Watershed Modeling of Phosphorus Reductions Agreement
between
State of Wisconsin, Department of Natural Resources
and
Science Museum of Minnesota – St. Croix Watershed Research Station

I. GENERAL INFORMATION:
Grantee/Project Sponsor: Science Museum of Minnesota-St. Croix Watershed Research Station
Project Title: Watershed Modeling of Phosphorus Reductions from Agricultural BMP's
Period Covered by This Agreement: July 1, 2014 – December 31, 2015

II. AGREEMENT RECIPIENT: Science Museum of Minnesota-St. Croix Watershed Research Station

III. AUTHORITY: This agreement between the State of Wisconsin Department of Natural Resources (hereinafter referred to as WDNR) and Science Museum of Minnesota-St. Croix Watershed Research Station (hereinafter referred to as SMM) is hereby entered into pursuant to Wis. Stat. s. 29.037

IV. PURPOSE: The purpose of this agreement is to enable the WDNR to make payments in accord with the St. Croix Crossing Mitigation Package, Watershed Modeling of Phosphorus Reductions from Agricultural BMP's MOU.

V. BACKGROUND: The St. Croix Crossing project involves the construction of a new bridge across the St. Croix River in St. Croix County, Wisconsin. The Supplemental Final EIS (SFEIS) prepared for the project includes a section on bridge mitigation items. Included in this mitigation package is $400,000 designated for the St. Croix Basin water Resources Planning Team (Basin Team). The purpose of this $400,000 is to study how the opening of a new bridge between Minnesota and Wisconsin may impact water quality in the St. Croix River. Once mitigation funds became available the Basin Team requested project proposals to decide how to allocate the $400,000. One of the approved proposals was to Watershed Modeling of Phosphorus Reductions from Agricultural BMP's. This is an agreement between the WDNR and the SMM on how the mitigation dollars will be spent on this project.

VI. SCOPE: The WDNR will provide the SMM with $55,000 to fund the costs of salary for senior personnel to provide modeling and subsequent reporting over a period of a year and a half.

Task 1: Collect client input and Task 2: Run SWAT- Subbasin & Rotation Yields 3: Run SWAT- BMP Scenarios; are to be completed in FY14. Task 4: Report Project Results: are to be completed for 2015.

An interim report for tasks 1, 2, and 3 will be provided by July 30, 2015. This report is required for the encumbrance of funds for Task 4.

In return the SMM and Jim Almedinger, or successor, shall complete the projects as described in the Basin Team Project Proposal Form and submit reports to WDNR upon completion of the projects.

Semiannual progress reports, describing completed Tasks 1-4, will be provided to the St. Croix Water Resources Planning Team. The Final Project Report is to be completed and submitted to WDNR by December 31, 2015.

VII. PERIOD OF PERFORMANCE: This agreement shall remain in effect until December 31, 2015. The WDNR and the SMM may jointly and periodically evaluate this agreement and, if mutually agreed, will amend the agreement as necessary. Any modifications to this agreement shall become effective upon approval by both parties.

PAYMENT: The Department agrees to provide funding to the Science Museum of MN up to a total $55,000 for the project. WDNR will encumber $44,000 for the first year of the project in which SMM will be eligible for a $22,000 advance payment and reimbursement of the remaining funding of $22,000 upon satisfaction of the deliverables outlined in the Basin Team Project Proposal. The WDNR will provide a second purchase order for the period of performance from July 1, 2015 to December 31, 2015 for the remaining $11,000 of the project. Ten percent ($2,500) of the total may be be withheld until all tasks are completed in full, as specified in the Project Work Plan submitted by Jim Almendinger.

VIII. PARTY REPRESENTATIVES: The representatives of the parties who shall serve as project coordinators and principal contacts for the purposes of this agreement are as follows:

SMM: Dr. Daniel R. Engstrom or his successor
St. Croix Watershed Research Station
16910 152nd Street North
Marine on St. Croix, MN 55047

WDNR: Dan Baumann, P.E., Regional Director
1300 West Clairemont Avenue
Eau Claire, WI 54701

IX. SPECIAL PROVISIONS:

A. The SMM agrees that information gathered as a result of the projects will be readily available, as needed, to other entities in St. Croix County operating within the context of the Watershed Modeling of Phosphorus Reductions from Agricultural BMP's MOU associated within the St. Croix Crossing SFEIS.

B. The SMM agrees that failure on its part to abide by the project contract and its stipulations could require a repayment of the mitigation funds.

C. This agreement does not impose any obligation, financial or otherwise, upon the WDNR in regards to the subsequent operation and/or maintenance of any facilities developed in this project.

X. LIABILITY: The SMM recognizes and understands that it may be responsible for the consequences of its own acts, errors, or omissions and those of its employees, agents, boards, commissions, agencies, officers and representatives, including providing its own defense. To the extent authorized by law, the WDNR shall be responsible for the consequences of its own acts, errors, or omissions and those of its employees, agents, contractors, officers, and representatives and shall be responsible for any losses, claims and liabilities which are attributable to such acts, errors or omissions. It is not the intent of the parties to impose liability beyond that imposed by Wisconsin Statutes. This clause applies only to actions of each party pursuant to this agreement, and does not apply to actions or events that occur outside the scope of this agreement.

By signature the SMM and the WDNR hereby accept all terms and conditions of this agreement without exception, deletion or alteration.

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed as of the date therein written.

SMM		WDNR
(Signature)		(Signature)
Eric J. Jolly, Ph.D., President	for	Cathy Stepp, Secretary
9/30/14		9/4/14
(Date)		(Date)

St. Croix River Crossing Mitigation Fund Project Workplan
Administered by Wisconsin Department of Natural Resources (WDNR) and the St. Croix Basin Water Resources Planning Team
Submitted May 2014

Title: **Watershed modeling of phosphorus reductions from agricultural BMPs:** *Use of the Soil and Water Assessment Tool (SWAT) to assess potential for agricultural best-management practices (BMPs) to compensate for increased nutrient loads to Lake St. Croix from bridge-related urbanization*

Manager: Jim Almendinger
St. Croix Watershed Research Station
Science Museum of Minnesota
16910 152nd St N
Marine on St Croix, MN 55047

Funding: $55K from MnDOT (via MOU with WDNR, distributed to St. Croix Basin Water Resources Planning Team)

Term: 18 months from starting date, starting July 2014

Summary

We propose to apply the existing Soil and Water Assessment Tool (SWAT) model of the St. Croix basin to target implementation efforts by testing agricultural best management practices (BMPs) for phosphorus reduction. These BMPs include no-till cropping of corn and soybeans, filter strips, grassed waterways, post-harvest cover crops, improved soil health, and reduced soil-test phosphorus. Changes in phosphorus load from each model subbasin will be mapped to allow spatial targeting of implementation. Phosphorus load reductions from agriculture will be necessary to achieve the existing Total Maximum Daily Load (TMDL) goals and to mitigate increases due to urbanization following construction of the new bridge at Stillwater.

Problem:

The St. Croix River along the Minnesota/Wisconsin border is a federally designated scenic and recreational riverway. The lowermost 40 km of the riverway is a naturally impounded lake (Lake St. Croix) that has been listed by both states as impaired by eutrophication caused by excess phosphorus loads. A recent (2012) USEPA-approved TMDL aims for a load of 360 metric tons per year (metT/yr) of total phosphorus to the lake, a reduction of 100 metT/yr (22%) from the 1990s baseline load of 460 metT/yr. When margin of safety and reserve capacity are included, the total reduction expands to 123 metT/yr, or a 27% reduction from the 1990s baseline.

In the face of this TMDL goal, pressures have mounted that will likely increase nutrient loads above the current baseline. Increased demand and prices for corn and soybeans in the last decade has created financial incentives for farmers to plant more acres of row crops at the expense of retired lands (CRP and CREP), thereby increasing nonpoint loads of sediment and nutrients. In addition, recent legislation has permitted construction of a new bridge at Stillwater, MN. The bridge will almost certainly spur urban development, which generates increased loads of nutrients not only from point sources, but commonly from nonpoint sources as well.

Consequently, achieving the TMDL goal will be challenging, because the phosphorus load reductions will have to go beyond the 27% stated in the TMDL to compensate for potential additional loads above the current baseline. Significant reductions in point-source loads have already been achieved since the 1990s, and thus most of the remainder of the load reduction will have to come from nonpoint sources. To reduce nonpoint loads, resource managers need to

know at least two critical pieces of information: the source (location and land use) of the largest contributors of the nutrient loads, and what best management practices (BMPs) are most effective in reducing these loads.

To address these needs, the current TMDL implementation process uses land cover alone as the determinant of which subbasins are the largest yielders of phosphorus in order to target implementation. For this analysis, total phosphorus export coefficients (TPECs) were carefully calibrated to observed loads at the basin-wide scale. Because of this calibration, the TPECs so calculated actually embed the basin-scale effect of transport between sources and receiving waters, spatially averaged over the entire basin. Hence, for use in the St. Croix basin, these St. Croix-specific TPECs are a significant improvement over generic TPECs developed elsewhere at a variety of scales. Nonetheless, these TPECs cannot accommodate spatial variation across the basin due to subbasin-specific transport differences. Neither can they account for changes in phosphorus export due to BMP implementation or to interannual weather variability, let alone directional climate change.

A watershed model provides an improved tool to target implementation, with additional capabilities to test BMPs and consider differences in weather from year to year. A watershed model can account for significant spatial differences in transport capacity across a watershed, caused by an uneven distribution of landscape depressions (lakes, ponds, and wetlands) that can trap nonpoint pollutants. Selected BMPs can be implemented in the model to test their local and aggregate effectiveness in reducing loads of sediment and nutrients. Changes in export can be tested under a range of weather variations, to identify loads for dry, wet, or typical years. Changes in land use can be input to the model to estimate changes in phosphorus loads due to increased urbanization resulting from the new Stillwater bridge, or due to conversion of grassland to row crops.

To these ends, the National Park Service funded a project to build a watershed computer model for the St. Croix basin with the Soil and Water Assessment Tool (SWAT). The model was built based on data sets developed by the St. Croix Watershed Research Station and calibrated by technicians at Texas A&M University (TAMU) to basin-wide data, principally loads at Stillwater calculated by the Metropolitan Council. This model, hereafter referred to as the TAMU-SWAT model of the St. Croix, provides a starting framework for locating the primary sources of nonpoint-source pollutants and assessing which BMPs may be effective in mitigating these loads. Since the original construction of the model, the SWAT modeling framework has evolved from the 2009 version to the 2012 version (SWAT2012). Consequently, the original St. Croix TAMU-SWAT2009 model was recently updated to SWAT2012 by TAMU technicians.

Objectives and scope:

We propose to apply the St. Croix TAMU-SWAT model to better target implementation efforts by identifying subbasins with large phosphorus yields and testing selected BMPs for phosphorus reductions. Results will be based upon the specific configuration of the existing TAMU-SWAT model and presented in terms of relative yields and loads of phosphorus. For selected BMP scenarios, relative changes in loads will be calculated for the following features: (a) Lake St. Croix, (b) the Apple River watershed, (c) the Willow River watershed, and (d) the Kinnickinnic River watershed. Lake St. Croix is the water body targeted by the TMDL for improvement, and the three listed watersheds are those most likely to see the largest changes in urbanization as a consequence of the new river crossing at Stillwater.

Approach:

The existing St. Croix SWAT model has subdivided the 20,000-km^2 basin into 419 subbasins, averaging therefore about 48 km^2 each (for comparison, HUC-12s range from about 40 to 160 km^2). This discretization was chosen as a balance, to integrate processes at the whole-basin scale, as well to simulate loads at the tributary scale for the approximately two dozen principal tributaries to the St. Croix. The land uses, soils, and slopes were intersected to identify 3,010 hydrologic response units (HRUs), which are aggregated areas of land within each subbasin assumed to have uniform hydrologic properties. Hence, each subbasin includes about seven or eight HRUs on average.

The model was constructed with land cover and cropping patterns representative of 2006-10, based on satellite imagery and countywide surveys. The model was calibrated with point-source discharges changing at annual intervals. However, when running model scenarios, each point source discharge will be converted to a constant output based on the most recent years of representative data, to prevent point-source variability from interfering with evaluating BMP effectiveness. Weather data are available from 1960-2008. Scenario results will be based on 30-year model runs, from 1979-2008, with 10-years prior to that (1969-78) allowed for model equilibration but discarded from the results.

Products and Communications:

We will deliver the following products:

- Maps identifying relative sediment and phosphorus yields from each model subbasin to spatially target implementation efforts
- Tables ranking land uses (specifically, which crop and pasturing rotations) by how much sediment and phosphorus they contribute to our waterways
- Figures showing relative reductions in sediment and phosphorus loads for selected hydrographic features resulting from selected agricultural BMPs. Selected BMPs will include the following: no-till cropping of row crops; filter strips along field edges; grassed waterways within fields; post-harvest cover crops, improved soil health, and reduction of soil-test phosphorus. Selected hydrographic features will include the combined input loads to Lake St. Croix, and the output loads from the Apple, Willow, and Kinnickinnic watersheds.
- A final report describing how BMPs were implemented in the SWAT model and presenting the above results.

During the course of the project, we anticipate the following meetings to discuss plans and results. For the purposes of this project, the Technical Advisory Committee (TAC) will consist of a subset of the St. Croix Basin Team Implementation Subcommittee, interested modeling personnel from the WDNR, and county conservation personnel principally from St. Croix, Polk, and Pierce counties in Wisconsin. In addition to meetings, the project manager will communicate on a regular basis with WDNR modeling personnel to vet methods and report progress.

- Meeting with the St. Croix Basin Team to present project plan and solicit comments.
- Meeting 1 with Technical Advisory Committee to discuss Task 1: present plan and solicit client input.
- Meeting 2 with Technical Advisory Committee to discuss Task 2: subbasin and rotation yields from current model.
- Meeting 3 with Technical Advisory Committee to discuss Task 3: BMP implementation and phosphorus reductions.
- Meeting 4 with Technical Advisory Committee to discuss Task 4: report format and preparation.
- Meeting with the St. Croix Basin Team to present results.

Further Uses of the Model:

Aside from the benefits in helping resource managers make informed decisions about implementation projects to achieve the current TMDL and mitigate the impacts from the new river crossing at Stillwater, the use and improvement of the existing SWAT model has benefits for further important work in the St. Croix basin:

- Output from the SWAT model quantifying loads of total phosphorus to Lake St. Croix will provide critical data to a lake-system response model being developed for the lake by the USGS.
- A proposal has been submitted to the National Park Service to couple the SWAT model with a stream-temperature model, to be run under future climate scenarios to predict habitat changes for desirable cold-water trout versus invasive warm-water Asian carp.
- Water supply for municipalities relies heavily on groundwater, and the SWAT model can be used to estimate recharge over broad areas under changed climate.

Budget:

The project will span one year to accomplish the following tasks:

Item	Cost
Task 1. Collect client input	$ 5,500.00
Task 2. Run SWAT: Subbasin & rotation yields	$ 11,000.00
Task 3. Run SWAT: BMP scenarios	$ 27,500.00
Task 4. Report results	$ 11,000.00
Total	**$ 55,000.00**

The personnel costs include about 26 weeks total for senior personnel to do the modeling and reporting.

Timeline:

The project will take approximately 18 months to complete. The starting time will depend on the timing of funding availability and other project schedules at the SCWRS, but we anticipate a starting time of July 2014 and project completion by the end of December 2015.

	FY2015												FY2016					
	CY2014						CY2015											
Tasks	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Task 1. Collect client input	•	•																
TAC & Basin Team meetings	•																	
Task 2. Run SWAT: Subbasin & rotation yields		•	•	•	•	•	•											
TAC meeting						•												
Task 3. Run SWAT: BMP scenarios						•	•	•	•	•	•	•	•	•				
TAC meeting												•						
Task 4. Report results													•	•	•	•	•	•
TAC & Basin Team meetings																	•	•

State of Wisconsin
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WISCONSIN
DEPT. OF NATURAL RESOURCES

September 5, 2014

Dr. Daniel R. Engstrom
St. Croix Watershed Research Station
16910 152nd Street North
Marine on St. Croix, MN 55047

SUBJECT: Memorandum of Understanding between the Science Museum of MN and the WDNR for funding Watershed Modeling of Phosphorus Reductions from Agricultural BMP's.

Dear Dr Engstrom:

Enclosed you will find three revised/signed copies of the "Memorandum of Understanding (MOU) between the Science Museum of MN and the Wisconsin Department of Natural Resources providing funding for Watershed Modeling of Phosphorus Reductions from Agricultural BMP's (Jim Almendinger).

Please sign all three copies of the agreement, retain one and return two signed copies to:

Ryan Raab
Bureau of Water Quality –WY/3
Wisconsin Dept. of Natural Resources
P.O. Box 7921
Madison, WI 53706

Please return all signed documents within 30 days.

We appreciate the benefits to the State which this award represents. If you have questions regarding this matter, please contact please contact Dan Baumann (program contact) 715-839-3722 or Ryan Raab (financial contact) at 608-267-2757.

Sincerely,

Cathy Stepp
Secretary

Enclosure
cc: Ryan Raab – WY/3
Renee Hoeft – FN/2
Dan Baumann – WCR, Eau Claire