Environment and Natural Resources Trust Fund (ENRTF) M.L. 2015 Work Plan

Date of Report: October 15, 2014

Date of Next Status Update Report: January 1, 2016

Date of Work Plan Approval:

Project Completion Date: December 31, 2018

Does this submission include an amendment request? No

PROJECT TITLE: Using Hydroacoustics to Monitor Sediment in Minnesota Rivers

Project Manager: Christopher A. Ellison

Organization: U.S. Geological Survey

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Location: Blue Earth, Brown, Carver, Dakota, Goodhue, Hennepin, Le Sueur, Nicollet, Ramsey, Scott, Sibley, Wabasha, Washington counties

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$455,000**
	Amount Spent:	**$0**
	Balance:	**$455,000**

Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 04g

Appropriation Language:
$455,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the United States Geological Survey to install hydroacoustic equipment on the lower Minnesota and Mississippi Rivers to improve measurement and monitoring accuracy for suspended sediment and enhance ongoing sediment reduction efforts by state, federal, and local agencies. This appropriation is not subject to the requirements in Minnesota Statutes, section 116P.10. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Using Hydroacoustics to Monitor Sediment in Minnesota Rivers

II. PROJECT STATEMENT:

Executive Summary: Sediment-laden rivers and streams cost the State of Minnesota millions of dollars each year. Excessive sediment in rivers degrades water quality and aquatic habitat, requires removal of dredge material, reduces recreational opportunities, and transports harmful contaminants. In Minnesota, sediment is listed as the top water quality impairment, affecting over 5,800 miles of streams. Representative, consistent, and accurate measurements of sediment are needed because significant resources are being dedicated to understanding the causes, effects, and sources of sediment in rivers. Due to the difficulty, expense, training and the limited opportunities to collect physical sediment samples, there are relatively few suspended-sediment concentration (SSC) samples available along the lower Minnesota and Mississippi Rivers in Minnesota. Given this, sediment prediction models are increasingly relied upon to obtain estimates of sediment concentrations and loads; however, model results often vary from measured loads by large amounts, causing a high level of uncertainty about their ability to accurately predict loads. Thus, physically collected samples of suspended sediment still remains the most accurate and reliable means for determining sediment loads and quantifying the amount of erosion from a watershed. The challenge is to meet the current and future needs of measuring sediment to improve accuracy while reducing costs. One method uses acoustic Doppler velocity meters (ADVMs) mounted permanently on bridge piers below the water surface to measure suspended sediments. Sound waves emitted from the ADVMs are generated from sediments in suspension and can be correlated to SSC from samples collected using specially designed isokinetic samplers. Project findings will provide important information for current and future water resource policy decisions.

Project outcomes:

- Accurate, high resolution, continuous measurements of sediment concentrations for the lower reach of the Minnesota River and the South-Metro Area of the Mississippi River
- Accurate sediment budgets and sediment load contributions from the Minnesota River
- Current calculations of fill rates and trapping efficiency for Lake Pepin
- Instrument for measuring the effectiveness of best management practices
- Tool for monitoring the progress of the State's sediment reduction strategy for the Minnesota and Mississippi Rivers

Elevated sediment loads have been attributed to human activities such as urbanization and agricultural activities that increase impervious surfaces and reduce soil permeability. Water that would normally infiltrate into the soil becomes overland flow that is available to erode and transport sediment to the stream channel. Increases in sediment also can be attributed to human-induced changes to the river like creating levees, and straightening, dredging and widening the channel for navigation. Levees prevent the river from connecting to the natural floodplain, and straightening and dredging the channel increases the river's gradient; all increase stream velocity and energy. In Minnesota, sediment is listed as the top water quality impairment, affecting over 5,800 miles of streams.

Suspended-sediment sampling in Minnesota began as early as 1879 by the U.S. Engineer Department as part of a larger sampling project along the Mississippi and Missouri Rivers. From 1930 through 1933, daily samples on the upper Mississippi River and its tributaries were collected by the St. Paul U.S. Engineer District, and in 1937 and 1938, suspended-sediment samples were collected on the Minnesota, Zumbro, and Root Rivers by the U.S. Army Corps of Engineers. The U.S. Geological Survey (USGS) began collecting suspended-sediment concentration (SSC) samples in Minnesota in the early 1960s using isokinetic samplers. Following an active sampling period in the 1970s and 1980s, suspended-sediment sampling declined in Minnesota for more than two decades until 2007 when the USGS, in cooperation with the Minnesota Pollution Control Agency (MPCA), established a sediment monitoring network of sites and began systematic sampling across the State.

Representative, consistent, and accurate measurements of sediment are needed because significant resources are being dedicated to understanding the causes, effects, and sources of sediment in rivers. For many decades, there have been few changes in the methods used to collect physical sediment samples. The MPCA had incorporated grab sampling and total suspended solids (TSS) laboratory analysis as its measure of fluvial sediment in the early 1970s. The TSS method was originally designed for analyses of point samples from wastewater treatment facilities. Total suspended solids were adopted by the MPCA for various reasons, some of which included the assumption that the TSS method would provide an adequate representation of suspended sediment and that isokinetic sampling and laboratory analysis of whole sample suspended-sediment concentration (SSC) was too costly. Total suspended solids samples are collected at the center of the stream cross-section less than 1 meter (3.3 feet) below the water surface, whereas SSC samples are collected using isokinetic samplers at 10 equally spaced locations across the stream cross-section and through the entire stream depth. Isokinetic samplers are designed to obtain a representative sample of the water-sediment mixture by allowing water in the stream to enter the sampler at the same speed and direction as the streamflow. The primary difference in laboratory procedures is that the TSS analytical method uses a pipette to extract a subsample from the original water sample to determine the amount of suspended material, whereas the SSC analytical method measures all of the sediment and the mass of the entire water-sediment mixture. According to a USGS report published by Gray and others (2000), the use of a pipette to obtain subsamples subjects the analyses to substantial biases as compared to the SSC method.

In 2007, the MPCA, in cooperation with the USGS, decided to determine if significant differences existed between the grab sampling method of collecting TSS and the USGS method of collecting suspended-sediment concentrations (SSC). Over 120 paired TSS/SSC samples were collected at 7 sites across the state. The data and subsequent analysis indicated that the TSS method was under-representing the amount of sediment in Minnesota's Rivers by approximately 50%. The concern is that the under-representation of sediment transmits directly into inaccuracies in sediment load computations and subsequent interpretations. It is possible that decisions based on inadequate data can cause the loss of millions of dollars if water-quality improvement programs and stream restoration and fish enhancement projects fail. The USGS study was released to the public in January 2014 and can be found at (http://pubs.usgs.gov/sir/2013/5205/pdf/sir2013-5205.pdf).

Due to the difficulty, expense, training and the limited opportunities to collect physical sediment samples, there are relatively few samples of SSC available along the lower Minnesota and Mississippi Rivers in Minnesota. Thus, alternate methods using models are often relied upon to obtain estimates of sediment concentrations and loads. Sediment transport models offer the advantage of examining various simulation scenarios; however, their ability to accurately predict sediment concentrations and loads are dependent upon reliable, consistent inputs and correct interpretations. Research has shown that sediment prediction models often vary from measured loads by large amounts, causing a high level of uncertainty about their ability to accurately predict loads. One of the problems associated with models is their ability to adequately determine sediment supply, which is dependent on many factors like sediment availability, season, watershed size, and source location in the watershed. Consequently, physically collected samples of suspended sediment still remains the most accurate and reliable means for determining sediment loads and quantifying the amount of erosion from a watershed. The challenge is to meet the current and future needs of measuring sediment to improve accuracy while reducing costs.

The objectives of this project are: 1) improve measurements of sediment concentrations for the lower reach of the Minnesota River; 2) to accurately quantify sediment load contributions to the Mississippi River from the Minnesota River; and 3) to calculate accurate fill rates for Lake Pepin. A total of nine sites will be used in the study. Five of the nine sites have a pre-existing hydroacoustic device installed as part of the USGS streamgaging network. Four additional hydroacoustic devices will be installed to meet the study design requirements. Recent technological advances along with the continued need to measure fluvial sediment has led to the use of surrogates for measuring suspended sediment, particularly in locations where streamflow alone is not a good estimator of SSC. One of these surrogate methods, proposed in this study, uses acoustic Doppler velocity meters (ADVMs) mounted permanently on bridge piers below the water surface (fig 1.). Sound waves emitted from the ADVMs are correlated to suspended-sediment concentrations (SSC) from samples collected using isokinetic samplers and rigorous sampling procedures. The benefit of using hydroacoustics as a surrogate is that the acoustic signal response is directly generated from sediment in suspension. Historically, streamflow has been used to predict sediment between sample collection intervals but results using streamflow are inconsistent. Gaps in the data will be eliminated because SSC will be measured continuously in real time. Using continuous measurements, load accuracies will be significantly improved. This will be accomplished by installing hydroacoustic equipment at permanent in-stream monitoring stations to collect continuous measurements at existing USGS and/or DNR streamgaging sites.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of January 1, 2016:

Project Status as of July 1, 2016:

Project Status as of January 1, 2017:

Project Status as of July 1, 2017:

Project Status as of January 1, 2018:

Project Status as of July 1, 2018:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

This project will establish a network of five sediment monitoring sites on the Minnesota River and four sediment monitoring sites on the Mississippi River (fig 2). Each hydroacoustic site will be co-located at a USGS or MPCA/DNR continuous recording streamgage with one exception. The exception is the site on the Mississippi River below Lake Pepin near Lake City. This site is located along the river between Lake Pepin and the confluence of the Mississippi River and the Chippewa River (fig 2). Establishing a site at this location will provide a measure of the sediment trapping efficiency of Lake Pepin prior to contributions from the Chippewa River. For the Minnesota River, sites will be established at Judson, Mankato, St. Peter, Jordan, and at Ft Snelling Park. These sites have continuous-recording streamgages and were selected to measure sediment loads in key reaches along the lower Minnesota River. The furthest upstream site at Judson is approximately 10.8 river miles above the erosive Blue Earth Watershed, which is estimated to contribute greater than 30% of the total suspended solids entering the Minnesota River. Measuring sediment concentrations and loads on the main stem of the Minnesota River above the confluence with the Blue Earth River is important to quantify the loads prior to contributions from the Blue Earth Watershed. Approximately 1 mile downstream from the Blue Earth River, sediment concentrations will be measured at the USGS streamgage at Mankato. Measuring loads at Mankato will help provide accurate load contributions from the Blue Earth River Watershed. In addition to the sites at Judson and Mankato, there are 3 other primary river reaches that will provide important information to understanding sediment transport along the lower Minnesota River. These include the river reaches between Mankato and St. Peter, St. Peter and Jordan, and Jordan to Ft Snelling Park (fig 2). Ft Snelling Park is within three river miles of the confluence with the Mississippi River. Placing hydroacoustic equipment at these sites will provide a data set that can be used to calculate the production, transport, discharge, and storage of sediment within each reach. This is important to correlating natural and anthropogenic conditions that affect variations in transport and storage rates within each of the reaches. These data can be used to measure the effectiveness of best management practices and to monitor the progress of the State's sediment reduction strategy. Additionally, this will provide decision-makers important information to focus efforts that will maximize sediment reductions. Datalogging and satellite telemetry equipment available at existing streamgages will be used to record and transmit the data to the USGS office in Mounds View.

ACTIVITY 1: Install ADVMs at four streamgaging sites on the Minnesota and Mississippi Rivers and collect water-samples for suspended-sediment concentration (SSC) following USGS sampling procedures

Description: Initially, site reconnaissance will be accomplished to determine optimum placement of the ADVM in the stream channel. To do this, an acoustic Doppler current profiler will be deployed to determine variability of the acoustic backscatter in the stream cross-section. The backscatter data will be evaluated to determine where the highest and most uniform backscatter values occur. Permits will be submitted to the appropriate county or state authority to obtain permission to use the bridge as a structure to support the ADVM and associated equipment. Once the permits are approved, the Minnesota Department of Transportation will be contacted to contract the "snooper" for use in installing the ADVMs. The snooper is a crane and bucket system that can transport personnel safely over the side of the bridge to allow the ADVM and cables to be attached to the bridge pier. At the top downstream side of the bridge, an enclosure containing a data transmitter (i.e. radio link or Satlink2), voltage conditioner and battery will be installed to the side of the bridge deck. The ADVM will be programmed to collect acoustic backscatter data in 5 cells and transmitted to the USGS office in Mounds View. This is expected to be completed by November 30, 2015. The following spring (2016), 3 teams of 2 personnel each will be deployed during spring snowmelt runoff to collect the initial set of physical sediment samples that will be correlated to the acoustic backscatter data. Samples will be collected using isokinetic samplers and will be width/depth integrated following USGS sampling procedures. Two sets of samples will be collected at each site during each visit. This will continue at each of the nine sites over a wide range of streamflow to encompass the rising and falling limbs of the streamflow hydrograph during the spring runoff period. A total of up to 90 sediment samples will be collected during the spring runoff period which typically ends in May – June. Following this sampling period, samples will be collected during lower flows to determine sediment concentrations at lower flows. Along with low flow sampling, storm events also will be sampled to determine the variability in sediment concentrations under these conditions. Up to 90 additional samples will be collected during this time period, which will continue until November until a total of up to 180 samples are collected. Samples will be kept in the USGS warehouse; in July and December, all samples will be transported to the USGS Iowa sediment lab for analysis. Laboratory analysis will consist of sediment concentration and an analysis of the percentage of particle sizes that are less than 0.062mm (fines size). Sizes larger than 0.062mm in suspension will be assumed to be sand-sized particles. It typically takes 4 – 6 weeks to receive the results from the lab. Once the results are received, the data will be formatted and inspected to determine if there are any anomalies that require further investigation. For example, if it is noticed that a sample has a large sediment concentration along with a relatively large percentage of sand when compared to other samples at similar flows, it may be that the field technician inadvertently disturbed the channel bottom with the sampler and contaminated the sample. Because the sample likely contains disturbed sediments from the channel bed, it is not representative of the suspended-sediment concentrations in the river and it may not be used in the data set.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 359,658
Amount Spent: $ 0
Balance: $ 359,658

Outcome	Completion Date
1. *ADVMs installed on Minnesota River at Judson, St. Peter, Jordan and on the Mississippi River below Lake Pepin near Lake City, initiate data logging and transmissions to USGS office in Mounds View*	November 30, 2015
2. *Collect up to 90 sediment samples (10 each site) during spring snowmelt runoff on Minnesota River at Judson, Mankato, St. Peter, Jordan, Ft. Snelling Park, on the St Croix River at Prescott, and on the Mississippi River at St. Paul, Red Wing, and below Lake Pepin near Lake City*	June 15, 2016
3. *Transport sediment samples to USGS Iowa sediment lab for analysis*	July 1, 2016
4. *Collect up to 90 sediment samples (10 each site) during storm events, if available, and during lower stream flows on the Minnesota River at Judson, Mankato, St. Peter, Jordan,*	November 15, 2016

Ft. Snelling Park, on the St Croix River at Prescott, and on the Mississippi River at St. Paul, Red Wing, and below Lake Pepin near Lake City	
5. *Transport sediment samples to USGS Iowa sediment lab for analysis*	December 1, 2016
6. *Receive data from Iowa Sediment lab. Format data and perform quality assurance/quality control, enter into National Water Information System database*	March 1, 2017
7. *Collect up to 90 sediment samples (10 each site) during spring snowmelt runoff on Minnesota River at Judson, Mankato, St. Peter, Jordan, Ft. Snelling Park, on the St Croix River at Prescott, and on the Mississippi River at St. Paul, Red Wing, and below Lake Pepin near Lake City*	June 15, 2017
8. *Transport sediment samples to USGS Iowa sediment lab for analysis*	July 1, 2017
9. *Collect up to 90 sediment samples (10 each site) during storm events, if available, and during lower stream flows on the Minnesota River at Judson, Mankato, St. Peter, Jordan, Ft. Snelling Park, on the St Croix River at Prescott, and on the Mississippi River at St. Paul, Red Wing, and below Lake Pepin near Lake City*	November 15, 2017
10. *Transport sediment samples to USGS Iowa sediment lab for analysis*	December 1, 2017
11. *Receive data from Iowa sediment lab. Format data and perform quality assurance/quality control, enter into National Water Information System database*	March 1, 2018

Activity Status as of January 1, 2016:

Activity Status as of July 1, 2016:

Activity Status as of January 1, 2017:

Activity Status as of July 1, 2017:

Activity Status as of January 1, 2018:

Activity Status as of July 1, 2018:

Final Report Summary:

ACTIVITY 2: Develop relations among streamflow, acoustic signals, and physical sediment samples and document the results in a Scientific Investigations Report.
Description:
This will entail formatting the data for input into "R" language statistical software. Data will be quality controlled/checked prior to analysis. Standard statistical methods of simple and/or multiple linear regression analysis will be used to evaluate the relations among the parameters. Results from the analyses will be documented in table format. Graphs will be constructed to display the relations among parameters. Once the tables and graphs are completed, an analysis and interpretation of the data will be completed and documented, along with the raw data, which will be presented in an appendix, in a Scientific Investigations Report (SIR). The draft SIR will be thoroughly reviewed by a minimum of 5 reviewers, including a final review by the USGS Bureau Approval Authority. Once the SIR and statistical models have been peer reviewed, an online web-based portal will be constructed for viewing real-time suspended-sediment concentrations at each of nine monitoring sites.

Summary Budget Information for Activity 2: | **ENRTF Budget:** **$ 95,342**
Amount Spent: **$ 0**
Balance: **$ 95,342**

Outcome	**Completion Date**

1. *Prepare ADVM, streamflow, and sediment data for analysis; match acoustic signals with streamflow and sediment concentrations*	April 1, 2018
2. *Develop relations among acoustic signals, streamflow, and sediment concentrations using standard statistical methods; identify outliers and construct regression equations*	May 15, 2018
3. *Complete draft SIR; write text, construct figures and graphs, and submit for initial in-office USGS peer review*	August 30, 2018
4. *Make corrections and complete additional analysis as recommended by reviewers, submit SIR for USGS colleague peer reviews (2 colleague reviews)*	September 30, 2018
5. *Make corrections and complete additional analysis as recommended by reviewers, submit SIR to USGS Bureau Approval Authority for final review*	October 30, 2018
6. *Submit SIR for final publication; release to public*	December 31, 2018

Activity Status as of January 1, 2016:

Activity Status as of July 1, 2016:

Activity Status as of January 1, 2017:

Activity Status as of July 1, 2017:

Activity Status as of January 1, 2018:

Activity Status as of July 1, 2018:

Final Report Summary:

V. DISSEMINATION:
Description:
The results of USGS sampling and analyses will be stored in the USGS National Water Information System (NWIS) data base and made available to the public via the USGS Minnesota Water Science Center web site at http://mn.water.usgs.gov/index.html. Once the hydroacoustic signals have been calibrated to the physical sediment samples, we will seek cooperator support to add additional equipment (CR1000 dataloggers - Campbell Scientific Inc.) that will enable online graphical illustrations for the public to view real-time continuous sediment concentrations at all nine sites at the above mentioned website. Additionally, a Scientific Investigations Report (SIR) will document the results of the study and will be available at the end of the study. All of the ADVM, streamflow, and sediment data will be provided in an attached appendix to the SIR. Also, these data will be presented at various forums such as the Minnesota Water Resources Conference and the Minnesota Annual Watershed District Meeting. These data will synthesize results for incorporation with past, present, and future sediment studies on the Minnesota and Mississippi Rivers.

Activity Status as of January 1, 2016:

Activity Status as of July 1, 2016:

Activity Status as of January 1, 2017:

Activity Status as of July 1, 2017:

Activity Status as of January 1, 2018:

Activity Status as of July 1, 2018:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 297,477	1 USGS Studies Chief at 4% FTE each year for 3 years; 1 USGS Project Chief at 20% FTE each year for 3 years; 1 USGS Hydrologist at 21% FTE each year for 3 years; 2 USGS Hydrologic Technicians at 21% FTE (each) each year for 3 years; 1 USGS junior Hydrologic Technician at 18% FTE each year for 3 years; 2 USGS Surface Water/Water Quality Specialists at 4% FTE (each) each year for 3 years; 2 Database/IT Support Specialists at 4% FTE (each) each year for 3 years; 2 Admin Support at 7.6% FTE (each) each year for 3 years.
Professional/Technical/Service Contracts:	$ 32,660	USGS Iowa sediment sample laboratory analysis; MNDOT contract (snooper) to install equipment on bridges; boat contract to collect samples and perform maintenance on ADVM equipment; Scientific Publishing Network contract to edit, assemble, and publish final report
Equipment/Tools/Supplies:	$ 31,630	Cables, weatherproof enclosures, radiolinks, solar panels, batteries, Satlink data transmitter, antenna
Capital Expenditures over $5,000:	$ 47,494	Acoustic Doppler Velocity Meters, D-96 sediment sampler for sampling large, deep rivers
Travel Expenses in MN:	$ 22,739	Mileage (.55/mile), lodging, meals
Other:	$ 23,000	Overtime compensation for extended field sampling days; shipping of equipment from vendors.
TOTAL ENRTF BUDGET:	**$455,000**	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than $5,000:
Capital expenditures greater than $5,000 include four acoustic Doppler velocity meters (ADVMs) ($10,343 each - $41,373 total) and one D-96 sediment sampler ($6,122). The ADVMs are expected to remain at the installation sites for the duration of their lifespan. Because they don't have moving parts, they should continue to work for 10 or more years. The ADVMs are installed on the downstream side of bridge piers and are protected from floating debris and strong stream velocities. It is anticipated that once the sites are established and the ADVMs are calibrated to the physical sediment samples, they will be maintained through cooperative agreements between the USGS, MPCA, U.S. Army Corps of Engineers, Lower Minnesota River Watershed District, and possibly other state, university, and local government agencies. The D-96 sediment sampler is designed to sample in large rivers with deep water columns (>15 feet) and during stream velocities up to 12 feet per second. The D-96 sampler is needed to collect representative samples in the Minnesota and Mississippi Rivers because it

allows the water-sediment mixture to enter the sampler at the same speed and direction as the flowing water. The USGS in Minnesota currently only has 1 of these samplers and needs the second sampler to ensure that all of the sites will be sampled during the limited time period available for spring snowmelt runoff and storm events. Having two samplers will enable two sampling teams to collect samples at sites simultaneously and ensure the desired numbers of samples are collected.

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 4.09 FTEs

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:
N/A

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
U.S. Geological Survey	$189,216	$0	Personnel, travel, supplies
State			
N/A	$0	$0	
TOTAL OTHER FUNDS:	**$189,216**	**$0**	

VII. PROJECT STRATEGY:
A. Project Partners: There are no current agreements with partners to collaborate with this project. Historically, there were three partners that provided funding to support the collection and analysis of sediment data at three of the sites (Minnesota River at Mankato, Jordan, Ft Snelling Park) listed as monitoring sites for this project.

B. Project Impact and Long-term Strategy:
It is anticipated that this project will provide important data to accurately quantify sediment loads discharging into the Mississippi River from the Minnesota River. These data will be useful for calculating the current sediment fill rate into Lake Pepin. Data gaps resulting from point samples (historically, periodic samples were collected using point samples) will be eliminated because SSC will be measured continuously in real time. Using continuous measurements, load accuracies will be significantly improved. Other expected benefits include the ability to distinguish among and/or attribute sediment loads to streambanks, ravines, and bluffs, which have been identified as major contributors (60-80%) of sediment. Monitoring the South-Metro Mississippi River will provide accurate sediment loads into Lake Pepin. Also, this data will provide direct monitoring support for the MPCA's Sediment Reduction Strategy to reduce sediment loads in the Minnesota River by 80-90 percent and in the South-Metro Mississippi River by 50-60 percent. These data will provide accurate sediment loads for maintaining the navigation channel on the Minnesota and Mississippi Rivers by the U.S. Army Corps of Engineers. The long term strategy is to maintain the sites for 10 or more years to monitor loads, expand their use to monitoring additional contaminants like nutrients, heavy metals and pesticides, and attribute changes in loads to natural causes, sediment reduction strategies, or land-use changes.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
Minnesota Pollution Control Agency: Appropriation of funds used to collect and analyze sediment concentrations at the Minnesota River at Mankato	July 1, 2010 – September 30, 2014	$200,000

U.S. Army Corps of Engineers: Appropriation of funds used to collect and analyze sediment concentrations at the Minnesota River near Jordan and at Ft. Snelling Park	October 1, 2011 – September 30, 2014	$128,000
Lower Minnesota River Watershed District: Appropriation of funds used to collect and analyze bedload sediments at the Minnesota River near Jordan and at Ft. Snelling Park	January 1, 2012 – December 31, 2014	$15,000

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

A. Parcel List: N/A

B. Acquisition/Restoration Information: N/A

IX. VISUAL COMPONENT or MAP(S): See attached figures.

X. RESEARCH ADDENDUM: N/A

XI. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than January 1, 2016; July 1, 2016; January 1, 2017; July 1, 2017; January 1, 2018; and July 1, 2018. A final report and associated products will be submitted no later than December 31, 2018.

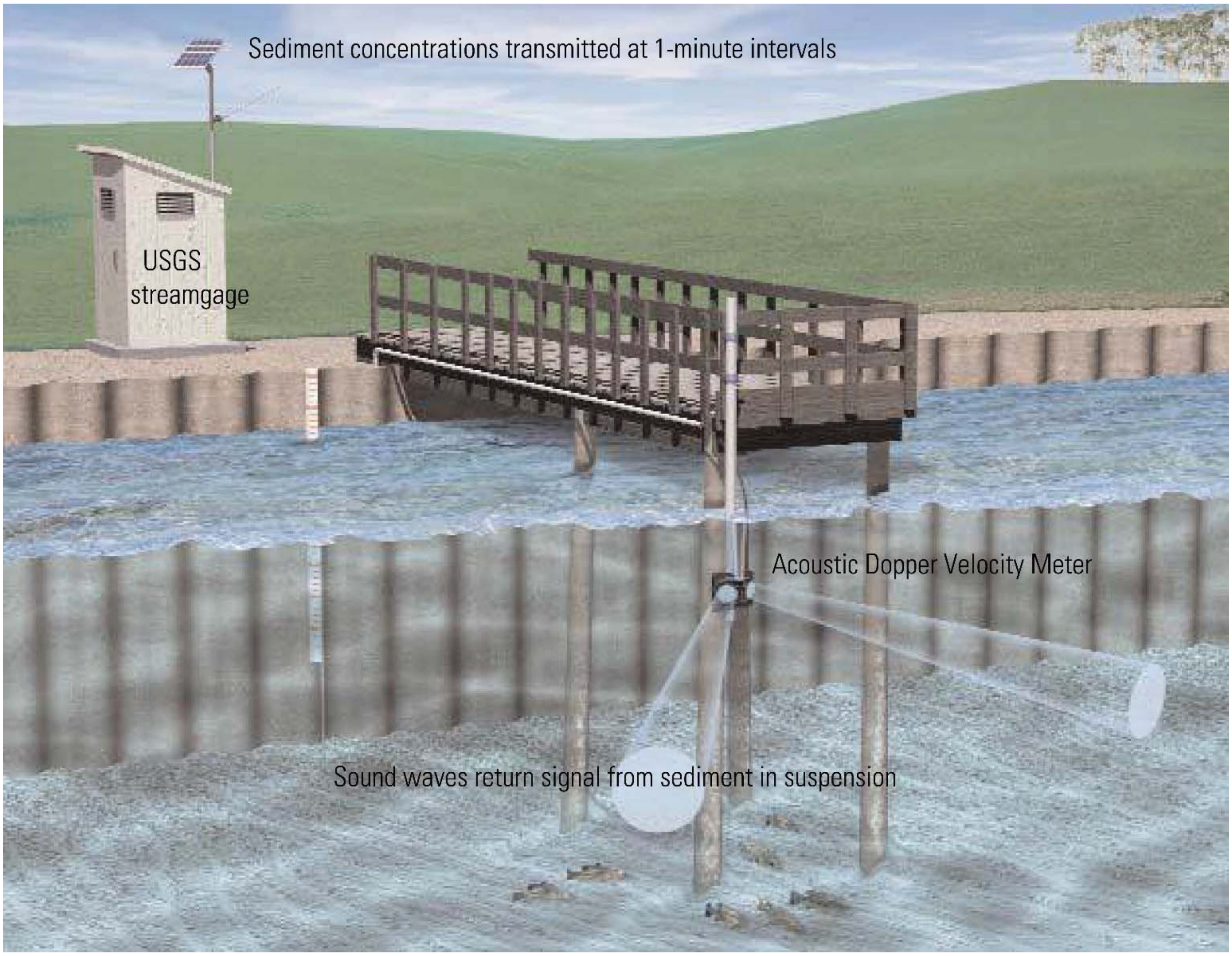

Figure 1. Illustration of acoustic Doppler velocity meter installation.

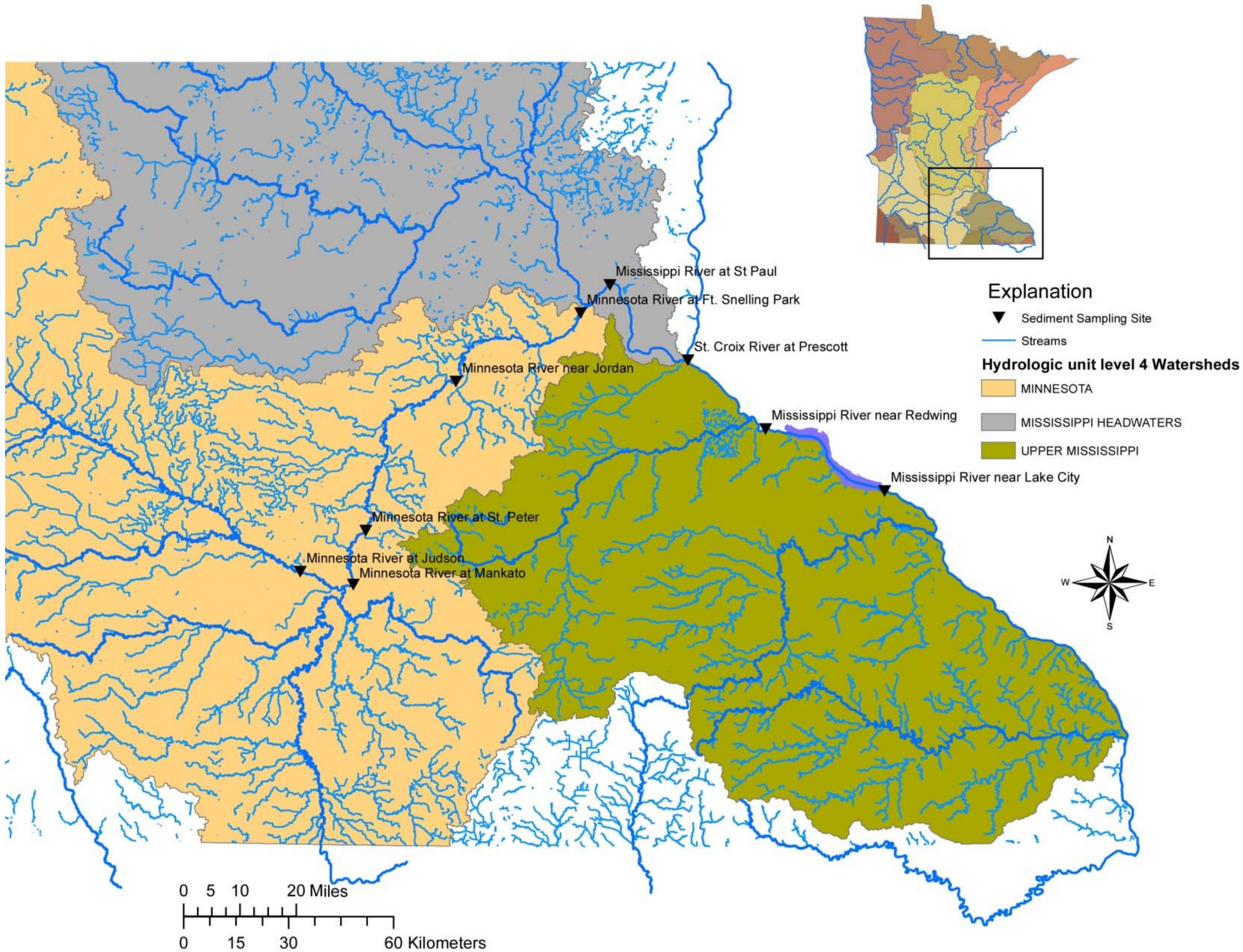

Figure 2. Locations of acoustic Doppler velocity meters on the Minnesota and Mississippi Rivers.

Environment and Natural Resources Trust Fund
M.L. 2015 Project Budget

Project Title: Using Hydroacoustics to Monitor Sediment in Minnesota Rivers
Legal Citation: M.L. 2015, Chp. Xx, Sec. xx, Subd. Xx
Project Manager: Chris Ellison
Organization: U.S. Geological Survey
M.L. 2015 ENRTF Appropriation: $ 455,000
Project Length and Completion Date: 4 Years, December 31, 2018
Date of Report: 10/15/2015

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Install Acoustic Doppler Velocity Meters; log and transmit data to office; collect sediment samples using USGS sampling protocols***			***Format Data; develop relations among streamflow, acoustic signals, and sediment samples; write Scientific Investigations Report***				
Personnel (Wages and Benefits)	$212,935	$0	$212,935	$84,542	$0	$84,542	**$297,477**	**$297,477**
1 USGS Studies Chief, (GS-13): $16,187 (73% salary, 27% benefits); Position at 4% FTE each year for 3 years								
1 USGS Project Chief, (GS-12): $72,438 (80% salary, 20% benefits); Position at 20% FTE each year for 3 years								
1 USGS Hydrologist, (GS-9): $45,076 (73% salary, 27% benefits); Position at 21% FTE each year for 3 years								
2 USGS Hydrologic Technicians, (GS-8): $50,945 (78% salary, 22% benefits); Position at 21% FTE each year for 3 years								
1 USGS Hydrologic Technician, (GS-5): $22,079 (83% salary, 17% benefits); Position at 18% FTE each year for 3 years								
2 USGS Surface Water/Water Quality Specialists (GS-13): $37,344 (77% salary, 23% benefits); Position at 4% FTE each year for 3 years								
2 Database/IT Support Specialists (GS-12): $31,108 (73% salary, 27% benefits); Position at 4% FTE each year for 3 years								
2 Admin Support, (GS-9): $22,299 (70% salary, 30% benefits); Position at 7.6% FTE each year for 3 years								
Professional/Technical/Service Contracts								
Sediment samples laboratory analyses: USGS Iowa sediment laboratory, 180 total samples at $50 each and 180 samples at $17 each = $12,060	$12,060	$0	$12,060				**$12,060**	**$12,060**
DOT contract (snooper): ADVM installations: $2,200	$2,200	$0	$2,200				**$2,200**	**$2,200**
Boat: $100/day - installation and maintenance of ADVMs; field sampling at Ft. Snelling and site below Lake Pepin; ADVM installations (28 days); sediment sampling at Ft. Snelling Park and Lake Pepin site (40 days); maintenance of ADVMs 2 times per year at 4 sites (16 days) - 84 days	$8,400	$0	$8,400				**$8,400**	**$8,400**

Contract fees for USGS report (Science Publishing Network) that includes editing, reviewing, and preparation for electronic publishing and distribution- $10,000. One contract.				$10,000	$0	$10,000	**$10,000**	**$10,000**
Equipment/Tools/Supplies	$30,830	$0	$30,830	$800	$0	$800	**$31,630**	**$31,630**
ADVM cable, 4 each, powers ADVM and transmits ADVM data, $1,008 each								
Weatherproof enclosures, 4 each, protect and secure electronic dataloggers, data transmission equipment, $700 each								
Electronic voltage conditioner, protects ADVM against voltage spikes, 4 each, $245.50 each								
RadioLink - DAA H-424-MS-SDI-12, 6 each, used to transmit ADVM data, $1495 each								
Solar Panel, 30 watt, Flat Unbreakable Panel, 4 each, $351 each								
Alkaline battery pack, SonTek; used to power ADVM, 4 each, $136 each								
Sutron SAT2-V2 w/GOES HDR, Enclosure, USB, Datalogger and data transmitter for ADVM at site below Lake Pepin, 1 each, $3,500 each								
Antenna, Yagi for GOES transmitter, $292 each								
Canal Mounting system, used to deploy ADVM at site below Lake Pepin on side of river bank, 35 feet, $4,350								
Miscellaneous supplies, H-beams, bolts, flanges, concrete, forms, liquitite conduit, wood posts, earth anchors, metal plates, pipes, etc.								
Capital Expenditures Over $5,000								
Acoustic Doppler Velocity Meter (ADVM) , SonTek SL1500, 4 each, used to collect acoustic backscatter to relate to sediment samples; $10,343 each	$41,372	$0	$41,372				**$41,372**	**$41,372**
1 D-96 Sediment Sampler, used for sampling large rivers with velocities >10ft/sec and depths > 15ft, $6,122	$6,122	$0	$6,122				**$6,122**	**$6,122**
Travel expenses in Minnesota								
Travel to complete installations of ADVM equipment; travel to collect sediment samples and perform periodic maintenance on ADVMs. Mileage: $9,740; lodging: $7,878; meals: $5,121	$22,739	$0	$22,739				**$22,739**	**$22,739**
Other								
Overtime: Compensation for field technicians during extended time needed to collect data during high flow events; determined to be more cost-effective as compared to terminating field sampling after an 8-hour day during high flows. ($22,000)	$22,000	$0	$22,000				**$22,000**	**$22,000**
Shipping: $1,000 for shipping equipment from vendors	$1,000	$0	$1,000				**$1,000**	**$1,000**
COLUMN TOTAL	**$359,658**	**$0**	**$359,658**	**$95,342**	**$0**	**$95,342**	**$455,000**	**$455,000**