**Appendix B - Tools for Prioritizing and Targeting**

Minnesota Nutrient Reduction Strategy Pilot Project: Le Sueur River Watershed, Freeborn Lake Subwatershed

**Tools for Prioritizing and Targeting**Source: Dave Wall, MPCA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **State or Basin** | **Major watershed (HUC8)** | **Minor watershed** | **Individual farm or neighborhood** |
| **Geographic priorities** - Identifying priority geographic areas based on where BMPs are most needed for WQ (i.e. considering geologically sensitive lands, land uses, biodiversity, and/or water quality) | WHAF  HSPF  ERT/EBI | WHAF  HSPF  ERT/EBI  SWAT | PTMA\*  HSPF  ERT/EBI  Zonation  SWAT | ERT/EBI  MN P Index  ACPT\* |
| **BMP Suites** - Targeting best combinations of BMPs to use for specific WQ parameters, flow/climate conditions, | NBMP  PBMP\*  Ag BMP AT\*  PTMA\* | NBMP  PBMP\*  Ag BMP AT\*  PTMA\*  HSPF SAM\*  SWAT | PTMA\*  HSPF SAM\*  Ag BMP AT\*  ACPT\*  SWAT | ACPT\* |
| **Cost effectiveness** - Targeting best BMPs based on cost effectiveness | NBMP  PBMP\* | NBMP  PBMP\* | PTMA\*  HSPF SAM\* |  |
| **Suitable lands** - Targeting land areas well-suited for specific BMPs | NBMP  PBMP\*  RWPT | NBMP  PBMP\*  RWPT | RWPT  ACPT\* | ACPT\* |
| **Meeting WQ goals** - Identifying the amount of land under new BMP adoption needed to meet specified water quality goals (for each BMP in the suite of BMPs) | PTMA\*  NBMP  PBMP\* | PTMA\*  NBMP  PBMP\* | PTMA\*  HSPF SAM\* |  |
| **Precision targeting** - Targeting very specific BMPs that would be needed/helpful in a given field or area |  |  |  | MN P Index  ACPT\* |
| **Multiple benefits**  Targeting lands for BMPs where multiple environmental benefits will be maximized | WHAF  ERT/EBI | WHAF  ERT/EBI  Zonation | ERT/EBI  Zonation | ERT/EBI |
| **Contributing watershed -** Identifying geographic area contributing to a specific water |  |  |  |  |
| **Source identification and allocation –**  Identifying specific sources and associated load reduction allocations to meet TMDLs/Standards | N Study |  | PTMA\* |  |

**Matrix Legend: Tools for Prioritizing and Targeting**

* **HSPF** – Hydrologic Simulation Program Fortran
  + Developer: Stanford University, Sponsorship by USEPA and USGS; (Local Application: MPCA)
  + Source: http://www.pca.state.mn.us/index.php/view-document.html?gid=21398 ; http://water.usgs.gov/cgi-bin/man\_wrdapp?hspf
* **HSPF SAM** – Hydrologic Simulation Program Fortran: Scenario Application Manager
  + Developer: RESPEC
  + Source: No online sources
* **SWAT –** Soil and Water Assessment Tool
  + Developer: USDA-ARS
  + Source: http://swat.tamu.edu/
* **PTMA\*** – Prioritization, Targeting, and Measuring Water Quality Improvement Application
  + Developer: Houston Engineering
  + Source: No online sources
* **ERT / EBI** – Ecological Ranking Tool / Ecological Benefits Index
  + Developer: BWSR / University of Minnesota Duluth
  + Source: <http://www.bwsr.state.mn.us/ecological_ranking/> ; http://beaver.nrri.umn.edu/EcolRank/ebi/
* **Zonation** – Zonation Conservation Framework
  + Developer: University of Helsinki (Local Application: DNR)
  + Source: http://www.helsinki.fi/bioscience/consplan/software/Zonation/Introduction.html
* **ACPT\*** – Agricultural Conservation Planning Toolbox (“Tomer”)
  + Developer: **I**owa State University
  + Source: <http://www.jswconline.org/content/68/5/113A.full.pdf>
* **GSSHA** – Gridded Surface Subsurface Hydrologic Assessment
  + Developer: Army Corps of Engineers; MN Application: DNR
  + Source: http://chl.erdc.usace.army.mil/gssha
* **Ag BMP AT\*** – Agricultural BMPs Assessment and Tracking Tool
  + Developer: Houston Engineering
  + Source: http://www.houstoneng.com/agricultural-best-management-practice-bmp-assessment-and-tracking-tool/
* **MN P Index** – Minnesota Phosphorus Index
  + Developer: University of Minnesota
  + Source: <http://www.mnpi.umn.edu/>
* **N Study** – Nitrogen in Minnesota Surface Waters Study
  + Developer: MPCA
  + Source: <http://www.pca.state.mn.us/index.php/about-mpca/mpca-news/featured-stories/report-on-nitrogen-in-surface-water.html>
* **NBMP** – Watershed Nitrogen BMP Assessment Tool
  + Developer: University of Minnesota
  + Source: [http://z.umn.edu/nbmp](http://z.umn.edu/nbmp%20%20) ; <http://faculty.apec.umn.edu/wlazarus/documents/nbmp_overview.pdf>
* **PBMP\*** – Watershed Phosphorus BMP Assessment Tool
  + Developer: University of Minnesota
  + Source: NOT FOUND
* **RWPT** – Restorable Wetland Prioritization Tool
  + Developer: University of Minnesota
  + Source: [www.mnwetlandrestore.org](http://www.mnwetlandrestore.org)
* **UDCT** – Upstream/downstream Catchment Tool
  + Developer: DNR
  + Source: http://www.dnr.state.mn.us/mis/gis/tools/arcgis/dnrwaters.html
* **WHAF** – Watershed Health Assessment Framework
  + Developer: DNR
  + Source: [www.dnr.state.mn.us/whaf/index.html](http://www.dnr.state.mn.us/whaf/index.html)
* **PMZ\*** –Priority Management Zone identification for BMPs in Impaired Watersheds
  + Developer: Barr Engineering, MDA, U of MN and others.
  + Source: http://www.mda.state.mn.us/protecting/cleanwaterfund/research/identifyingpmz.aspx
* **EVAAL** – Erosion Vulnerability Assessment for Agricultural Lands
  + Developer: Wisconsin DNR
  + Source: <http://dnr.wi.gov/topic/nonpoint/evaal.html>

\* Tool is under development

**Tool Descriptions**

**HSPF – Hydrologic Simulation Program Fortran**

* **Developer**: Stanford University, Sponsorship by USEPA and USGS; (Local Application: MPCA)
* **Description**: The Hydrologic Simulation Program – Fortran (HSPF) is a watershed scale model that can simulate water flow rates as well as sediment (including sand, silt, and clay), nutrients, and other substances found in a water body. The model uses real world observed data to ensure it properly mimics these interconnected processes. After confirming the model’s accuracy, with a process called calibration, agency scientists and local partners can use it to model different scenarios of land-use change and how those changes might affect water quality. In an effort to support the development and implementation of TMDLs across the state and support watershed programmatic activities, the MPCA has invested in statewide expansion of the HSPF model at the major watershed scale. Load reductions established in the WRAPS use HSPF, and should be used in the One Watershed, One Plan planning process to set goals.  Model results from HSPF, such as pollutant-loading maps, can be used in prioritizing, likely using GIS analysis. HSPF is not capable of site-specific targeting.
* **Source**: <http://www.pca.state.mn.us/index.php/view-document.html?gid=21398>

<http://water.usgs.gov/cgi-bin/man_wrdapp?hspf>

**HSPF SAM – Hydrologic Simulation Program Fortran: Scenario Application Manager**

* **Developer**: RESPEC
* **Description**: HSPF Scenario Application Manager (HSPF-SAM) is a watershed scale tool that consists of GIS for subwatershed selection, HSPF to simulate the transport and fate of pollutants, and a BMP database. The tool will assist in developing custom implementation plans by combining individual and/or suites of BMPs that are simulated and applying reduction efficiencies to the appropriate source loads represented in the HSPF model. The tool also includes a cost-effective optimization and water quality component. (\*\*Note: This summary has not been verified by RESPEC for accuracy\*\*)
* **Source**: No summary available online

**SWAT – Soil and Water Assessment Tool**

* **Developer**: USDA Agricultural Research Service
* **Description**: The Soil Water Assessment Tool (SWAT) is a watershed-scale model, primarily used to predict and evaluate the effect of long-term land cover and land management practices on the quantity and quality of water that is exported from a watershed. This model can estimate the amount of water that contributes to stream flow and the relative sediment, nutrient, and pesticide losses under different agricultural field conditions and management scenarios. Output from this model can be used to identify critical portions of the landscape that may disproportionately contribute sediment or nutrients to waterways, which is essential for the effective and efficient implementation of agricultural management practices.
* **Source**: <http://swat.tamu.edu/>

**PTMA\* – Prioritization, Targeting, and Measuring Water Quality Improvement Application**

* **Developer:** Houston Engineering
* **Description:** The Prioritization, Targeting, and Measuring Water Quality Improvement Application (PTMA) builds off of the existing Water Quality Decision Support Application that has been piloted in the Red River Basin (shown below). The PTMA is a GIS web and desktop application that can be used by local decision-makers to prioritize subwatersheds for implementation, target specific fields for best management practices, and project water quality improvement by cost and expected load reductions within the watershed. This tool is also capable of “ingesting” HSPF model results. (\*\*Note: This summary has not been verified by Houston for accuracy\*\*)
* **Source**: No summary available online

**ERT / EBI – Ecological Ranking Tool / Ecological Benefits Index**

* **Developer**: BWSR / University of Minnesota Duluth
* **Description**: Ecological Ranking Tool/Environmental Benefits combines soil erosion potential, terrain analysis / proximity to surface water, and habitat quality indices to establish a composite priority-ranking map for areas of the state. This tool can be used to help prioritize tracts of land to be targeted for conservation easements or other conservation practices, and has the potential to incorporate additional data sets where they are available.
* **Source**: <http://www.bwsr.state.mn.us/ecological_ranking/>

<http://beaver.nrri.umn.edu/EcolRank/ebi/>

**Zonation – Zonation Conservation Planning Software**

* **Developer:** University of Helsinki (Local Application: DNR)
* **Description:** Zonation provides the framework for large-scale spatial conservation planning by identifying priority areas based on habitat quality, connectivity, and biological value of sites. Features can be used in the model, such as biology, hydrology, water quality, geomorphology, and connectivity. Each feature can be weighted in the model to reflect stakeholder values. The resulting hierarchical list can then be outputted to GIS for further analysis. From here, sites can be prioritized for restoration or protection.
* **Source:** <http://www.helsinki.fi/bioscience/consplan/software/Zonation/Introduction.html>

**ACPT\* – Agricultural Conservation Planning Toolbox (“Tomer”)**

* **Developer**: **I**owa State University (Tomer et al., 2013)
* **Description**: The Agricultural Conservation Planning Toolbox develops conservation planning scenarios that are matched to both landowner preferences and landscape-based risks. In example, areas in the landscape where the water table is close to the ground surface may be targeted for wetland restoration. After landscape-level targeting occurs, results from this tool can be used to narrow down from a landscape scale to a site-specific location. It also tailors management practices to the selected site.
* **Source:** <http://www.jswconline.org/content/68/5/113A.full.pdf>

**GSSHA – Gridded Surface Subsurface Hydrologic Assessment**

* **Developer**: Army Corps of Engineers; MN Application: DNR
* **Description**: Gridded Surface Subsurface Hydrologic Analysis (GSSHA) is a grid-based two-dimensional hydrologic model. Features include 2D overland flow, 1D stream flow, 1D infiltration, 2D groundwater, and full coupling between the groundwater, vadoze zone, streams, and overland flow. GSSHA can run in both single event and long-term modes. The fully coupled groundwater to surfacewater interaction allows GSSHA to model both Hortonian and Non-Hortonian basins.
* **Source**: <http://chl.erdc.usace.army.mil/gssha>

**Ag BMP AT – Agricultural BMPs Assessment and Tracking Tool**

* **Developer**: Houston Engineering
* **Description**: The vision of this research was to bring information on agricultural BMPs to Minnesota’s water resource professionals. Resources include: 1) a comprehensive database of information related to agricultural BMPs and their application toward cleaner waters in Minnesota; 2) a web-based BMP assessment tool, for use in designing BMP scenarios and anticipating their impact; 3) a web-based BMP tracking tool, for tracking the implementation of BMPs and holding information related to their use; and 4) a webpage devoted to agricultural BMPs in Minnesota and providing a publically-accessible platform to access each of the Tool’s components.
* **Source**: <http://www.houstoneng.com/agricultural-best-management-practice-bmp-assessment-and-tracking-tool/>

**MN P Index – Minnesota Phosphorus Index**

* **Developer:** University of Minnesota
* **Description:** The Minnesota Phosphorus Index (P Index) is a management tool to estimate the relative risk that phosphorus is being lost from an agricultural field and delivered to a nearby ditch, stream, or lake. It allows the user to evaluate management options that can reduce the risk.
* **Source:** <http://www.mnpi.umn.edu/>

**N Study – Nitrogen in Minnesota Surface Waters Study**

* **Developer**: MPCA
* **Description**: The MPCA conducted a study of nitrogen in surface waters so that we can better understand the nitrogen conditions in Minnesota’s surface waters, along with the sources, pathways, trends and potential ways to reduce nitrogen in waters.
* **Source**: <http://www.pca.state.mn.us/index.php/about-mpca/mpca-news/featured-stories/report-on-nitrogen-in-surface-water.html>

**NBMP – Watershed Nitrogen BMP Assessment Tool**

* **Developer**: University of Minnesota
* **Description:** The Watershed Nitrogen Reduction Planning Tool was developed as part of a comprehensive study of surface water nitrogen conditions, sources, pathways to waters, trends, and solutions. The project purpose was to develop a framework for a watershed nitrogen planning aid that could be used to compare and optimize selection of “Best Management Practices” for reducing the nitrogen load from the highest contributing sources and pathways in a watershed. NBMP is intended to serve as that framework. It compares the effectiveness and cost of potential BMPs that could be implemented to reduce the nitrogen load entering surface waters from cropland in a watershed.
* **Source**: <http://z.umn.edu/nbmp>

<http://faculty.apec.umn.edu/wlazarus/documents/nbmp_overview.pdf>

**PBMP\* – Watershed Phosphorus BMP Assessment Tool**

* Developer: University of Minnesota
* Source: http://wlazarus.cfans.umn.edu/william-f-lazarus-water-air-quality/
* Description: The Watershed Phosphorus Reduction Planning Tool was developed as part of the Minnesota Nutrient Reduction Strategy. It compares the effectiveness and cost of potential BMPs that could be implemented to reduce the phosphorus load entering surface waters from cropland in a watershed.

**RWPT – Restorable Wetland Prioritization Tool**

* **Developer:** University of Minnesota
* **Description:** Restorable Wetland Prioritization Tool is a statewide online decision platform to assist watershed planners and managers with identifying and prioritizing wetland restoration opportunities based on potential stress, benefits and project viability outcomes generated for phosphorus, nitrogen and/or habitat focus. Watershed managers are able to readily integrate these three base management decision layers along with two different restorable wetland layers and many supporting data layers and background imagery for various scales from major watershed down to local catchment scales.
* **Source**: [www.mnwetlandrestore.org](http://www.mnwetlandrestore.org)

**UDCT – Upstream/downstream Catchment Tool (DNR Hydrography (Upstream/Downstream) Toolbar)**

* **Developer:** DNR
* **Description:** The Toolbar allows users to identify DNR Catchments upstream and downstream from your DNR Catchment of interest
* **Source:** <http://www.dnr.state.mn.us/mis/gis/tools/arcgis/dnrwaters.html>

**WHAF – Watershed Health Assessment Framework**

* **Developer:** DNR
* **Description:** The Watershed Health Assessment Framework (WHAF) provides a comprehensive overview of the ecological health of Minnesota's watersheds.  By applying a consistent statewide approach, the WHAF expands our understanding of processes and interactions that create healthy and unhealthy responses in Minnesota's watersheds.   Health scores are used to provide a baseline for exploring patterns and relationships in emerging health trends. In order to explore the watershed system in a consistent, systematic way, the ecological processes have been divided into 5 different components: biology, connectivity, geomorphology, hydrology, and water quality.
* **Source:** [www.dnr.state.mn.us/whaf/index.html](http://www.dnr.state.mn.us/whaf/index.html)

**PMZ\* – Priority Management Zone identification for BMPs in Impaired Watersheds**

* **Developer:** Barr Engineering, MDA, U of MN and others
* **Description:** This project will develop a compendium of the assessment tools and provide a decision-support system for identifying and delineating PMZs and CSAs. This support system can be used by state and local watershed professionals and will help target conservation practices to areas of the landscape where they will have the greatest environmental benefit. This project will also result in the development of guidance and training materials for field data collection. With the increasing availability of LiDAR data in Minnesota, there is greater potential for rapid landscape assessments that help identify PMZs and CSAs for conservation.
* **Source:** <http://www.mda.state.mn.us/protecting/cleanwaterfund/research/identifyingpmz.aspx>

**EVAAL – Erosion Vulnerability Assessment for Agricultural Lands**

* **Developer:** Wisconsin DNR
* **Description:** The Wisconsin Department of Natural Resources (WDNR) Bureau of Water Quality has developed the Erosion Vulnerability Assessment for Agricultural Lands (EVAAL) toolset to assist watershed managers in prioritizing areas within a watershed which may be vulnerable to water erosion (and thus increased nutrient export) and thus may contribute to downstream surface water quality problems. It evaluates locations of relative vulnerability to sheet, rill and gully erosion using information about topography, soils, rainfall and land cover. This tool enables watershed managers to prioritize and focus field-scale data collection efforts, thus saving time and money while increasing the probability of locating fields with high sediment and nutrient export for implementation of best management practices (BMPs).
* **Source:** http://dnr.wi.gov/topic/nonpoint/evaal.html

**Nitrate Models**

The following computer simulation models all have the ability to simulate the movement of nitrate in water. ADAPT, AGNPS, APEX, and GSSHA can all simulate nitrate leaching in the soil profile. GSSHA and MODFLOW can simulate the movement of nitrate in groundwater. MODFLOW can simulate the transport of nitrate in karst conduits. ADAPT and REMM are field–scale. APEX is farm–scale. AGNPS and GSSHA are distributed–parameter watershed models.

1. **Agricultural Drainage and Pesticide Transport Model (ADAPT)**

ADAPT is a field scale agricultural model which predicts the loss of surface and subsurface nitrate from an agricultural system. ADAPT features the merger of the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) root zone water quality model and the DRAINMOD subsurface drainage model. ADAPT can be used to simulate crop rotations and the associated tillage and residue, as well as edge of field and vadose zone water, sediment, pesticides, and nutrients under different management alternatives. Manure and fertilizer application, nitrogen fixation by legumes, and nitrogen crop uptake can be simulated. ADAPT simulates the response of vadose zone water and the water table to changes in surface hydrology and subsurface drainage. ADAPT also simulates denitrification as a function of soil temperature, water content, and active organic carbon. Additions to ADAPT include frost depth and snowmelt algorithms.

1. **Agricultural Nonpoint Source Pollution Model (AGNPS)**

AGNPS is a distributed–parameter watershed scale agricultural model capable of predicting hydrology, sediment, nutrient, and pesticide loadings from agricultural systems. AGNPS includes an explicit feedlot model and incorporates the DRAINMOD tile drainage algorithms. Nitrogen processes included in AGNPS are: plant uptake, nitrification, denitrification, volatilization, mineralization, immobilization, atmospheric nitrogen fixation, leaching, and composition of fresh residue. Special features include the ability to simulate gully erosion, riparian buffers, wetlands, and to perform source tracking of land or reach sources to a downstream point. AGNPS provides linkage to the CCHE1D stream channel model and the CONCEPTS geomorphological model.

1. **Agricultural Policy/Environmental eXtender (APEX).**

APEX is a farm–scale cropping systems model that evaluates the effect of various agricultural land management strategies upon pollutant loads and crop productivity. Land management activities simulated by APEX include irrigation, drainage, buffer strips, terraces, waterways, fertilization management, reservoirs, and crop rotation and tillage. Water, sediment, nutrients (including nitrate), and pesticides are routed between subareas and stream channels. APEX simulates the complete nitrogen cycle, including nitrate leaching. An automated linkage has been developed between APEX and the Soil and Water Assessment Tool (SWAT).

1. **Modular Finite–Difference Ground–Water Flow model (MODFLOW)**.

USGS three–dimensional groundwater flow model which includes the capability to simulate conduit flow in karst geology. The MODFLOW extension MT3D can be used to simulate the transport of nitrate in groundwater, which requires linkage to a surface nitrate loading model.

1. **Gridded Surface Subsurface Hydrologic Analysis (GSSHA)**

GSSHA is a two–dimensional distributed parameter finite difference watershed model which uses advanced fluid mechanics to simulate surface, vadose zone, and groundwater flow.

Additions to the model have included the ability to simulate tile drainage with SUPERLINK and the ability to simulate the transport of nutrients – including nitrate. GSSHA can simulate small lakes, detention basins, and wetlands. The model does not explicitly simulate agricultural systems, but input parameters can be altered to replicate crop systems. The soil nitrogen cycle, including plant uptake, leaching, volatilization, denitrification, fertilizer and manure application, bacterial fixation, and wet deposition has been added to GSSHA.

1. **The Riparian Ecosystem Management Model (REMM)** is a field scale two dimensional model which simulates the reduction in constituents, including nitrate, due to the presence of a riparian forest buffer.
   1. Simulates surface and subsurface hydrology.
   2. Designed to work with a field hydrology and water quality model which contributes surface and subsurface flow and water quality paramete