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Missouri River Division

Missouri River Study of the Lateral and Longitudinal Mixing Characteristics of the Missouri River in Lewis and Clark Lake

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V. SUMMARY AND RECOMMENDATIONS

A continuous-injection dye study was conducted on Lewis and Clark Lake from September 9 to September 15. Rhodamine WT dye was released as a constant-rate point source at river mile 875.2 Injection continued from 6:30 p.m. on September 9 to 7:30 a.m. on September 11. The resulting dye cloud was followed through the lake by taking repeated samples at cross sections located every 1-2 mi. Velocity and depth data were also collected at each cross section.

The purpose of the study was to determine the travel path of the dye and the residence time in the lake. Both are important considerations for water quality and sediment studies. In addition, the mixing characteristics of the lake were to be determined, along with the feasibility of modeling sediment transport in the headwaters. A two-dimensional mathematical transport model was used for the latter investigation.

In the upper portion of the lake the dye followed the thread of maximum velocity. This coincided with the maximum water depth. Below mile 866.8 in the central portion of the lake the dye tended to remain near the southern shore. The location of the peak dye concentration at any cross section varied with time and appeared to be influenced by the wind. The influence of wind was confirmed by mathematical model studies. At a discharge of 34,400 cfs (974 m^3/sec), the residence time in the lake was approximately 6½ days.

The mixing characteristics of the lake were studied by calibrating a two-dimensional mass transport model using the dye data along with velocity and cross-section data collected

over the period of the study. The model results indicate that the lateral mixing rate in the lake as measured by the lateral diffusion coefficient, E_z, is 1.34 times the product of the average depth and shear velocity. This compares to the 0.25 value commonly associated with stream reaches.

The same mathematical model used to study mixing was modified to include the effects of wind on lateral transport and the ability to model sediment settling. Incorporation of daily wind variations allowed improved modeling of observed concentration profiles at several cross sections. Further improvement should be possible with more-frequent wind updates and more-extensive data.

The sediment portion of the transport model was tested on a hypothetical rectangular channel with good results. The model was then tested using Lewis and Clark Lake data from a 1970 aggradation study. The model predicted the disposition locations for 0.1- and 0.063-mm sands in reasonable agreement with the limited data. Model concentration predictions were oscillatory for the larger sediment size.

Velocity measurements taken in the main body of the lake (mile 866.8 to 848.9) were very inaccurate. Wave motion acting on the boats from which the current meters were suspended resulted in measured velocities three to five times those actually occurring. It is recommended that in any future studies a method for anchoring meters to the lake bed be developed. Data should be transferred to the boat by a slack wire.

Results of incorporating wind in the model were reasonably successful. It is recommended that investigations be made of the effect of wind on model stability. In the present study it

was necessary to reduce the time step by a factor of four to obtain good results. Criteria are needed to determine the model operating range with wind included.

Results of the sediment model experiments were also reasonably successful. It is recommended that in a future study a good sediment data set be collected. Ideally this should include a continuous record of suspended sediment inflow, including size analysis, suspended sediment samples at frequent intervals at each model cross section, and bed-load samples, if possible. It is also recommended that consideration be given to modifying the model to allow routing of multiple-sized fractions of sediment. If sediment modeling is to include any significant length of stream reach reintrainment capability should also be added.