Multiple Benefits for People and Nature:

Mapping and Modeling Tools to Identify Priorities for The Nature Conservancy's Freshwater Program and the Minnesota Headwaters Fund

The goal of The Nature Conservancy's (TNC) Freshwater Program is to conserve the lands that protect clean water, and to support high-impact conservation projects to protect and improve Minnesota's groundwater and surface water quality for the benefit of nature, people, and the economy. As threats continue to mount, it is becoming increasingly important to identify and conserve priority areas for habitat and clean water benefits. Identifying where in the landscape protection and restoration can provide multiple, overlapping benefits can help more effectively target efforts and more efficiently utilize limited resources. Examples of protection and restoration approaches throughout the Upper Mississippi River Basin include conservation acquisitions, easements, wetland and floodplain restoration, and other projects that prevent pollutants, such as nitrates and sediment, from entering key rivers and lakes.

This document describes the methodology and criteria used to make recommendations for investments to support clean water for people and nature. This includes recommendations for investments in natural infrastructure for multiple ecosystem service benefits, across the full spectrum of protection to restoration.

The process developed and scored priorities according to specific but multiple cross-cutting needs, looking for the "sweet spot" where multiple benefits overlap (e.g. habitat, water quality, water user benefit, flood benefit). However, criteria for prioritizing protection and restoration should be dynamic, reflecting the evolution of better and more accurate tools. This may include both aquatic and terrestrial habitat protection priorities as well as lands that are disproportionately important to local or downstream drinking water, water quality, or other ecosystem services benefits to people.

Analysis is ongoing to better understand threats, thresholds, and how much conservation is enough at multiple watershed scales (small watersheds, large watersheds, and river basins); to identify management/habitat improvement opportunities on already public/protected land; to identify which lands need to be acquired to reach those desired goals; to measure and document the effectiveness of habitat restoration and protection activities; and to set targets and goals for landscape scale conservation. The interpretation of outputs needs to consider appropriate **spatial scale** (e.g. major HUC8 watershed, minor HUC12 watershed, field scale projects). We emphasize that developing and implementing protection and restoration projects requires additional planning with local and agency partners at these multiple scales.

Outline

Multiple Benefits Tool for Prioritizing Freshwater Conservation Investments

We built on a systematic approach originally pursued by the North Central Conservation Roundtable (NCCR) in 2014, working with Minnesota DNR's Division of Ecological Resources, to develop a "blueprint" of conservation priorities across the Mississippi Headwaters region. The approach uses a software tool called Zonation, which allows stakeholders to aggregate multiple layers representing landscape features and conservation criteria, using an objective weighting function. The weighting is based on the relative value participants ascribe to each layer. The result is a map showing weighted priorities within the landscape for conservation, protection, or restoration. This approach has been widely adopted at the major watershed (HUC8) scale in the context of the MPCA's Watershed Restoration and Protection Strategy (WRAPS) planning process.

Using ArcMap, TNC developed a version of this approach for the entire Mississippi Headwaters that incorporates newly available data layers and is composed of separate individual "modules" based on intuitively similar benefit themes. The "Multiple Benefits" tool is composed of 4 primary modules:

1. Fish and Wildlife Habitat
2. Drinking Water and Groundwater Quality
3. Flooding and Erosion Control
4. Groundwater Quantity

Module data layers

Fish & Wildlife Habitat Benefits

- Ecological patches and connections
- Protected lands
- Rare features
- Areas of biodiversity significance
- Lakes of biological significance
- High quality wild rice lakes
- High quality cisco lakes
- Forest conservation value/ drinking water value

Drinking Water/Source Water Benefits

- Drinking water management supply area vulnerability
- Groundwater contamination susceptibility
- Proximity to water

Reduce Erosion, Enhance Storage, and Reduce Hydrologic Alteration

- Existing wetlands, riparian areas, and floodplains providing storage and sediment retention benefits
- Areas vulnerable to erosion

Protect Groundwater Quantity

- Protect recharge and manage withdrawals
- Groundwater recharge
- Water use intensity relative to sustainable supply

Multiple Benefits Modules

Fish and Wildlife Module

The Fish and Wildlife module is intended to represent priority areas for ***protection*** primarily based on aquatic habitat protection value and secondarily on terrestrial fish and wildlife benefits. The module incorporates available data layers designed to represent parts of the Basin where protection will have the highest benefits to fish and wildlife and their habitats. Much of the northern half of the Basin, including Itasca State Park, Leech and Cass Lake, the area around Chippewa National Forest, northern Brainerd Lakes and Gull Lake areas, Lake Alexander, Mille Lacs Lake, and the Mississippi River Corridor score highest on this module.

Components – Each of the component layers described below is re-scaled so that it contributes equal weight in the final fish and wildlife module (3 of 30 points).

1. Restorable Wetland Inventory (RWI) Benefit to Species Value: This layer is a component of the Restorable Wetland Prioritization Tool developed by researchers at the University of Minnesota-Duluth Natural Resources Research Institute (NRRI) to prioritize wetland restoration and protection[1]. The layer was developed using a subset of the individual habitat components from the Environmental Benefits Index (EBI) including sites of biodiversity significance, Species of Greatest Conservation Need (SGCN) (number of species of greatest conservation need for which the land may provide suitable habitat); potential bird habitat (probable number of birds from a modeled set of 17 that might use the habitat); and weighted habitat protection (the number of terrestrial vertebrate species potentially using this land weighted by the current level of habitat protection statewide for each species). The individual EBI inputs were combined using a weighting process to form a single species benefits decision layer designed to predict potential habitat enhancements that would result from wetland restoration or protection. This layer was included in the module as a statewide data layer representing overall habitat value weighted approximately equal for aquatic and terrestrial species and SGCN. In the future, this layer will be updated with the 2015 Wildlife Action Plan update.
2. Biodiversity Significance Score: The Minnesota Biological Survey (MBS) has assigned a biodiversity significance rank to surveyed sites across the state intended to reflect landscape context and ecological function, existing native plant community quality and rarity, and species quality and rarity. There are four biodiversity significance rankings: outstanding, high, moderate, and below. This layer is included in the Fish and Wildlife module to give greater weight in the final model to areas with moderate (1 pt), high (2 pts), and outstanding (3 pts) biodiversity.
3. Lakes of Biological Significance: Lakes were identified and classified by DNR subject matter experts on objective criteria for four community types (aquatic plants, fish, amphibians, and birds); or if the lake is included in TNC's lake portfolio. This layer is scored by lakes that meet standard (1 pt), higher (2 pts), and highest (3 pts).
4. Index of Biological Integrity: This layer includes lake catchments with outstanding Index of Biological Integrity (IBI) scores based on the preliminary fisheries lake IBI[2]. The IBI is a biologically-based, multi-metric method for measuring the integrity of aquatic systems. Minnesota DNR Fisheries

[1] http://www.mnwetlandrestore.org/project-description/subtopic-copy/subtopic-copy-2/
[2] https://gisdata.mn.gov/el/dataset/env-ibi-lakes-fisheries

Research has developed a fish-based lake IBI that incorporates fish data collected by various methods (trap nets, gill nets, shoreline seines, and backpack electrofishing units) into 8-15 metrics in three categories: species richness, community assemblage, and trophic composition. Lake catchments are scored based on the highest scoring lake meeting the IBI standard: meeting standard (1 pt), above standard (2 pts), and exceptional (3 pts), plus (+1 pt) if the catchment contains a lake in the TNC lake portfolio.

5. Wild Rice Catchments: Wild rice is a unique resource in Minnesota, important culturally, as well as to migrating waterfowl and other wildlife. Because wild rice is both important and sensitive to hydrologic and water quality disturbance, lake catchments identified as having significant wild rice were included as a layer in this module.

6. Coldwater Refuge – Cisco: This layer represents the level 8 DNR lake catchments for lakes identified by the Minnesota DNR to be the most resilient, likely refugia for ciscoes (tullibee, *Coregonus artedi*), a keystone species for Minnesota's deep, coldwater lake class. Because these lakes are likely to be the most resilient in the face of climate change, they are priorities for protection in the Minnesota DNR Aquatic Habitat Strategic Plan.

7. High Conservation Value Forests: The original NCCR model only included forests designated as "old-growth." We used FLEET results (ecological value) for northern headwaters. However, because FLEET does not extend beyond the Superior Mixed Forest ecoregion to include the entire Mississippi River Headwaters Basin, we rescaled the USFWS Upper Mississippi River Forest Partnership Priority Forest for Drinking Water to use those scores for the portion of the Basin not covered by FLEET. *Caveat: the methodology is not the same across the study area, especially significant when evaluating finer scale scores along the Superior Mixed Forest border. Future iterations of the tool could be revised to use a cumulative forest disturbance layer currently being developed by Minnesota DNR (Corcoran 2015). For this version, we used the ecological value layer.*

8. Ecological Patches or Connections: Statewide, riparian corridors constitute some of the most extensive and complete terrestrial habitat corridors for fish and wildlife, particularly in areas disturbed by urban or agricultural land use. This layer represents landscape habitat connectivity for both aquatic and terrestrial species based on perennial lands within the Active River Area (ARA) layer as derived for the Mississippi Headwaters (2014).

9. Proximity (inverse distance) to Protected Lands: This layer is scaled 0-100 based on inverse distance to protected lands, on the assumption that all else being equal, lands more closely connected to an existing network of protected lands are of relatively higher conservation value.

10. Proximity (inverse distance) to Water: This layer is scaled 0-33 based on inverse distance to water features, on the assumption that the value of lands to fish and wildlife is in direct proportion to their distance from water.

Drinking Water Quality Module

The Drinking Water module is intended to represent priority areas for **protection *and/or* restoration**, weighted on the relative potential impact on estimated actual users where they obtain their drinking water. This module may be used with or without the Groundwater Recharge module. Inclusion of the Groundwater Recharge module reduces the apparent resolution of the visual output from the module, because the latter is based on larger, coarser grid cell resolution of the Smith et al. (2015) analysis.

Caveats:

- *Because of the limitations of the resolution and projection accuracy of the groundwater susceptibility component in particular, parcel scores evaluated on this module should not be over-interpreted in local project context.*
- *The methodology for assigning relative importance of ARA lands upstream in terms of influence on downstream surface water drinking intakes is approximate; it could be improved in collaboration with the drinking water utilities and others working to develop similar tools.*
- *Many additional groundwater data layers have become available in the last several years, and these should be incorporated into planning efforts.*

Components:

1. Drinking Water Supply Management Area (DWSMA) Vulnerability: This is a delineation of areas of concern for and relative risk for a potential contaminant source within the DWSMA to contaminate a public water supply well based on the aquifer's inherent geological sensitivity and the chemical and isotopic composition of the groundwater. Source: MDH.

   Wellhead Protected Area (WHPA): WHPA is the surface and subsurface area surrounding a public water supply well or well field that supplies a public water system, through which contaminants are likely to move toward and reach the well or well field. Source: MDH.

   The maximum score for these two layers is scored 1-5 (0 for non-DWSMA or WHPA areas). They do not have 100% overlap.

2. Groundwater Contamination Susceptibility: A broad, generalized interpretation of groundwater contamination susceptibility for the state, based on modeling that relies on data inputs from the MLMIS40 (40-acre raster) soils and geology data, with additional geology inputs[3]. The parameters that control groundwater susceptibility to contamination are quite varied and overlapping, and include: soil media, topography, depth to water, aquifer media, vadose zone materials, net recharge, hydraulic conductivity of aquifer, hydraulic gradient, distance to nearest drinking water supply, depth to bedrock, unsaturated zone permeability and thickness, and net precipitation. *Caveats: this layer does not display accurately into UTM15 NAD83 projection; it is offset by up to 300 m. Metadata reinforces that it is not appropriate for site-specific use.*

3. Proximity to Mainstem River Water Supply (Mississippi River and Major Tributaries): Lands within the ARA upstream of surface water intakes for major drinking water supply areas are assigned zonal values based on downstream distance to the supply area.

4. Private Well Density: This layer summarizes the County Well Index (CWI) layer (Source: MDH[4]) by HUC12 watershed to summarize the number of private domestic water supply wells in each 12-digit watershed that are located in a vulnerable or highly vulnerable groundwater area, and is converted to 10 density classes by HUC12. The CWI layer is known to be dated and incomplete, but represents an accurate representation of the population density relying on private domestic groundwater wells.

Flooding and Erosion Control Module

Components:

[3] http://www.mngeo.state.mn.us/chouse/metadata/gwc.html
[4] http://www.health.state.mn.us/divs/eh/cwi/

1. Benefits to Water (RWI)[5]: This water quality layer predicts the potential water quality benefits in the form of reduced erosion risk from wetland restoration or protection. The layer utilizes the data inputs Soil Erosion Risk and Water Quality Risk from the EBI along with the downstream flow distance to open water. The EBI is an ecological ranking tool (30m grids) developed by Minnesota Board of Soil and Water Resources (MNBWSR) and NRRI. The flow accumulated soil erosion risk, water quality risk, and downstream flow distance to water were combined through a weighting process to form a single water quality/erosion benefits layer.
    - Soil Erosion Risk layer estimates the potential risk of soil erosion on a 0-100 scale based on components of the Universal Soil Loss Equation (USLE) (rainfall runoff factor, slope length slope gradient, and soil erodibility factor) at a 30m resolution. NRRI modified the layer to predict the potential flow accumulated soil erosion risk downstream to the nearest second order stream for each 30m cell.
    - Water Quality Risk layer estimates each 30m cell's risk to water quality based on the likelihood of overland flow during a rain event and its proximity to water. The likelihood of overland flow was estimated from stream power index (SPI). The downstream flow distance to water measures the closest downstream distance to water.
2. Sediment Retention Benefits: Mosaic of the following three layers, then averaged over a focal statistics rectangle 9 cells wide and tall.
    - Existing Perennial Cover x Sediment Retention from InVEST Model: InVEST – Integrated Valuation of Ecosystem Services and Tradeoffs – is an open-source software suite aimed at quantifying and mapping ecosystem services. The sediment results were generated January-February 2015 using InVEST 3_1_0b1 version of the sediment delivery and retention model. This layer represents the lands already in perennial land cover that had the highest scores for sediment retention.
    - Existing ARA x Sediment Retention from InVEST Model: This layer represents the lands within the ARA that had the highest scores for sediment retention.
    - Existing NWI x Sediment Retention from InVEST Model: This layer represents wetlands with the highest scores for sediment retention.

3. Total Upstream Contributing Area / Wetland Acres (storage): This layer shows relative ecosystem service value of existing wetland storage. It represents the ratio of upstream watershed delivery area to existing wetlands, on the assumption that the greater the upstream contributing area, the greater the relative contribution to storage of any given area of wetland storage. Research suggests that the value of remaining wetland storage increases exponentially as percentage of wetlands decreases, and that there is a hydrologic threshold at around 10% wetlands.

Groundwater Recharge Module

Components:

1. Groundwater Recharge (inches/year) (Smith et. al 2015) and Groundwater Recharge (inches/year) (Lorenz and Delin 2007)

   The two layers are averaged together to yield a long term potential average recharge (inches/year of rainfall that recharges groundwater and supports streamflow).

[5] http://www.mnwetlandrestore.org/project-description/subtopic-copy/subtopic-copy-2/

2. Water Use Vulnerability Index, Catchment Predicted Vulnerability – DNR Watershed Health Assessment Framework Catchment Score
   http://www.dnr.state.mn.us/whaf/about/scores/hydrology/waterwithdraw.html

   The index is based on the sum of permitted withdrawal from surface and groundwater. Using the State Water Use Database (SWUD), total potential consumption was calculated by summing permitted use and comparing to annual runoff. The Water Use Vulnerability Index is scaled as the greater the amount of water used as percentage of runoff, the lower the score. The Catchment Predicted Vulnerability is the five-year trend in reported use as a percentage of runoff.

Multiple Benefits Map

The Multiple Benefits Map is an overlay of the top quartile scoring areas for each of the Fish and Wildlife, Drinking Water, Flooding and Erosion Control, and Groundwater Quantity modules. The value is the total number of modules for which the area scores in the top quartile.

Combined Quartile Scores (=Sum of Quartile Scores)

A combined overlay of the quartile scores for each of the Fish and Wildlife, Drinking Water, Flooding and Erosion Control, and Groundwater Quantity Modules, where each layer is scored 1-4 with 4 representing the highest quartile. The value is the total sum of quartile scores.

Interpreting and Using Mapped Results to Implement Conservation (Protection and Restoration)

Mapped scores are intended to reflect priority areas for protection and/or restoration based on multiple benefits. High scores for riparian lands, shorelands, and large floodplain areas, including the Mississippi River Corridor from Grand Rapids to St. Cloud, reflect the fact that these lands score on multiple modules. The lake-rich areas south of Walker and Aitkin and north of Brainerd and Grand Rapids also score high. This reflects the high priority of shorelands as well as the fact that shorelands often occur in areas of high groundwater contaminant susceptibility, and along the river corridors in proximity to important drinking water supply areas (e.g. Park Rapids, Grand Rapids, St. Cloud).

The model is intended as a tool to help the Conservancy and our partners set programmatic direction goals as well as identify opportunities and focus areas. It is designed to be used in conjunction with information on ***opportunities, threats,*** and ***costs*** – none of which the model is designed to account for – to evaluate benefits and tradeoffs among potential conservation projects.

Protection: Using Multiple Benefits to Identify Priority Parcels

Goal

Permanent protection of land is an important strategy for safeguarding the clean water we enjoy in the Mississippi Headwaters. Acquiring land in fee or conservation easements helps avoid land conversion and degradation. Land use has a direct impact on our water meaning that land protection is a critical part of the equation. This is why The Nature Conservancy has set a goal for us and our partners to protect 100,000 acres of land in the Mississippi Headwaters.

Identifying Priority Parcels

To determine where protection strategies should be employed, The Nature Conservancy used the Multiple Benefits Analysis to identify priority parcels of private land. These parcels include land where partners can invest limited resources and know that this work will have an outsized positive impact on clean water in the Mississippi Headwaters.

Below is a description of criteria used for identifying priority parcels for protection:

- Land must not be entirely in development, agriculture, open water, or permanently protected.
- Parcel size must be greater than 160 acres.
- Land must have two or more multiple benefits with scores in the top quartile. In this case, each multiple benefit data module is scored 1-4 with 4 as the highest score, otherwise known as the top quartile. Qualifying parcels must have greater than 80 acres of land scoring in the top quartile for two or more benefits.
- Parcel includes land scoring in the top 10% if the Multiple Benefits scores (1-4) were added up for each parcel. This is known as the Sum of Quartile Scores.
- Parcels meeting all these criteria were ranked into three tiers based on what percentage of the parcel met Criteria 4 (had a score in the top 10% of the Sum of Quartile Scores). These rankings included 0.1 – 24.9%, 25 – 49.9%, or more than 50% of the tract with that high score.

These criteria ensure that the parcels prioritized for protection have the largest possible impact on the conservation of multiple benefits. This is a tool that the Conservancy and partners can use to prioritize protection in the Mississippi Headwaters. However, it is not the only tool and additional criteria should be considered in conjunction, such as the following:

- Adjacency to protected land
- Size and type of threats to conservation value
- Comparison with other protection opportunities
- Cost

Protection Strategies

The Nature Conservancy will share the Multiple Benefits Analysis and all detailed methods with partners. Several partner efforts are already underway to protect land in the Mississippi Headwaters through programs that purchase land in fee or conservation easements from willing sellers. It will be critical for all partners, including the Conservancy, to be sensitive and respectful as we create programs in regions of the Headwaters and approach landowners with protection options. The Conservancy will work closely with non-profit and government partners to identify if protection programs should be modified or bolstered through capacity or funding to be truly effective and reach our 100,000-acre goal. The Conservancy will raise private funds for this critical work and use those funds to leverage public funds through grants and bonding.

Restoration: Priorities and Strategies

Goals & Measures
Protect and restore priority watersheds for the benefit of people and nature.

Measures were selected to be easy to understand and communicate, measurable, and consistent with statewide monitoring already in place to ensure data will be available to assess progress in the future. Measures include:

- Reduce nitrogen loading by 20%
- Reduce phosphorus loading by 20%
- Maintain flows on the upper Mississippi River within 10% of long-term historical mean flows
- Maintain low flow for drinking water supply in Minneapolis at the water treatment plant (7-day low flow not less than 1000 cfs)

Our goals, measures, and strategies are intentionally designed to have significant overlap with those established by local, state, and regional partners under the statewide nutrient reduction strategy as well as the Gulf Hypoxia Action Plan. The Nature Conservancy's role in restoration is to catalyze high leverage restoration projects and program opportunities with partners by building capacity to do restoration at scale.

Restoration Priorities and Strategies

- Improve watershed resiliency to projected future land and climate change.
- Increase the ecosystem function of stream and wetland restoration projects to maximize the project benefit downstream.
- Increase water storage through wetland restoration, soil health improvements, and other practices to prevent or mitigate increases in stream flow.
- Address localized problems in watersheds that pose a threat to local and/or downstream freshwater goals.
- Reduce threats to the five healthy watershed components (as described by the DNR Watershed Health Assessment Framework) – hydrology, biology, geomorphology, water quality, and connectivity. These five components are functionally analogous to "key ecological attributes (KEAs)" of freshwater systems. As defined in The Nature Conservancy's conservation action planning guidance, key ecological attributes or processes are those components of the biology or ecology of a conservation target (whether a species or a system) that, if missing or altered, threaten the long-term viability of that conservation target.

We developed restoration strategy maps designed to communicate general restoration priorities basin-wide, as well as priority areas for specific restoration strategies. Restoration mapping was based on a combination of needs assessment and feasibility of attaining or maintaining "healthy" waters criteria (i.e., where targeted restoration is most likely to "move the needle").

The final strategy maps depict:

1. Soil Health and Agricultural Nutrient Reduction with Drinking Water/Source Water Protection Priority Overlay
2. Restoration of Altered Hydrology/Water Management Priorities with Stormwater Priority Needs Overlay

Strategy 1. Soil Health and Agricultural Nutrient Reduction: This map represents priority areas for applying TNC's "4R" (right source, right rate, right time, right place) agricultural nutrient reduction

strategies within the Mississippi Headwaters Basin. Minor basin watersheds (MNDNR) are displayed based on the total acres of cropland, weighted by their relative importance to drinking water, groundwater, and flooding and erosion reduction benefits on TNC's Multiple Benefits model.

Soil health and nutrient priorities at the DNR minor watershed basin scale were calculated as follows: Cells identified as cropland in the 2010 Cropland Data Layer (CDL; NASS) were intersected with The Nature Conservancy's Multiple Benefits modules for drinking water, groundwater, and flooding and erosion benefits, each scored by quartiles. Each cropland cell was scored based on its total quartile sum. Basin scores were based on the sum of cropland scores, equivalent to the total cropland weighted by its relative importance to drinking water, groundwater, flood, and erosion storage.

The drinking water overlay map displays priority minor watersheds in the Mississippi Headwaters Basin for implementing drinking water/source water restoration strategies, consistent with TNC's "Water for People" strategic priority. Minor watershed basins were identified as priorities for drinking water/source water protection if they scored above the mean for TNC's Multiple Benefits "Drinking Water Module", have more than 100 vulnerable domestic or community water supply wells, or overlap with a vulnerable drinking water supply. It is displayed as an overlay with the Soil Health and Nutrient Management map because in the Mississippi Headwaters, agricultural pollution is the primary and most widespread land-based threat to drinking water. Strategies may include capacity building, partnering with local government units (LGUs), development of water quality trading and environmental markets, and policy and planning at multiple scales.

Strategy 2. Edge-of-Field/Water Management: This map represents priority areas for implementing strategies designed to restore altered hydrology, water quality, and/or aquatic habitat such as wetland restoration, physical restoration/enhancement of stream channels or ditches, or "edge-of-field" practices such as bioreactors, riparian buffers, and natural channel retrofits, designed to intercept nutrients and flows from croplands as well as provide ancillary benefits. Minor watersheds are displayed both on the overall potential for maintaining healthy, resilient conditions at larger watershed scale as well as restoration need based on total amount of altered watercourses and drained wetlands.

Priority minor watersheds for restoring altered hydrology were derived by weighting The Nature Conservancy's Multiple Benefits (Quartile Sum) with restorable wetlands and altered watercourses. For each minor watershed, (1) a mean cumulative score was determined for Multiple Benefits, (2) restorable wetland area was divided by total minor watershed catchment area to get a percentage of restorable wetlands per minor watershed, and (3) length of altered watercourses was divided by total minor watershed catchment area to get a percentage of altered watercourses per minor watershed. These scores were normalized 0-100 and summed.

Priority watersheds for stormwater management, depicted as an overlay, were determined based on whether the minor watershed basins intersect with the center point of a designated MS4 boundary or have a low mean index score (<30) for impervious surface based on 2011 land cover (where a lower index score indicates greater impervious cover) on Minnesota DNR's Watershed Health Assessment Framework (WHAF). The WHAF score was scaled up from the level 8 catchment to the minor watershed basin based on the area-weighted mean score. It is displayed as an overlay with the Edge-of-Field/Watershed Management map because in the Mississippi Headwaters, stormwater represents an acute and significant cause of hydrologic alteration. Strategies may include capacity building, partnering with LGUs, development of stormwater trading and environmental markets, and policy and planning at multiple scales.

Disclaimer

All strategy maps are based on analysis at the basin scale from data layers ranging from 1:24,000 to 1:100,000 scale accuracy, 30m grid-based resolution, or catchment scores from the DNR Watershed Health Assessment Framework. All boundaries are therefore approximate, and do not completely preclude implementation of strategies outside of priority areas shown on the maps based on finer scale or additional relevant analysis or information.

We fully expect that developing and implementing a portfolio of projects under each of these strategies will include additional planning with local and agency partners through local, county, municipal, WRAPs, 1W1P, and other planning processes, as well as additional strategy and project design and prioritization at the local scale based on additional data, information, and planning criteria. This includes ongoing planning and analysis using additional available tools and data applicable to finer scale watershed and project planning, potentially including HSPF Scenario Application Manager (SAM)[6], the Agricultural Conservation Planning Framework (ACPF), and PTMApp.

[6] HSPF Scenario Application Manager (SAM) is a user-friendly, comprehensive tool that assists in understanding watershed conditions and identifying priority areas and cost-effective BMPs to achieve the water quality goals established through watershed protection and restoration programs. SAM was developed by RESPEC to help local SWCDs and other users develop scenarios and plans based on the HSPF water quality models developed to support the MPCA watershed approach.