

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

## 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:

Eliminating Water Loss by Cutting Evaporation by 50%

Description of Option:

Every year the Colorado Basin Reservoirs lose 2,466,000 acre-feet of water to evaporation. Lake Mead accounts for over 900,000 acre-feet or around 7.5 feet depth loss to surface level. From the start of the recent drought in 2000, if the water loss strictly to evaporation was added together, a total of 82 feet of water loss would have occurred during this 11 year period. This is if no water was going out of the reservoir and no water was coming into the reservoir. Evaporation cannot be ignored any longer. Using all the tools for water conservation is the best avenue to having this water last beyond 2050. In 2003, a new solution to decrease evaporation was invented and has been used on reservoirs with great success. The product branded, Aquatain reduces evaporation by 50%. Thus if Aquatain had been used from the year 2000, it would have saved 41 feet of water depth from the Lake.

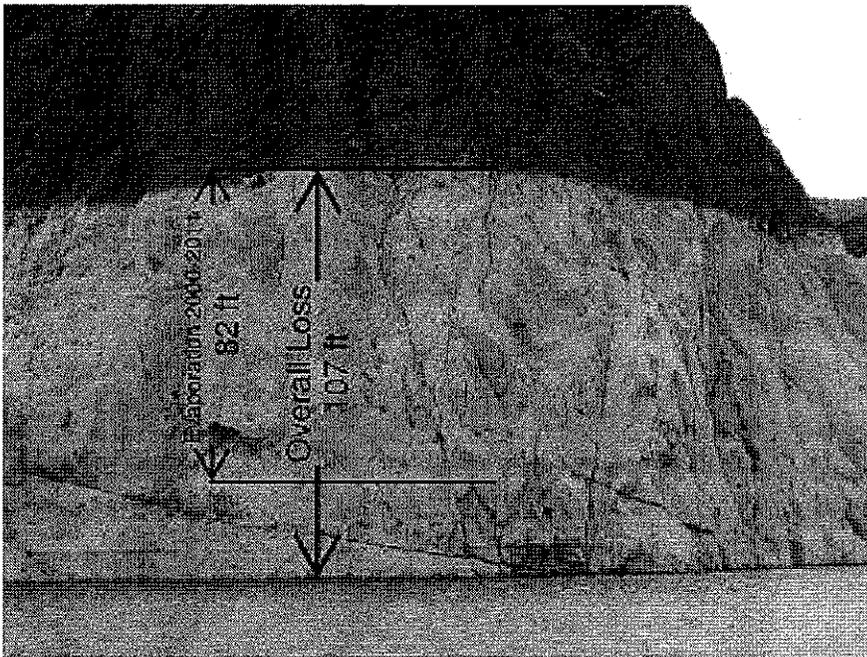


Photo: Cable Jones 2011

Aquatain is a liquid based on silicone that can be poured onto a body of water where it will form a very, very thin layer right across the top, hence retarding the ability of the sun, wind and weather to evaporate the water – reducing losses by 50%. The inventor, Graham Strachan, invented this anti-evaporation liquid to combat the

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

droughts in Australia.

Evaporation is more complex than you might think: it's not just about the sun heating the water, but also the action of the wind along with several other factors. When molecules of water get energetic enough (because of sun or wind energy, or their ambient temperature in relation to the external temperature) and they're at the surface of the water body, then they can cross the liquid/gas threshold and literally escape into the atmosphere as a gas.

Reservoirs such as Lake Mead have a great depth to the water which actually decreases the amount of surface area available thus reducing evaporative losses. Evaporation can be retarded by building dams deeper to reduce the surface area in proportion to the total volume of the dam, and by building wind breaks to shade the reservoir from the action of wind. However, this isn't any good for an already established reservoir that's losing thousands of acre-feet of water into the air. What is the solution then?

Since the 1950s attempts have been made to use anti-evaporation liquids to stop water from evaporating, but all solutions to this time have needed almost daily re-application. At their best these anti-evaporation liquids have reduced evaporation by 30% or 40% and require special storage specifications.

Lake Havasu, a reservoir used for drinking water, uses its own anti-evaporation method shown below by trying to cover its lake surface by as many boats as possible. Using the anti-evaporation liquid, Aquatain is a solution that is much less resource-intensive than covering the lake surface with boats.



Photograph: Cable Jones 2011 of an aerial picture at Lake Havasu Water District Office

Aquatain is the first anti-evaporation film that is based on silicone as a polydimethylsiloxane. The basic idea is that if you could create a film or monolayer (layers that are one molecule thick) over the surface of the water, the action of evaporation (water turning into water vapor) could be decreased.

Simple to apply, Aquatain will be poured onto the surface of Lake Mead to cut evaporation dramatically. Rain water falls straight through Aquatain into the reservoir and the Aquatain film re-forms above it.

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
- 

**Location:** Describe location(s) where option could be implemented and other areas that the option would affect, if applicable. Attach a map, if applicable.

The solution involves the entire surface area of Lake Mead, and, hopefully, in the future, every other reservoir surface in the Colorado River Basin saving over 853,000 acre-feet of water annually.

**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.

This solution involves the entire surface area of Lake Mead and in the future every other reservoir surface in the Colorado River Basin. If all the reservoir surfaces in the Colorado River Basin were covered with Aquatain, a total of 42,675,000 acre-feet of water could be collected over 50 years and this amount would fill Lake Mead over 1.5 times. At Lake Mead alone, a total of 20,000,000 acre-feet of water over 50 years or 400,000 acre-feet per year could be saved starting from the first year of implementation. More water will be available during years when there is a larger surface area due to higher lake levels. Evaporation goes up in the summer, so the amount of water available during the peak times of water use would be greater and the effects of using anti-evaporation liquid can be more readily seen. Conservative numbers of 800,000 acre-feet loss from Lake Mead due to evaporation was used in calculations, although evaporation is more close to 937,500 acre-feet average for the last 50 years.

In 1998, the highest loss of evaporation was recorded at 2,283,000 acre-feet for the past 30 years in the entire Colorado River Basin. Taking half this amount times 50 years would equal 57,075,000 acre-feet close to the amount of the entire reservoirs' storage capacity (roughly four times the average natural inflow) in the Colorado River Basin.

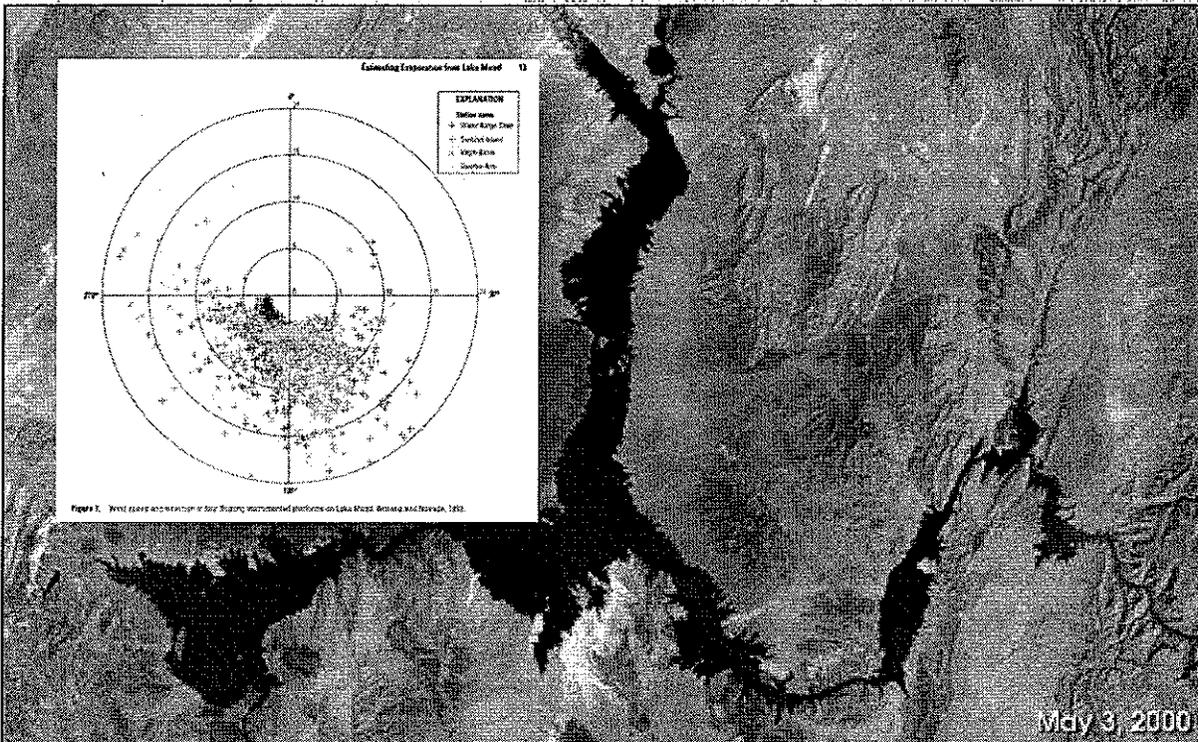
**SUBMIT OPTION SUBMITTAL FORM BY:**

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

## 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.

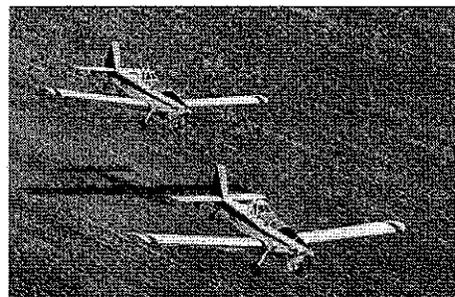
Lake Mead is very large, averaging 125, 600 acres of surface area and will require aerial application to spread the anti-evaporation liquid, Aquatain, over the entire surface of the reservoir in a few hours. This anti-evaporation liquid, Aquatain, would be applied with a tail wind to increase spreading capability. The photograph below shows an aerial of Lake Mead with a diagram of wind direction and intensity superimposed on top. The diagram shows



the directions that the wind hits four research buoys and the intensity of the wind. The diagram was taken for a research project conducted by the USGS from 1997-1999 to better quantify actual evaporation losses from different areas of the lake. Much of the wind comes from the southwest with some from the southeast and reaches greatest intensity in the 5 to 10 mph range.

The anti-evaporation liquid would be applied at an application rate of 10,000 gallons every 10 days for the average surface area of 125,600 acres. The Aquatain anti-evaporation liquid spreads across the surface of the water easily. To cover the entire surface when the reservoir is completely full about 160,000 acres, 14,000 gallons would be needed. The liquid breaks down slowly over the ten days and requires reapplication. A pair of two single-engine aircraft flying parallel or one in front of the other (as shown in the photograph at the right) with about 600 feet between them is best for application.

Each plane would carry 800 gallons of Aquatain. It would take 7 to 9 roundtrips at the surface areas noted above to cover the entire reservoir surface with 10,000 to 14,000 gallons of Aquatain anti-evaporation liquid. The drop speed of these aircraft is 120 miles per hour and the entire length of the reservoir is 112 miles.



**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

They can travel for a total of 610 miles before needing to refuel, so the aircraft will circle the reservoir twice before refueling. The Boulder City Airport would probably be the airport where the aircraft would refuel and pick up more Aquatain anti-evaporation liquid. Lake Mead is four miles southeast of Boulder City making the refueling and pickup of more anti-evaporation liquid easier. A gravel strip could even be built where the aircraft would land to load more Aquatain anti-evaporation liquid.

Aquatain is insoluble in water, and degrades into carbon dioxide, Inorganic Silicate and water. Aquatain has been approved for drinking water use and is pending approval for mosquito abatement use across the nation. The technology has been developed and available commercially since 2003. Facilities currently using Aquatain in the United States are swimming pools, golf course ponds, community ponds and lagoons.

**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.

Quantifying costs do vary widely, so to give some sense of the affordability of this solution, other data is provided in the next two paragraphs that explain the amount spent on other projects with resulting acre-feet costs.

SNWA recently spent 115 million dollars on Brock reservoir to receive 400,000 acre-feet over 20 years; this would make the cost of water at \$288 acre-foot. SNWA, being a wholesaler sells untreated water for \$220 per acre-foot.

California wholesalers have paid \$800 per acre-foot in past years. The proposed pipeline, SNWA is trying to put in to bring 200,000 acre-feet from Northern counties in Nevada is at the cost of \$3.5 billion or \$20,000 per acre-foot initially due to high capital costs and then ongoing for 50 years will equal about \$350 an acre-foot.

The cost of applying anti-evaporation liquid, Aquatain to the surface of Lake Mead will cost approximately \$91/AF plus aircraft, fuel, delivery fees, permits and maintenance fees. Factors including quantity and monitoring could affect price per year. In the table below, anticipated costs are shown:

50 year Costs					
#	Item	Capital	Operations	Repair	Replacement
2	AT-802A Aircraft	\$3,600,000	\$1,000,000	\$1,000,000	\$3,600,000
166,878	Gallons Gasoline	na	\$951,205	na	na
18,250,000	Gallons Aquatain anti-evaporation liquid	\$1,825,000,000	na	na	na
2	Pilots	na	\$7,000,000	na	na
50	Monitoring and Reporting	na	\$3,750,000	na	na
<b>Total</b>		<b>\$1,828,600,000</b>	<b>\$12,701,205</b>	<b>\$1,000,000</b>	<b>\$3,600,000</b>
Operations		\$12,701,205			
Repair		\$1,000,000			
Replacement		\$3,600,000			
<b>Overall Total</b>		<b>\$1,846,000,000</b>			

Lake Mead - 50 years total savings: 20,000,000 acre-feet of water.

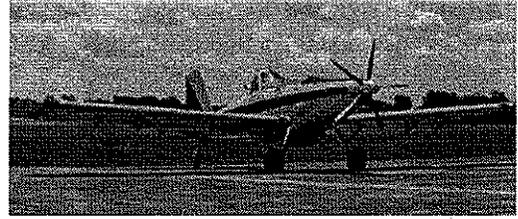
**SUBMIT OPTION SUBMITTAL FORM BY:**

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

The AT-802/802A is the world's largest single engine aircraft, and its popularity reflects the industry's trend to larger, high-production turbine equipment. With a payload of 9,500 lbs, the AT-802A provides more working capacity than any other single-engine agriculture plane. Its power, speed and payload deliver large operation efficiencies.



The AT-802A aircraft will carry 800 US gallons of Aquatain along with 254 US gallons of gasoline. The lead time for buying this aircraft is 15 months. The AT-802A aircraft with all required equipment is 1.8 million dollars. The aircraft is designed to operate "loaded" from small community airports or remote gravel strips having a minimum runway length of 4,000 feet. Once it has dropped its initial load, aircraft can return for more Aquatain. Because of its speed, maneuverability and quick turn-around, the AT-802A aircraft are especially effective for this.

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

None 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.

A new type of surplus called Intentionally Created Surplus (ICS) was recently instituted and the saved water by applying Aquatain anti-evaporation liquid could give SNWA or any other entity interested in creating ICS, a way of producing a quantity of water any year they want to apply it.

Aquatain does not affect water chemistry or prevent oxygenation. Aquatain is safe for human contact, even ingestion. Aquatain does not affect the environment or bio-accumulate and does not adversely affect potable water. Aquatain is Certified by NSF International/ANSI60 as safe for human contact and application to drinking water storages. There are 50 years of medical studies on PDMS (main ingredient) and examples where formulations of this substance are used would be in syringes (it coats the inside making it easier for the rubber washer to slide up and down), infant care such as baby bottle nipples and personal care like shampoos, lotions, sun screens, lipsticks, eye liner and are food additives.

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

Water Rights to Evaporation Loss: Who has the authority to take control of this water? Anyone that puts up enough money?

**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

**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.

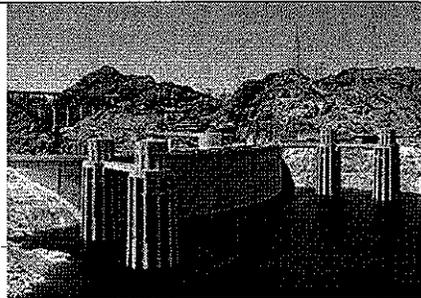


Photo: Hoover Dam Images

The intakes to the Hoover Dam will need to be surrounded by a one foot depth barrier on the surface of the water to prevent the Aquatain from leaving the reservoir by being sucked into the intakes.

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

Decreasing evaporation will decrease the salinity creation. Evaporation is the main culprit in leaving salt behind during the evaporation process. Adding anti-evaporation liquid is a solution to mitigate this problem.

**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
Not applicable	

**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
Hoover Dam	<p>For every foot of surface elevation lost, 5.7 Megawatts of power generation is lost. Each year 3.75 feet of evaporation would be cut increasing the potential generation power of the Hoover Dam.</p> <p>The water intakes at the Hoover Dam provide a maximum hydraulic head (water pressure) of 590 feet as the water reaches a speed of about 85 mph. The total generation of the dam is 2080 MW. The full elevation of the lake is at 1,219 feet. The current level is 1,112 feet. The lowest recorded level happened in June 2010 at 1,082 feet. The level at which power cannot be generated any longer is 1,050 feet. The bottom of the dam is at elevation 506 feet. Hoover Dam is in the process of replacing their turbines with a new design that can work at surface elevation 1,000. The new turbine would only need 540 feet of hydraulic head.</p>

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

Location(s)	Anticipate Benefits or Impacts

**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

Entire Lake Mead	No impacts on recreation.

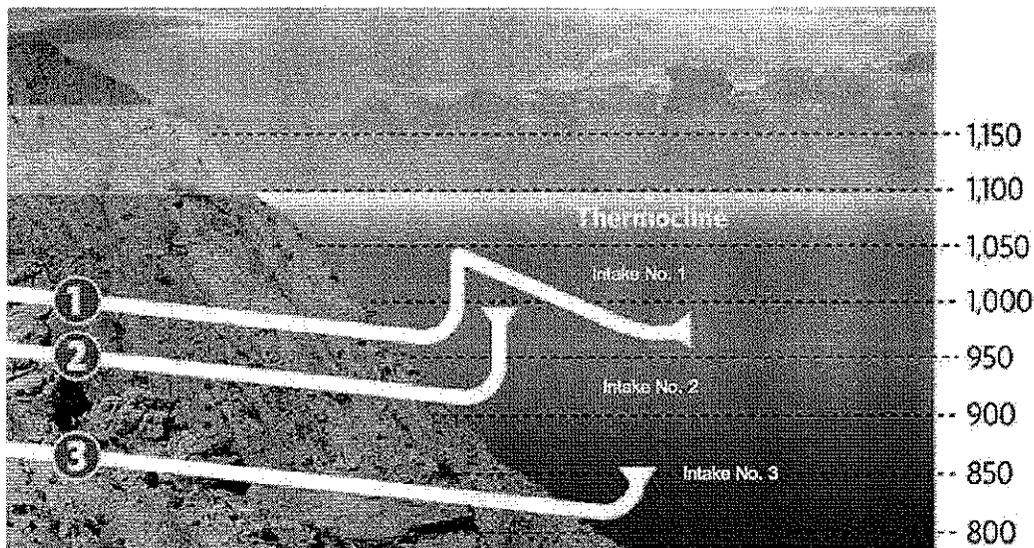
**Environment:** Describe any anticipated positive or negative effects on ecosystems within or outside of the Colorado River Basin.

Location(s)	Anticipated Benefits or Impacts
Entire Lake Mead Reservoir	Less evaporation means less heat loss from the surface of the water. Heat loss will be decreased by 15% to 20%. Before the dams were created, the water temperature ranged from over 80 degree F in the heat of the summer to just above 32 degrees F in the winter. Impounding water in reservoirs affects the water temperature of dam releases due to thermal stratification. During the summer, the surface layers of the reservoirs are typically warm as the result of inflows, ambient air temperature, and solar radiation. Conversely, lower reservoir layers remain cooler year-round. For these reasons, water temperatures downstream of reservoirs are influenced by reservoir water levels. Water temperature can affect the health of flow- and water-dependent species in the Basin.

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

The Metropolitan Water District of Southern California pumps water across the Colorado River Aqueduct to hydrate much of Southern California and without Hoover Dam's hydroelectric power, Metropolitan's costs to transport water will double or even triple.

Metropolitan and the Southern Nevada Water Authority are storing excess water from other sources in Lake Mead, and so when water leaves due to evaporation, that storage leaves with it. This solution is a win-win for all stakeholders on the Colorado River Basin.



Source: Southern Nevada Water Authority and Jean Reid Norman, "Water demand drop-off postpones intake work," *Las Vegas Sun*, Sunday, Sept. 13, 2009.

SNWA also has interest in creating additional storage in the lake and keeping the level of the lake higher than

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

their first intake. At the cost per acre-foot much lower than current projects underway, many stakeholders will have interest in submitting money to have a portion of this water set aside for them.

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

Potential secondary benefits:

The solution is not permanent.