US Army Corps
of Engineers
Omaha District

Suspended Sediment Data Assessment Study, Missouri River at Omaha, Nebraska

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EXECUTIVE SUMMARY

An assessment of the suspended sediment data collection program was undertaken to determine if it was possible to reduce the sampling frequency, or even to halt sampling for a time, without compromising the precision and accuracy of the annual suspended sediment discharge calculations. This study evaluated the adequacy of the existing suspended sediment data and the effectiveness of alternative sampling strategies. The same procedure used to develop a sampling strategy at the Omaha, Nebraska, sampling site was also used to assess the suspended sediment sampling program at the Sioux City, Iowa, and the Nebraska City, Nebraska, sampling sites on the Missouri River. The results of the Omaha study are summarized below.

DATA COLLECTION

The U.S. Geological Survey, under a cooperative stream gaging program with the U.S. Army Corps of Engineers, Omaha District, has collected bed material and suspended sediment samples on the Missouri River at Omaha, Nebraska, since October 1976. Between October 1976 and September 1991, point-integrated suspended sediment samples were collected at six-week intervals during the open water season. From July 1992 to present, depth-integrated samples were collected twice weekly except when limited by adverse weather conditions or equipment failure. The missed sampling events were not rescheduled. A total of 586 suspended sediment samples were collected: 57 point-integrated samples and 529 depth-integrated samples.

SUSPENDED SEDIMENT RATING CURVES

Suspended sediment rating curves were developed from the suspended sediment measurements using a log-linear regression model. The minimum variance unbiased estimator was applied to correct for the re-transformation bias from the logarithmic to the linear form.

The relationship between streamflow and suspended sediment discharge is variable and may change with temperature, type of runoff (rainfall versus snowmelt), properties of the sediment, and characteristics of the river or watershed. To account for these changes, rating curves were developed for six-month seasonal groupings: (1) fall/winter (October 1 through March 31), and (2) spring/summer (April 1 through September 30).

There were some suspended sediment measurements, called outliers, that deviated significantly from the other measurements at similar streamflows. In this analysis, it was assumed that all of the suspended sediment measurements, including the outliers, were valid, and that the outliers did not result from sampling error. Therefore, the outliers were included in the regression analyses. For future sample collection, data quality criteria should be established to test the validity of the outliers.

SAMPLING DESIGN

The objective of this study was to assess the suspended sediment data collection program to determine if it was possible to reduce the sampling frequency, or even to halt sampling for specific periods of time, without compromising the precision and accuracy of the annual suspended sediment discharge calculations. Discontinuation of suspended sediment sampling is not recommended because some suspended sediment samples should be collected annually to measure shifts in the suspended sediment rating curve that may occur in response to changes in the river or the watershed. The study evaluated the adequacy of the existing suspended sediment data set and the effectiveness of different sampling strategies.

The existing suspended sediment data set was systematically thinned to simulate different sampling strategies. The recommend sampling strategy was a seasonal, flow-stratified suspended sediment sampling design having the following properties:

1. Suspended sediment samples that span the entire streamflow range for low, moderate and high water discharges.

2. More suspended sediment samples concentrated in streamflow intervals having the largest fraction of the total suspended sediment discharge.

3. The number of annual suspended sediment samples necessary to observe shifts in the suspended sediment rating curves that can occur in response to changes in the river or watershed.

4. An adequate number of samples that will maintain or improve the precision and accuracy of the suspended sediment rating curves.

The proposed sampling design requires fewer annual sampling events than the current twice-weekly sampling scheme. In order to demonstrate the sample reduction, the current and proposed sampling schemes were implemented for future Water Years 2000 through 2022. It was assumed that the streamflow patterns for these water years were the same as the historical patterns from Water Years 1977 through 1999. Although historically there were missed sampling events, for the purposes of comparison, it was assumed that missed sampling events resulting from adverse weather or equipment failures would be rescheduled rather than skipped in future water years. Therefore, all potential sampling events for both the existing and proposed sampling schemes were counted. For most of the Water Years 2000 through 2022, the number of samples collected under the proposed sampling design was less than the number collected under the twice-weekly sampling scheme. The average number of samples collected annually during Water Years 2000 through 2022 under the current and proposed sampling schemes are 104 and 72, respectively. This corresponds to an average annual sample reduction of 31 percent on the Missouri River at Omaha, Nebraska.

ANNUAL SUSPENDED SEDIMENT DISCHARGE

The total annual suspended sediment discharge for each of the water years in the study period (1977 through 1999) was calculated using the rating curves developed from the existing suspended sediment data. In general, the suspended sediment discharge was higher during the spring/summer season due to higher streamflows. The highest annual suspended sediment discharge was during Water Year 1997 and the lowest during Water Year 1990.

There was not a sufficient amount of data to compute the suspended sediment discharge by size fraction. For future data collection, it is recommended that grain size distributions be measured periodically for the suspended sediment samples in the different streamflow intervals in order to estimate the suspended sediment discharge by size fraction.