mexico will be reduced in the same proportion as consumptive uses in the United States are reduced.

[4] The Reclamation States Emergency Drought Relief Act of 1991, 43 U.S.C. §§ 2201 *et seq.*, provides the Secretary of Interior the authority to purchase water "from willing sellers, including, but not limited to, water made available by Federal Reclamation project contractors through conservation or other means with respect to which the seller has reduced the consumption of water." 43 U.S.C. § 2211(c).

Given the significant loss in generating capacity that has already occurred as a result of declines in power pool elevations,[5] and the even more significant impacts that would be associated with a total loss of generating capacity, the implementation of "Conservation Before Shortage" would clearly benefit power purchasers and consumers. As such, it would seem reasonable to derive a percentage of the funding for the proposed voluntary conservation program from a modest, conditional surcharge on power rates under existing or renewed contracts for hydropower produced at Hoover Dam as a means to mitigate against the loss of power head and stave off the complete loss of power production at Hoover Dam.[6] This surcharge could be imposed in years when Reclamation's August 24-month study projects that the storage in Lake Mead falls below fifty percent of its active capacity. The revenues generated by this surcharge could be collected in a "power pool protection fund," to be maintained by Reclamation for expenditure when and if lake elevations reach a conservation "trigger."

Temporary Cost Recovery/Delivery Surcharges

Pursuant to the Drought Relief Act, the Secretary of Interior is authorized to engage in water purchases from willing sellers and to seek cost recovery for water delivered from the users of that water under temporary contracts. 43 U.S.C. §2211(c), §2212(a),(c). Reclamation could utilize this authority to purchase water through temporary, part-year fallowing arrangements, dry-year options, or similar mechanisms, and would seek cost recovery from Colorado River users. In recognition of the Basin-wide interest in alleviating the impacts of drought and reducing uncertainty on the Lower Colorado, and in the interests of encouraging extraordinary conservation to minimize the likelihood of significant delivery interruptions, the cost of some portion of conservation agreements, including those with Colorado River users in Mexico, could be funded through a conservation surcharge imposed on a per-acre-foot basis on all Lower Basin contractors.

Anticipated Cost of Conservation

Current short-term leasing agreements between farmers and irrigation districts or municipal water agencies, as well as recent research on the net returns per acre-foot of irrigation water, suggest that "Conservation Before Shortage" water could be obtained for $20 - 100 per acre-foot. To ensure that such water remains available in times of increased scarcity (when market forces might otherwise increase the cost), the Secretary should be granted the authority to enter into "Conservation Before Shortage option agreements," similar to existing dry-year leasing agreements/interruptible supply agreements that have been enacted within the basin states.

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[5] Largely as a result of declining reservoir elevations, power production at Hoover and Glen Canyon has declined steadily since the onset of drought conditions in the Colorado River Basin. Annual power production at Hoover fell from 5,697 gigawatt-hours (GWh) in 1998 to 4,094 GWh in 2003, according to Western Area Power Administration (WAPA) Annual Reports, 1998 – 2003. A portion of hydropower revenues currently supports the two Upper Basin endangered fish recovery programs, the Glen Canyon Adaptive Management Program, and the Colorado River Salinity Control Program; alternative sources of revenue should be identified and implemented to fully fund these recovery programs. The Department of the Interior should also work proactively with WAPA to identify alternative sources of power for those Indian tribes that have experienced power shortages, or drastic increases in power costs, due to the declining production associated with falling reservoir levels.

[6] The rates for power produced at Hoover Dam have increased as reservoir levels and power production have declined, but may still remain well below open market rates. Although annual revenues tend to vary from year to year, revenues from Hoover Dam power production have generally been in the range of $50 million annually.

IV. Analysis: Benefits of Conservation Before Shortage Policy

To date, actual shortage criteria for the Colorado River have not been defined. For the purposes of comparison, a 'baseline' was defined as the current operating conditions for the Colorado River, with the addition of a policy requiring the absolute protection of Lake Mead at 1000 feet (that is, Hoover Dam would not release any water to cause the elevation of Lake Mead to drop below 1000 feet). The baseline policy does *not* provide for the implementation of conservation measures. These 'baseline' conditions, reflecting current operating conditions, are depicted in the following figures.

Analysis of the "Conservation Before Shortage" policy suggests that this policy could produce significant benefits for Basin water users by:

- Consistently maintaining reservoir storage and power head above baseline conditions in average to low flow conditions, resulting in increased power production and improved power revenues;
- Significantly reducing the likelihood of involuntary, uncompensated shortages in the Lower Basin and corresponding, unmitigated economic impacts;
- Significantly reducing the likelihood of involuntary and uncompensated shortages in the Lower Basin at levels above 500,000 acre-feet (the approximate level at which a shortage imposed by the Secretary would cut into CAP deliveries, by exceeding the ability of the Arizona Water Bank to readily buffer the shortage); and
- Eliminating the risk that elevations at Lake Mead will drop below minimum power head, improving the reliability of power production and associated revenues.

The analyses below show the impacts of the "Conservation Before Shortage" (CBS) policy on reservoir operations based on historic flows in the Colorado River Basin.

Modeling Assumptions

The proposed "Conservation Before Shortage" policy was modeled using Reclamation's Riverware model, which is based on historical records of flows in the Colorado River Basin over approximately the past century. Conservation triggers, as described in Section III, were implemented at 1100 feet, 1075 feet and 1050 feet, with the assumption that required measures to reduce Lower Basin consumptive use by 200,000, 400,000, and 600,000 acre-feet, respectively, would be implemented in years when the January 1 elevation at Lake Mead is below the triggers. An absolute protection trigger was implemented at Lake Mead elevation 1000 feet, with releases from Lake Mead to meet delivery obligations to Lower Basin users reduced as necessary to maintain that level. To avoid even modestly under-predicting the elevations of Mead and Powell pools, particularly in the near term, this modeling has assumed that the schedule of Upper Basin depletions will effectively begin with the last reported actual level for CY 2000, will increase at a

slower rate than projected by the Upper Colorado River Basin Commission through CY 2009, and will increase at the rate projected by the Commission thereafter.[7]

For purposes of the model, the minimum objective release out of Lake Powell was assumed to be 8.23 maf per year (reflecting current operating conditions).[8] Alternative scenarios for conjunctive management were not modeled, and the protection of a minimum power pool at Lake Powell was not incorporated into this proposal; either or both of these assumptions would affect the elevation of Lake Powell. Model runs used end-of-year 2004 elevations at Lake Mead and Lake Powell to establish initial conditions for 2005, and were run through year 2025.

Protection of Lake Mead

Figures 1 -3 show the potential value of implementing the CBS policy, under a range of average to extremely low flow conditions. **These and following figures show that the CBS policy would greatly benefit the elevation of Lake Mead.**

As shown in Figure 1 below, under average conditions, the CBS policy would maintain reservoir elevations at Mead approximately 30 feet above the baseline policy. As shown by Figures 2 and 3, the CBS policy would significantly reduce the rate of decline in the lower 25th and in the very low 10th percentile reservoir elevations for Mead and maintain even these lower reservoir elevations above the 1000 foot protection level. Model runs showed essentially no impact of the CBS on the higher 90th percentile Mead elevations, so no figure is provided.

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[7] *See* "Estimates of Future Depletions in the Upper Division States," Upper Colorado River Commission Memorandum, December 23, 1999. This schedule predicts a 440,000 acre-foot increase in Upper Basin depletions between 2000 and 2010 and a 542,000 acre-foot increase over actual CY2000 depletions, as reported in Reclamation's Consumptive Uses and Losses 1996-2000 report (see Tables UC-1 & UC-6). Actual increases in Upper Basin depletions water may not keep pace with this schedule, because water that would otherwise have been utilized has been and may continue to be physically unavailable for depletion in the Upper Basin due to drought conditions, and in other cases, projects that were proposed to have been constructed during this period may not yet have been or will not be completed through CY 2009. A slower rate of increase from 2000 to 2009 was modeled by subtracting four increments of 100,000 acre-feet from the Commission's schedule from CY 2005 to 2009. This and all other Riverware modeling exercises should be revised to reflect actual increases in Upper Basin depletions as soon as more current information becomes available.

[8] This assumption is not intended to endorse or reject the Secretary's current use of 8.23 maf as the minimum release objective for Powell, the protection of a minimum power pool at Powell, or proposals for the conjunctive management of the combined storage of Mead and Powell. Alternative release scenarios should be incorporated into the modeling for this proposal as they are developed. As a general matter, none of the assumptions used in this proposal should be construed as an interpretation of the 1922 Colorado River Compact, the 1944 Treaty with Mexico, or any other aspect of the Law of the River.

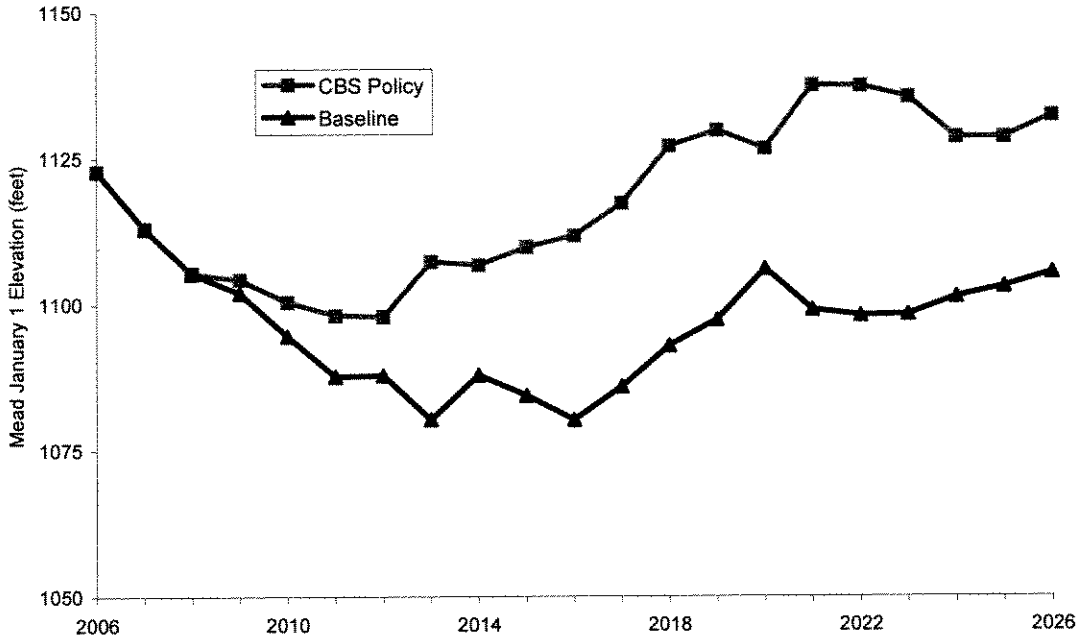

Figure 1. Impact of CBS policy on elevations at Lake Mead, at 50th percentile elevation.

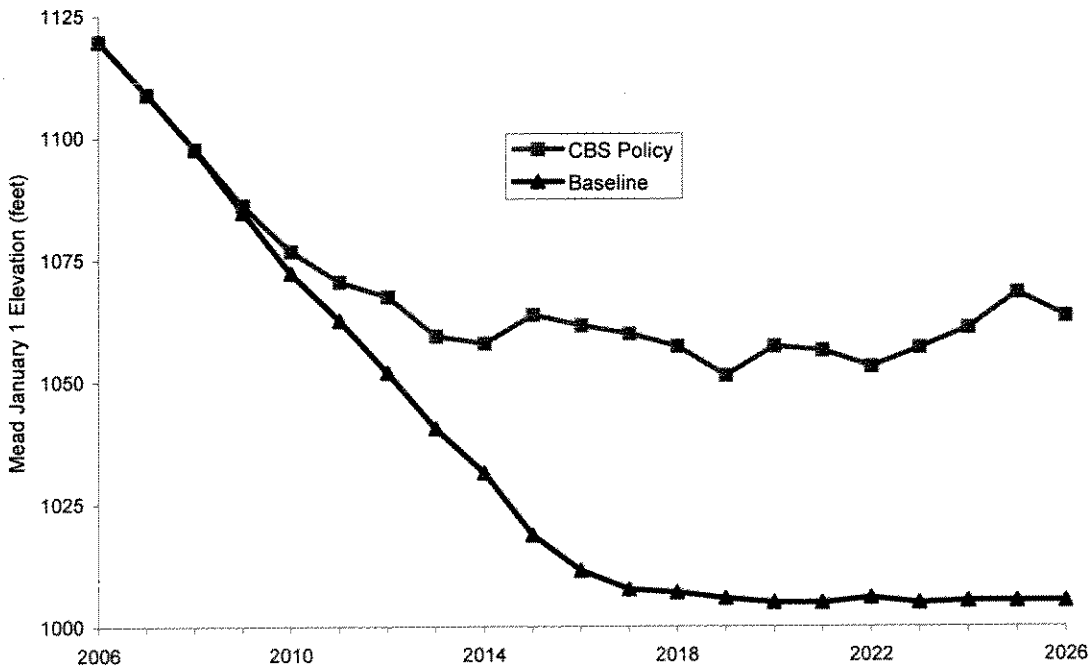

Figure 2. Impact of CBS policy on elevations at Lake Mead, at 25th percentile elevation.

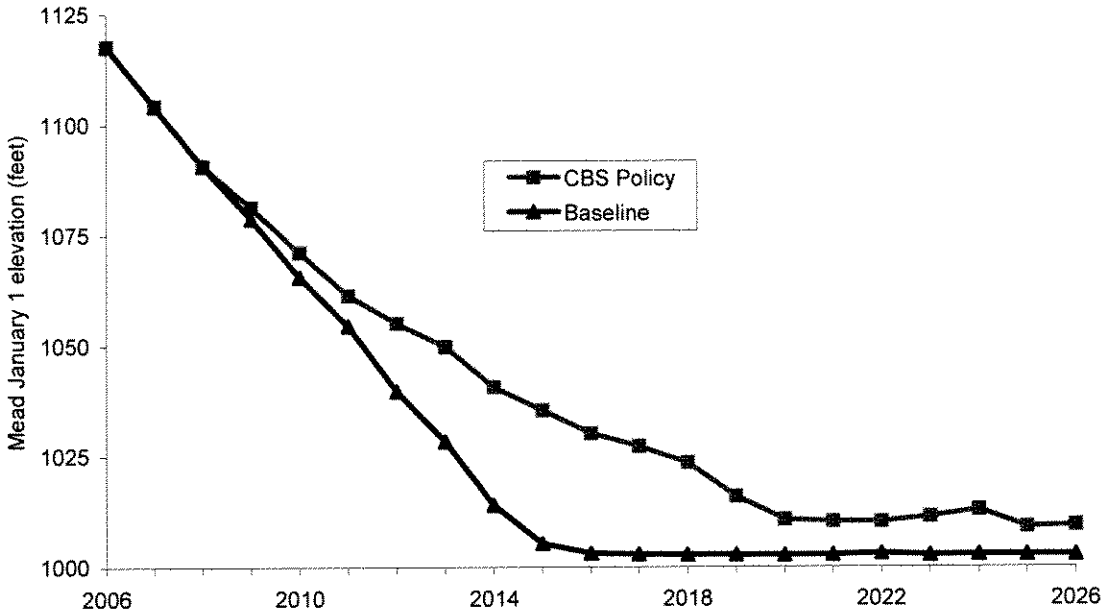

Figure 3. Impact of CBS policy on Lake Mead elevation, at 10th percentile elevation.

Probability of Shortages

As noted above, a primary goal of the CBS policy is to significantly reduce the probability of an involuntary, uncompensated shortage in excess of 500,000 acre-feet (the approximate level at which CAP deliveries would be reduced beyond that currently utilized for water banking). **As shown in Figure 4, below, the probability of shortages exceeding 500,000 acre-feet is reduced to 5% or less through the entire modeled period under the CBS policy. By contrast, the probability of shortage under the baseline policy rapidly approaches 30% during this same period. Furthermore, as shown in Figure 5, below, the CBS policy reduces the probability of any involuntary shortage by approximately 20% over the next 20 years.**

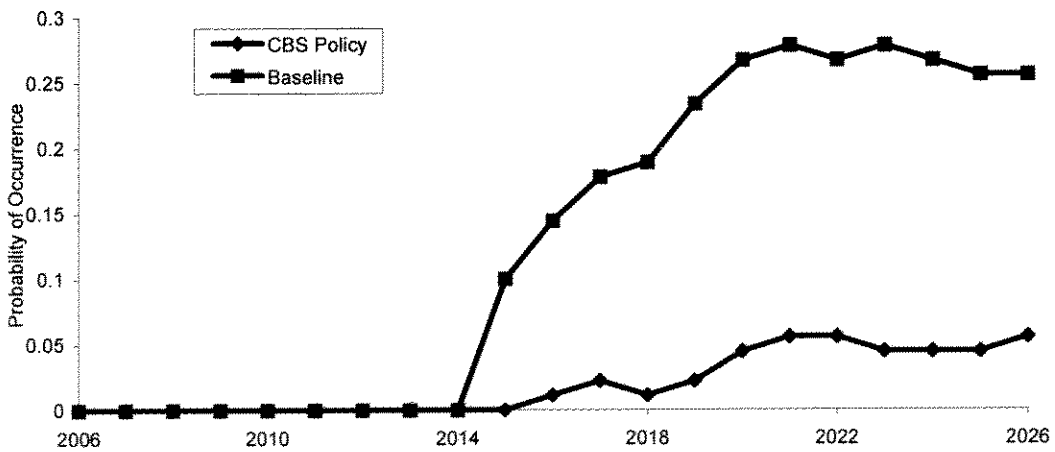

Figure 4. Impact of CBS policy on probability of involuntary Lower Basin shortage greater than 500,000 acre-feet.

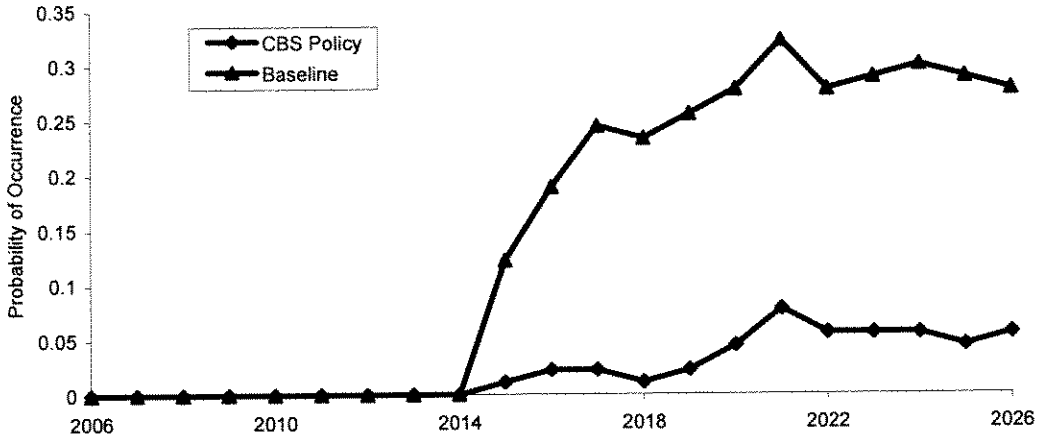

Figure 5. Impact of CBS policy on probability of any involuntary shortage in the Lower Basin.

Probability of Reaching Conservation Triggers

Figures 6 - 8, below, show the relative probability of reaching or exceeding any of the proposed conservation triggers at 1100 feet, 1075 feet and 1050 feet. As one might expect, the probability of reaching the first two triggers is highest in the earlier years of the modeled period, while the probability of reaching the third trigger is higher towards the end of the modeled period. However, the probability of reaching and continuing to remain below a given trigger for an extended period of time appears to be low because of the conservation measures tied to the triggers. For obvious reasons, trigger levels are most likely to be reached under low or very low flow conditions, and are rarely (if ever) reached under high flow conditions.

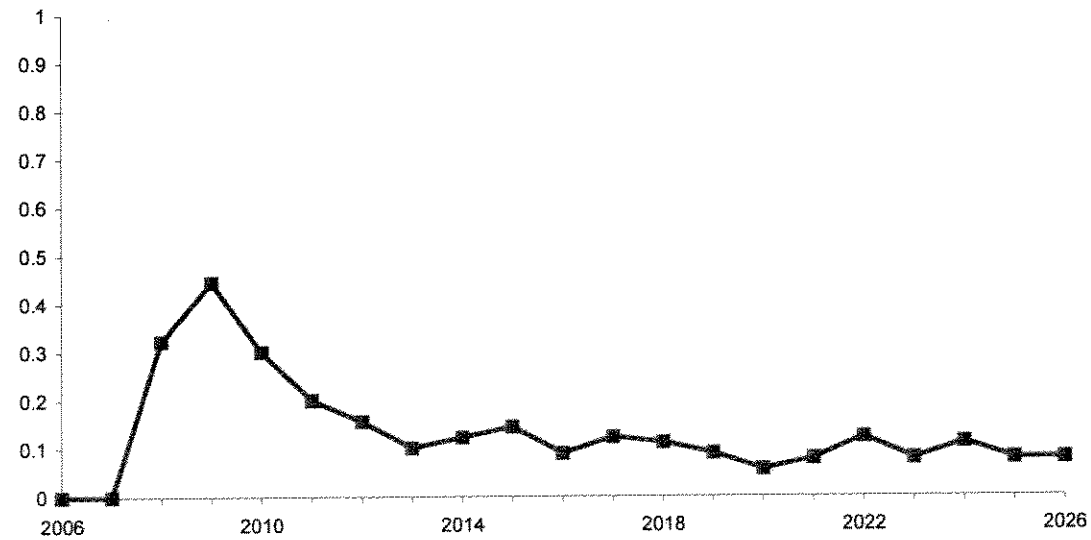

Figure 6. Probability of Lake Mead January 1 elevation occurring in a bounded range of 1100 feet to 1075 feet, with CBS policy in place.

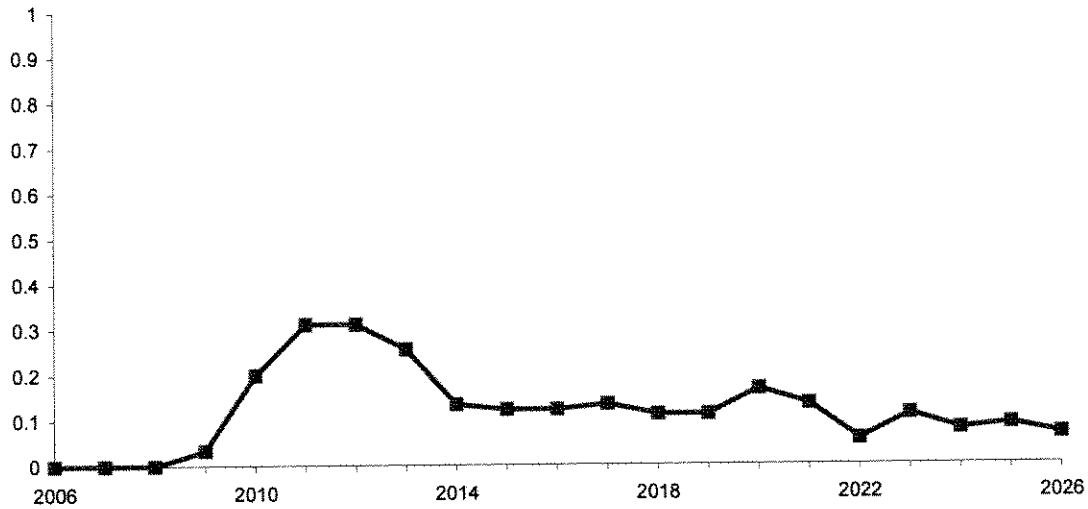

Figure 7. Probability of Lake Mead January 1 elevation occurring in a bounded range of 1075 feet to 1050 feet, with CBS policy in place.

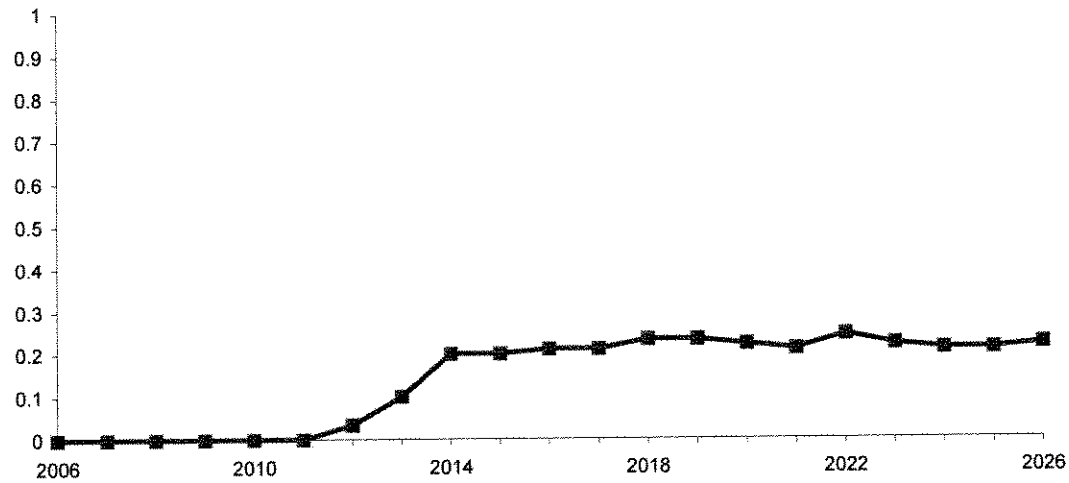

Figure 8. Probability of Lake Mead January 1 elevation occurring below 1050 feet, with CBS policy in place.

Cost of Implementing Conservation Triggers

The cost of implementing conservation triggers is directly related to the cost of obtaining water using the proposed voluntary, market-based conservation mechanisms. Recent purchases of water from farmers in the Lower Basin, as well as analysis of agricultural production in this area, suggest that there is a substantial volume of water used for irrigation which could potentially be obtained on a temporary basis for $20 - 100 per acre-foot. For example, in 2004, the Imperial Irrigation District acquired water from its farmers for less than $60 per acre-foot.

As shown in Figure 9, a recent economic study by Environmental Defense into the profits returned by field crops suggests that slightly more than 2.3 million acre-feet of agricultural water

is being used by Lower Basin farmers in California and Arizona to produce profits of less than $100 per acre-foot; more than one million acre-feet of agricultural water is being used to produce profits of less than $20 per acre-foot. (Figures are based on the average volume of water applied to produce a crop unit and market rates for each crop, less costs of production.)

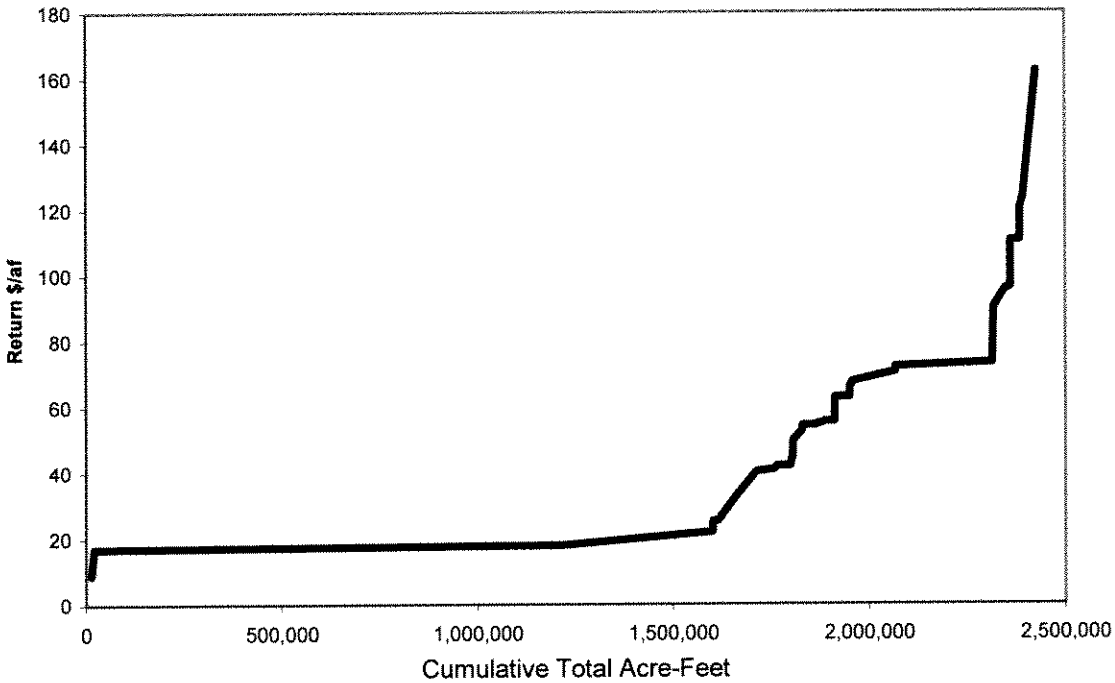

Figure 9. Profits per acre-foot returned on Colorado River water used in the production of selected crops in the Lower Colorado River Basin. [9]

While these figures do not necessarily reflect the amount at which any given water user would be willing to take part in a part-year fallowing program or agree to a dry-year option, they do suggest that if an open, market-based approach is used to identify potential participants, a number of water users in the Lower Basin would probably be willing to temporarily reduce or forgo the use of water for agricultural production in a price range between $20 and $100 per acre-foot (as the sale of water in this range would produce equal or greater monetary returns to the user than the use of water to irrigate crops).

In order to mitigate third-party impacts of fallowing, the federal government could establish a drought economic adjustment fund that would provide economic development grants to affected communities in the counties of origin. These funds preferentially would go to established county-based farm labor assistance programs to the extent that such programs exist, and could include lump sum payments to displaced workers based on a percentage of foregone annual income.

[9] This graph has not been published elsewhere. For methodology, please contact Jennifer Pitt at jpitt@environmentaldefense.org. A study using similar methodology, but limited to crop values in the Wellton-Mohawk Irrigation and Drainage District, has been published previously (Pitt et al., New Water for the Colorado River: Replacing the Bypass Flow, 6 U. Denver Water L. Rev. 68 (2002)). The study found a range of prices similar to that represented here for profits derived from water use in that area.

Using these assumptions for water acquisition costs, Table 1 suggests the approximate range of costs for implementing each of the conservation triggers under the CBS policy.

Table 1. Approximate federal and power/water user cost of implementation of CBS policy conservation trigger levels (assumes that water can be acquired temporarily for $20 - $100/acre-foot, and that the annual federal bypass obligation of 110,000 acre-feet has not otherwise been satisfied).

Trigger	Conservation required	Federal obligation (bypass + 50%)	Federal cost (millions)	Remaining Obligation	Water user cost (millions)	Power Surcharge (millions)	User cost per af (all Lower Basin users)
1075-1100	200,000 af	155,000 af	$3 - $15.4	45,000 af	$0.45 - $2.3	$0.45 - $2.3	$0.06 - $0.30
1050-1075	400,000 af	255,000 af	$5 - $25.4	145,000 af	$1.5 - $7.3	$1.5 - $7.3	$0.19 - $0.97
Below 1050	600,000 af	355,000 af	$7 - $35.4	245,000 af	$2.5 - $12.3	$2.5 - $12.3	$0.33 - $1.63

Cost of Not Implementing "Conservation Before Shortage" Policy

Although the "Conservation Before Shortage" policy would impose notable costs on water and power users, and on taxpayers generally, these costs should be compared with the much larger financial costs that would occur if the Secretary were to impose involuntary, uncompensated shortages, as well as the costs due to the lack of certainty and reliability that would exist without the CBS policy. The recent drought and decrease in power production at both Hoover Dam and Glen Canyon Dam point to the dramatic costs imposed by the loss of reservoir storage.

If Lake Mead falls to 1050 feet, power rates will need to be increased to an approximate composite rate of 2.31 cents/kWh, which is a 44.3% increase over current rates. Replacement power purchases would be (depending on the user) 2.9 to 3.7 times the Hoover rate. In FY03, replacement power may have cost customers an additional $24 million.

e

ENVIRONMENTAL DEFENSE

finding the ways that work

November 2, 2005

Comments for the Bureau of Reclamation public scoping meeting to discuss Development of Shortage Criteria for the Colorado River

Submitted by Jennifer Pitt

1. We believe a full NEPA analysis is called for, with complete analyses of costs, benefits, and environmental implications of each alternative. 1

2. Shortage Criteria should be crafted for the long haul and should be implemented as a permanent policy. The recent drought is likely only a preview of what is to come given what we have learned from the long-term record of Colorado River flows, and given the probability of climate change to reduce flows over the next several decades. 2

3. We have a proposal for managing shortages, called Conservation Before Shortage (CBS).[1] Benefits of Conservation Before Shortage include: 3

A - Reduced need for new water projects.

The introduction of flexibility into Colorado River management will allow those who are willing and able to reduce their water use to be compensated for doing so, and avoid the need to impose reductions in water use on those who cannot. By eliminating the potential for water shortages where they cannot easily be accommodated, this policy will limit the need for costly new water projects to protect water users that cannot tolerate interruptions in water supplies.

B - Protection of the environment.

Fish, wildlife, and natural areas on the Colorado River do not, for the most part, have their own water rights. As such, they are "last in line" for water, and are the most vulnerable of all water users to drought. "Conservation Before Shortage" reduces

[1] The Conservation Before Shortage policy was developed collaboratively by Defenders of Wildlife, Environmental Defense, National Wildlife Federation, The Nature Conservancy, Pacific Institute, and Sonoran Institute.

overall water consumption in dry years, decreasing the risk of shortages that could disproportionately impact environmental uses in the future. Also, by increasing protection against shortage for water users that have inflexible demands, it will allow some water to remain in the river for the wildlife that needs it to survive while still meeting critical human needs.

C - Improved power production.

Consistent maintenance of reservoir storage and power head above baseline conditions in average to low flow conditions will result in increased power production and improved power revenues, as well as elimination of the risk that elevations at Lake Mead will drop below minimum power head, improving the reliability of power production.

D - Increased certainty for water users:

"Conservation Before Shortage" will significantly reduce the likelihood of involuntary and uncompensated shortages in the Lower Basin at levels above 500,000 acre-feet (the approximate level at which a shortage exceeds the ability of the Arizona Water Bank to readily buffer the shortage).

CBS offers a proactive approach that protects Colorado River water users and the environment from abrupt reductions in the amount of water available.

It's hard to reach consensus when someone has to lose. The current deadlock between the states reflects a zero-sum approach to river management, where one state or one water user is expected to shoulder the full burden of a drought by suffering a large, uncompensated shortage while other users are unaffected. CBS suggests a more cooperative, evenhanded approach to coping with drought.

CBS would create a predictable, rational system for water users, and distribute the costs between water and power users and the federal government.

CBS would include Mexican water users in the solution, thereby reducing the need for conservation among US water users.

Defenders of Wildlife · Environmental Defense · National Wildlife Federation
Pacific Institute · Sierra Club · Sonoran Institute

July 18, 2005

Honorable Gale A. Norton, Secretary
Department of the Interior
1849 C Street, NW
Washington DC 20240

Re: Development of Lower Basin Shortage Guidelines

Dear Secretary Norton:

Last year, you asked the Colorado River basin states to recommend approaches regarding proactive drought management actions in the basin. Last month, the Bureau of Reclamation published a notice to solicit comments and hold public meetings on the development of Lower Basin shortage guidelines (70 Fed.Reg. 34794). Defenders of Wildlife, Environmental Defense, National Wildlife Federation, Pacific Institute, Sierra Club, and Sonoran Institute respectfully submit the attached "Conservation Before Shortage" policy proposal in response to these requests.

We believe that it is preferable for water users to voluntarily engage in predictable, small-scale reductions in use – and receive compensation for those reductions – rather than face large-scale, involuntary, and uncompensated disruptions in water deliveries that could cut into municipal and agricultural water supplies and create unmitigated economic impacts. Our "Conservation Before Shortage" proposal would dramatically reduce the risk of large-scale, involuntary shortages to Lower Basin users and to Mexico, by implementing a series of increasing conservation targets linked to the declining elevation of Lake Mead. The required amount of water would be conserved by offering to pay Colorado River water users, located anywhere in the Lower Colorado River basin or in Mexico, to voluntarily forbear water use.

Funds to pay for forbearance would come from federal appropriations as well as a surcharge applied to all Lower Basin water users and consumers of power generated at the Hoover Dam. One of the more significant corollary benefits of the conservation program described in the "Conservation Before Shortage" proposal, beyond the primary benefit of protecting water users from involuntary and uncompensated shortages, would be the preservation of power production at Hoover Dam at higher levels and for longer durations than would otherwise occur.

CONSERVATION BEFORE SHORTAGE BENEFITS

- *Reduced need for new water projects.* The introduction of flexibility into Colorado River management will allow those who are willing and able to reduce their water use to be compensated for doing so, and will avoid the need to impose reductions in water use on those who cannot. By eliminating the potential for water shortages where they cannot easily be accommodated, this policy will limit the need for costly new water projects to protect water users that cannot tolerate interruptions in water supplies.
- *Protection of the environment.* Fish, wildlife, and natural areas on the Colorado River do not, for the most part, have their own water rights. As such, they are "last in line" for water, and are the most vulnerable of all water users to drought. "Conservation Before Shortage" reduces overall water consumption in dry years, decreasing the risk of shortages that could disproportionately impact environmental uses in the future. Also, by increasing protection against shortage for water users that have inflexible demands, it will allow some water to

remain in the river for the wildlife that needs it to survive while still meeting critical human needs.

- *Improved power production.* Consistent maintenance of reservoir storage and power head above baseline conditions in average to low flow conditions, resulting in increased power production and improved power revenues, as well as elimination of the risk that elevations at Lake Mead will drop below minimum power head, improving the reliability of power production.
- *Increased certainty for water users.* Significant reduction in the likelihood of involuntary and uncompensated shortages in the Lower Basin at levels above 500,000 acre-feet (the approximate level at which a shortage exceeds the ability of the Arizona Water Bank to readily buffer the shortage).
- *Reduces risk of involuntary shortage.* In the past, the established priority system on the Colorado River has prompted those most at risk of shortage to limit their exposure by promoting actions that could have devastated invaluable ecological resources. Minimizing this risk will benefit all Colorado River stakeholders.

We look forward to working with Reclamation on the development of shortage guidelines. Please do not hesitate to contact any of us if you would like any additional information on the Conservation Before Shortage proposal.

Sincerely,

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attachment – "Conservation Before Shortage" proposal

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Conservation Before Shortage

Proposed Shortage Criteria for
Colorado River Operations

I. Background/Context

The effects of a multi-year drought have had a tremendous impact on storage in the Colorado River basin. Although above-average precipitation in the Lower Basin has led to small recoveries in system storage over the winter of 2004-2005, total system storage on the Colorado River has decreased by more than 40% over the past several years. As a result, there is a real possibility that the Secretary of the Interior will declare an actual shortage on the lower Colorado River in the near future. A shortage declaration would reduce deliveries to the Central Arizona Project (CAP) and to southern Nevada (which are among the first in line for cuts in the event of a shortage).

The surface elevation of Lake Mead dropped more than 80 feet from the end of 2000 through the end of 2004; Lake Powell dropped by more than 115 feet in this period. The Bureau of Reclamation's (Reclamation's) Riverware model of the Colorado, based on historic flow records, projects that reservoir levels at Lake Powell could head quickly towards the minimum power pool if the drought continues, and reservoir levels at Lake Mead could fall below the elevation of southern Nevada's upper intakes or remain in a long-term decline that will be difficult to reverse until Powell begins to re-fill. In addition, the model predicts that even if precipitation levels returned to average today, it could take 10-20 years for the Colorado River reservoir system to recover fully (during which time continued development of water supplies in the Upper Basin will further shrink available supplies). As a result, it is time to begin a long-delayed discussion about the method for defining, mitigating, and sharing shortages on the Colorado River.

Although the Secretary of the Department of the Interior (Secretary) has the authority to declare a shortage on the Colorado River, thereby reducing deliveries to some Lower Colorado River contractors, to date no criteria exist for determining when such a shortage will be declared. In June 2005, the Department of the Interior (DOI) noticed its intent to begin a public scoping process for the development of "Lower Basin Shortage Guidelines," (70 Fed.Reg. 34794). In 2004, DOI initiated a series of technical meetings with the Colorado Basin states to discuss drought issues, and the seven Basin states met frequently among themselves throughout the winter of 2004-2005 to discuss potential shortage criteria. Non-governmental organizations (NGOs) were not invited to participate in these discussions; however, several NGOs with interest and expertise in Colorado River issues began meeting over the winter to develop an alternative shortage proposal. These organizations met with Reclamation staff to review the results of technical modeling runs developed in support of the states' discussions, and Reclamation has provided additional modeling data to these interested NGOs in response to their inquiries and to evaluate potential shortage criteria.

These meetings led to the development of this document, which proposes an approach to the management of shortages in the Lower Colorado through the implementation of a tiered conservation program that is tied to the surface elevation of Lake Mead.

II. Rationale for this Proposal

The basic rationale behind this "Conservation Before Shortage" proposal is that shortage criteria should attempt to maximize the reliability and predictability of water deliveries on the Lower Colorado by introducing increased flexibility into the management of river resources when shortage conditions are imminent.

Principles:

- It is desirable to protect the elevation of Lake Mead at 1050 feet (the current minimum power pool) to the extent feasible without implementing shortages that would involuntarily curtail deliveries to Lower Basin users.
- It is desirable to protect the elevation of Lake Mead at no less than 1000 feet under any condition in order to protect Southern Nevada Water Authority's lower intake structures, as well as the new minimum power pool if proposed low-pressure turbines are installed at Hoover Dam.
- It is desirable to avoid shortages in the Lower Basin above 500,000 acre-feet whenever possible (the approximate level at which shortages would cut into CAP's deliveries beyond those currently utilized for water banking).
- It is preferable for Lower Basin water users to voluntarily engage in predictable, small-scale reductions in use – and receive compensation for those reductions – rather than face large-scale, involuntary, and uncompensated disruptions in water deliveries that could cut into municipal and agricultural water supplies and create unmitigated economic impacts.
- Minimizing large, forced disruptions to normal deliveries as a result of shortage declarations will minimize the threat of unmitigated environmental impacts in the Lower Colorado River and Delta as a result of significantly decreased deliveries to low-priority users and corresponding return flows that support environmental values.
- Market-based programs, with low transaction costs and appropriate mitigation of third-party impacts, can offer a reasonable mechanism for minimizing the risk and impacts of shortage.[1]
- Users of Colorado River water in Mexico may wish to participate in short-term conservation agreements, to reduce the probability of larger, uncompensated future reductions due to a declaration of shortage under the 1944 Treaty with Mexico.
- Water can be obtained from agricultural users in the United States, and could be obtained in Mexico with an appropriate agreement,[2] through the use of voluntary, market-based forbearance programs. Economic studies of Lower Basin agricultural use, as well as recent leases of water from farmers in this area, suggest that there is a large volume of water in the basin that could be obtained for $20 - 100 per acre-foot (see Figure 9).

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[1] Some 4.5 million acre-feet of Colorado River water are used to irrigate crops in the Lower Basin states, and more than 1 million acre-feet are used to irrigate crops in Mexico. Conservation of between 200,000 and 600,000 acre-feet through the use of part-year fallowing programs, dry year options, or other similar arrangements would constitute only 4-11% of total Lower Basin agricultural use in the United States and Mexico. (However, as even small-scale reductions in agricultural water use may have third-party impacts, some portion of funds accrued for the purchase of water should be set aside to support community economic development in affected areas.) Conversely, without these small-scale reductions, water users would likely be faced with the need to curtail large amounts of water quite abruptly, with significant economic consequences. (Shortages of nearly 2 million acre-feet in a single year are predicted by Reclamation's model when the 1000 feet elevation is protected at Lake Mead without conservation measures).

[2] Such an agreement would likely require a new Minute to the 1944 Treaty with Mexico. Fallowing agreements in Mexico would have to be administered by the appropriate authorities.

III. Conservation Before Shortage Policy

The "Conservation Before Shortage" policy essentially consists of two sets of criteria tied to projected elevations at Lake Mead on January 1 of a given year, according to the Bureau of Reclamation's August 24-month study. These criteria consist of three "conservation triggers," which impose progressively increasing conservation goals as lake levels drop from 1100 feet to 1050 feet, and a "shortage trigger," which imposes involuntary shortages in the Lower Basin as are necessary to accomplish absolute protection of Lake Mead at a minimum elevation of 1000 feet.

(A) Normal Conditions

In years when the 24-month study projects the elevation of Lake Mead on January 1 will be at or above 1100 feet, the Secretary of the Interior (Secretary) shall determine a Normal or Surplus (as defined by the Interim Surplus Guidelines) year.

(B) Conservation Triggers

First Conservation Trigger: Below 1100 Feet at Lake Mead

In years when the 24-month study projects the elevation of Lake Mead on January 1 will be at or above 1075 feet but below 1100 feet, the Secretary will seek to conserve 200,000 acre-feet of water. On behalf of the Secretary, Reclamation will preferentially seek to achieve this 200,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

Second Conservation Trigger: Below 1075 Feet at Lake Mead

In years when the 24-month study projects that the elevation of Lake Mead on January 1 will be at or above 1050 feet but below 1075 feet, the Secretary will seek to conserve 400,000 acre-feet of water. Reclamation will preferentially seek to achieve this 400,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

Third Conservation Trigger: Below 1050 Feet at Lake Mead

In years when the 24-month study projects that the elevation of Lake Mead on January 1 will be below 1050 feet (minimum power pool absent the installation of low-pressure turbines), the Secretary will seek to conserve 600,000 acre-feet of water. Reclamation will preferentially seek to achieve this 600,000 acre-feet of savings by means of voluntary conservation agreements (including forbearance agreements) with Lower Basin delivery-contract holders. Additionally, Reclamation will, to the extent permitted by law and through the appropriate authorities, seek

forbearance or other such water conservation agreements with Colorado River users in Mexico. In the case of such agreements, U.S. deliveries of Colorado River water to Mexico at the Northerly International Boundary will be reduced by the total volume indicated by these binational agreements.

(C) Shortage Trigger

Absolute Protection of Lake Mead Elevation 1000 Feet

The Secretary shall not permit the elevation of Lake Mead to drop below elevation 1000 feet (minimum low-pressure power pool and Southern Nevada Water Authority intakes) at any time. Shortages to Colorado River contractors shall be implemented in the Lower Basin and in Mexico[3] to the extent necessary to prevent such declines.

(D) Funding Mechanisms

In recognition of the federal government's continuing national obligation to replace the MODE bypass flow to Mexico, 43 U.S.C. § 1571(c), the federal government will assume responsibility for the cost of all conservation agreements up to the volume of the bypass flow that the Secretary has not otherwise replaced in the year that a conservation trigger becomes effective. Given the national interest in minimizing both environmental impacts and economic disruptions resulting from the involuntary curtailment of deliveries to Colorado River users, the federal government would also assume responsibility for half of the cost of any additional agreements required to generate conserved water for the "Conservation Before Shortage" policy, pursuant to the Secretary's authority under the Reclamation States Emergency Drought Relief Act of 1991 (Drought Relief Act),[4] conservation authorities in the Farm Bill, or other appropriate authority that may be granted by Congress.

To the extent that conservation of water is required beyond that to be funded by the federal government in the manner described above, conservation activities would be funded through one or both of the following:

Power Pool Protection Fund

The priority of water used for power generation is considered to be tertiary to that of irrigation and domestic use under the Law of the River. As a result, Hoover and Glen Canyon Dams are operated to maintain deliveries to water users regardless of the impact of declining reservoir levels on power production. However, one of the more significant corollary benefits of the conservation program described in this proposal, beyond the primary benefit of protecting water users from involuntary and uncompensated shortages, would be the preservation of power production at Hoover Dam at higher levels and for longer durations by reducing deliveries for irrigation, domestic use, and underground storage in a manner that would not otherwise occur under current practices.

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[3] In the event that a shortage is declared and is also considered to be an extraordinary drought under the 1944 Treaty, deliveries to Mexico will be reduced in the same proportion as consumptive uses in the United States are reduced.

[4] The Reclamation States Emergency Drought Relief Act of 1991, 43 U.S.C. §§ 2201 *et seq.*, provides the Secretary of Interior the authority to purchase water "from willing sellers, including, but not limited to, water made available by Federal Reclamation project contractors through conservation or other means with respect to which the seller has reduced the consumption of water." 43 U.S.C. § 2211(c).

Given the significant loss in generating capacity that has already occurred as a result of declines in power pool elevations,[5] and the even more significant impacts that would be associated with a total loss of generating capacity, the implementation of "Conservation Before Shortage" would clearly benefit power purchasers and consumers. As such, it would seem reasonable to derive a percentage of the funding for the proposed voluntary conservation program from a modest, conditional surcharge on power rates under existing or renewed contracts for hydropower produced at Hoover Dam as a means to mitigate against the loss of power head and stave off the complete loss of power production at Hoover Dam.[6] This surcharge could be imposed in years when Reclamation's August 24-month study projects that the storage in Lake Mead falls below fifty percent of its active capacity. The revenues generated by this surcharge could be collected in a "power pool protection fund," to be maintained by Reclamation for expenditure when and if lake elevations reach a conservation "trigger."

Temporary Cost Recovery/Delivery Surcharges

Pursuant to the Drought Relief Act, the Secretary of Interior is authorized to engage in water purchases from willing sellers and to seek cost recovery for water delivered from the users of that water under temporary contracts. 43 U.S.C. §2211(c), §2212(a),(c). Reclamation could utilize this authority to purchase water through temporary, part-year fallowing arrangements, dry-year options, or similar mechanisms, and would seek cost recovery from Colorado River users. In recognition of the Basin-wide interest in alleviating the impacts of drought and reducing uncertainty on the Lower Colorado, and in the interests of encouraging extraordinary conservation to minimize the likelihood of significant delivery interruptions, the cost of some portion of conservation agreements, including those with Colorado River users in Mexico, could be funded through a conservation surcharge imposed on a per-acre-foot basis on all Lower Basin contractors.

Anticipated Cost of Conservation

Current short-term leasing agreements between farmers and irrigation districts or municipal water agencies, as well as recent research on the net returns per acre-foot of irrigation water, suggest that "Conservation Before Shortage" water could be obtained for $20 - 100 per acre-foot. To ensure that such water remains available in times of increased scarcity (when market forces might otherwise increase the cost), the Secretary should be granted the authority to enter into "Conservation Before Shortage option agreements," similar to existing dry-year leasing agreements/interruptible supply agreements that have been enacted within the basin states.

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[5] Largely as a result of declining reservoir elevations, power production at Hoover and Glen Canyon has declined steadily since the onset of drought conditions in the Colorado River Basin. Annual power production at Hoover fell from 5,697 gigawatt-hours (GWh) in 1998 to 4,094 GWh in 2003, according to Western Area Power Administration (WAPA) Annual Reports, 1998 – 2003. A portion of hydropower revenues currently supports the two Upper Basin endangered fish recovery programs, the Glen Canyon Adaptive Management Program, and the Colorado River Salinity Control Program; alternative sources of revenue should be identified and implemented to fully fund these recovery programs. The Department of the Interior should also work proactively with WAPA to identify alternative sources of power for those Indian tribes that have experienced power shortages, or drastic increases in power costs, due to the declining production associated with falling reservoir levels.

[6] The rates for power produced at Hoover Dam have increased as reservoir levels and power production have declined, but may still remain well below open market rates. Although annual revenues tend to vary from year to year, revenues from Hoover Dam power production have generally been in the range of $50 million annually.

IV. Analysis: Benefits of Conservation Before Shortage Policy

To date, actual shortage criteria for the Colorado River have not been defined. For the purposes of comparison, a 'baseline' was defined as the current operating conditions for the Colorado River, with the addition of a policy requiring the absolute protection of Lake Mead at 1000 feet (that is, Hoover Dam would not release any water to cause the elevation of Lake Mead to drop below 1000 feet). The baseline policy does *not* provide for the implementation of conservation measures. These 'baseline' conditions, reflecting current operating conditions, are depicted in the following figures.

Analysis of the "Conservation Before Shortage" policy suggests that this policy could produce significant benefits for Basin water users by:

- Consistently maintaining reservoir storage and power head above baseline conditions in average to low flow conditions, resulting in increased power production and improved power revenues;
- Significantly reducing the likelihood of involuntary, uncompensated shortages in the Lower Basin and corresponding, unmitigated economic impacts;
- Significantly reducing the likelihood of involuntary and uncompensated shortages in the Lower Basin at levels above 500,000 acre-feet (the approximate level at which a shortage imposed by the Secretary would cut into CAP deliveries, by exceeding the ability of the Arizona Water Bank to readily buffer the shortage); and
- Eliminating the risk that elevations at Lake Mead will drop below minimum power head, improving the reliability of power production and associated revenues.

The analyses below show the impacts of the "Conservation Before Shortage" (CBS) policy on reservoir operations based on historic flows in the Colorado River Basin.

Modeling Assumptions

The proposed "Conservation Before Shortage" policy was modeled using Reclamation's Riverware model, which is based on historical records of flows in the Colorado River Basin over approximately the past century. Conservation triggers, as described in Section III, were implemented at 1100 feet, 1075 feet and 1050 feet, with the assumption that required measures to reduce Lower Basin consumptive use by 200,000, 400,000, and 600,000 acre-feet, respectively, would be implemented in years when the January 1 elevation at Lake Mead is below the triggers. An absolute protection trigger was implemented at Lake Mead elevation 1000 feet, with releases from Lake Mead to meet delivery obligations to Lower Basin users reduced as necessary to maintain that level. To avoid even modestly under-predicting the elevations of Mead and Powell pools, particularly in the near term, this modeling has assumed that the schedule of Upper Basin depletions will effectively begin with the last reported actual level for CY 2000, will increase at a

slower rate than projected by the Upper Colorado River Basin Commission through CY 2009, and will increase at the rate projected by the Commission thereafter.[7]

For purposes of the model, the minimum objective release out of Lake Powell was assumed to be 8.23 maf per year (reflecting current operating conditions).[8] Alternative scenarios for conjunctive management were not modeled, and the protection of a minimum power pool at Lake Powell was not incorporated into this proposal; either or both of these assumptions would affect the elevation of Lake Powell. Model runs used end-of-year 2004 elevations at Lake Mead and Lake Powell to establish initial conditions for 2005, and were run through year 2025.

Protection of Lake Mead

Figures 1 -3 show the potential value of implementing the CBS policy, under a range of average to extremely low flow conditions. **These and following figures show that the CBS policy would greatly benefit the elevation of Lake Mead.**

As shown in Figure 1 below, under average conditions, the CBS policy would maintain reservoir elevations at Mead approximately 30 feet above the baseline policy. As shown by Figures 2 and 3, the CBS policy would significantly reduce the rate of decline in the lower 25th and in the very low 10th percentile reservoir elevations for Mead and maintain even these lower reservoir elevations above the 1000 foot protection level. Model runs showed essentially no impact of the CBS on the higher 90th percentile Mead elevations, so no figure is provided.

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[7] *See* "Estimates of Future Depletions in the Upper Division States," Upper Colorado River Commission Memorandum, December 23, 1999. This schedule predicts a 440,000 acre-foot increase in Upper Basin depletions between 2000 and 2010 and a 542,000 acre-foot increase over actual CY2000 depletions, as reported in Reclamation's Consumptive Uses and Losses 1996-2000 report (see Tables UC-1 & UC-6). Actual increases in Upper Basin depletions water may not keep pace with this schedule, because water that would otherwise have been utilized has been and may continue to be physically unavailable for depletion in the Upper Basin due to drought conditions, and in other cases, projects that were proposed to have been constructed during this period may not yet have been or will not be completed through CY 2009. A slower rate of increase from 2000 to 2009 was modeled by subtracting four increments of 100,000 acre-feet from the Commission's schedule from CY 2005 to 2009. This and all other Riverware modeling exercises should be revised to reflect actual increases in Upper Basin depletions as soon as more current information becomes available.

[8] This assumption is not intended to endorse or reject the Secretary's current use of 8.23 maf as the minimum release objective for Powell, the protection of a minimum power pool at Powell, or proposals for the conjunctive management of the combined storage of Mead and Powell. Alternative release scenarios should be incorporated into the modeling for this proposal as they are developed. As a general matter, none of the assumptions used in this proposal should be construed as an interpretation of the 1922 Colorado River Compact, the 1944 Treaty with Mexico, or any other aspect of the Law of the River.

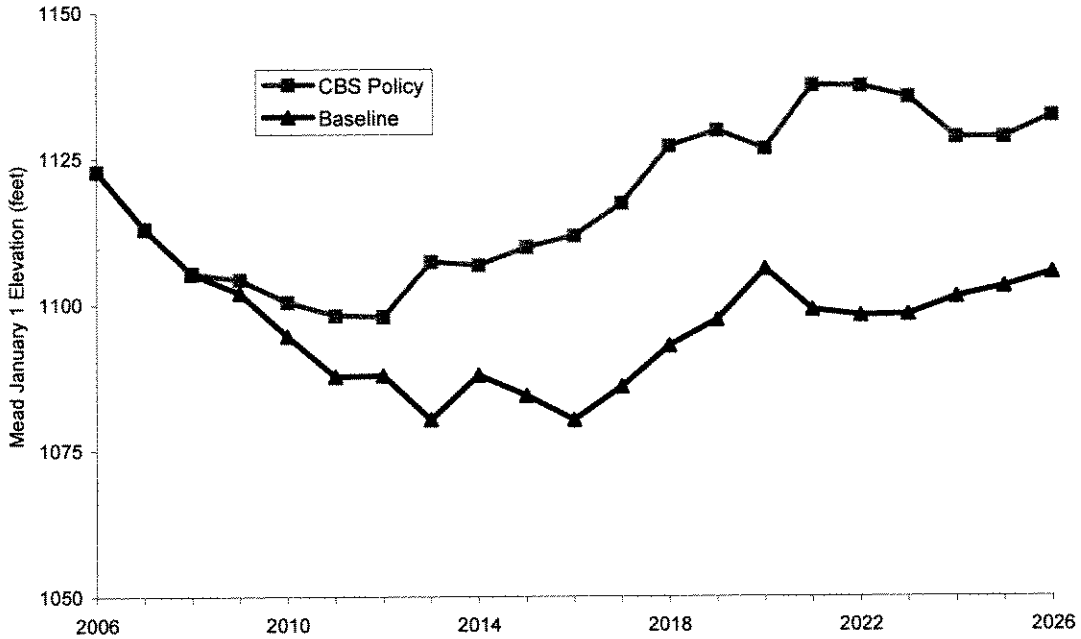

Figure 1. Impact of CBS policy on elevations at Lake Mead, at 50th percentile elevation.

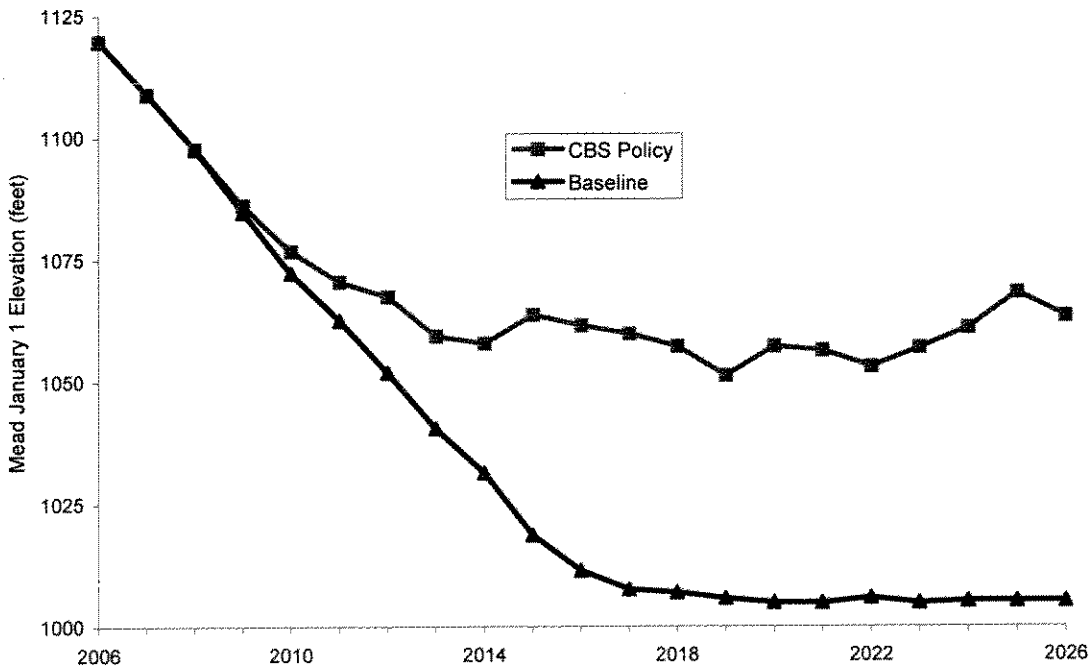

Figure 2. Impact of CBS policy on elevations at Lake Mead, at 25th percentile elevation.

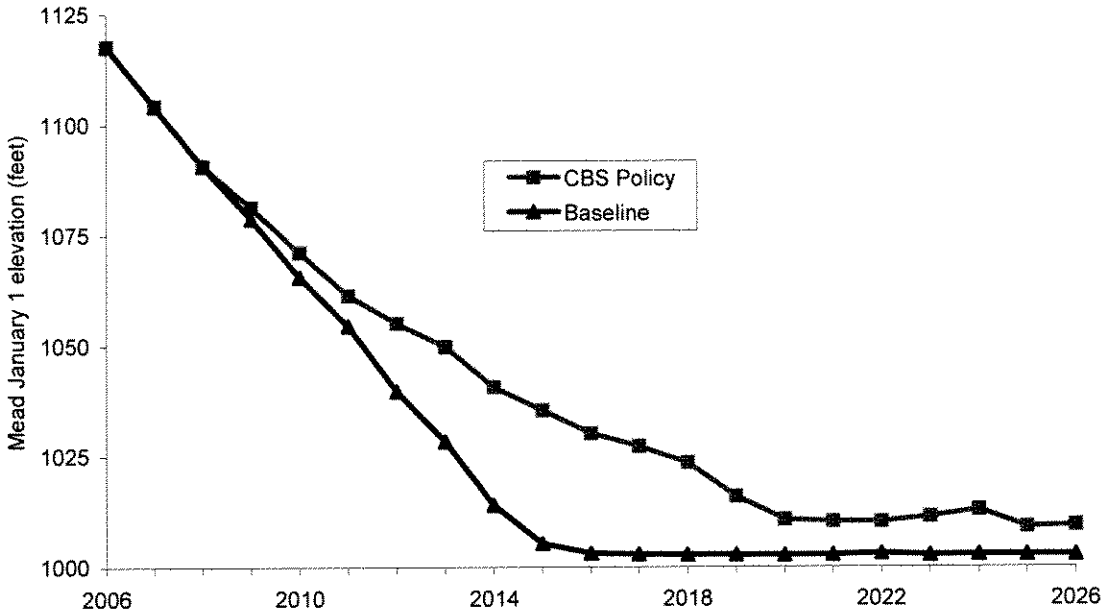

Figure 3. Impact of CBS policy on Lake Mead elevation, at 10th percentile elevation.

Probability of Shortages

As noted above, a primary goal of the CBS policy is to significantly reduce the probability of an involuntary, uncompensated shortage in excess of 500,000 acre-feet (the approximate level at which CAP deliveries would be reduced beyond that currently utilized for water banking). **As shown in Figure 4, below, the probability of shortages exceeding 500,000 acre-feet is reduced to 5% or less through the entire modeled period under the CBS policy. By contrast, the probability of shortage under the baseline policy rapidly approaches 30% during this same period. Furthermore, as shown in Figure 5, below, the CBS policy reduces the probability of any involuntary shortage by approximately 20% over the next 20 years.**

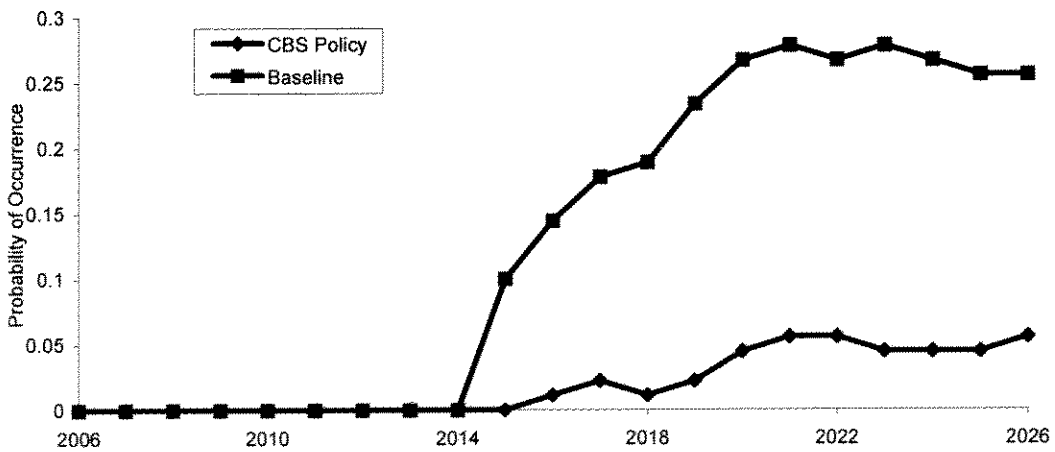

Figure 4. Impact of CBS policy on probability of involuntary Lower Basin shortage greater than 500,000 acre-feet.

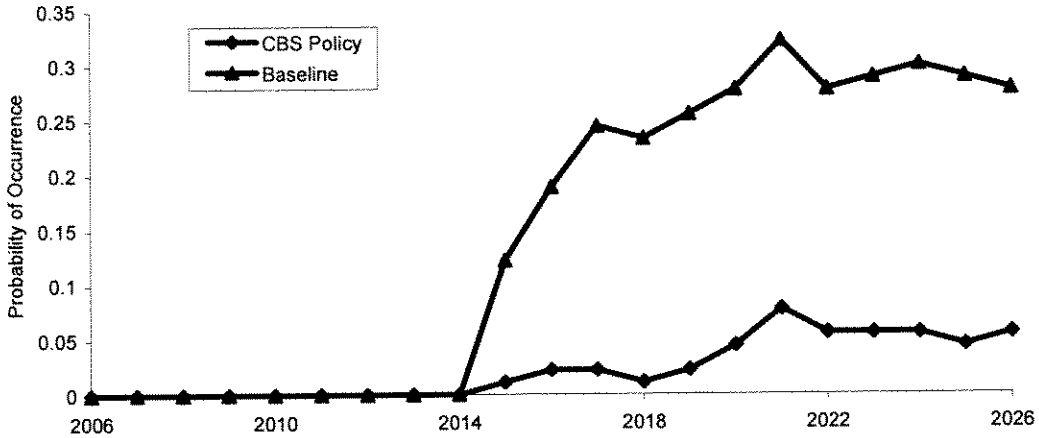

Figure 5. Impact of CBS policy on probability of any involuntary shortage in the Lower Basin.

Probability of Reaching Conservation Triggers

Figures 6 - 8, below, show the relative probability of reaching or exceeding any of the proposed conservation triggers at 1100 feet, 1075 feet and 1050 feet. As one might expect, the probability of reaching the first two triggers is highest in the earlier years of the modeled period, while the probability of reaching the third trigger is higher towards the end of the modeled period. However, the probability of reaching and continuing to remain below a given trigger for an extended period of time appears to be low because of the conservation measures tied to the triggers. For obvious reasons, trigger levels are most likely to be reached under low or very low flow conditions, and are rarely (if ever) reached under high flow conditions.

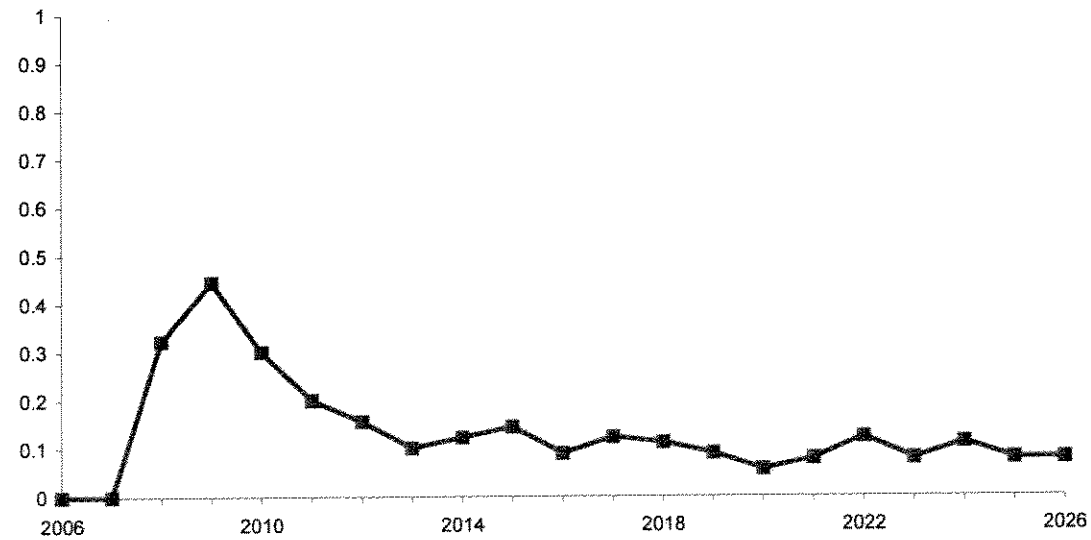

Figure 6. Probability of Lake Mead January 1 elevation occurring in a bounded range of 1100 feet to 1075 feet, with CBS policy in place.

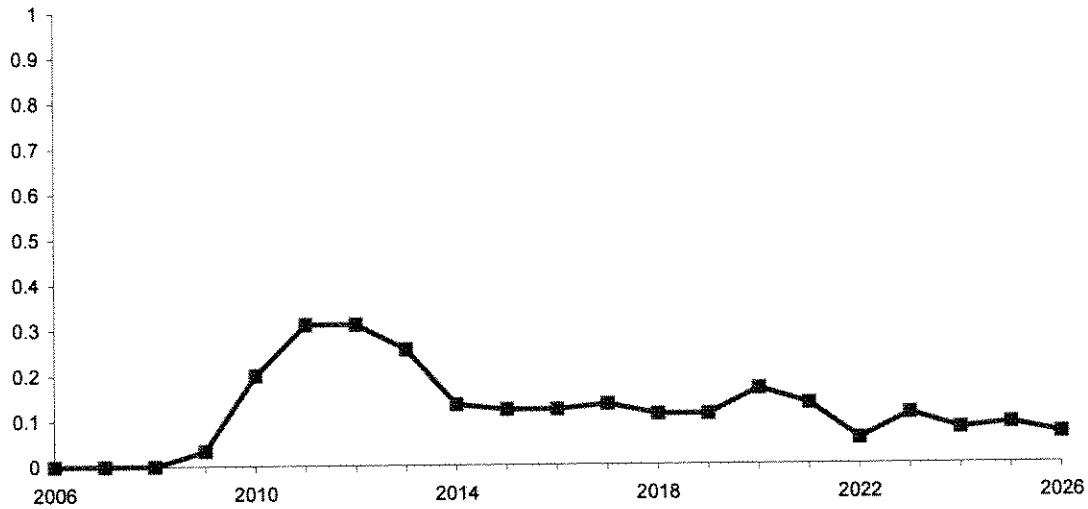

Figure 7. Probability of Lake Mead January 1 elevation occurring in a bounded range of 1075 feet to 1050 feet, with CBS policy in place.

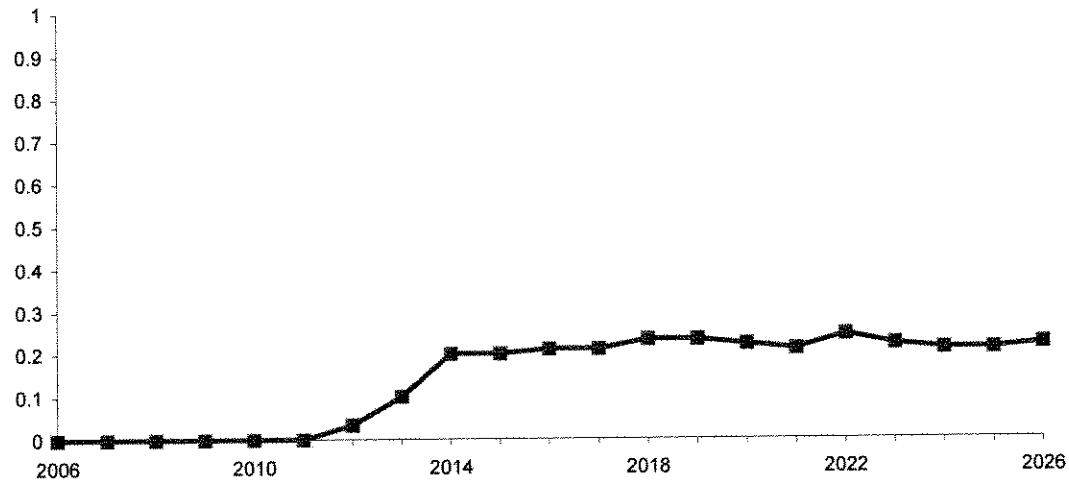

Figure 8. Probability of Lake Mead January 1 elevation occurring below 1050 feet, with CBS policy in place.

Cost of Implementing Conservation Triggers

The cost of implementing conservation triggers is directly related to the cost of obtaining water using the proposed voluntary, market-based conservation mechanisms. Recent purchases of water from farmers in the Lower Basin, as well as analysis of agricultural production in this area, suggest that there is a substantial volume of water used for irrigation which could potentially be obtained on a temporary basis for $20 - 100 per acre-foot. For example, in 2004, the Imperial Irrigation District acquired water from its farmers for less than $60 per acre-foot.

As shown in Figure 9, a recent economic study by Environmental Defense into the profits returned by field crops suggests that slightly more than 2.3 million acre-feet of agricultural water

is being used by Lower Basin farmers in California and Arizona to produce profits of less than $100 per acre-foot; more than one million acre-feet of agricultural water is being used to produce profits of less than $20 per acre-foot. (Figures are based on the average volume of water applied to produce a crop unit and market rates for each crop, less costs of production.)

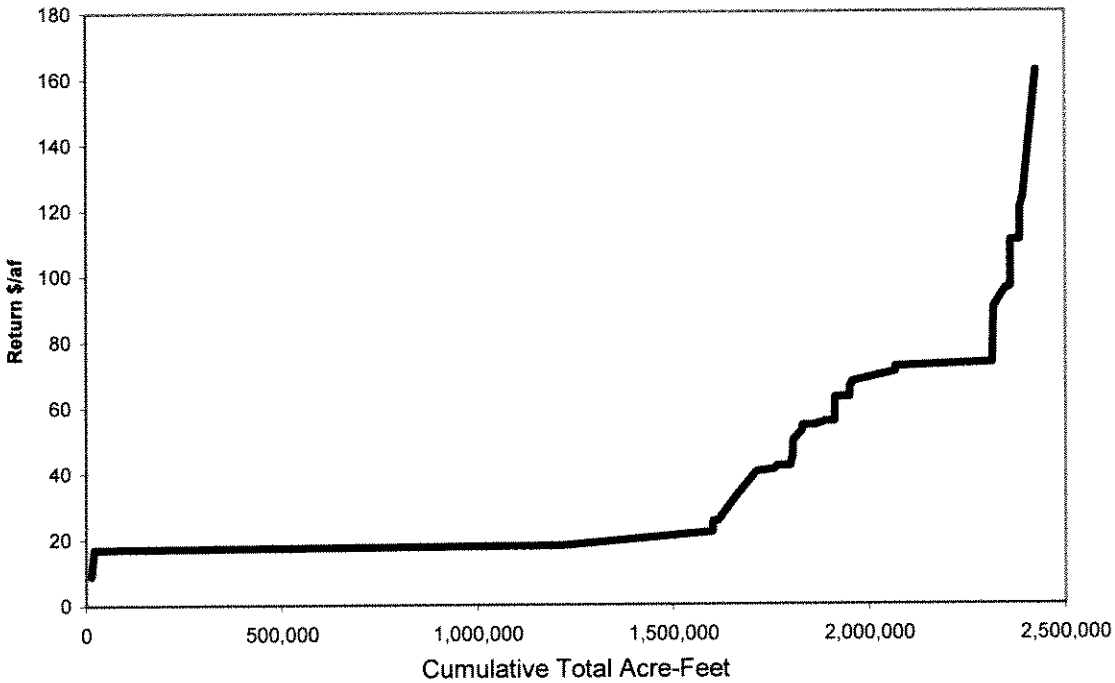

Figure 9. Profits per acre-foot returned on Colorado River water used in the production of selected crops in the Lower Colorado River Basin. [9]

While these figures do not necessarily reflect the amount at which any given water user would be willing to take part in a part-year fallowing program or agree to a dry-year option, they do suggest that if an open, market-based approach is used to identify potential participants, a number of water users in the Lower Basin would probably be willing to temporarily reduce or forgo the use of water for agricultural production in a price range between $20 and $100 per acre-foot (as the sale of water in this range would produce equal or greater monetary returns to the user than the use of water to irrigate crops).

In order to mitigate third-party impacts of fallowing, the federal government could establish a drought economic adjustment fund that would provide economic development grants to affected communities in the counties of origin. These funds preferentially would go to established county-based farm labor assistance programs to the extent that such programs exist, and could include lump sum payments to displaced workers based on a percentage of foregone annual income.

[9] This graph has not been published elsewhere. For methodology, please contact Jennifer Pitt at jpitt@environmentaldefense.org. A study using similar methodology, but limited to crop values in the Wellton-Mohawk Irrigation and Drainage District, has been published previously (Pitt et al., New Water for the Colorado River: Replacing the Bypass Flow, 6 U. Denver Water L. Rev. 68 (2002)). The study found a range of prices similar to that represented here for profits derived from water use in that area.

Using these assumptions for water acquisition costs, Table 1 suggests the approximate range of costs for implementing each of the conservation triggers under the CBS policy.

Table 1. Approximate federal and power/water user cost of implementation of CBS policy conservation trigger levels (assumes that water can be acquired temporarily for $20 - $100/acre-foot, and that the annual federal bypass obligation of 110,000 acre-feet has not otherwise been satisfied).

Trigger	Conservation required	Federal obligation (bypass + 50%)	Federal cost (millions)	Remaining Obligation	Water user cost (millions)	Power Surcharge (millions)	User cost per af (all Lower Basin users)
1075-1100	200,000 af	155,000 af	$3 - $15.4	45,000 af	$0.45 - $2.3	$0.45 - $2.3	$0.06 - $0.30
1050-1075	400,000 af	255,000 af	$5 - $25.4	145,000 af	$1.5 - $7.3	$1.5 - $7.3	$0.19 - $0.97
Below 1050	600,000 af	355,000 af	$7 - $35.4	245,000 af	$2.5 - $12.3	$2.5 - $12.3	$0.33 - $1.63

Cost of Not Implementing "Conservation Before Shortage" Policy

Although the "Conservation Before Shortage" policy would impose notable costs on water and power users, and on taxpayers generally, these costs should be compared with the much larger financial costs that would occur if the Secretary were to impose involuntary, uncompensated shortages, as well as the costs due to the lack of certainty and reliability that would exist without the CBS policy. The recent drought and decrease in power production at both Hoover Dam and Glen Canyon Dam point to the dramatic costs imposed by the loss of reservoir storage.

If Lake Mead falls to 1050 feet, power rates will need to be increased to an approximate composite rate of 2.31 cents/kWh, which is a 44.3% increase over current rates. Replacement power purchases would be (depending on the user) 2.9 to 3.7 times the Hoover rate. In FY03, replacement power may have cost customers an additional $24 million.