Summary of CCRS White Paper 5

Stream flow and Losses of the Colorado River in the Southern Colorado Plateau

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Knowing the Data

A confounding uncertainty for predicting stream flow and losses in anticipation of renegotiation of the *2007 Interim Guidelines for Lower Basin Shortages* concerns the accuracy and precision of those data. We analyzed data reported by the Bureau of Reclamation and the U.S. Geological Survey that describe the primary inflows to Lake Powell and to the Colorado River between Glen Canyon Dam and Lake Mead, as well as the losses from both reservoir and the releases from Hoover Dam, evaluated the uncertainty in those data, and identified key locations where stream-flow information is essential to managing the water supply provided by the Colorado River. Remember that the annual consumptive uses by the state of Nevada cannot exceed 300,000 acre feet/year (af/yr).

Our analysis indicates that ~150,000 af/yr is lost from Lake Powell as seepage around the Glen Canyon Dam, and this water comes back into the Colorado River upstream from Lees Ferry. This amount of water is a transfer of Upper Basin water to the Lower Basin, even though this water is not formally counted as a reservoir release. These data are based on comparing accurate and precise data about Glen Canyon Dam releases since 2005 and stream-flow measurements made at Lees Ferry, 15 miles downstream from the dam.

Downstream from Lees Ferry, there is significant intervening inflow whose sources are springs within the Grand Canyon. Between 1990 and 2018, ~770,000 af/yr entered the Colorado River, of which only 17% came from the Paria River and the Little Colorado River upstream from Cameron. Since 2007, more than 600,000 af/yr has come from springs within the Grand Canyon. On average, ~170,000 af/yr has its source in springs in the downstream end of the Little Colorado River Canyon. Downstream from the Grand Canyon gage, intervening inflows to the Colorado River have been ~390,000 af/yr since 2007. The impacts of proposed ground-water development and the effects

Photo courtesy Michael Collier

What you'll find in the paper:

- An exploration of the uncertainty in quantifying stream flow and losses of the Colorado River in the southern Colorado Plateau, including Lake Powell, the Grand Canyon, and Lake Mead.
- A discussion of key gages that offer critical insight into understanding future watershed conditions.
- Recommendations for a gage to be established at Hite on the Colorado River, renewed study of the magnitude of seepage around Glen Canyon Dam, maintaining the long-term program to measure evaporation from Lake Mead, and studies to quantify bank storage and Lakes Mead and Powell.

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of decreased precipitation in the Grand Canyon region have the potential to decrease the amount of spring-fed intervening flows that augment the releases from Glen Canyon Dam in maintaining water storage in lake Mead.

Ninety-nine percent of all inflow to Lake Mead comes from the Colorado River. Losses from Lake Mead are evaporation, direct withdrawals by the state of Nevada, and releases from Hoover Dam. Between 2010 and 2015, 5% of the total losses and releases were by evaporation, 2.2% by the net consumptive use of the state of Nevada, and the rest was released downstream. Measured inflows, measured outflows, and changes in reservoir storage agree within a range of uncertainty of +/- 200,000 af/yr. Although data are available to estimate most of the inflow to and outflow from Lake Powell, there is greater uncertainty in estimates of evaporation. Inflows, outflows, losses, and change in reservoir storage do not agree in a way that makes physical sense.

Effective water-supply negotiation and river management are best served if Colorado River stakeholders are mindful of the precision and accuracy of the many components of the hydrologic cycle that affect the water supply of the Colorado River.

Overlooked on the River

Several key gages that are not used in CRSS and are not considered part of the standard network of gages used to manage the Colorado River offer critical insight into understanding future watershed conditions:

- Colorado River at Potash (USGS gage 09185600), because data from this gage reduces the ungaged drainage area to Lake Powell by 1,306 mi^2.
- Green River at Mineral Bottom (USGS gage 09328920), because data from this gage eliminates the need to estimate the contribution of inflow from the San Rafael River.
- Little Colorado River above mouth near Desert View (USGS gage 09402300), because spring flow into the Little Colorado River downstream from Cameron contributes ~20% of all inflows (~170,000 af/yr) to the Colorado River between Lees Ferry and Lake Mead that arise within the Grand Canyon.
- Colorado River above Diamond Creek (USGS gage 09404200), because this gage allows quantification of inflows to the Colorado River in the east-central and west-central Grand Canyon that are between 300,000 and 400,000 af/yr. Funding should be provided to USGS to improve the accuracy of reported annual flow at this gage, because these flows represent 99% of the inflows to Lake Mead.

We encourage continued efforts by the USGS to establish a gage on the Colorado River at Hite. Such a gage would allow direct measurement of all inflows from the upper Colorado and Green Rivers into Lake Powell.

There should be renewed study of the magnitude of seepage around Glen Canyon Dam that reenters the Colorado River upstream from Lees Ferry, including ground water modeling. Measurements since 2005 indicate that ~150,000 af/yr seeps around the dam.

We suggest maintaining the long-term program to measure evaporation from Lake Mead and make the present experimental program at Lake Powell a permanent monitoring program. Total, or gross, evaporation should be regularly reported for both reservoirs, because that is the actual amount of water lost to the atmosphere. We suggest initiating studies to quantify bank storage at Lakes Mead and Powell.

There is a need for clarification of the different types of data in Reclamation's Natural Flow and Salt Data base, because the reported natural intervening flow of some segments are actually accounting artifacts associated with the uncertainty in reservoir water budgets.

Similar analysis of the uncertainty about stream flow measurements, other hydrologic processes, and water budgets should be conducted between Hoover Dam and the North International Boundary (NIB). The water distribution system downstream from Hoover Dam is complex, and the losses associated with irrigated agriculture, evapotranspiration from riparian forests, and evaporation from reservoirs have significant uncertainty. Inflows from the Bill Williams and Gila Rivers may be poorly known.

Hydrologic data concerning streamflow and losses of the Colorado River should be made available in a simple and easily accessible database. Reclamation's new Hydrologic Database is a great improvement because it centralizes data availability.

Find Out More:

- Read the complete white paper : https://qcnr.usu.edu/coloradoriver/files/WhitePaper5.pdf
- Data Citation: Data can be found at https://www.hydroshare.org/resource/cc3eb5b8f36e4e7c9bead6fa8e3a06aa/