

**SUBMIT OPTION SUBMITTAL FORM BY:**

1. EMAIL TO: [COLORADORIVERBASINSTUDY@USBR.GOV](mailto:COLORADORIVERBASINSTUDY@USBR.GOV)

2. U.S. MAIL TO: BUREAU OF RECLAMATION, ATTENTION MS. PAM ADAMS, LC-2721, P.O. BOX 61470, BOULDER CITY, NV 89006-1470

3. FACSIMILE TO: 702-293-8418

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## Option Submittal Form

**Contact Information (optional):**

**Keep my contact information private.**

Contact Name: _____	Title: _____
Affiliation: _____	
Address: _____	
Telephone: _____	E-mail Address: _____

Date Option Submitted: February 1, 2012

**Option Name:**

Fill Mead First
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**Description of Option:**

<p>The Fill Mead First option would designate Lake Mead as the primary water storage and distribution facility for the upper and lower Colorado River basins. Operation of Glen Canyon Dam would be changed to allow water to flow through the power plant and outlet works at Glen Canyon Dam, filling Lake Mead reservoir before impounding water in Lake Powell. Lake Powell would be generally kept close to the power pool elevation level of 3,490 and the dam used primarily for seasonal flow variations, flood control, and sediment distribution purposes. The Fill Mead First option could be enhanced by the addition of other strategies as appropriate. This includes mechanical sediment augmentation and addition of a temperature control device.</p>
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**Location:** Describe location(s) where option could be implemented and other areas that the option would affect, if applicable. Attach a map, if applicable.

<p>The Fill Mead First option would involve a change in the traditional operation and management of Glen Canyon Dam. It would directly affect the Colorado River Basin from Cataract Canyon to Hoover Dam and indirectly affect the entire Basin in terms of distribution and storage of water, and ecosystem health.</p>
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**Water Quantity and Timing:** Roughly quantify the range of the potential amount of water that the option could provide over the next 50 years and in what timeframe that amount could be available. If option could be implemented in phases, include quantity estimates associated with each phase. If known, specify any important seasonal (e.g., more water could be available in winter) and/or frequency (e.g., more water could likely be available during above-average hydrologic years) considerations. If known, describe any key assumptions made in order to quantify the potential amount.

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The Fill Mead First option would keep Lake Mead as full as possible, helping to meet the needs of 25 million water users in the Lower Colorado Basin who depend on Mead reservoir. Shifting the storage of most water from Lake Powell to Lake Mead would not reduce the amount of water flowing from the Upper Basin, the legal requirements of the Colorado River Compact of 1922 or the Mexican Water Treaty of 1944. The changes would only impact the timing of the flow.

Based on research done for Glen Canyon Institute, the Fill Mead First option could result in significant savings of water now lost from the Colorado River. It is estimated that evaporation and bank seepage from a lowered Lake Powell would be reduced by approximately 637,000 acre-feet per year (af/year). Meanwhile, evaporation and bank seepage from a full Lake Mead would be increased by 355,000 af/year. However, the net result would be a water savings of approximately 282,000 af/year in the Colorado River system. This is a substantial savings — equivalent to 94 percent of the state of Nevada's entire annual appropriation from the Colorado River. This option effectively addresses the effects of climate change — one of the major concerns identified in the preliminary findings of the Bureau of Reclamation's (BOR) Colorado River Basin Supply and Demand study.

The benefits of the Fill Mead First option would begin immediately. Because Glen Canyon Dam would remain operational, water flows could be adjusted as needed, in the event of an extraordinary flood or dry year.

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## Additional Information

**Technical Feasibility:** Describe the maturity and feasibility of the concept/technology being proposed, and what research and/or technological development might first be needed.

The basic Fill Mead First option does NOT require major re-engineering of Glen Canyon Dam or new technology. Efforts to determine and implement the best possible flow regime to ensure adequate sediment deposition, restore and protect fish communities, maintain cultural sites, and provide recreational uses are already underway. The Fill Mead First option would provide greater flexibility of flows that would benefit these efforts. If mechanical sediment augmentation or a temperature control device were added, it would involve further research and engineering. This would no doubt delay the implementation of these features for several years at least.

**Costs:** Provide cost and funding information, if available, including capital, operations, maintenance, repair, replacement, and any other costs and sources of funds (e.g., public, private, or both public and private). Identify what is and is not included in the provided cost numbers and provide references used for cost justification. Methodologies for calculating unit costs (e.g., \$/acre-foot or \$/million gallons) vary widely; therefore, do not provide unit costs without also providing the assumed capital and annual costs for the option, and the methodology used to calculate unit costs.

The Fill Mead First Alternative would not add any significant new costs. Moreover, it could save significant amounts of Colorado River Storage Project (CRSP) revenue allocation. The CRSP Basin Fund pays the cost of the Glen Canyon Adaptive Management Program (GCDAMP), which totals more than \$10 million a year. The GCCAMP is mainly necessary because of the need to assess and mitigate the damage caused by current operations of Glen Canyon Dam. The Fill Mead First Alternative would allow for more natural river flows, with more flexibility to address adverse impacts on the downstream natural, recreational, and cultural resources in the park units, including resources of importance to American Indian tribes. This could significantly reduce the need, and related expenses, for the GCDAMP in the long run. Because most of the funding for this program comes from hydropower revenues, this would also reduce the pressure on the BOR to maximize hydropower production.

**Permitting:** List the permits and/or approvals required and status of any permits and/or approvals received.

Revised permits and approvals may be required to implement the Fill Mead First option. These would be determined as a part of the further National Environmental Policy Act (NEPA) analysis that would be needed to implement this option. No revisions to the Colorado River Compact or the Mexican Water Treaty would be required.

**Legal / Public Policy Considerations:** Describe legal/public policy considerations associated with the option. Describe any agreements necessary for implementation and any potential water rights issues, if known.

The Fill Mead First option has obvious policy and political implications. However, it appears that it could be implemented within the current legal and regulatory framework. The Colorado River Compact requires the Upper Basin to deliver a ten-year rolling average of 75 million acre-feet (maf) of water at Lee Ferry. However, the Compact does not include the "equalization" rule, which was introduced in the 1968 Colorado River Basin Project Act and was implemented by the 1970 Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs, most recently amended in 2005 (Criteria for Long-Range Operation). The Compact also does not include the objective of maintaining a minimum release of water from Lake Powell of 8.23 maf per year, which was a part of the Criteria for Long-Range Operation.

Modifying the equalization rule to allow Lake Mead to be kept full, even if Lake Powell is not, would provide increased flexibility to implement the original goals of the Colorado River Basin Project Act. The Department of the Interior could embark on a reoperation study of Glen Canyon Dam within the present constraints of Colorado River

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water management. The Act's purpose is "to provide a program for the further comprehensive development of the water resources of the Colorado River Basin and for the provision of additional and adequate water supplies for use in the upper as well as in the lower Colorado River Basin." The language of the Act regarding the equalization rule is not absolute. The goal is to maintain equalization "as nearly as practicable."

The Bureau of Reclamation already allows for modification of the equalization rule under some circumstances. For example, when Lake Powell is below a certain elevation, the Interim Guidelines call for the amount of water released to be driven by flow volume, not equalization of the two reservoirs. Since it is increasingly not "practicable" to maintain Lake Powell and Lake Mead at equal active storage volumes, the BOR could potentially further modify implementation of the equalization rule to allow most of the water to be consolidated in Lake Mead. Another approach could be for the Congress to amend the 1968 Colorado River Basin Project Act to modify or eliminate the equalization rule.

In the current Colorado River management system, Lake Powell and Lake Mead are maintained as two separate reservoirs divided by Lee Ferry. Lee Ferry is the "counting point," where water delivery from Upper Basin to Lower Basin states is measured. The equalization rule is justified by the perceived need to keep the two reservoirs equally full to ensure even allocation of water to the two basins.

The Fill Mead First option would not change the line between the Upper Basin and the Lower Basin. It would not change the allocation of water to either basin. Instead, the Upper Basin would simply be allowed to store water in Lake Mead, which would otherwise be stored in Lake Powell. Upper Basin rights would be protected, because water shifted from Lake Powell to Lake Mead would be counted toward the Upper Basin solely for the purposes of delivery and not for consumptive use. In effect, Lake Mead and Lake Powell would be considered as one reservoir with two units.

Currently, under the Criteria for Long Range Operation and the Annual Operating Plans developed by the Secretary of the Interior, the Upper Basin meets its Compact obligations on an annual basis. However, the Compact itself only requires that delivery obligations be met on a ten-year rolling average. This provides flexibility to meet those requirements.

The most workable approach may be to change the Criteria for Long Range Operation and the Annual Operating Plan to count Upper Basin deliveries on the basis of a ten-year rolling average, as required by the Compact. All the Upper Basin deliveries of water past Lee Ferry would be counted against the 10-year rolling average of 75 maf. The amount sent in any year could vary, but delivery now would reduce the later delivery requirement — in effect, "paying off the mortgage early." This would require no Upper Basin reservoir storage rights in Lake Mead unless the Upper Basin exceeded its 10-year rolling average at any point (a highly unlikely possibility). The additional volume necessary to meet the Mexican Water Treaty flows can be added to the 75 maf rolling average.

The proposed changes would be consistent with the provisions of the Colorado River Compact. As such, both the Upper and Lower basins would be meeting their obligations under the Compact and not subject to legitimate legal challenge.

The Fill Mead First option would also help to fulfill the responsibility of the Bureau of Reclamation and National Park Service to meet the mandate of the 1992 Grand Canyon Protection Act (GCPA). Specifically, that is, "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." Further, this option may help the agencies to comply with the Endangered Species Act, by promoting the recovery the endangered humpback chub and other imperiled species in Grand Canyon and Glen Canyon.

**Implementation Risk / Uncertainty:** Describe any aspects of the option that involves risk or uncertainty related to implementing the option.

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The Fill Mead First option has the benefit of being reversible. If it did not produce the desired results, Glen Canyon Dam could be returned to current operations in a short period of time. Indeed, it could be implemented as an experiment, with the decision as to whether to make it permanent left until the future, when more information is available.

**Reliability:** Describe the anticipated reliability of the option and any known risks to supply or demand, such as: drought risk, water contamination risk, risk of infrastructure failure, etc.

The Fill Mead First option would not significantly re-engineer Glen Canyon Dam, so it would not involve a major change in reliability from the status quo. Moreover, its implementation would be flexible. Operations could be readily adjusted, if necessary, to address unforeseen problems. This option also addresses the need to address climate change impacts and the ability to meet delivery requirements defined in the Mexican Water Treaty.

**Water Quality:** Identify key water quality implications (salinity and other constituents) associated with the option in all of the locations the option may affect.

Lake Mead has hovered around the half-empty level for more than a decade, and this situation is likely to continue for the foreseeable future. This major reduction in water volume has significantly concentrated salinity, heavy metals, toxic pollution, and other water impurities. This has been a major concern for Lower Basin water authorities. By keeping Lake Mead as full as possible, water quality would be increased. Water quality in Lake Powell would probably be decreased, but the small number of people who depend on this water source could be provided with water from an alternate source.

**Energy Needs:** Describe, and quantify if known, the energy needs associated with the option. Include any energy required to obtain, treat, and deliver the water to the defined location at the defined quality.

Energy Required	Source(s) of Energy
It is unlikely that the Fill Mead First option would result in any net change in energy needs. No additional energy needs would be required to implement this option.	NA

**Hydroelectric Energy Generation:** Describe, and quantify if known, any anticipated increases or decreases in hydroelectric energy generation as a result of the option.

Location of Generation	Impact to Generation
Glen Canyon Dam	The Fill Mead First option would have an impact on the timing of Glen Canyon Dam hydropower production. Glen Canyon Dam has a peak generating capacity of 1,320 megawatts (MW). However, Glen Canyon Dam hydropower production has been reduced to about 1,000 MW, due to the restrictions of continuing drought and the Glen Canyon Dam Adaptive Management Program, which was created to meet the legal obligation to mitigate environmental damage in Grand Canyon. In 2007, the Glen Canyon Dam power plant generated 3,600,000 megawatt-hours (MWh), only 31 percent of the design capacity of 11,563,200 MWh, and only 69 percent of the 5,196,113 MWh annual average from 1978-1999. Colorado River flows are likely to continue decreasing and the LTEMP EIS process could well find that additional modifications in dam releases are necessary to meet the mandate of the Grand Canyon Protection Act and other

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	<p>laws. This could result in further decreases in hydropower production.</p> <p>The Fill Mead First option would maintain Lake Powell at approximately the power pool level of 3,490 feet most of the time and adjust water flows to more closely emulate natural river flows. These strategies could potentially reduce hydropower production to some extent. However, in light of the already-compromised production and likely future declines, the impacts of The Fill Mead First option on Glen Canyon Dam hydropower production are likely to be fairly insignificant. Moreover, as noted previously, implementation of the Fill Mead First option could help to lessen the need for the GCDAMP. This could save tens of millions of dollars in the coming years that now come from hydropower revenues.</p>
Hoover Dam	<p>The Fill Mead First option would have a significant positive impact on Hoover Dam hydropower production. Hoover Dam has a peak generating capacity of 2,078 MW. However, this has been reduced to 1731 MW, because of chronic low water levels in Lake Mead due to reduced Colorado River flows. In 2007, the Hoover Dam power plant generated only 3,700,000 MWh, a capacity factor of only 20 percent when compared with the plant’s design rating of 18,203,280 MWh. In 1998, before the current drought, Hoover Dam’s net power generation was 5,800,000 MWh — 36 percent higher than current levels. Power generation can be expected to be depressed for the foreseeable future, due to continuing low Lake Mead levels. In fact, there is a danger that Lake Mead levels will fall so low that hydropower generation will not be possible at times.</p> <p>The Fill Mead First option would keep Lake Mead as full as possible. As a result, hydropower generation at Hoover Dam could be expected to increase 36 percent to the previous 1998 level. This would result in a net increase of 2,100,000 MWh of power generation from the average in recent years.</p>

**Recreation:** Describe any anticipated positive or negative effects on recreation.

Location(s)	Anticipate Benefits or Impacts
Grand Canyon National Park	<p>Under current Glen Canyon Dam operations, beaches in Grand Canyon have continued to erode, which has displaced and degraded river-based recreational uses and undermined the integrity of cultural sites. It is unclear whether any permutation of the current management approach will reverse this deteriorating situation. The Fill Mead First option would allow increased flexibility to maximize the synergy between river flows and available sediment, to rebuild beaches in Grand Canyon and prevent the deterioration of cultural sites, and ultimately to meet the requirements of the Grand Canyon Protection Act. This would have a significant positive impact on the quality of the visitor experience.</p>
Glen Canyon National Recreation Area	<p>At full pool, Lake Powell floods 186 miles of the main-stem Colorado River and many miles of side canyons. After a decade of reduced river flows, Lake Powell has hovered around half-empty most of the time. This has allowed the recovery of hundreds of miles of formerly flooded canyons, Native American sites, and backcountry recreation areas. However, under current management guidelines, Lake Powell levels can fluctuate significantly, setting back ecological restoration, damaging exposed archaeological sites, and degrading recreational values. With Lake Powell kept at approximately the 3,490-foot power pool level, the restoration of Glen Canyon would be much more extensive and lasting. For example, legendary</p>

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	<p>places such as Rainbow Bridge (3,657 feet), Davis Gulch (3,580 feet), Anasazi Canyon (3,560 feet), Cathedral in the Desert (3,551 feet), Gregory Natural Bridge (3,550 feet), and Moqui Canyon (3,540 feet) would be newly exposed or saved from being re-flooded by rising reservoir waters. The recovery of the vast backcountry of Glen Canyon National Recreation Area (GCNRA) that is now flooded would attract a wide diversity of new user groups for activities such as hiking, camping, cayoneering, kayaking.</p> <p>The Fill Mead First option would have a negative recreational impact on flat-water based recreation in GCNRA. By keeping Lake Powell at the power pool level of about 3,490 feet, the size of the reservoir and area available for these activities would be reduced. However, the comparison in recreation must be made between today's already declining Lake Powell, instead of the full Lake Powell of the past. The Fill Mead First option would also have a negative impact on the non-native trout sports fishery immediately downstream of Glen Canyon Dam. However, this is an acceptable and necessary tradeoff that must be made in order to save the irreplaceable and globally significant Grand Canyon ecosystem and the endangered native fish populations that inhabit the Grand Canyon.</p>
Lake Mead National Recreation Area	<p>The declining levels of Lake Mead in recent years have seriously affected the quality of recreation in Lake Mead National Recreation Area (LMNRA) and increased the difficulty for the National Park Service in managing recreational resources. Docks and shoreline facilities have had to be moved or abandoned due to the huge changes in Lake Mead levels. By keeping Lake Mead as full as possible, the Fill Mead option would benefit the millions of recreationists who utilize LMNRA, and those who may be more likely to visit if they know Lake Mead is likely to be full.</p>

**Environment:** Describe any anticipated positive or negative effects on ecosystems within or outside of the Colorado River Basin.

Location(s)	Anticipated Benefits or Impacts
Grand Canyon National Park	<p>The Fill Mead First option would provide more flexibility for efforts to protect the Grand Canyon ecosystem downstream from Glen Canyon Dam. In doing so, it would help the Bureau of Reclamation and National Park Service to meet the requirements of the Grand Canyon Protection Act, "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." The specific environmental benefits of this option include water released from the dam that is closer to pre-dam temperatures, more natural river flows downstream, greater chance of replenishing Grand Canyon beaches, improved habitat for the endangered humpback chub, and a decrease in some non-native fish species. The main potentially negative impact is that non-native warm-water fish could possibly be allowed to expand their habitats, to the detriment of native species. This is an issue that needs further scientific analysis.</p>
Glen Canyon National Recreation Area	<p>Before being flooded under Lake Powell, Glen Canyon was a vast landscape of gorges, spires, cliffs, and grottoes. It was the biological heart of the Colorado River, with more than 79 species of plants, 189 species of birds, and 34 species of mammals. It contained more than 3,000 documented ruins from ancient cultures. The decline of Lake Powell during the last decade has exposed significant portions of Glen Canyon and its extensive side canyons. In these areas, spectacular formations have emerged, streams and seasonal floods have washed away accumulated sediment, and ecosystems have begun to recover. By maintaining Lake Powell near the 3,490-foot level, the Fill Mead First option would allow this recovery to continue</p>

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	and expand. Landscapes that have been submerged for four decades would be revealed. Extirpated and threatened species, such as the Colorado pikeminnow, razorback sucker, humpback chub, bonytail chub, peregrine falcon, southwestern willow flycatcher, northern leopard frog, and numerous native plants could potentially be restored. Ancient and historic sites and artifacts would be accessible for research, education, and sacred purposes.
Lake Mead National Recreation Area	Declining Lake Mead levels have had a negative impact on fish and wildlife populations, due to concentrations of salinity, heavy metals, toxic pollutants, and other contaminants. By keeping Lake Mead as full as possible, the Fill Mead First option would reduce these concentrations, with positive impacts on these fish and wildlife communities.

**Socioeconomics:** Describe anticipated positive or negative socioeconomic (social and economic factors) effects.

Grand Canyon National Park. By promoting the restoration of Grand Canyon, the Fill Mead First option would stabilize and strengthen the businesses of the numerous river guides who depend on water-based recreation in Grand Canyon National Park. These businesses have been harmed by the degradation of the beaches and the ecosystem of Grand Canyon. Because the Fill Mead First option would institute more natural water releases from Glen Canyon Dam, it would potentially reduce the recreation industry that is based on trout fishing downstream of the dam. However, this must be seen in the context of the inexorable decline of Lake Powell, regardless of the Fill Mead First option, and the legal mandate under the GCPA that will almost inevitably require changes in dam operations that negatively impact the non-native trout fishery.

Glen Canyon National Recreation Area. By allowing substantial restoration of Glen Canyon, the Fill Mead First option would open up new opportunities for recreation at Glen Canyon National Recreation Area, helping to strengthen the local economy. Instead of a recreation economy dependent almost exclusively on power boating on the reservoir, a more diverse economy could develop — one that not only includes boating on Lake Powell, but also takes advantage of a vast, newly revealed redrock wilderness and a newly restored Colorado River flowing through the scenic wonders of Glen Canyon. Stabilizing Lake Powell at a lower level would potentially reduce the flat-water recreation and tourism industry on Lake Powell. However, climate change is already modifying the recreation dynamic on Lake Powell. The impacts of the drought seen in the past decade show us that as the reservoir elevation declines, houseboat and power boat recreation declines. In recent years, while visitation has risen at other Utah national park areas, it has dropped at Glen Canyon National Recreation Area.

Lake Mead National Recreation Area. In recent years, the recreational experience at Lake Mead National Recreation Area has been degraded by chronically low Lake Mead levels. This has forced the National Park Service to make major changes in facilities to accommodate the declining reservoir, and harmed recreation and local tourism businesses. It has discouraged recreationists who do not find the greatly reduced Lake Mead as inviting as before. By keeping Lake Mead as full as possible, the Fill Mead First option would have a positive impact on the recreation and tourism industry that depends on Lake Mead National Recreation Area and reduce National Park Service expenses for low-water driven facilities modifications.

**Other Information:** Provide other information as appropriate, including potential secondary benefits or considerations. Attach supporting documentation or references, if applicable.

See attached paper:

Myers, Tom. 2012. Reservoir loss rates from Lake Powell, and long-term management of the Colorado River system. [In review]