THE BATHTUB RING

Shrinking Lake Mead: *Impacts on Water Supply, Hydropower, Recreation and the Environment*

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OVERVIEW OF THE COLORADO RIVER BASIN AND LAKE MEAD

The Colorado River is the water supply for approximately 40 million people, irrigating over 5.5 million acres of land across seven states and two countries. Virtually every drop of the Colorado River is allocated to a consumptive use. In addition to supplying water, the Colorado River is an important source of hydroelectricity, water recreation, tourism and ecological habitat.

Increasing demand combined with prolonged multi-year climatic drought has lead to precipitously low reservoir levels in Lake Mead, which is impounded behind Hoover Dam. To begin addressing potential water shortages, the Department of Interior issued the Colorado River Interim Guidelines in 2007. Predominantly focused on water allocations to the Lower Basin states (California, Arizona and Nevada), the guidelines specify water levels in Lake Mead that trigger delivery curtailments to the Lower Basin. If the drought continues, Lake Mead will likely drop below 1075', triggering the first set of mandated water delivery curtailments set forth in the Interim Guidelines.

PROJECT OBJECTIVES

We examined physical and economic impacts to water deliveries, hydropower generation, recreation, and downstream ecosystems as reservoir elevations in Lake Mead drop to the key elevations identified in the Interim Guidelines: 1075', 1050', 1025', and 1000'.

KEY FINDINGS

Vulnerability varies by state due to differences in magnitude of curtailments and water priority. Although attention is often focused on water curtailments, there are substantial economic losses associated with changes to recreation, hydropower generation, and ecosystems.

1. *DETERMINE THE DISTRIBUTIONAL EFFECTS TO EACH STATE AND SECTOR OF WATER DELIVERY CURTAILMENTS*
2. *DETERMINE THE OPERATIONAL AND FINANCIAL IMPLICATIONS OF REDUCED RESERVOIR LEVELS ON GENERATION AT HOOVER DAM*
3. *DETERMINE THE IMPACTS TO RECREATIONAL USE AT LAKE MEAD NATIONAL RECREATION AREA*
4. *DETERMINE THE ENVIRONMENTAL IMPACTS ASSOCIATED WITH DECLINING RESERVOIR LEVELS*

- *WATER CURTAILMENT DOESN'T PREDICT VULNERABILITY*
- *COST OF HYDROPOWER COULD ROUGHLY QUINTUPLE*
- *ANNUAL VISITATION COULD BE REDUCED BY ALMOST HALF*
- *THE GREATEST ENVIRONMENTAL IMPACTS ARE INDIRECT*

WATER CURTAILMENT DOESN'T PREDICT VULNERABILITY

It is generally assumed that the priority of water rights determines vulnerability and consequently, Nevada water users should be the most vulnerable to water supply curtailments, and California users the least vulnerable. Our analysis concludes that the opposite is true. Impacts to Central Arizona Project users, as expected, will be significant, but will be confined to agricultural users, not municipal or tribal water users.

CALIFORNIA: *HIGH* VULNERABLITY

- *California receives no curtailments due to their senior status.*
- *Municipal/industrial water users are vulnerable because they lose the ability to divert Intentionally Created Surplus water.*

NEVADA: *LOW* VULNERABLITY

- *The Southern Nevada Water Authority return flow credit program allows Nevada to keep their consumptive water use below their apportionment.*
- *A third water intake in Lake Mead allows SNWA to withdraw water below 1000', eliminating the concern that Nevada won't be able to access their water supply.*

ARIZONA MAINSTEM: *LOW* VULNERABILITY

- *Arizona Mainstem users that would be impacted do not share in shortage at current water use.*

CENTRAL ARIZONA PROJECT: *HIGH* VULNERABILITY

- *CAP currently bears all shortages applied to Arizona.*
- *Water used for groundwater recharge will be the first cut, followed by agricultural water users.*
- *At current water use levels, municipal/industrial and tribal water users are unaffected by curtailments.*

ANNUAL VISITATION COULD BE REDUCED BY ALMOST HALF

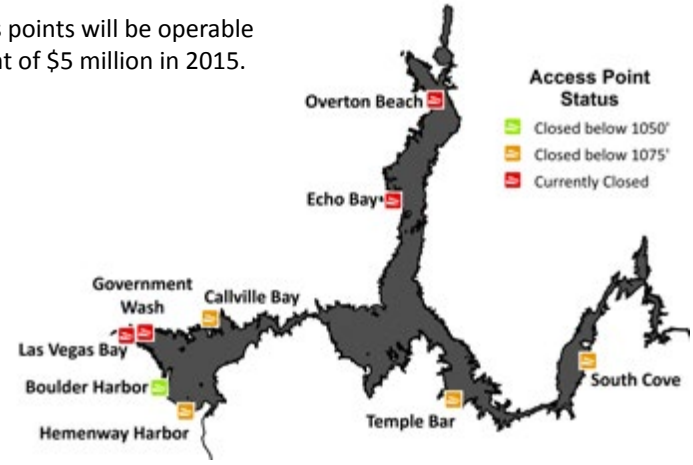
Currently, the National Park Service predicts that no access points will be operable below 1060' despite an additional infrastructure investment of $5 million in 2015.

Visitation is projected to drop from:

7 → 4 MILLION

The decrease will be compounded by the inoperability of access points.

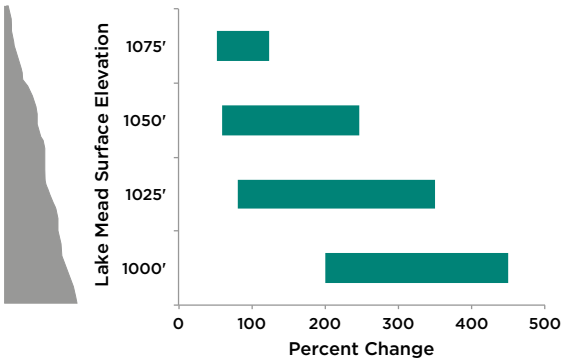
Lake Mead National Recreation Area provides over one-third of the economic and tourism value in the Colorado River Basin due to its proximity to the major metropolitan center of Las Vegas. More than 125 small businesses depend on the recreation industry at Lake Mead and create 3,000 local jobs.



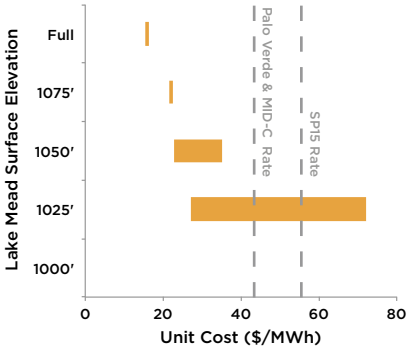
COST OF HYDROPOWER COULD ROUGHLY QUINTUPLE

Hydropower generation will decline as Lake Mead shrinks, increasing energy costs. Costs paid by contractors for hydropower and spot market power will roughly double at 1075', triple at 1050', quadruple at 1025' and quintuple at 1000'. Though hydropower rates will surpass spot market rates at lower elevations, Hoover customers are contractually bound to purchase Hoover power until 2067.

With each 25' drop, total costs increase by roughly 100% compared to a full reservoir.



Hydropower rates will exceed spot market rates.



CROSS SECTOR INTERACTIONS

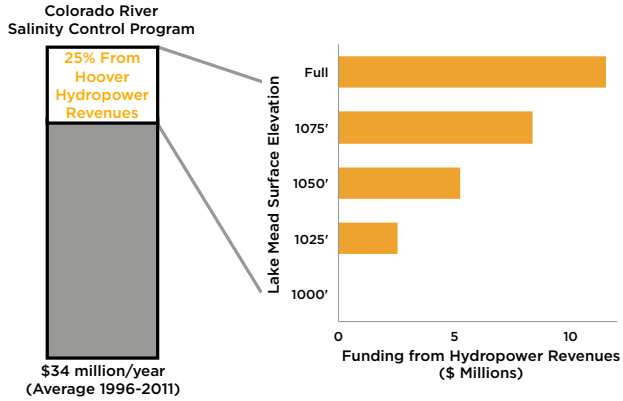
Increased costs will be borne by urban residents, farmers, and commercial operators.

CAP's and MWD's pumping costs will increase, causing increased water rates.

CAP customers claim they will switch back to groundwater pumping if water rates increase, even if just by a small amount. Rough calculations by CAP show even a 1 cent per kWh increase in CAP's electricity costs would increase the cost of each AF of water by 3.5%. If CAP customers to switch back to groundwater pumping because of increased water rates, the stress on central Arizona's groundwater supplies from water curtailments at each key elevation will be further exacerbated.

THE GREATEST ENVIRONMENTAL IMPACTS ARE INDIRECT

Reduced agricultural runoff could threaten the Colorado River Delta since it is the main water source for the Delta's remaining ecosystems. Funding for the Salinity Control Program will be reduced due to declines in hydropower revenue. Although less water will move through the Colorado River corridor downstream from Lake Mead during curtailments, the amount of flow reduction is small compared to the water delivery requirements. There is little evidence showing future water shortages will directly affect the downstream corridor ecosystem, which has already been severely altered due to on-going human usage of the river. The link between reservoir levels and the Colorado River Delta is more clear, through the impact on agricultural runoff. Irrigation runoff, the main source for the remaining Delta, will be reduced as less water is delivered to Mexicali agriculture at each key elevation.

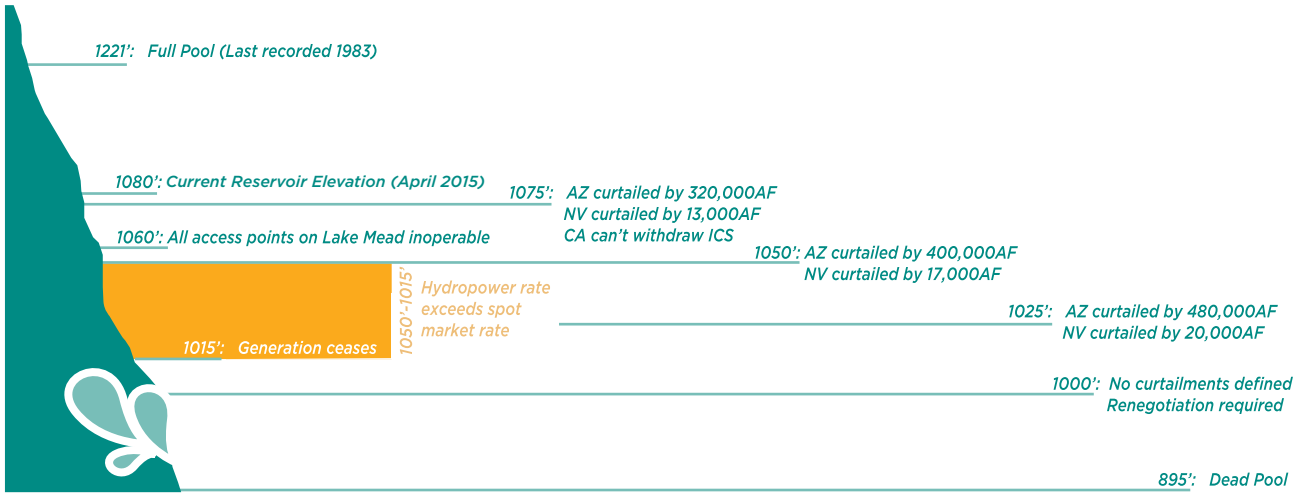


REDUCTIONS IN AGRICULTURAL RETURN FLOWS MAY IMPACT DELTA ECOSYSTEMS

1/4 OF THE FUNDING FOR THE SALINITY CONTROL PROGRAM WILL BE IMPACTED

IMPACTS BY ELEVATION

The following graphic depicts a handful of impacts by elevation, and identifies stakeholder vulnerability.



MITIGATION STRATEGIES

To mitigate the risk of curtailments the legal and policy frameworks in the Lower Basin are continually changing. Federal and state agencies, municipalities and agricultural groups recognize the risk of curtailments to water deliveries and are developing mitigation strategies to reduce the probability of curtailments. These strategies include local conservation measures, the Intentionally Created Surplus program, and new initiatives that have and are forming currently including the Colorado River System Conservation Program. While most mitigation strategies are driven by risk to water supplies, our analysis provides additional information about the impacts of low reservoir levels on other areas as well such as hydropower generation, recreation at Lake Mead and the environment.

CONCLUSIONS

Water in Lake Mead is simultaneously used for water supply, hydropower, recreation, and environmental needs. Our findings demonstrate that water lost in Lake Mead at each successively lower elevation is accompanied by quantifiable impacts for all four stakeholder groups. Declining reservoir levels have both physical and economic implications for: water supply deliveries to California, Nevada and Arizona; hydropower generation at Hoover Powerplant; recreation at Lake Mead National Recreation Area; Lower Colorado River ecosystems. This analysis doesn't project when Lake Mead will reach the curtailment elevations, but instead provides both quantitative and qualitative frameworks to support decision-making and as shortages occur and guide long-term adaptation strategies. The potential impacts to areas other than water supply could motivate additional mitigations strategies. If low reservoir levels become the norm both Upper and Lower Basin stakeholders will need to adapt to the impacts outlined in this report.

ACKNOWLEDGEMENTS:

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