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Journal of the

HYDRAULICS DIVISION

Proceedings of the American Society of Civil Engineers

DISCUSSION

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DUAL CHANNEL STREAM MONITOR[a]

Discussion by D. W. Hubbell and W. L. Haushild

D. W. HUBBELL[8] and W. L. HAUSHILD,[9] M. ASCE.—The monitor developed by the authors and the organizations they represent exemplifies a new breed of instruments that can be used with accuracy in both the field and the laboratory. By using fully transistorized circuitry, they have produced an instrument that is light, compact, capable of operating on batteries, and highly portable. In addition, the instrument is simple to operate and the components are easy to assemble.

In November, 1960, an early model of the monitor was used in the North Loup River, Nebraska, during a study that was conducted by the U. S. Geological Survey Dept. of the Interior (USGS). The model that was used was essentially identical to the one depicted in Fig. 1. In the study, the monitor was used to measure the bed configuration and depth within a reach of the stream in which sand labelled with a radioactive isotope had been released. Measurements were made by traversing the reach with a boat that housed the monitor and recorder, as well as other equipment, and that had the transducers and probe mounted by a simple bracket at its bow. Power was supplied to the monitor from a portable motor-generator unit rather than from the self-contained battery pack; the generator was required to power other electronic equipment as well.

During the course of the study, the stream monitor was used daily for a two-week period when the air temperature varied from approximately 20°F to 40°F and the water temperature varied from 32°F to about 38°F. Although the conditions were somewhat adverse, the monitor operated satisfactorily and required no maintenance. In addition, the instrument was reasonably stable. Periodic calibration checks only indicated the need for infrequent minor adjustments. The procedure for calibration was relatively simple and was done with a bracket arrangement that allowed the transducers to be fixed at various distances from a metal plate. By changing the distance between the transducer and the plate, both the "scale" and "range" of the instrument could be checked.

At the time of the study, the bed material, which has a median diameter of approximately 0.31 mm, was formed into large dunes having lengths of about 10 ft and amplitudes of approximately 1.0 ft. The depth in the reach varied from about 1.0 ft to 6.0 ft, and averaged about 2.4 ft. The mean velocity

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[a] November, 1961, by S. S. Karaki, E. E. Gray, and J. Collins (Proc. Paper 2976).

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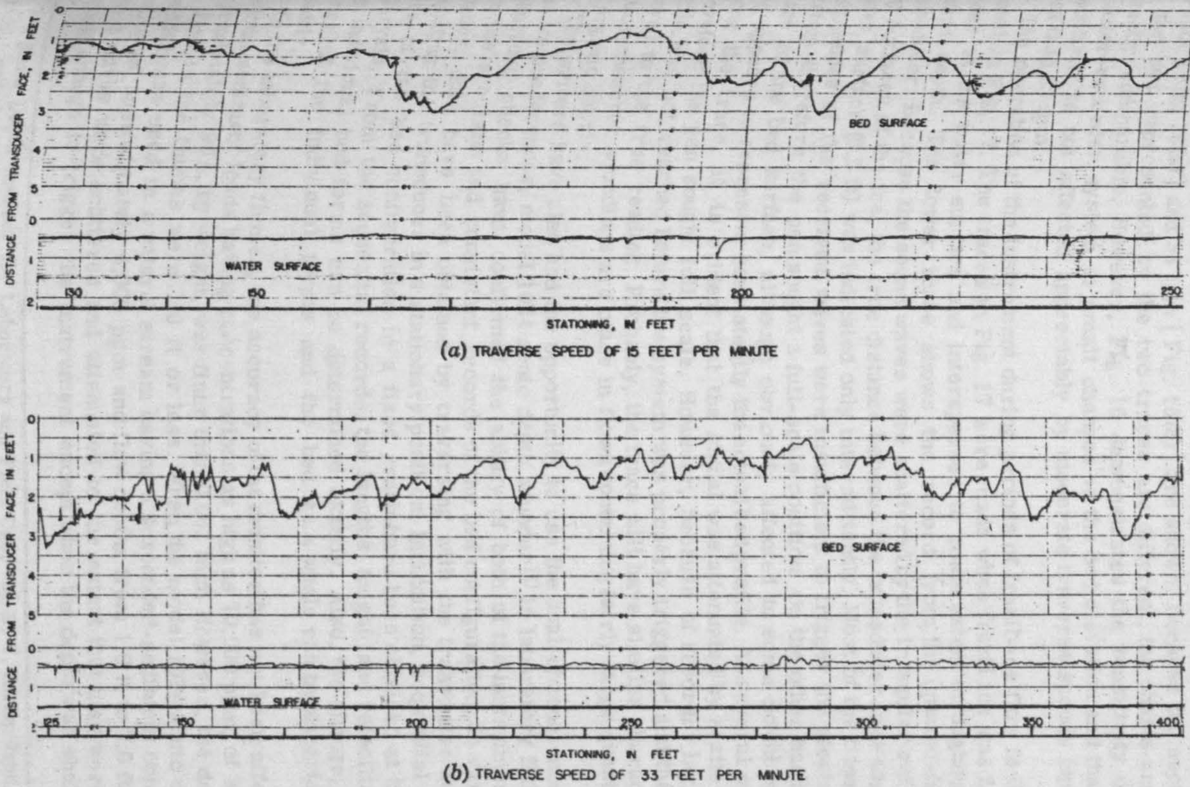

FIG. 16.—WATER AND BED-SURFACE PROFILES DEFINED BY THE DUAL CHANNEL STREAM MONITOR, NORTH LOUP RIVER (NEBR.)

flow was approximately 2.3 fps. The suspended sediment load had a concentration of about 500 ppm and a size distribution such that nearly 50%, by weight, was finer than 0.16 mm and approximately 10% was finer than 0.062 mm. Fig. 16 shows typical examples of the records that were obtained. For comparison, parts of records obtained with longitudinal traverse speeds of 5 fpm [Fig. 16(a)] and 33 fpm [Fig. 16(b)] are shown. Because the sections of the bed represented by the two traces are different, the charts are not directly comparable. However, Fig. 16 demonstrates the sensitivity of the monitor-recorder system to small changes in the bed elevation and that the sensitivity is not affected appreciably by moderate traverse speeds (speeds less than 33 fpm).

The operation of the instrument during periods of frazil-ice flow is illustrated in Fig. 17. The traces in Fig. 17 were made when frazil ice was fairly dense at the water surface and interspersed to some extent throughout the entire depth. The lower trace shows the record from the upward-facing transducer. Because the sound waves were scattered by the irregular reflecting surfaces of the ice, the true distance between the transducer face and the water surface (0.5 ft) was indicated only intermittently. Most of the time, the magnitudes of the received waves were insufficient to trigger the electronic system therefore the pen sought a full-scale position. On the other hand, the trace of the bed surface, although obviously affected to some extent by the ice, appears to represent consistently the actual bed profile. At several points along the trace, it is evident that the signal was attenuated by scattering, therefore the pen sought full scale. However, because of recorder lag, full scale was not reached before the system was properly triggered and the pen moved to the true reading. Probably, the trace will have similar characteristics whenever soundings are made in flows containing fairly large quantities of organic debris.

The writers have also had the opportunity to use the dual-channel monitor and its predecessor, model 1024 sonic depth sounder[10] in laboratory flumes. Numerous checks have confirmed the ability of both of the instruments to provide accurate and consistent records of the bed configuration. In various studies, data have been obtained by traversing with the transducer and by mounting the transducer in a stationary position. In addition, sequential profiles of the bed configuration in a fixed reach have been obtained at timed intervals. From the sequential records, the lengths, height, and velocities of the individual bed forms can be determined exactly. Also, the change, with time, of the individual forms and the bed as a whole can be ascertained readily.

In the laboratory flumes, the accuracy of the monitor has not been affected by total sediment loads having concentrations as high as 70,000 ppm, of which approximately 90%, by weight, was finer than 0.062 mm. However, the depths of flow in the flumes were 1.0 ft or less. When the model 1024 sonic depth sounder was used in a natural stream having a suspended-sediment concentration of approximately 4,000 ppm and flow depths from 1.0 ft to 7.0 ft, the sound waves were scattered and attenuated to the extent that they were not strong enough to trigger the instrument except when the depth was shallow.

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10 "Sonic Depth Sounder for Laboratory and Field Use," by E. V. Richardson, D.B. Simons, and G. J. Posakony, U. S. Geol. Survey Circular 450, Dept. of the Interior, Washington, D. C., 1961.

Although the operation of the dual-channel monitor is satisfactory, several modifications and additions would make it more versatile and easier to use. In order to facilitate calibration and adjustment, the "scale" and "range" potentiometers should be located in accessible positions. Also, the monitor should be provided, if possible, with some kind of stable electrical component that could be attached in place of the probe and regulated to simulate various underwater distances. The depth simulator would be used to calibrate the

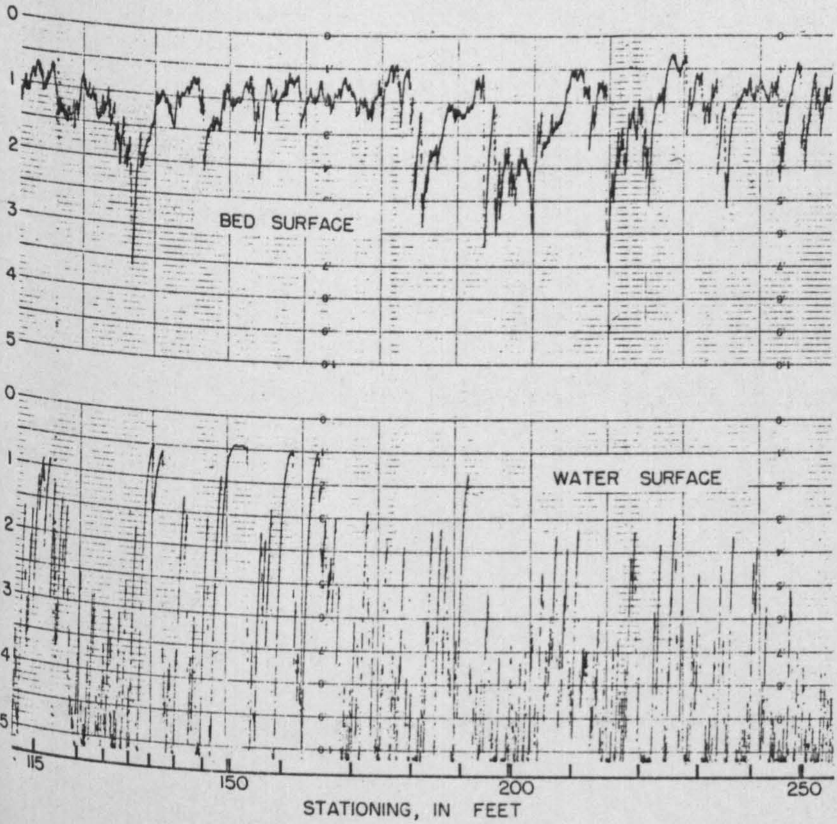

FIG. 17.—WATER AND BED-SURFACE PROFILES DEFINED BY THE DUAL CHANNEL STREAM MONITOR, NORTH LOUP RIVER (NEBR.)

monitor electrically rather than mechanically. Inasmuch as the total depth, as well as the bed and water-surface profiles, often is desired, a provision for the direct readout of depth would be beneficial. If the monitor was modified to provide a direct readout of the depth, the signal could be accumulated with an integrating-type recorder and mean depths could be determined easily from the average accumulation. For field use, the capability to sound distances to 10 ft with each transducer is highly desirable. For some kinds of measurements there is a need for a battery of transducers. Although several dual-channel monitors could be used together, a design that would provide for the accommodation of the circuitry of multiple transducers in a single unit would be convenient. Possibly this could be accomplished by constructing each channel as an independent interchangeable module.

The writers recognize that some of the recommended modifications and additions may not be practical at this time, however, the ideas are suggested herein with the hope that the recommendations will be considered as the monitor is progressively improved.