Surface Water Models and Tools for Minnesota's Water Management Framework

CLEAN WATER LAND & LEGACY AMENDMENT

In February 2016, the Minnesota Department of Agriculture (MDA) hosted a two-day symposium for state agency employees involved in managing Minnesota's water resources. Participants shared knowledge about surface water quality models and tools currently used, supported, or funded by state agencies. These models and tools allow the prioritization and targeting of conservation practices and measurement of water quality impacts. The goal is to estimate the potential benefit of conservation practices at varying scales for the purpose of meeting MN's water quality goals through the Water Restoration and Protection Strategy (WRAPS) process.

Videos of the presentations are available at www.mda.state.mn.us/modelsandtools.

This fact sheet highlights the models that can be used during steps 1-3.

There are a number of applicable models and tools, each with a specific use, strength, or limitation, all which defines its placement within the 10-year monitoring and assessment cycle. Steps 1-3 of the WRAPS process are conducted with state agency oversight and coordination, while Step 4 and Ongoing Implementation are lead by the local government units.

STEP 4
Conduct Restoration and Protection Projects in the Watershed

- Civic engagement and public participation
- **Prioritize, target and measure** implementation of restoration and protection projects

Reporting

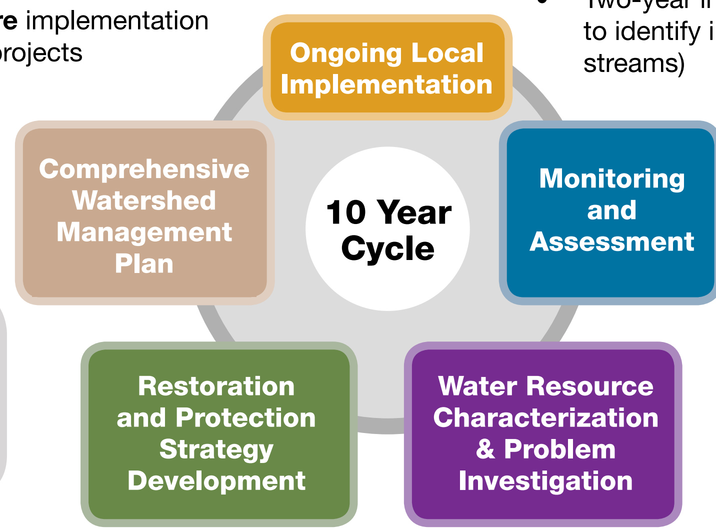
- Local Water Plan
- One Watershed One Plan

STEP 1
Monitor Water Bodies and Collect Data

- Two-year intensive water monitoring to identify impairments (lakes & streams)

Reporting

- Monitoring & Assessment Report
- Stressor Identification Report



Applicable Models/Tools

- ACPF
- HSPF-SAM
- N&P-BMP
- PTMApp
- WHAF
- Zonation

STEP 3
Develop Strategies to Restore and Protect the Watershed's Water Bodies

- Summarize details on water quality issues
- Determine reduction goals for impaired or protected water bodies

Reporting

- Total Maximum Daily Load (TMDL)
- WRAPS Report

Applicable Models

- BATHTUB
- GSSHA
- HSPF
- SWAT

STEP 2
Assess the Data

- Identify impaired waters
- Identify stressors affecting aquatic life
- Analyze data with water quality models and maps

Minnesota Department of Agriculture | Minnesota Pollution Control Agency | Minnesota Board of Water & Soil Resources | MNDNR | MDH Minnesota Department of Health | Metropolitan Council

Data Errors and Uncertainty: Consideration for Model and Tool Selection

Bruce Wilson, Ph.D., P.E. (University of Minnesota)

In the real world, modeling uncertainty is a combination of both data and model uncertainty.

Reasons for potential difference in modeled versus observed values (i.e. uncertainty):

- Data errors
- Incorrect model selection
- A combination of 1) and 2)

Data Errors

Observed data including flow, weather, sampling, sensor response, and lab analyses are subject to measurement error. Long-term monitoring of parameter response, watershed behavior, and Best Management Practices (BMP) effectiveness is necessary to improve data for hydrologic modeling.

Model Selection

Hydrologic models attempt to find mathematical relationships between individual hydrologic processes to understand the response of the system, with the goal of reducing uncertainty. If the observed data is assumed correct, there are two possible sources of error:

- Wrong model or incorrect framework used.
- Incorrect parameter values input into model.

A more rigorous model may represent the system better than a simpler model, but it also may have more uncertainty. Large uncertainty can create challenges for communicating outputs and may result in a lack of confidence by a farmer or watershed manager that a conservation practice will work effectively.

Applying Einstein's words... **a model should be as simple as possible, but not too simple**.

Acronym Summary List

GSSHA: Gridded Surface Subsurface Hydrologic Analysis
HSPF: Hydrological Simulation Program – Fortran
HUC: Hydrologic Unit Code
SWAT: Soil and Water Assessment Tool

Models and Tools for Identifying and Quantifying Pollutant Sources

Model Name (Developer)	Description	Considerations
BATHTUB (US Army Corps of Engineers)	A simple hydrology and water quality (including nitrogen and phosphorus dynamics) model for lakes or reservoirs.	User must have basic model experience and limnology understanding. Incorporates internal loading and assumes steady-state. Minimal input requirements including lake morphometric, land use and nutrient (measured or estimated) inputs. Provides error estimates. MPCA training available.
GSSHA (US Army Corps of Engineers)	A complex hydrologic watershed model requiring Light Detection and Ranging (LiDAR), soils, land cover, geology and climate data.	Requires calibration and an experienced user. Steep learning curve. Requires large computer processing capacity. Water quality features (nutrients) is not well tested. The model has a fairly small research based user community. Characterizing soil parameters appropriately is critical. Can evaluate benefits of given suite of BMPs.
HSPF (USEPA)	Watershed scale model routing water, nutrients and sediments to a receiving water body from point and non-point sources.	Simulates peak and low flows at various time steps. Can simulate BMPs (ag and urban); crop and tillage management practices can be difficult. Requires high expertise for variable input and calibration. Modeling spatial variation at fine scales requires increased complexity and computational time.
SWAT (USDA, ARS)	Complex watershed model to simulate hydrology, nutrient dynamics and crop growth over long periods.	Simulates hydrology, vegetation growth, and management practices by units of unique soil, land cover type and management practice (i.e. Hydrologic Response Unit- HRU). Requires calibration and an experienced user. There are 100+ parameters, that can be adjusted so user knowledge is critical.

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