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Arizona Water Science Center Activities at Lees Ferry, Arizona

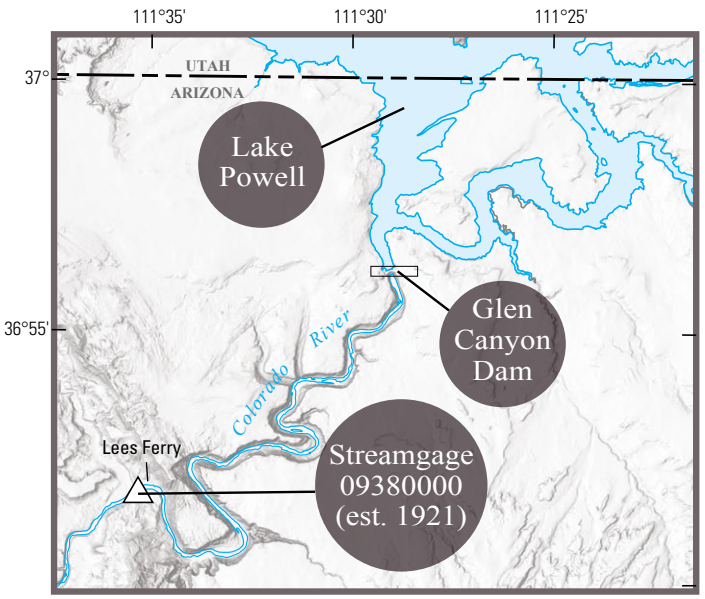
In 1921, the U.S. Geological Survey (USGS) established a streamgage on the Colorado River at Lees Ferry, Arizona, to monitor the river's flow and level as it enters Grand Canyon. The following year, the seven States encompassing the Colorado River Basin (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming) negotiated the 1922 Colorado River Compact to regulate distribution of the river's waters between them. The compact divided the basin into two regions—the Upper Basin and the Lower Basin—and established the dividing point between them about one mile downstream from Lees Ferry, just below the confluence of the Colorado and Paria Rivers.

The Colorado River at Lees Ferry streamgage (USGS station 09380000) is one of the most important streamgages in the United States because it is used to measure how much water passes from the Upper Basin to the Lower Basin through Glen Canyon Dam. The dam, constructed between 1956 and 1966, generates hydropower and stores water in Lake Powell reservoir, which is used to provide Upper and Lower Basin states with the water allotted to them by the compact. Lower Basin states depend on releases from the dam to receive their allotments. The Lees Ferry streamgage, located less than 16 miles downstream from Glen Canyon Dam, produces publicly available, real-time water data that allows the Colorado River's streamflow below the dam to be monitored.

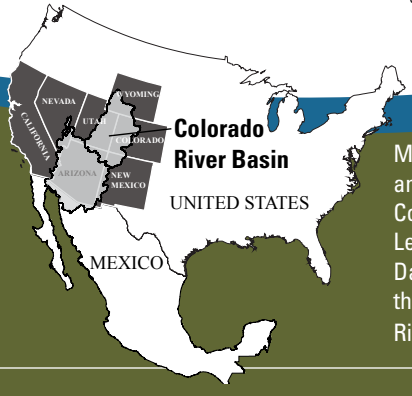
Most years, the Colorado River runs dry before reaching its historical terminus at the Gulf of California in Mexico, so measuring and monitoring the river at Lees Ferry is critical for the Lower Basin ecosystems, agricultural resources, and municipal industries that rely on the river's every drop. Additionally, Grand Canyon river guides and recreationalists depend on water level data from the Lees Ferry streamgage to determine when to run rapids and camp on sandbars. Streamflow and water-quality data collected at Lees Ferry are also important for monitoring the health of the Colorado River's aquatic life because some species, including fish and macroinvertebrates, require certain water conditions to survive, reproduce, and spawn.

Historical photograph of the Lees Ferry streamgage, September 1923, by G.C. Stevens (U.S. Geological Survey).

Shaded relief from U.S. Geological Survey 30-meter digital data
Hydrography from Natural Earth, 10,000,000 and National Hydrography Dataset,
Basins from U.S. Geological Survey Watershed Boundary Dataset
Albers Equal-Area Conic U.S. Geological Survey contiguous United States projection



Shaded relief from U.S. Geological Survey 1-meter digital data
Hydrography from National Hydrography Dataset
Universal Transverse Mercator, zone 12 north



Maps showing the Upper and Lower Basins of the Colorado River (*top*), the Lees Ferry and Glen Canyon Dam vicinity (*middle*), and the location of the Colorado River Basin (*bottom*).

U.S. Department of the Interior
U.S. Geological Survey

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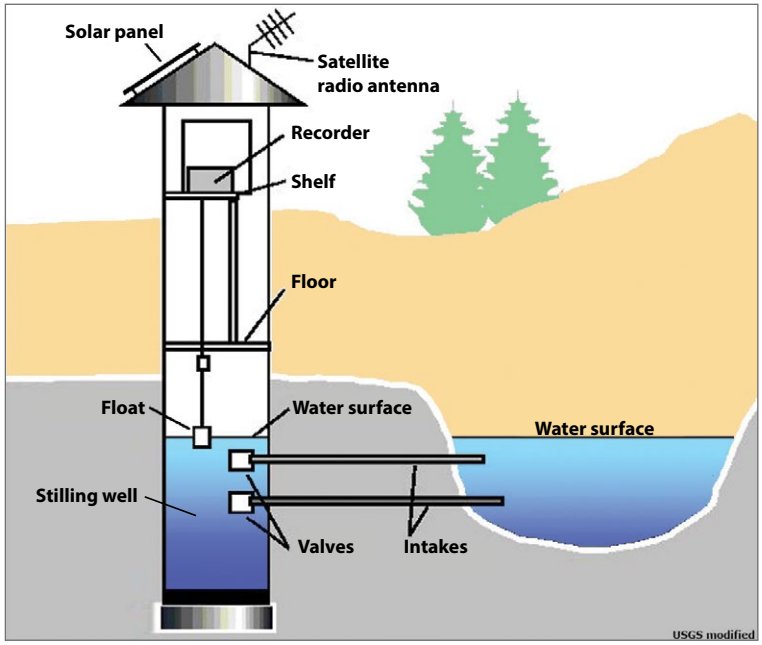
The Arizona Water Science Center is responsible for maintaining and collecting water data from the Lees Ferry streamgage. The Arizona Water Science Center is a branch of the USGS dedicated to providing high quality, impartial water data to resource managers and the public for their use in understanding and managing critical water resources in Arizona and the Southwest.

100 Years of Streamflow Monitoring at Lees Ferry:

https://www.usgs.gov/lees-ferry-100-years-video



Gage height can be measured using a variety of methods. One common approach uses a stilling well and float, as shown in this diagram.

Streamgaging

The USGS maintains a nationwide network of over 13,500 stations that provide real-time stream, lake, reservoir, groundwater, and precipitation data. Streamgages measure water level (also called gage height or stream stage) above an established reference point known as the gage datum. The elevation of the gage datum is generally lower than the streambed and is unique to each streamgaging site. Gage height is zero at the gage datum. Note that gage height should not be confused with water depth—a gage height of 8 feet means the water level is 8 feet above the gage datum, not that the river is 8 feet deep. Likewise, a change in gage height from 8 feet to 9 feet means the water level has increased by 1 foot. The Lees Ferry streamgage utilizes a float in a stilling well and a radar system to monitor changes in gage height of the Colorado River. The streamgage collects measurements every 15 minutes and transmits them to the Water Data for the Nation dashboard every hour to produce a continuous data record.

Streamflow, or discharge, is the volume of water flowing down a river per unit of time (for example, cubic feet per second). Discharge is measured across a wide range of gage heights (stream stages) to develop and maintain a stage-discharge relation, or rating curve, from which discharge can be calculated for any gage height; this allows a continuous record of discharge to be computed in real time from gage height measurements transmitted by the streamgage. Because stage-discharge relations are influenced by physical characteristics of the stream channel and stream channels are constantly undergoing change (due to vegetation growth, sediment deposition, channel erosion, and other factors), stage-discharge relations naturally vary over time. Maintaining an accurate rating curve therefore requires that stage-discharge relations be regularly updated with physical measurements of discharge.

How do streamgages work?

https://www.usgs.gov/streamgaging-basics

U.S. Geological Survey (USGS) technicians perform many duties to provide accurate water data for the Colorado River at Lees Ferry, such as collecting water quality samples, preparing samples onsite for laboratory analysis, and measuring discharge. Photographs by the USGS.

At Lees Ferry, physical discharge measurements are collected by moving an acoustic Doppler current profiler (ADCP) across the width of the river via boat or cableway. An ADCP uses sonar-like technology to send sound signals into the water at a constant frequency; signals are then reflected back to the instrument after bouncing off the riverbed and particles within the moving water. By detecting changes in the frequency of the signals, the ADCP is able to collect water depth and velocity data within the channel and use those measurements to compute discharge. The ADCP is ferried across the channel several times in a row to collect multiple discharge measurements, and the average of these measurements is then used to update the rating curve.

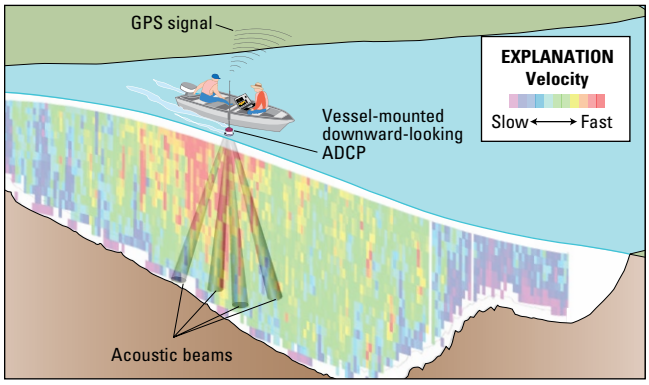
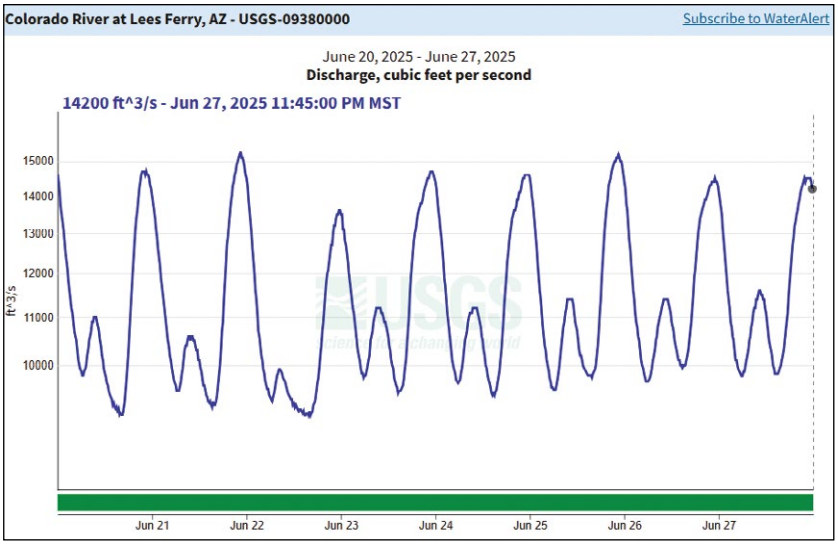


Illustration of a boat-mounted ADCP measuring discharge.

Having an accurate rating curve for the Colorado River at Lees Ferry is important for understanding how Glen Canyon Dam affects the river. Daily, cyclical releases from the dam (the volume of which are determined by the power generation needs of the dam, water availability, and water requirements of the Lower Basin states) can cause water level to change by over a foot and discharge to fluctuate by several thousand cubic feet per second (cfs) throughout a day. Peak flows often exceed 10,000 cfs throughout the year. For reference, one cubic foot is approximately the size of a basketball—now imagine 10,000 basketballs traveling past you each second! This release cycle creates a tidal effect that ripples through the Grand Canyon.

View real-time discharge data at Lees Ferry:

https://waterdata.usgs.gov/monitoring-location/USGS-09380000



The hydrograph at right shows Colorado River discharge data at Lees Ferry during June 20–27, 2025. Flows fluctuate daily based on power generation needs at Glen Canyon Dam, water availability, and water requirements of the Lower Basin.

Water Quality

Water-quality data have been collected at Lees Ferry since the 1920s. Today, water quality at Lees Ferry is monitored as part of the National Water Quality Network (NWQN) to determine concentrations of major ions (such as sodium, chloride, and calcium), trace metals (such as uranium, arsenic, or lead), nutrients (such as nitrogen and phosphorus), pesticides, and suspended sediment (among other parameters). Representative water-quality samples are collected across the channel at Lees Ferry using a crane-mounted boat. Samples are processed on site in a mobile laboratory before being shipped to the USGS National Water Quality Laboratory for analysis.

National Water Quality Network

In 2013, the National Water Quality Network (NWQN) was established to develop long-term comparable data collection at surface water sites across the United States. NWQN builds on decades of previous monitoring programs including the Hydrologic Benchmark Network, National Stream Quality Accounting Network, National Water-Quality Assessment Project, and the National Monitoring Network. Data provided by NWQN are used to inform models that characterize connections between landscapes, climate, and water quality.

Continuous Water-Quality Monitoring

Discrete water-quality samples like those collected for the NWQN provide valuable information on water-quality trends, but each sample only represents a snapshot of the river's water quality. Continuous water-quality meters provide real-time data that can be used to inform decisions regarding drinking water, regulatory programs, and recreation that are too time-sensitive to rely on discrete water-quality sampling. Continuous water-quality monitoring for pH, specific conductance, dissolved oxygen, water temperature, and turbidity was historically measured at Lees Ferry by a meter deployed on the side of the streamgage's stone housing on the river's bank. Over time, water-quality data collected from the riverbank became nonrepresentative of the main channel. In February 2024, a buoy containing a continuous water-quality meter was deployed in the middle of the channel near the Lees Ferry streamgage to collect real-time water-quality data that is more representative of water quality in the main channel. These data are available on the USGS's publicly accessible Water Data for the Nation website.

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The Colorado River at Lees Ferry. The Lees Ferry streamgage is visible at the base of the cliffs on the left side of the photograph. U.S. Geological Survey photograph.

Read more about water-quality streamgages:
https://pubs.usgs.gov/fs/2020/3019/fs20203019.pdf

Learn more about NWQN:
https://pubs.usgs.gov/fs/2021/3019/fs20213019.pdf

Arizona Water Science Center technicians at Lees Ferry. U.S. Geological Survey photograph.

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