

United States
Department of the Interior
Water and Power Resources Service

**RAINBOW BRIDGE NATIONAL MONUMENT
MONITORING PROGRAM**

STATUS REPORT NO. 11

April 1, 1978 - September 30, 1979


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EXECUTIVE SUMMARY

In a suit dated August, 1973 (Friends of the Earth et al. vs. Armstrong et al.) the 10th Circuit Court decreed that the Bureau of Reclamation (Water and Power Resources Service) monitor Rainbow Bridge National Monument for a period of 10 years to determine any effects from the incursion of Lake Powell waters.

A monitoring program of a nondestructive nature was developed which includes geologic studies, surveys and photography. The program has been conducted on a periodic basis, checking for any changes in the structural stability of Rainbow Bridge.

Studies conducted during this report period (April 1, 1978 - September 30, 1979), concur with previous reports and indicate that no adverse effects have occurred to the stability of Rainbow Bridge from the incursion of Lake Powell waters.

GENERAL COMMENTS

This status report of the Rainbow Bridge Monitoring Program includes results and observations of all data collected between April 1, 1978 to September 30, 1979.

Distance and elevation surveys were conducted semi-annually at established quadrilaterals within Rainbow Bridge National Monument. Photographs from established photopoints were taken for comparison with previous photographs. Readings were taken at all strain gauge stations. These stations monitor the movement of selected cracks on Rainbow Bridge. Two stations have been monitored on a monthly basis and on July 12, 1979, one station was monitored hourly. These frequent readings have helped identify a more complete picture of crack motion and how the Bridge responds to weather, temperature, and exposure to the sun. Meteorological data has been compiled from a nearby weather barge to monitor weather conditions near the Bridge. A seismograph network has also recorded all seismic activity in the area on a continual basis.

As stated in previous status reports, Rainbow Bridge tends to expand and contract in response to seasonal changes in weather and temperature. Daily changes, also due to temperature, weather, and exposure time to the sun were also observed. The expansion and contraction is minute, not observable by naked eye, and requires careful measurements with precise instruments to be detected. These changes are within the elastic capabilities of the sandstone and no cumulative differences of lasting duration have been detected. This motion continues to be cyclical in nature, repeating itself on a daily and seasonal basis.

Data collected during this status report period indicate that no adverse effects have occurred to Rainbow Bridge from the incursion of Lake Powell into the Monument.

SPECIFIC COMMENTS

Included in the following comments are an explanation of the purpose and procedure of the different monitoring programs, and an analysis of the information obtained during the report period.

1. Bridge Creek Canyon Quadrilateral Surveys

As part of the monitoring program, field surveys were conducted semi-annually to continue to observe the behavior of the Rainbow Bridge structure and foundation. Survey methods include precise triangulation and distance measurements at four established quadrilaterals.

As explained in previous status reports, the surveys have shown that movement does occur on Rainbow Bridge as a reaction to changes in temperature and other weather conditions. Results of the surveys conducted during this report period indicate the same cyclical motion of the bridge structure due to temperature changes while foundation readings have remained constant.

No short-term adverse effects to Rainbow Bridge from Lake Powell waters have been observed from the quadrilateral surveys.

2. Elevation Surveys

Elevation surveys are associated with the quadrilateral surveys and continue to provide similar results as the monitoring program progresses. Elevation changes occur as a result of seasonal temperature fluctuations, and changes in other weather conditions. This motion continues to be cyclical, and no lasting change in elevation of different stations on the bridge has been detected.

These results indicate that cyclical changes in elevation of Rainbow Bridge are independent of the influence of Lake Powell waters.

3. Whittemore Strain Gauge Readings

Readings taken by a Whittemore Strain Gauge record the response of selected cracks on Rainbow Bridge to environmental changes. Information gathered during this report period continues to correlate with previously gathered data, and reveals that the Bridge responds to both daily and seasonal temperature changes.

On a seasonal scale, the cracks tend to close as the rock expands in the summer and open as the rock contracts during the winter. The motion is cyclical and no accumulative expansion or contraction has been detected.

On July 12, 1979, several readings were taken throughout the day to understand more clearly the extent of daily crack motion due to temperature changes. The readings indicated a cyclical pattern of expansion and contraction as the rock heated and cooled. The magnitude of this daily change is quite small, but does indicate that minor deviations in seasonal readings are due to daily temperature variations.

All data collected thus far indicates no correlation exists between reservoir water and crack movement of the Bridge.

4. Photogeology

Semi-annual visits were made to the bridge for the purpose of obtaining photographs from selected photopoints. The photographs were then compared with sets of photographs taken earlier from the same photopoints.

The comparison of photographs indicates that no changes have occurred to the structure or foundation of Rainbow Bridge.

Due to the higher water level (3684.7 feet in July, 1979), the latest set of photographs did not reveal any changes or displacement of cobbles

and small boulders at the base of Bridge Creek Canyon. However, some displacements of rocks and cobbles can be seen along the sides of the channel above the water level. As explained in previous status reports, runoff from precipitation, reservoir fluctuation, and especially wear and tear from tourists are the main contributors to overall minor erosion. Thus far, the photograph series has revealed only small disturbances of loose materials along the canyon slopes and benches, but no changes to the bridge structure or foundation have been detected.

5. Seismic Monitoring Program

A seismograph, installed in January 1976, about 1 mile west of Rainbow Bridge on a high ridge, is part of a regional seismograph network (maintained by the U.S. Geological Survey) which identifies the location and magnitude of local seismic events.

Of the 159 total seismic events recorded from July 1, 1977, to June 30, 1978, none were identified as earthquakes. One hundred and forty-eight events were identified as blasting in coal-mining operations in the Black Mesa and Chuska Mountain regions of northern Arizona (about 50 and 120 miles southeast of Rainbow Bridge, respectively). Eleven events were so small that their location was not determined.

The data collected indicates that no significant seismic events have occurred near Rainbow Bridge during this report period.

6. Sedimentation Surveys

Sedimentation studies conducted within the Monument along Bridge Creek Channel have provided a basis for evaluating the sedimentation

process near Rainbow Bridge. Changing sedimentation patterns have been observed as a result of changing reservoir elevations, normal stream flow, and flash floods.

Results of sedimentation data collected during this status report period indicate that sediments have accumulated downstream of Rainbow Bridge. Part of this accumulation can be attributed to channel scouring of the stream bottom upstream of the bridge. The energy required to scour and move sediments (i.e. flash flooding) dissipates once the stream waters come in contact with the main reservoir and the suspended sediments are deposited. This has caused no short-term adverse effects to Rainbow Bridge as the stream bottom underneath and nearby the bridge has not experienced any significant changes due to channel scouring or sediment accumulation.

7. Meteorologic Data

Included in this status report is a summary data sheet of data obtained by the weather barge located 1/4 mile downstream of the bridge. Due to functional problems of some of the recording instruments, each category lists an approximation of the percentage of time that the instrument was functional.

Status Period #11
WEATHER DATA SUMMARY - RAINBOW BRIDGE
from April 1, 1978 through Sept. 30, 1979

WEATHER: Location of Weather Barge - .25 miles downstream from Bridge

Air Temperature: Functioning - 50% of report period
 Not Functioning - 50% of report period
 Maximum 91 °F on date several in July-August
 Minimum 18 °F on date 1/3/79 and February
 Average 68 °F for time functioning.

Water Temperature: Functioning 80%
 Not Functioning 20%
 Average 62 °F for time functioning.

Relative Humidity: Functioning 60%
 Not Functioning 40%
 Maximum 68 % on date 3 days in August 1979
 Minimum 54 % on date 2 days in July 1978
 Average 61 % for time functioning.

Wind: Functioning 75%
 Not Functioning 25%
 Average Speed 4 mph during time functioning
 Average Direction _____ aximuth

LAKE POWELL ELEVATIONS: Maximum 3684.77 on date July 21, 1979
 Minimum 3622.73 on date April 11, 1978

Comments: Average Wind Direction recorder was not functioning during most of the status report period.

