United States Department of the Interior
GRAND CANYON MONITORING AND RESEARCH CENTER
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Memorandum

September 6, 2001

To: Glen Canyon Dam Technical Work Group (September 2001, meeting)

From: Ted S. Melis, Physical Science Program Manager
Grand Canyon Monitoring and Research Center

Subject: Briefing on initial results of LISST-100 field testing in the Colorado River ecosystem

LISST, stands for "Laser In-Situ Scattering and Transmissometry," and is a laser-diffraction based instrument designed to analyze grain-size distributions for naturally occurring suspended sediments within a variety of field environments. On the basis of optical scattering (Mie) theory, the instrument detects not only the grain size distribution of suspended sediments (in a manner not unlike many laboratory instruments currently can), but from this information, determines the volumetric, and ultimately, the mass concentration for the suspended load at frequencies of up to five times per second (5Hz). No other commercially produced instrument does this within a laboratory or field setting (in-situ).

In July 2001, the GCMRC, in collaboration with cooperating scientists from the Geologic and Water Resources Discipline, conducted a limited field test of LISST instrumentation within the Colorado River ecosystem at the Grand Canyon gage. The LISST-100 instrument was borrowed from Drs. Jeffrey Gartner and Ralph Cheng, of the USGS National Research Program (WRD) in Menlo Park, and deployed immediately below the stilling well of the Grand Canyon gage for exactly 24 hours, from 16:00 on July 19th, to 16:00 on the 20th.

During this in-situ deployment, the normal twice daily suspended-sediment sampling at the gage, conducted as part of the normal intensive monitoring protocol for fine-sediment export, was increased from 2 to 13, for purposes of verification of the LISST data. The preliminary results of this initial field test are shown in the pages of the attachment. The X's on the plots represent the LISST-100 data, while the open circles represent data obtained from depth-integrated water samples collected using the D-77 suspended sediment sampler deployed and the standard EDI method of the USGS at the Grand Canyon cableway.

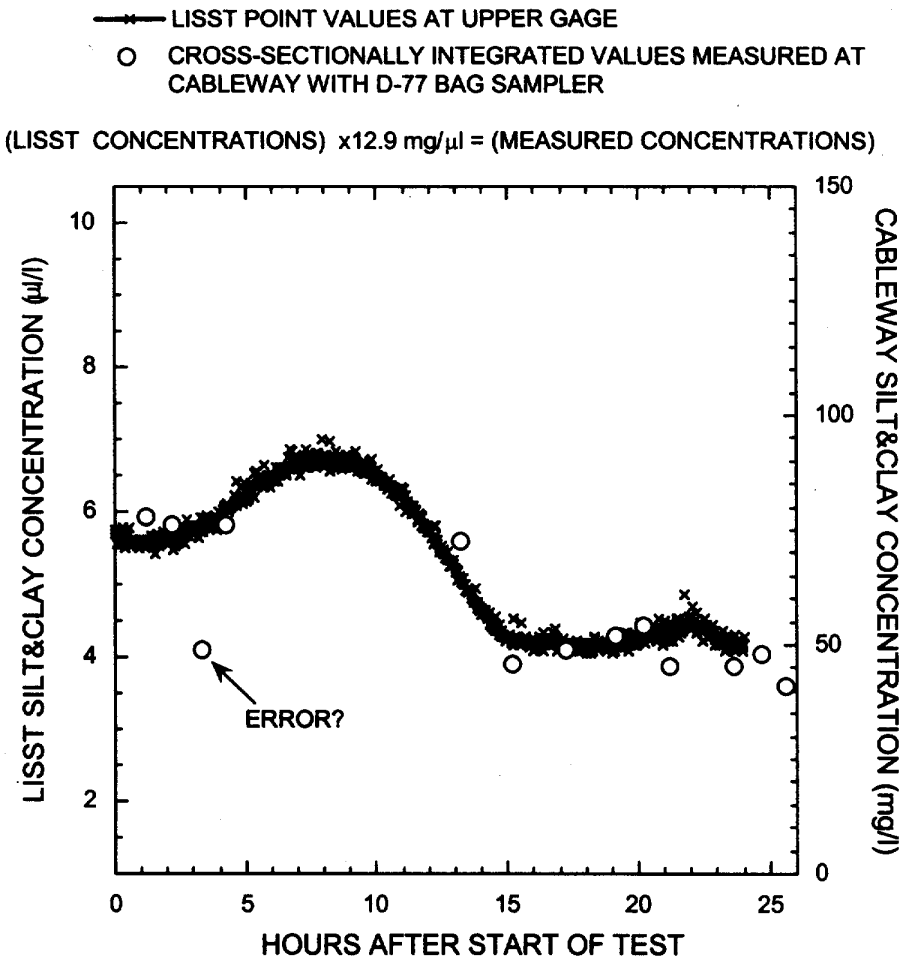
Some 720 sediment samples were collected by the LISST-100 (one sample every two minutes) during the 24-hour diurnal cycle, while flows in the river ranged from approximately 9,000 to 17,000 cfs.

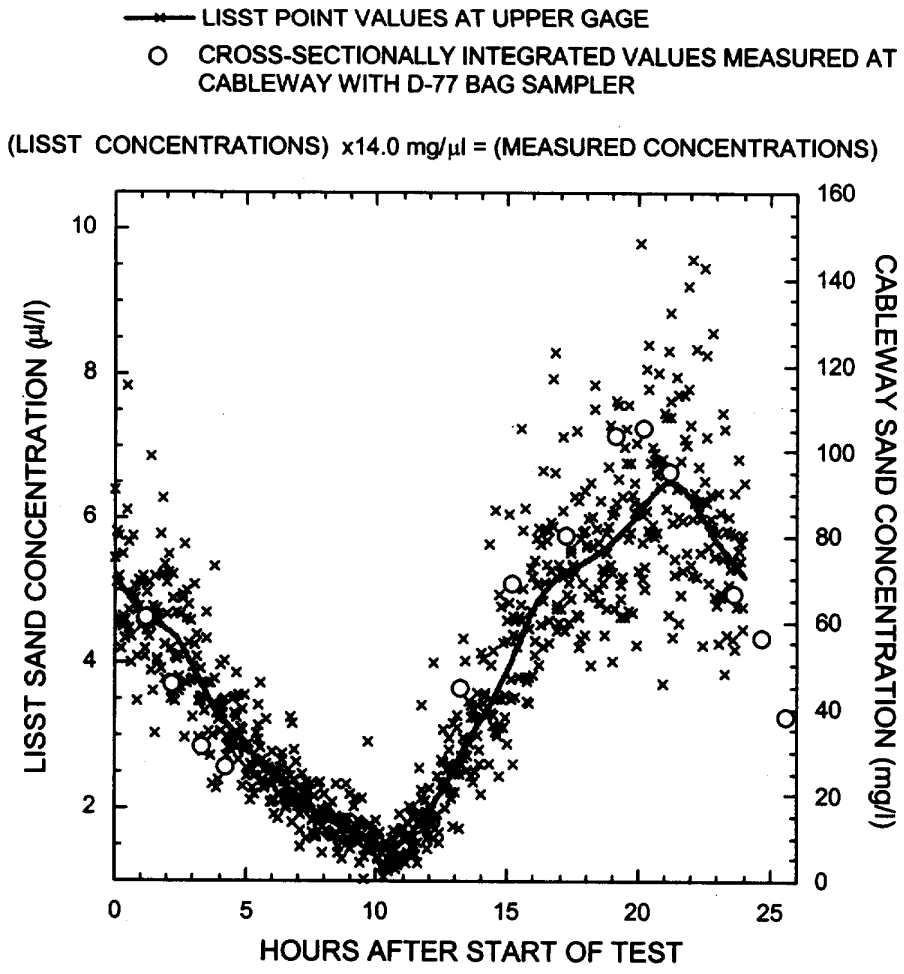
The preliminary results of this field test are quite astonishing, and exceeded all expectations for how well this technology might work within the Colorado River ecosystem to monitor suspended-sediment transport conditions from a near-shore, fixed-depth deployment. The LISST-100 data tracked the sediment transport conditions with respect to grain size and mass concentration very well when compared to the D-77 derived data (using standard laboratory procedures for determining the mass concentrations, as well as a Beckman-Coulter LS100Q bench instrument to determine the grain-size distribution for sand-sized particles contained in the verification water samples).

Of particular relevance to the GCMRC monitoring program, the LISST-100 provides the two basic pieces of information (median grain size and mass concentration) required to calculate the *Beta* parameter, recently described by Drs. Rubin and Topping. Recall that *Beta*, is a reach-averaged indicator of fine-sediment supply conditions within the Colorado River ecosystem related to channel-bed storage. For more information on Beta, please see the April GCMRC Science Symposium abstract by Rubin and Topping, as well as the attached plot of *Beta* versus sand mass balance for Lees Ferry to Phantom Ranch shown on final page of this document.

This instrumentation has the potential to greatly improve the GCMRC's ability to estimate sediment transport conditions in real time within the Colorado River ecosystem; especially at time scales within the diurnal cycle. Using recent cost estimates from USGS, the estimated value of grain-size and mass concentration data for 720 individual suspended-sediment samples collected at the Grand Canyon site over the course of, say one year (two samples per day), would be approximately $150,000.00. However, similar sediment transport data could never be collected at the resolution shown in this field test using conventional sampling protocols. Further, the post-processing time required for extracting these data from daily water samples is currently on the order of weeks to months. The LISST-100 data can be processed in seconds, and transmitted via satellite telemetry each hour of the day.

The GCMRC proposes to undertake more rigorous and prolonged field tests of the LISST-100 in collaboration with its USGS cooperating scientists over the next 1-2 years, should funding and support be made available.





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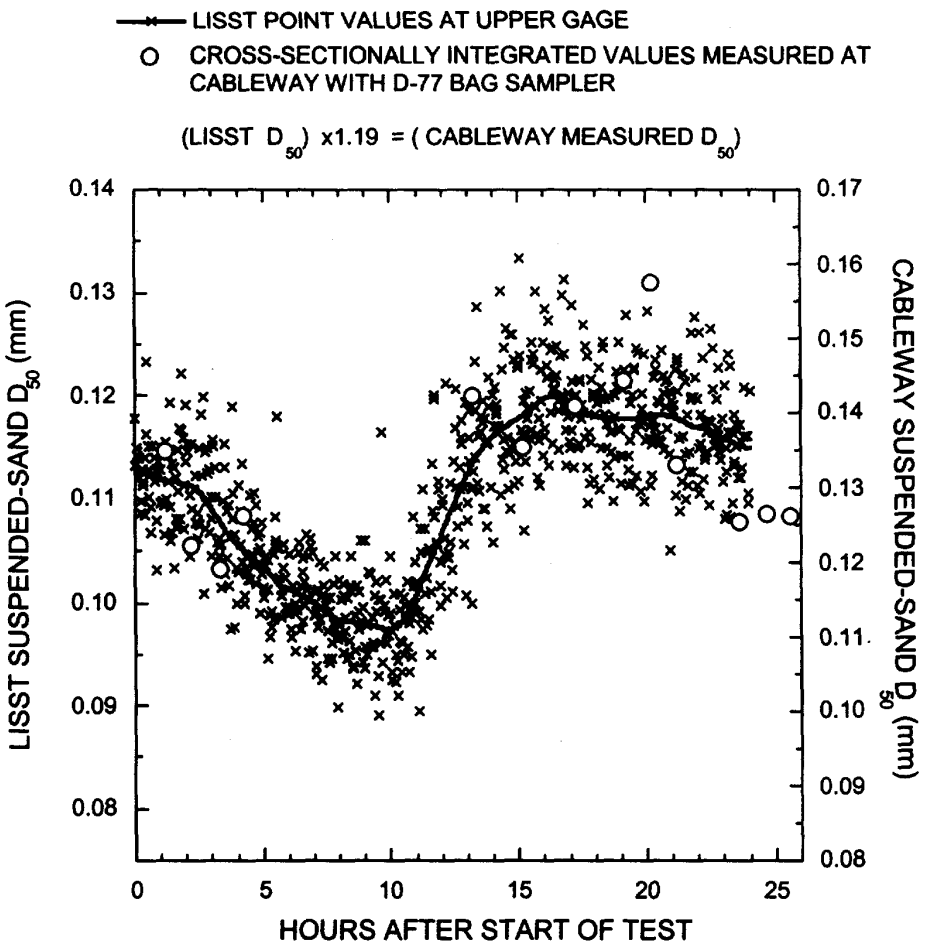

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