

SECTION 4: MODEL RESULTS AND BMP APPLICATIONS

Forecasting Stormwater Pollution

Utilizing existing water quality, hydrology, and land use data, the Rein in the Runoff project team developed forecasts of the most likely source locations for stormwater pollution to Spring Lake. The watershed was broken down into smaller hydrologic units in an attempt to pinpoint general sources of polluted runoff, now and into the future.

Best Management Practices (BMPs)

The primary way to control stormwater discharges is through the use of best management practices (BMPs). "BMPs" is a term used to describe different ways to keep pollutants out of runoff and to slow down high volumes of runoff. Preventing pollution from entering the water is much more cost-efficient than cleaning up water after it is polluted. The project team has provided a recommended suite of BMPs for use in specific locations throughout the Spring Lake Watershed.

Example Stormwater BMPs

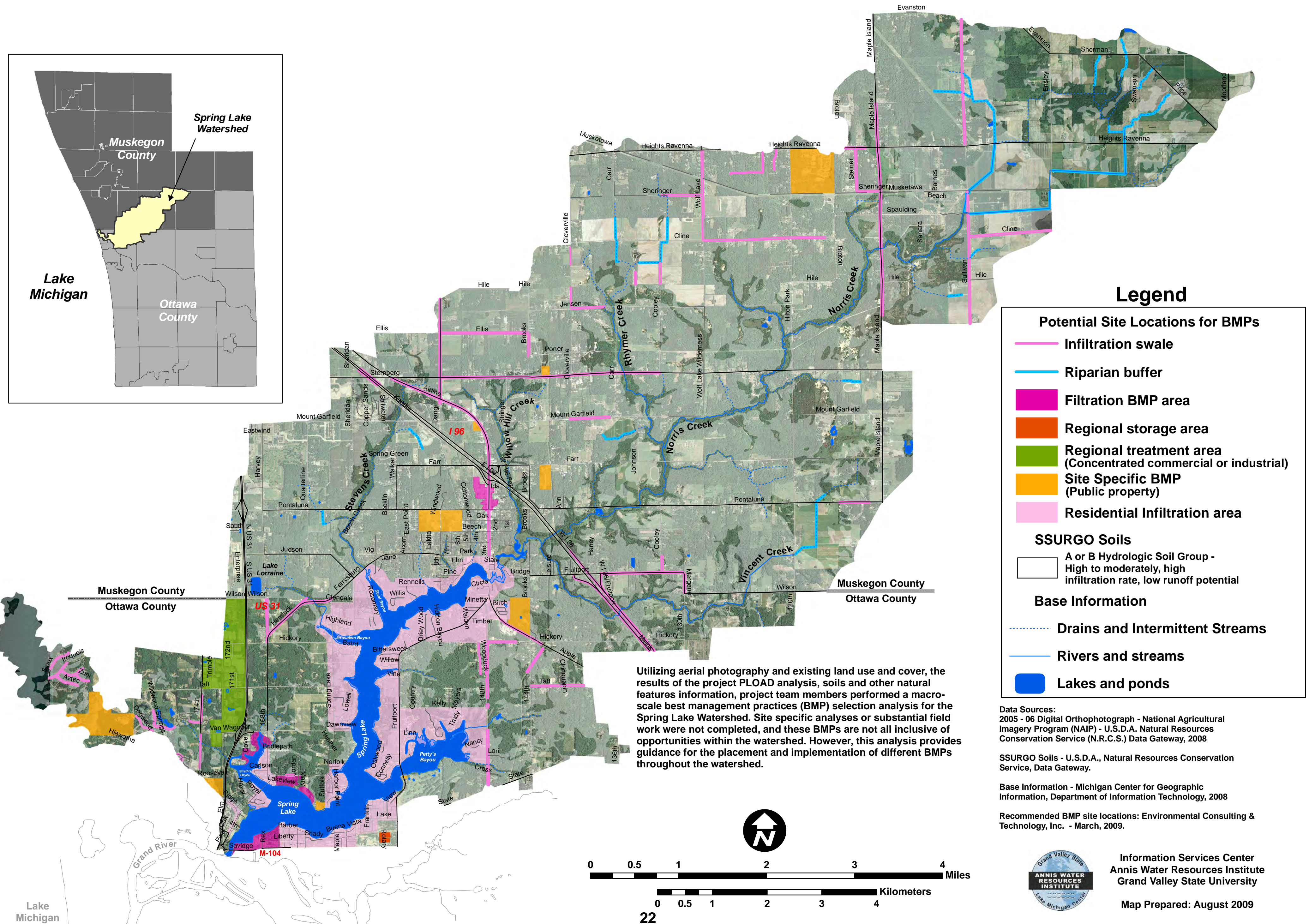
- Vegetative practices such as naturally vegetated filter strips along rivers, streams and lake banks; grassed swales; constructed wetlands; and tree plantings
- Structural practices such as concrete grid and modular pavement; water diversion structures; extended water detention, retention and infiltration basins; porous pavement; green roofs; and water quality inlets (oil/grit separators)
- Maintenance practices such as limited application of fertilizers and pesticides; laws regulating litter, pet wastes, leaves, yard waste, and hazardous materials disposal; regular vehicle and boat maintenance; street cleaning; and erosion controls from agricultural lands and construction sites
- Education of local residents about how to prevent pollution from entering waterways in the first place



Photo credits: E. S. Isely



Potential Site Locations for BMPs



Legend

- Potential Site Locations for BMPs**
- Infiltration swale
 - Riparian buffer
 - Filtration BMP area
 - Regional storage area
 - Regional treatment area (Concentrated commercial or industrial)
 - Site Specific BMP (Public property)
 - Residential Infiltration area
- SSURGO Soils**
- A or B Hydrologic Soil Group - High to moderately, high infiltration rate, low runoff potential
- Base Information**
- - - - - Drains and Intermittent Streams
 - Rivers and streams
 - Lakes and ponds

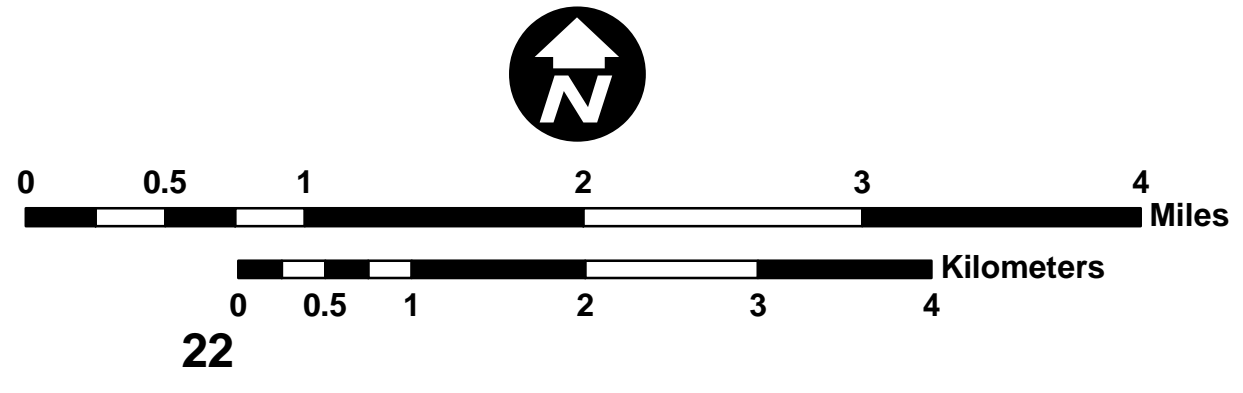
Utilizing aerial photography and existing land use and cover, the results of the project PLOAD analysis, soils and other natural features information, project team members performed a macro-scale best management practices (BMP) selection analysis for the Spring Lake Watershed. Site specific analyses or substantial field work were not completed, and these BMPs are not all inclusive of opportunities within the watershed. However, this analysis provides guidance for the placement and implementation of different BMPs throughout the watershed.

Data Sources:
 2005 - 06 Digital Orthophotograph - National Agricultural Imagery Program (NAIP) - U.S.D.A. Natural Resources Conservation Service (N.R.C.S.) Data Gateway, 2008

SSURGO Soils - U.S.D.A., Natural Resources Conservation Service, Data Gateway.

Base Information - Michigan Center for Geographic Information, Department of Information Technology, 2008

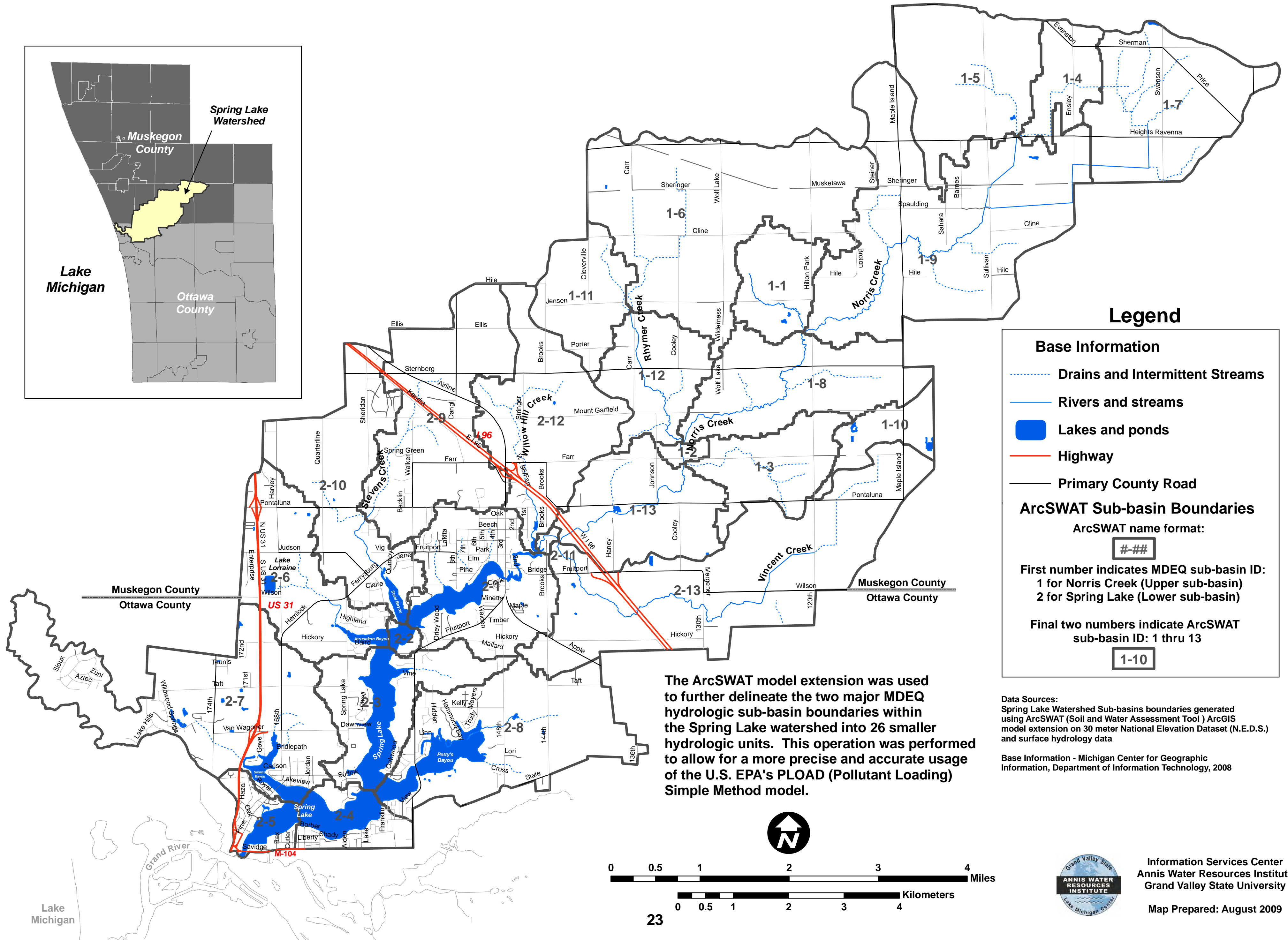
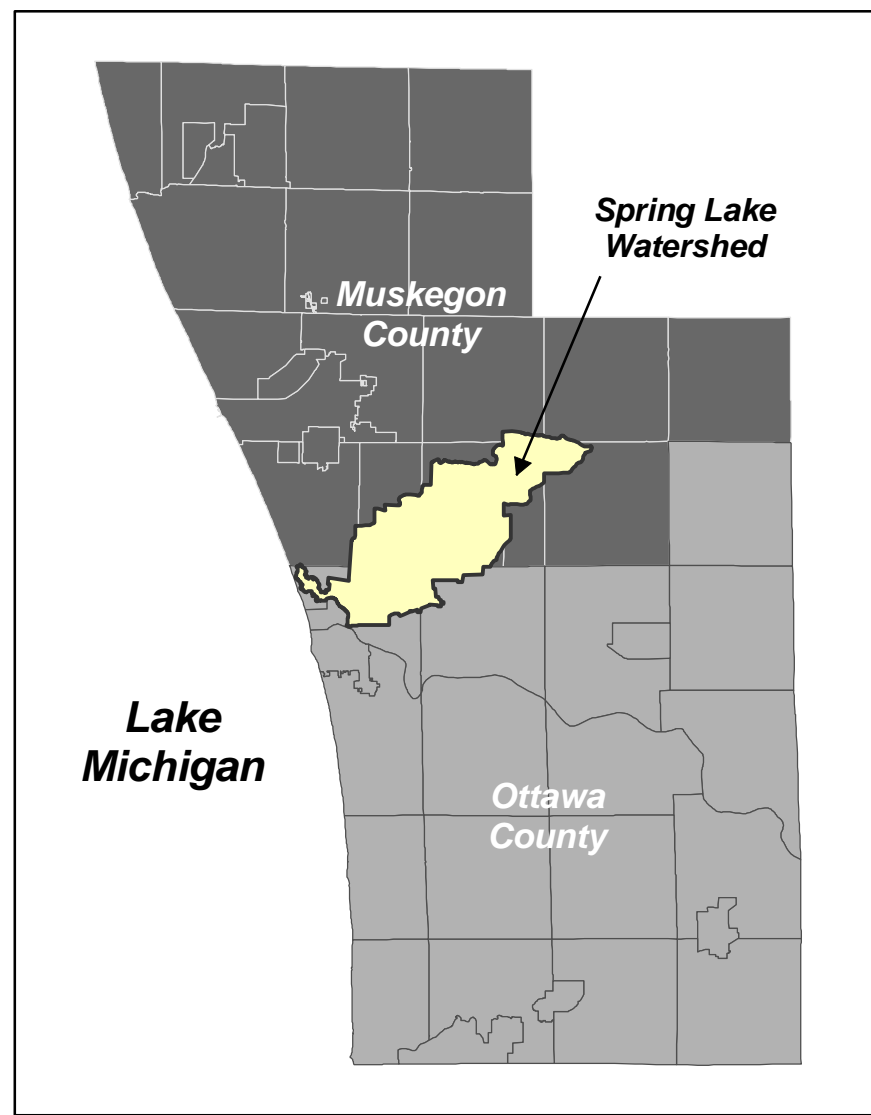
Recommended BMP site locations: Environmental Consulting & Technology, Inc. - March, 2009.



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ArcSWAT Sub-basin Boundaries



Legend

Base Information

- Drains and Intermittent Streams
- Rivers and streams
- Lakes and ponds
- Highway
- Primary County Road

ArcSWAT Sub-basin Boundaries

ArcSWAT name format:

###

First number indicates MDEQ sub-basin ID:
1 for Norris Creek (Upper sub-basin)
2 for Spring Lake (Lower sub-basin)

Final two numbers indicate ArcSWAT sub-basin ID: 1 thru 13

1-10

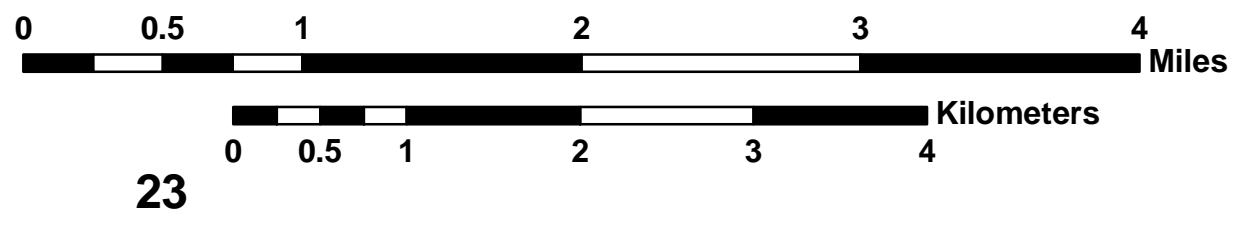
The ArcSWAT model extension was used to further delineate the two major MDEQ hydrologic sub-basin boundaries within the Spring Lake watershed into 26 smaller hydrologic units. This operation was performed to allow for a more precise and accurate usage of the U.S. EPA's PLOAD (Pollutant Loading) Simple Method model.

Data Sources:
Spring Lake Watershed Sub-basins boundaries generated using ArcSWAT (Soil and Water Assessment Tool) ArcGIS model extension on 30 meter National Elevation Dataset (N.E.D.S.) and surface hydrology data

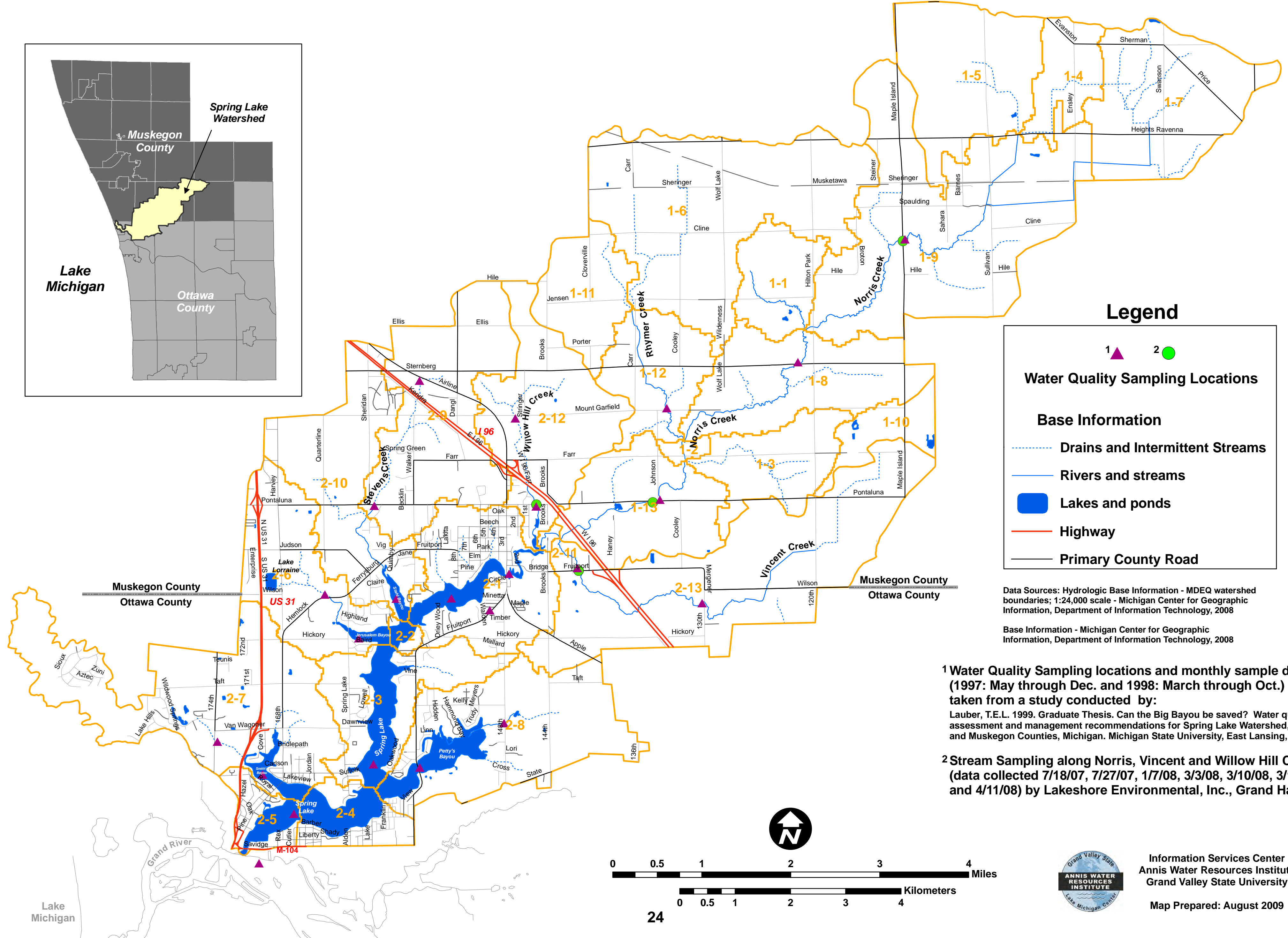
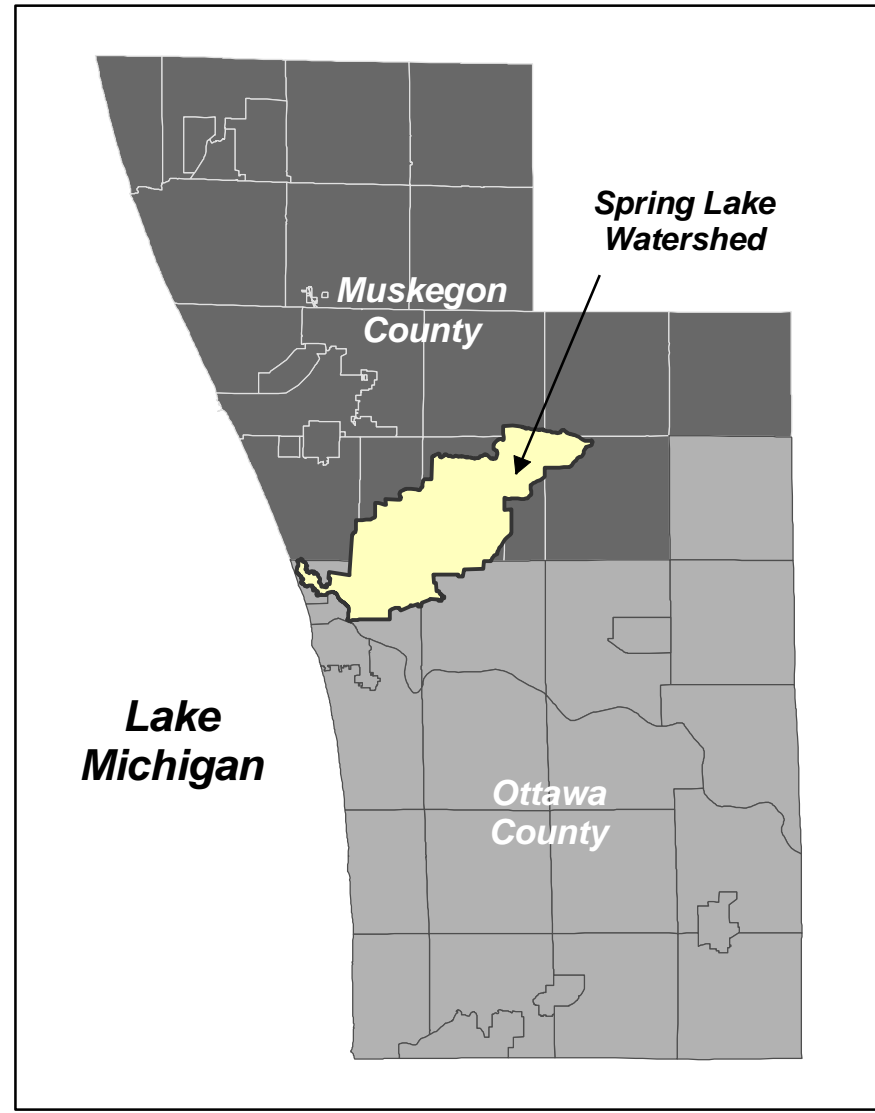
Base Information - Michigan Center for Geographic Information, Department of Information Technology, 2008



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Water Quality Sampling Locations



Legend

1 ▲ 2 ●

Water Quality Sampling Locations

Base Information

- Drains and Intermittent Streams
- Rivers and streams
- Lakes and ponds
- Highway
- Primary County Road

Data Sources: Hydrologic Base Information - MDEQ watershed boundaries; 1:24,000 scale - Michigan Center for Geographic Information, Department of Information Technology, 2008

Base Information - Michigan Center for Geographic Information, Department of Information Technology, 2008

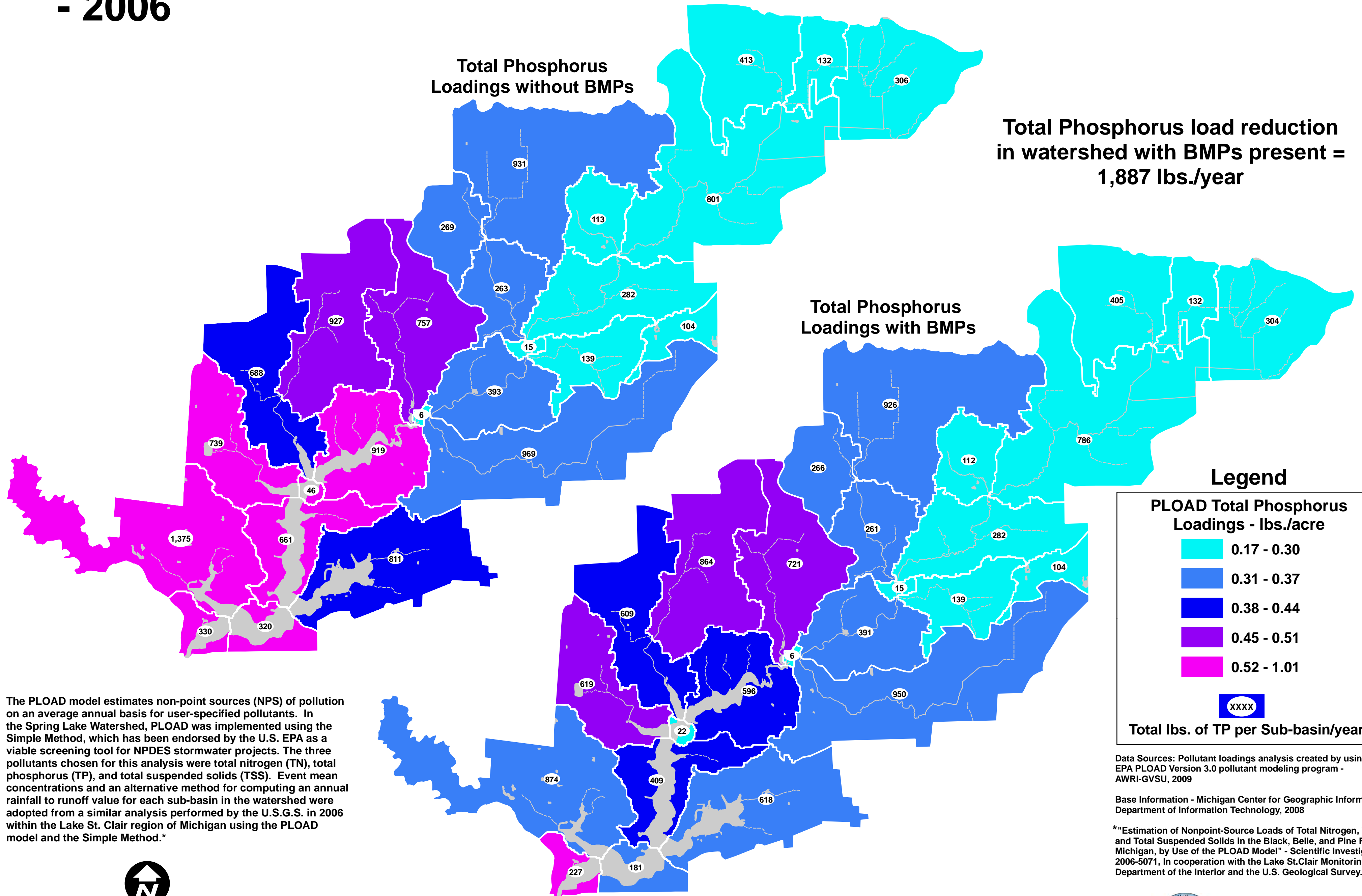
1 Water Quality Sampling locations and monthly sample data (1997: May through Dec. and 1998: March through Oct.) were taken from a study conducted by:
 Lauber, T.E.L. 1999. Graduate Thesis. Can the Big Bayou be saved? Water quality assessment and management recommendations for Spring Lake Watershed, Ottawa and Muskegon Counties, Michigan. Michigan State University, East Lansing, MI

2 Stream Sampling along Norris, Vincent and Willow Hill Creeks (data collected 7/18/07, 7/27/07, 1/7/08, 3/3/08, 3/10/08, 3/18/08, and 4/11/08) by Lakeshore Environmental, Inc., Grand Haven, MI.



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PLOAD Results for Total Phosphorus Loadings with and without BMPs - 2006



The PLOAD model estimates non-point sources (NPS) of pollution on an average annual basis for user-specified pollutants. In the Spring Lake Watershed, PLOAD was implemented using the Simple Method, which has been endorsed by the U.S. EPA as a viable screening tool for NPDES stormwater projects. The three pollutants chosen for this analysis were total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS). Event mean concentrations and an alternative method for computing an annual rainfall to runoff value for each sub-basin in the watershed were adopted from a similar analysis performed by the U.S.G.S. in 2006 within the Lake St. Clair region of Michigan using the PLOAD model and the Simple Method.*

Legend

PLOAD Total Phosphorus Loadings - lbs./acre

- 0.17 - 0.30
- 0.31 - 0.37
- 0.38 - 0.44
- 0.45 - 0.51
- 0.52 - 1.01

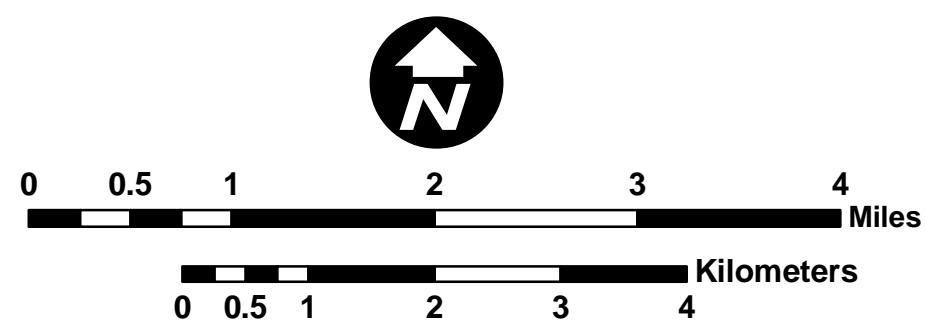
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Total lbs. of TP per Sub-basin/year

Data Sources: Pollutant loadings analysis created by using U.S. EPA PLOAD Version 3.0 pollutant modeling program - AWRI-GVSU, 2009

Base Information - Michigan Center for Geographic Information, Department of Information Technology, 2008

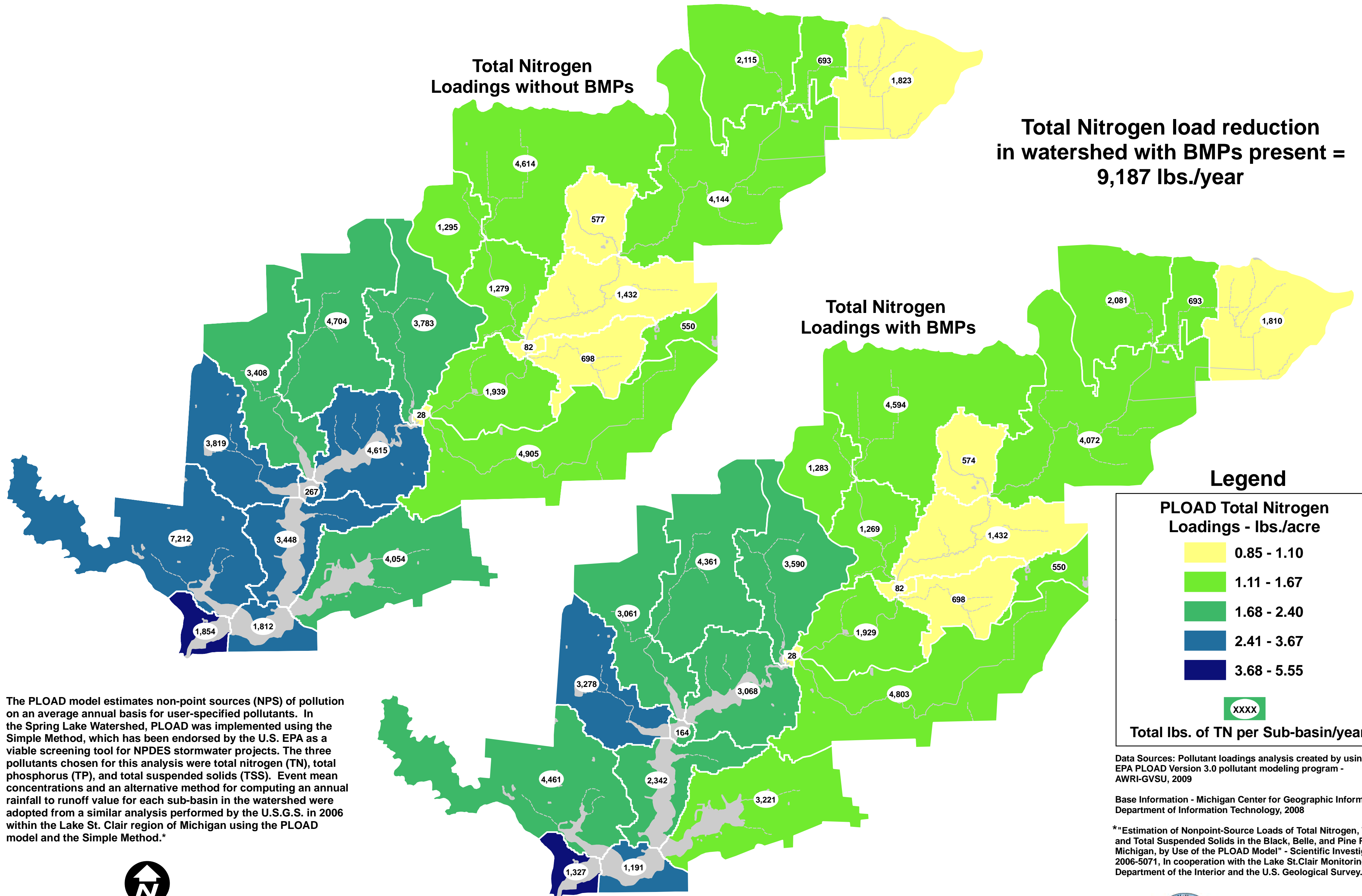
*"Estimation of Nonpoint-Source Loads of Total Nitrogen, Total Phosphorus, and Total Suspended Solids in the Black, Belle, and Pine River Basins, Michigan, by Use of the PLOAD Model" - Scientific Investigations Report 2006-5071, In cooperation with the Lake St. Clair Monitoring Project, U.S. Department of the Interior and the U.S. Geological Survey.



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PLOAD Results for Total Nitrogen Loadings with and without BMPs - 2006

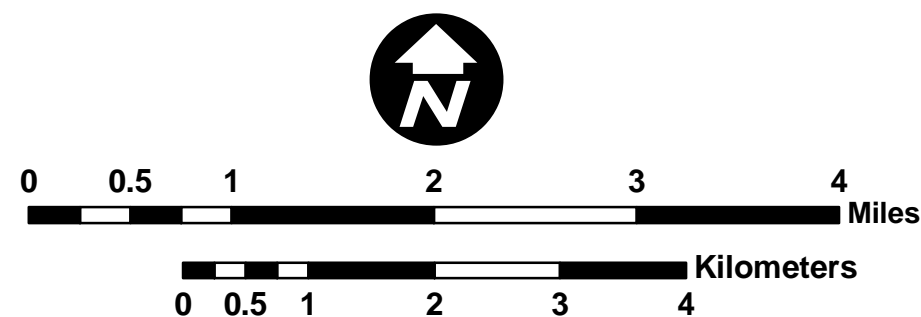


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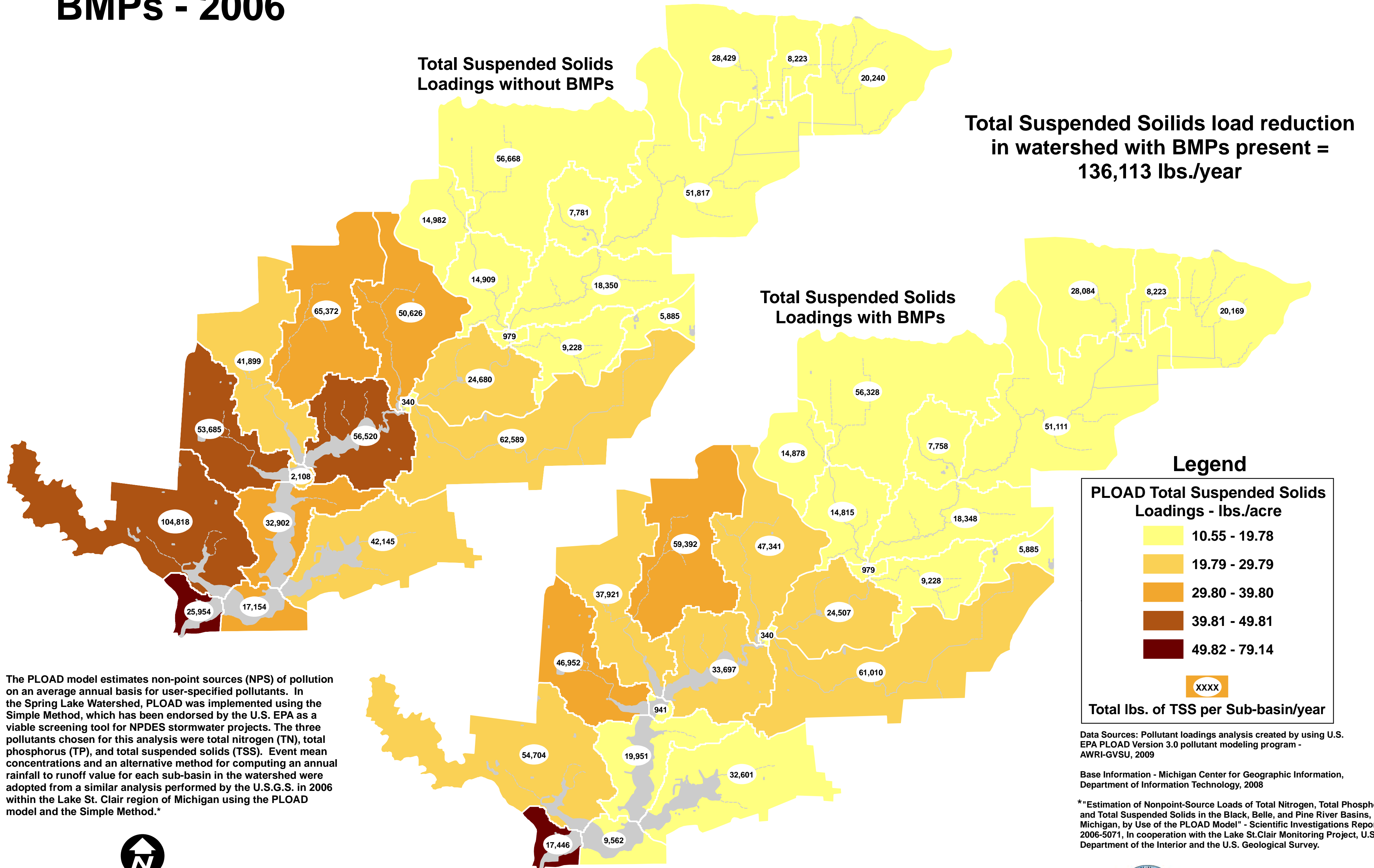
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PLOAD Results for Total Suspended Solids Loadings with and without BMPs - 2006

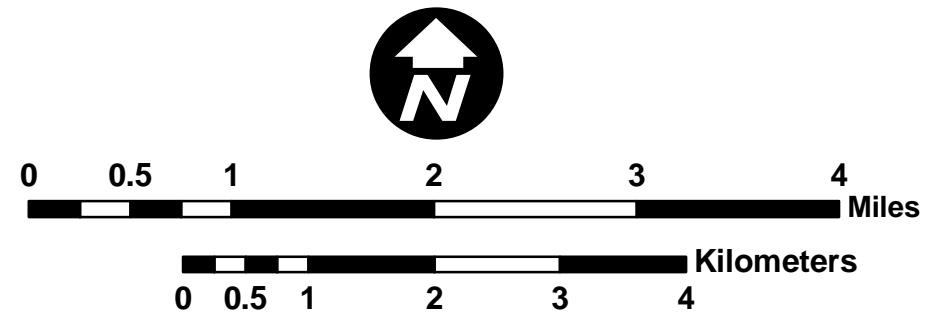


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Data Sources: Pollutant loadings analysis created by using U.S. EPA PLOAD Version 3.0 pollutant modeling program - AWRI-GVSU, 2009

Base Information - Michigan Center for Geographic Information, Department of Information Technology, 2008

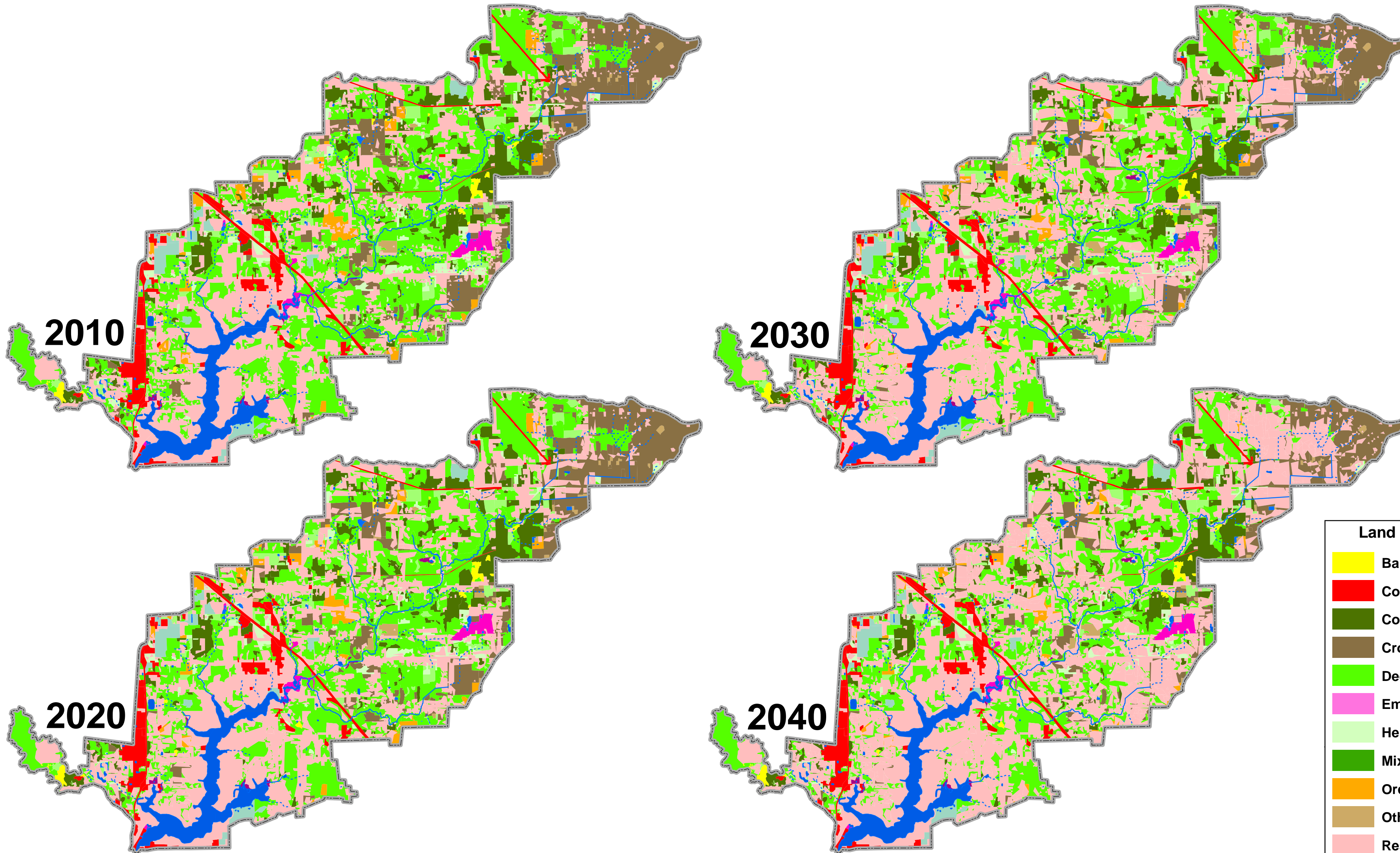
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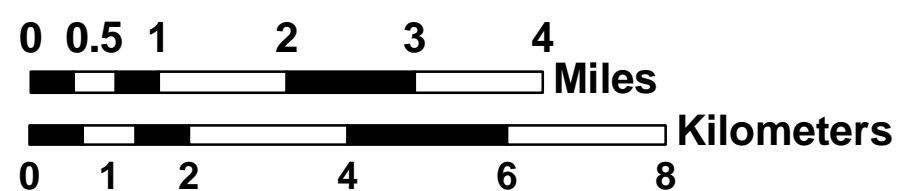
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PAM Analysis: Projected Residential Growth for 2010, 2020, 2030 and 2040



Population Allocation Model (PAM) was run using a 40 year average population growth rate of 1.76% (U.S. Census Bureau) and a population density of 2.16 persons/acre (determined by the PAM model). The PAM model analyzes current and past residential development patterns for the Spring Lake Watershed and predicts future residential growth based on these development trends, average population growth rate, and population density.



Data Sources:
 2006 Land Use and Cover - AWRI-GVSU Updated using
 2006 National Agricultural Imagery Program (NAIP) Digital
 Orthophotograph with AWRI-GVSU 1992-97 Land Use and Cover Data

Base Information - Michigan Center for Geographic
 Information, Department of Information Technology, 2008

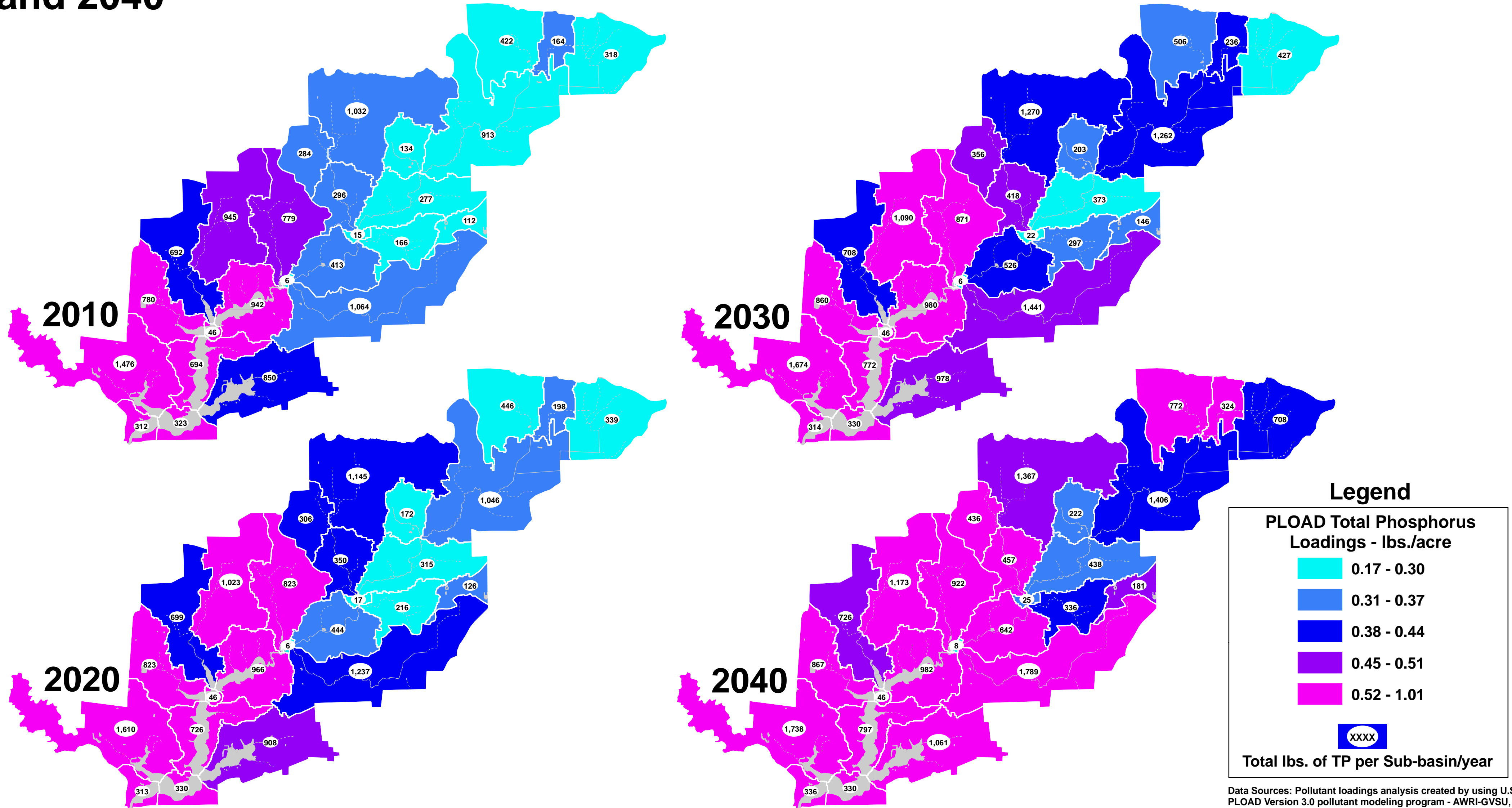
Population Allocation Model (PAM) developed by GVSU-AWRI
 Population Data: U.S. Census Bureau (1960 - 2000)



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PAM Analysis: Projected Results for Total Phosphorus Loading for 2010, 2020, 2030, and 2040

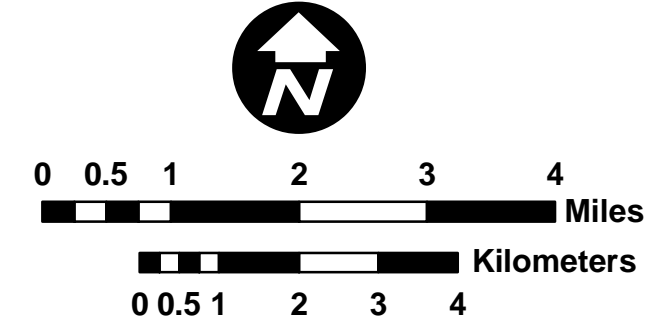


Data Sources: Pollutant loadings analysis created by using U.S. EPA PLOAD Version 3.0 pollutant modeling program - AWRI-GVSU, 2009

Population Allocation Model (PAM) developed by GVSU-AWRI; Population Data: U.S. Census Bureau (1960 - 2000)

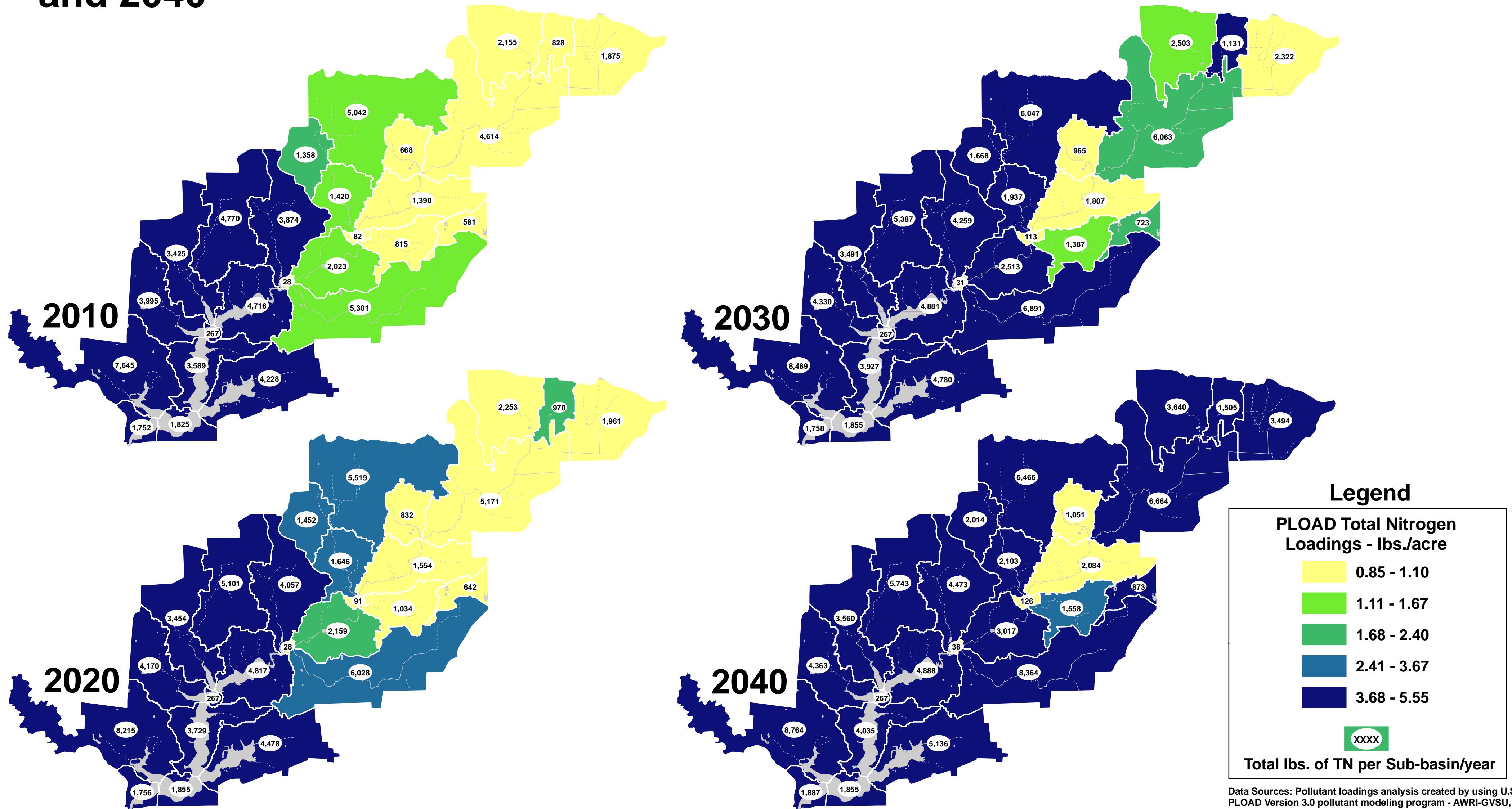
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This analysis shows the total phosphorus loads over time in the Spring Lake Watershed. Based on the land use changes projected with the Population Allocation Model, the increased residential land cover and decreased natural land cover result in an overall increase of TP of 4,634 lbs./year between 2010 and 2040.



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PAM Analysis: Projected Results for Total Nitrogen Loading for 2010, 2020, 2030, and 2040



Legend

PLOAD Total Nitrogen Loadings - lbs./acre

- 0.85 - 1.10
- 1.11 - 1.67
- 1.68 - 2.40
- 2.41 - 3.67
- 3.68 - 5.55

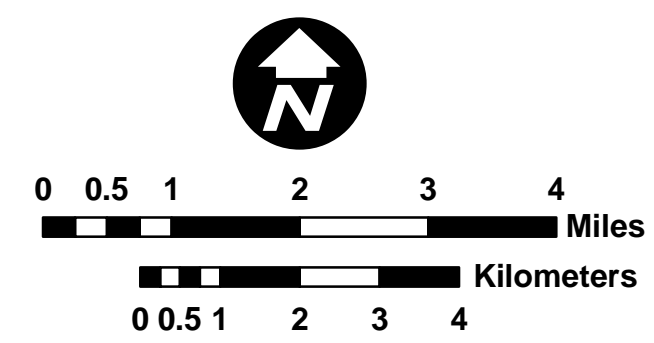
XXXX
Total lbs. of TN per Sub-basin/year

Data Sources: Pollutant loadings analysis created by using U.S. EPA PLOAD Version 3.0 pollutant modeling program - AWRI-GVSU, 2009

Population Allocation Model (PAM) developed by GVSU-AWRI;
Population Data: U.S. Census Bureau (1960 - 2000)

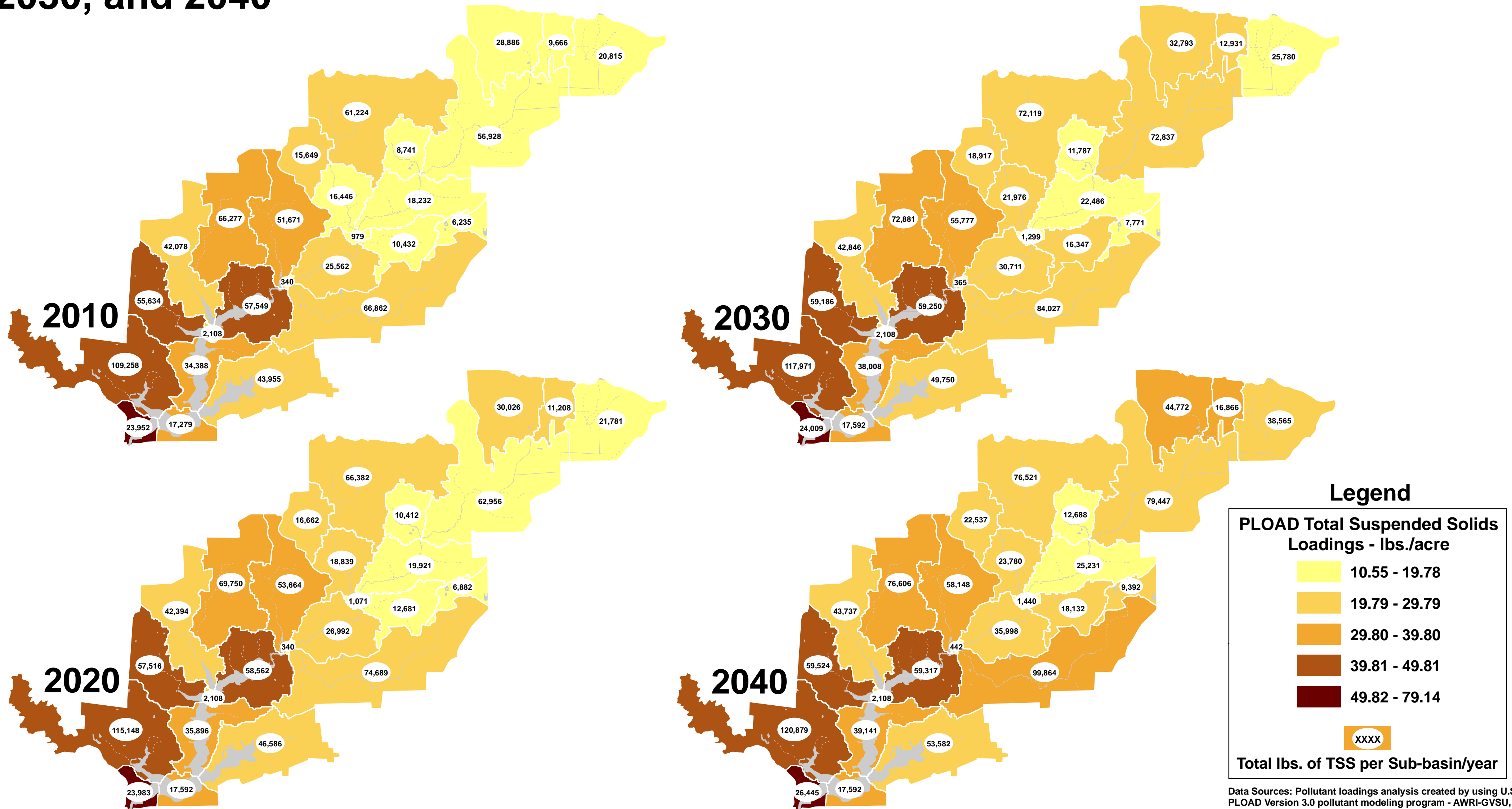
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This analysis shows the total nitrogen loads over time in the Spring Lake Watershed. Based on the land use changes projected with the Population Allocation Model, the increased residential land cover and decreased natural land cover result in an overall increase of TN of 19,698 lbs./year between 2010 and 2040.



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PAM Analysis: Projected Results for Total Suspended Solids Loading for 2010, 2020, 2030, and 2040



Data Sources: Pollutant loadings analysis created by using U.S. EPA PLOAD Version 3.0 pollutant modeling program - AWRI-GVSU, 2009

Population Allocation Model (PAM) developed by GVSU-AWRI;
Population Data: U.S. Census Bureau (1960 - 2000)

"Estimation of Nonpoint-Source Loads of Total Nitrogen, Total Phosphorus, and Total Suspended Solids in the Black, Belle, and Pine River Basins, Michigan, by Use of the PLOAD Model" - Scientific Investigations Report 2006-5071, In cooperation with the Lake St. Clair Monitoring Project, U.S. Department of the Interior and the U.S. Geological Survey.

This analysis shows the total suspended solids loads over time in the Spring Lake Watershed. Based on the land use changes projected with the Population Allocation Model, the increased residential land cover and decreased natural land cover result in an overall increase of TSS of 211,605 lbs./year between 2010 and 2040.

