Chapter 2: Conditions in the Spring Lake Watershed related to Stormwater Pollution

To identify the primary causes and consequences of stormwater discharges to Spring Lake and its adjoining waterbodies, the Rein in the Runoff project team looked at the environmental, social, and economic conditions within the watershed. This included the examination of existing datasets, data updates and analyses, and the use of hydrologic and population growth models to assess the current status and historic trends of those conditions related to the geography and natural features, development and population growth, changes in land use and land cover, and the effects of stormwater runoff on local and regional water quality and quantity within – and downstream – of the Spring Lake Watershed. For details regarding the underlying data and modeling approaches relied on by the project team, please see Appendix A.

GEOGRAPHY AND NATURAL FEATURES

Spring Lake is located on the west side of Michigan's lower peninsula (Figure 2-1). It is one of many drowned river mouths located along Lake Michigan's eastern shoreline. These geological features are remnants of the most recent Ice Age, when retreating glacial ice melted and flooded the mouths of these rivers where they entered Lake Michigan.

Spring Lake flows into the Grand River in northwestern Ottawa County, just 2.6 nautical miles to the east and upstream of Lake Michigan. The watershed encompasses 52.8 square miles in Ottawa and Muskegon counties, and includes 11 municipalities; there are two communities downstream of Spring Lake along the Grand River toward its outlet at Lake Michigan (Figure 2-2). Forty-one percent of the Spring Lake Watershed is forested, and other natural features include the lake and several tributary streams (~1,100 acres), approximately 340 acres of

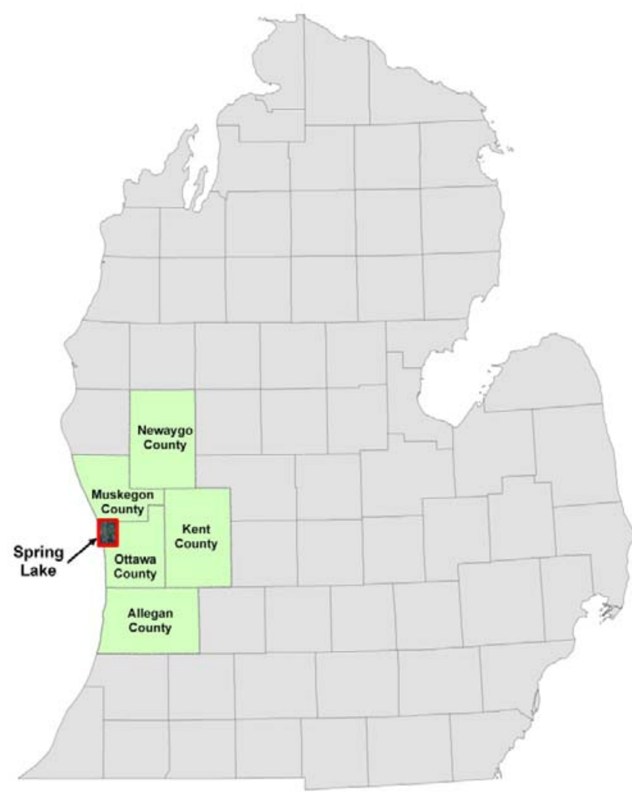

Figure 2-1. Geographic location of Spring Lake in Michigan's western lower peninsula.

wetlands, and more than 2,200 acres of urban and rural shrub and grasslands (Michigan Center for Geographic Information, Department of Information Technology 2008; Michigan Resources Information System (MIRIS), MDNR Land and Water Management Division 1978; 2006 update by AWRI).

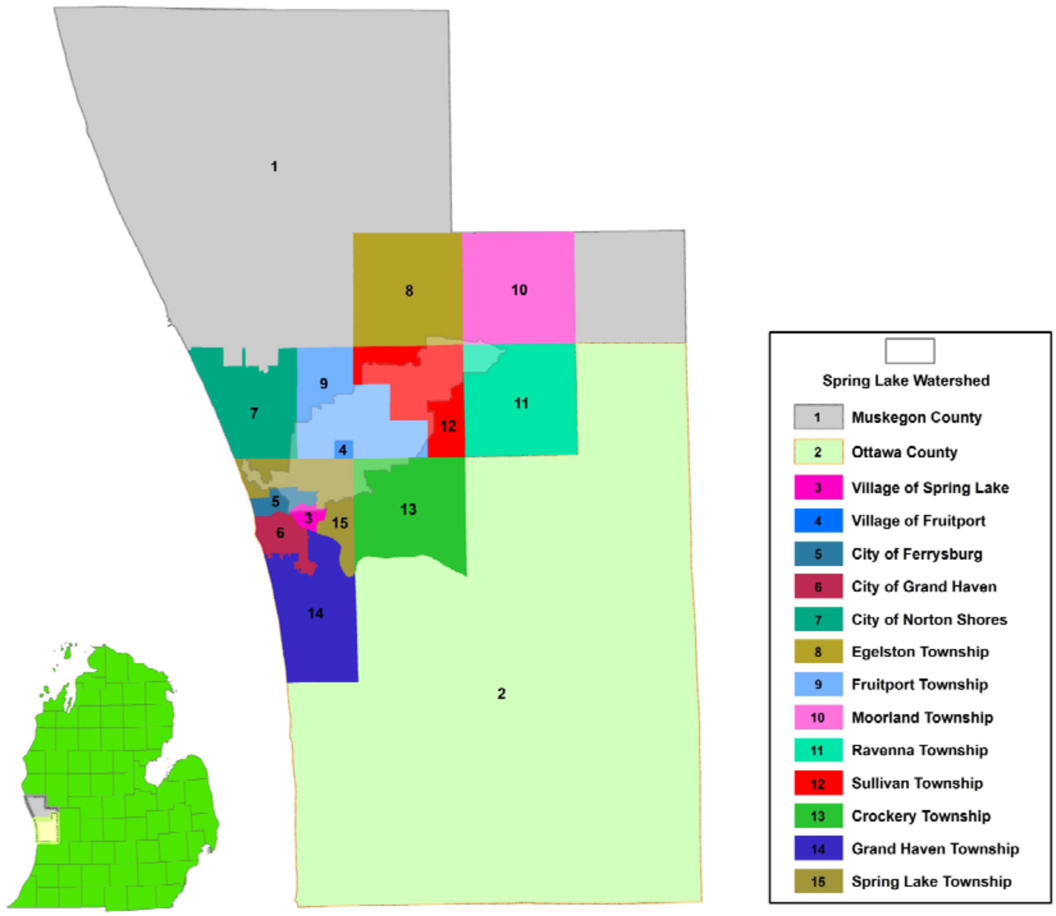

Figure 2-2. Municipal jurisdictions within the Spring Lake Watershed boundary and downstream to the mouth of the Grand River.

The soils throughout the watershed are predominantly sand or sandy-textured (Figure 2-3). More than 76% of the soils in the Spring Lake Watershed are classified under Hydrologic Soil Groups A or B, which have high to highly moderate rainfall infiltration rates and low stormwater runoff potential (Table 2-1). This results in a very pervious natural landscape which is well-suited to handle natural precipitation.

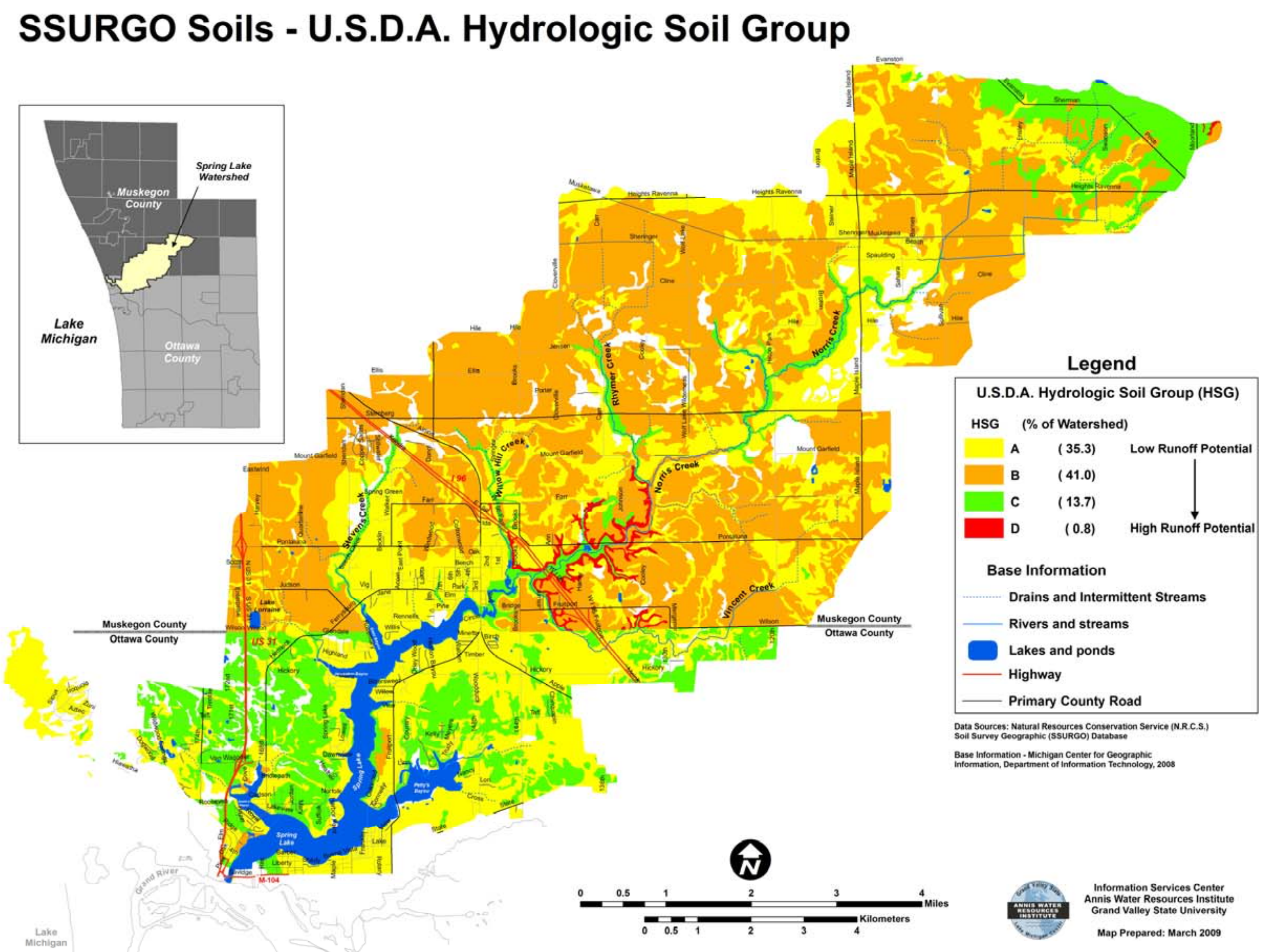

Figure 2-3. Classification of soils in the Spring Lake Watershed by Hydrologic Soil Groups.

Table 2-1. Natural Resources Conservation Service Hydrologic Soil Groups (USDA National Resources Conservation Service, TR-55, June 1986).

Hydrologic Soil Group	Runoff Potential	Description	Texture
A	Low	High infiltration rates, even when thoroughly wetted; consists chiefly of deep, well to excessively drained sand or gravel	Sand, loamy sand or sandy loam
B	Moderately Low	Moderate infiltration rates when thoroughly wetted; consists chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures	Silt loam or loam
C	Moderately High	Low infiltration rates when thoroughly Wetted; consists chiefly of a layer that impedes downward movement of water and with moderately fine to fine texture	Sandy clay loam
D	High	Very low infiltration rates when thoroughly wetted; consists chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material	Clay loam, silty clay loam, sandy clay, silty clay or clay

POPULATION GROWTH AND LAND USE CHANGE

Located in one of the only regions in Michigan to see continued population growth in the last decade, the Spring Lake Watershed has seen large historic increases in residential and commercial development, and corresponding decreases in forested and agricultural lands (Figure 2-4). Because Spring Lake is connected to Lake Michigan by the Grand River, boating is popular and property values are high. Most of the existing development has occurred along these waterways (Figure 2-5), and there is a great deal of continued pressure to develop the few remaining natural areas around the lake (Progressive AE, Project No. 54060102, April 2001). As natural lands are converted to residential and commercial development, water that was once absorbed by soil or transpired by vegetation is now conveyed from roadways, rooftops, and parking lots by storm drains, canals, and pipes to nearby surface waters as stormwater runoff. Spring Lake and the Grand River are already impacted by high levels of phosphorus, potentially-toxic cyanobacteria blooms, and waterborne pathogens; the nearshore areas of Lake Michigan are also showing significant signs of impairment from nonpoint source pollution.

2-4a.

2-4b.

2-4c.

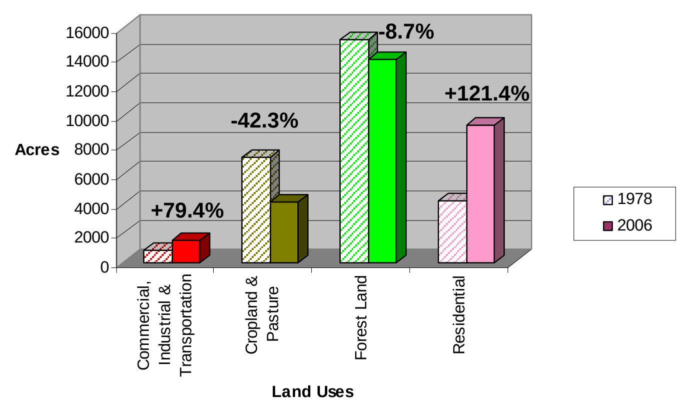

Figure 2-4: Significant land use change in the Spring Lake Watershed 1978-2006.[1]

1 Full-sized land use and land cover maps can be found in the Rein in the Runoff Project Atlas, Section 2.

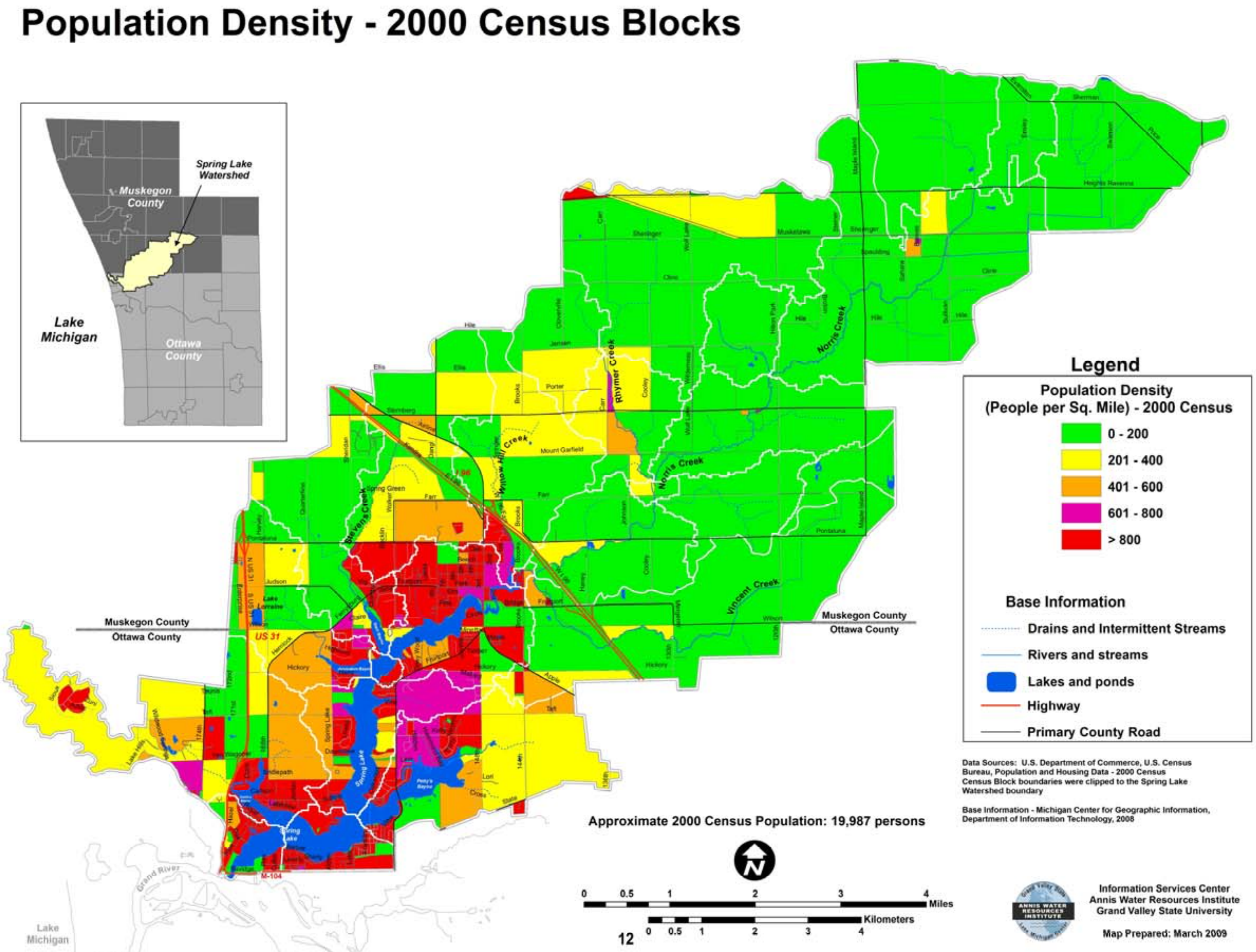

Figure 2-5. Population density (2000) of the Spring Lake Watershed.

This urban growth in the Spring Lake Watershed has resulted in a dramatic increase in total impervious area[1], particularly in the communities adjacent to Spring Lake (Figure 2-6). In the last decade, the watershed has gone from a mean percent impervious surface area of 10% to 15%. In 1992-97, more than 63% of the watershed consisted of land uses and land covers associated with impervious surface areas of less than 10%; in 2006, this percentage had decreased to less than 27% (see Figure 2-6). The areas immediately adjacent to Spring Lake have total impervious surface cover greater than 15% - and in most cases, greater than 20%. This has dramatically affected the way precipitation moves through this system. As noted above, in its natural, presettlement state, the predominantly sandy soils in the Spring Lake Watershed had high to moderately high rainfall infiltration rates and low runoff potential. The increase in imperviousness, particularly in the areas surrounding the lake, has removed these natural stormwater control benefits.

SCOPE OF STORMWATER PROBLEM

As a result of the dramatic increases in development and impervious surfaces in the watershed, Spring Lake has been impacted by stormwater pollution – most notably high levels of phosphorus (P). Spring Lake has had some of the highest P concentrations measured in West Michigan, with total phosphorus (TP) levels averaging 100 parts per billion (ppb) and reaching as high as 631 ppb during ice-free periods from 1999 – 2003 (Steinman et al. 2006; Figure 2-7). Approximately 55-65% of the TP entering the system during this period came from internal loading, which is the release of P from sediments on the lake-bottom (Steinman et al. 2004, 2006). Internal P loading can be a significant source of nutrients in shallow, eutrophic lakes such as Spring Lake, and can result in serious impairment to water quality (Welch and Cooke 1995, 1999; Steinman et al. 1999, 2004; Søndergaard et al. 2001; Nürnberg and LaZerte 2004).


Photo credit: Spring Lake Lake Board

[1] This analysis looked at total impervious area for the Rein in the Runoff-defined land use and land covers present in the Spring Lake Watershed sub-basins. The project team did not take into consideration connected impervious area, which includes only those impervious surfaces which flow directly into a storm sewer, drain, channel, or waterway, without flowing over any pervious surfaces. Because the team delineated percent impervious surface values based solely on land use and cover type, this analysis may overestimate potential impairments.

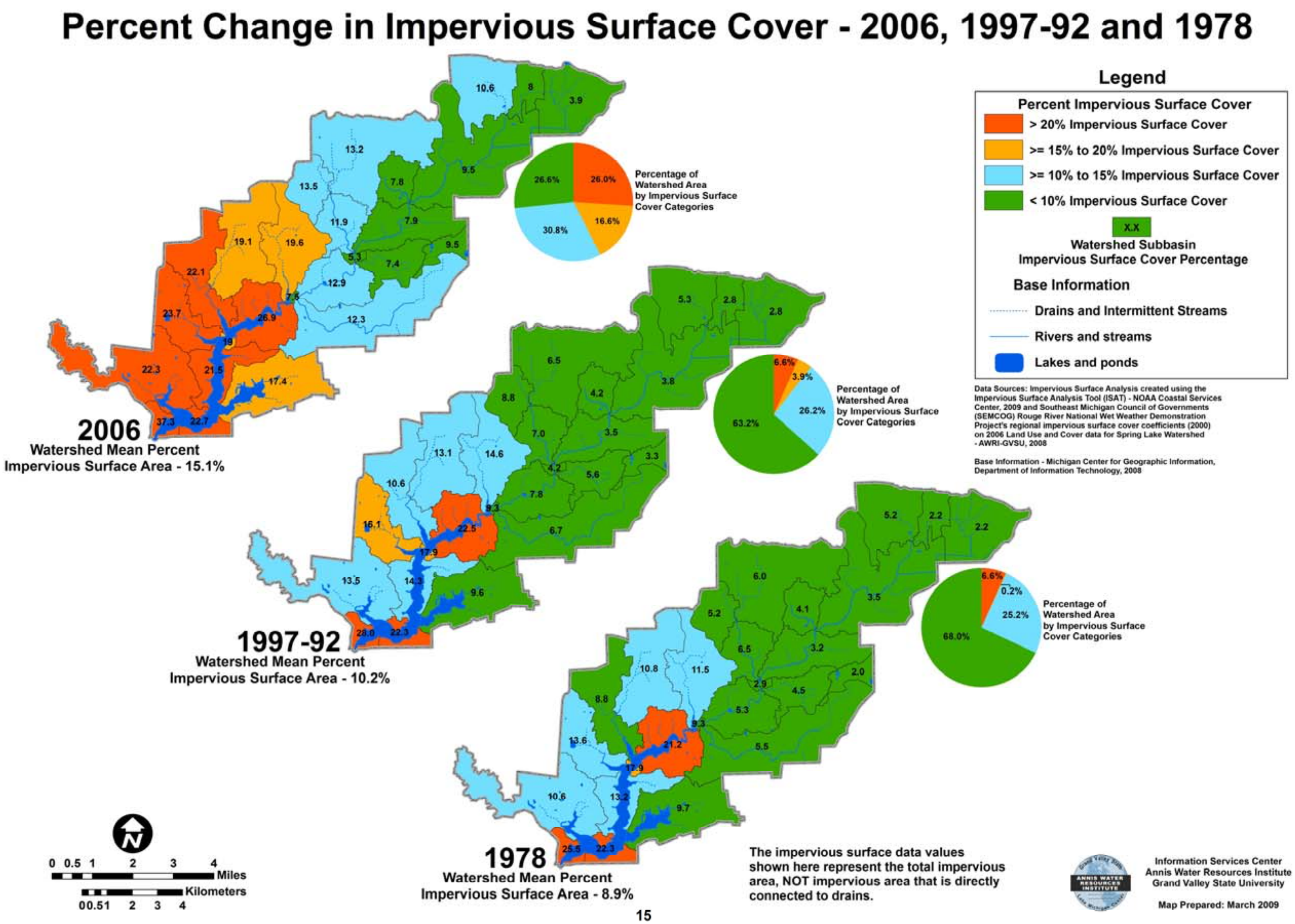

Figure 2-6. Percent change in impervious surface cover in the Spring Lake Watershed from 1978 – 2006.

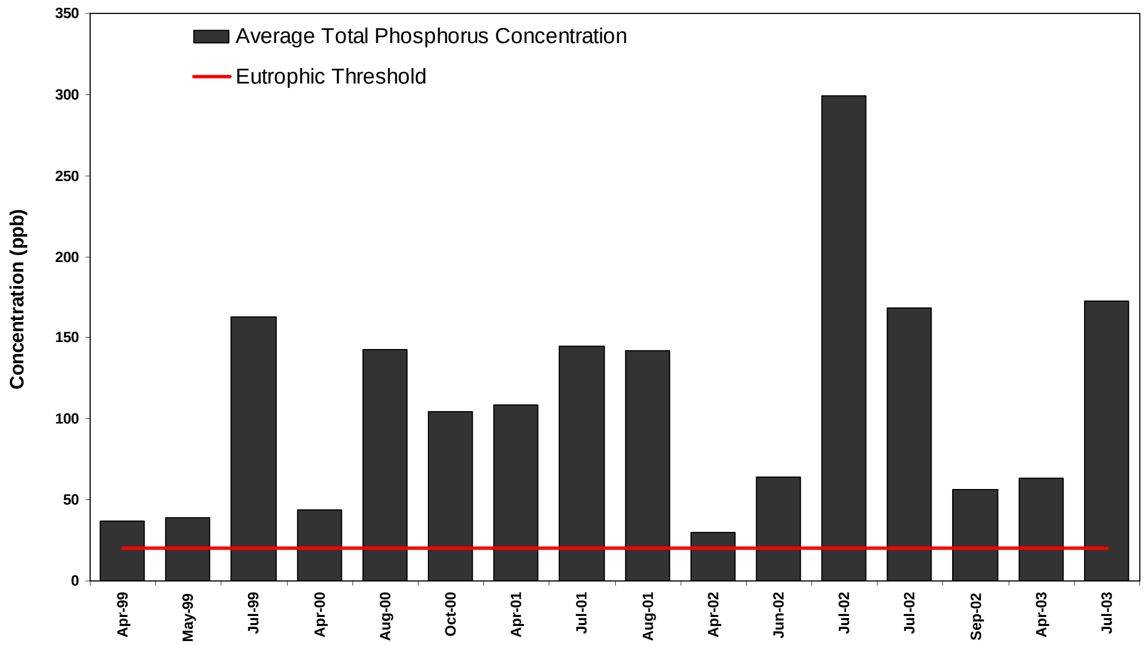

Figure 2-7. Total phosphorus levels (parts per billion) in Spring Lake (1999 – 2003) (data courtesy of Progressive AE).

Even when external P loading rates are relatively low, high internal loading rates can help trigger or sustain algal blooms, which was the case in Spring Lake. To help alleviate this problem, in the Fall of 2005 an alum treatment of ~80 g Al m^{-2} was applied to approximately 47% of the lake's surface area. Alum binds with P and restricts its release from the sediment (Steinman et al. 2004). This resulted in an overall decrease in P concentrations and reduced the rate of internal P loading (Steinman and Ogdahl 2008).

However, even after application of the alum treatment, mean TP concentrations in Spring Lake remain above eutrophic thresholds, suggesting ongoing external P loads to the system (Steinman and Ogdahl 2008). To support this conclusion, the Rein in the Runoff project team modeled the effects of past and current land use and cover in the Spring Lake Watershed on nutrient loads to Spring Lake (see Appendix A). The PLOAD model results showed increased pollutant loads for Total Phosphorus (TP) (Figure 2-8), Total Nitrogen (TN) (Figure 2-9), and Total Suspended Solids (TSS) (Figure 2-10) from 1978 to 2006.

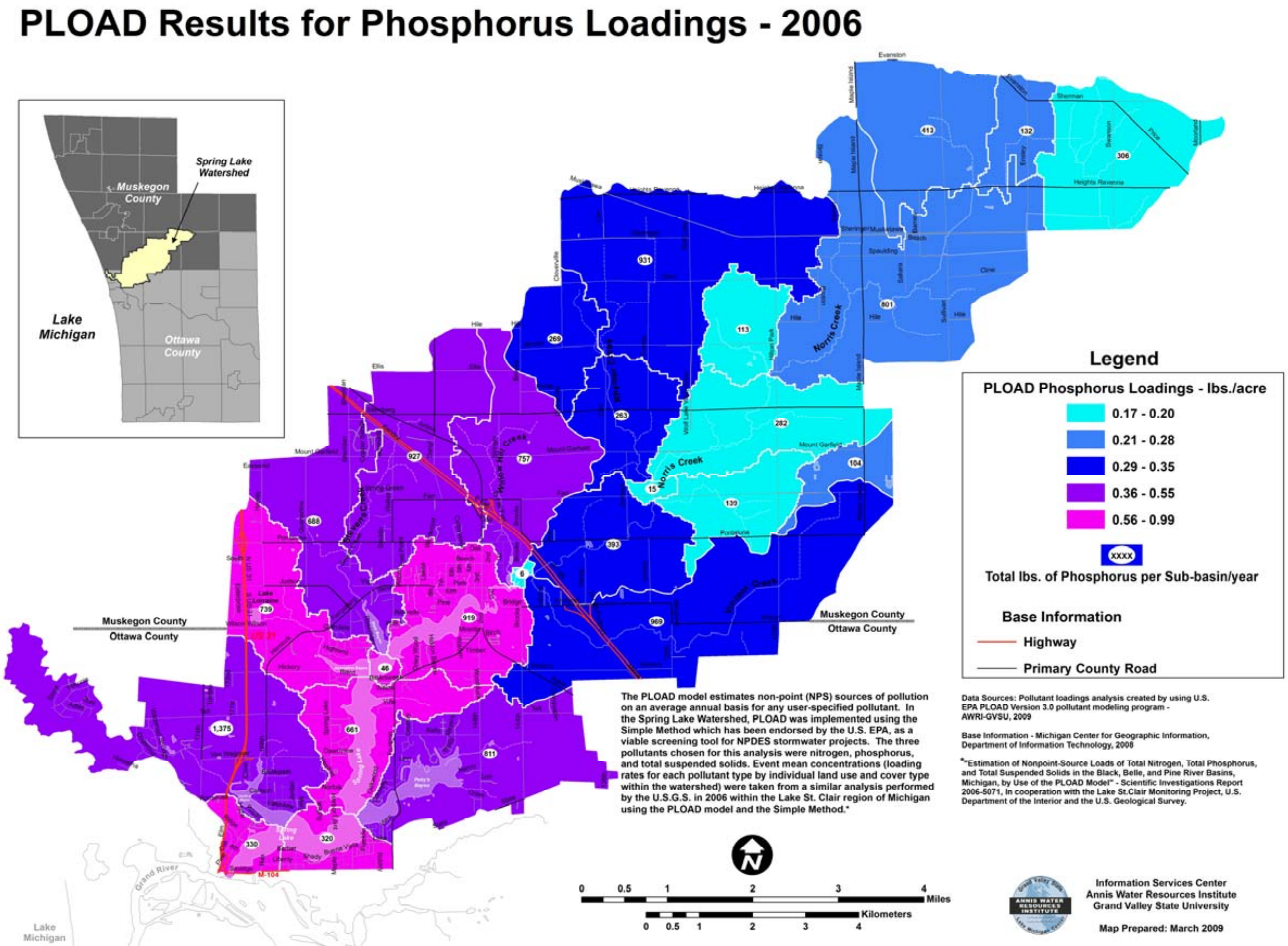

Figure 2-8. Rein in the Runoff modeling results for Total Phosphorus loadings from the Spring Lake Watershed based on 2006 land use and land cover.

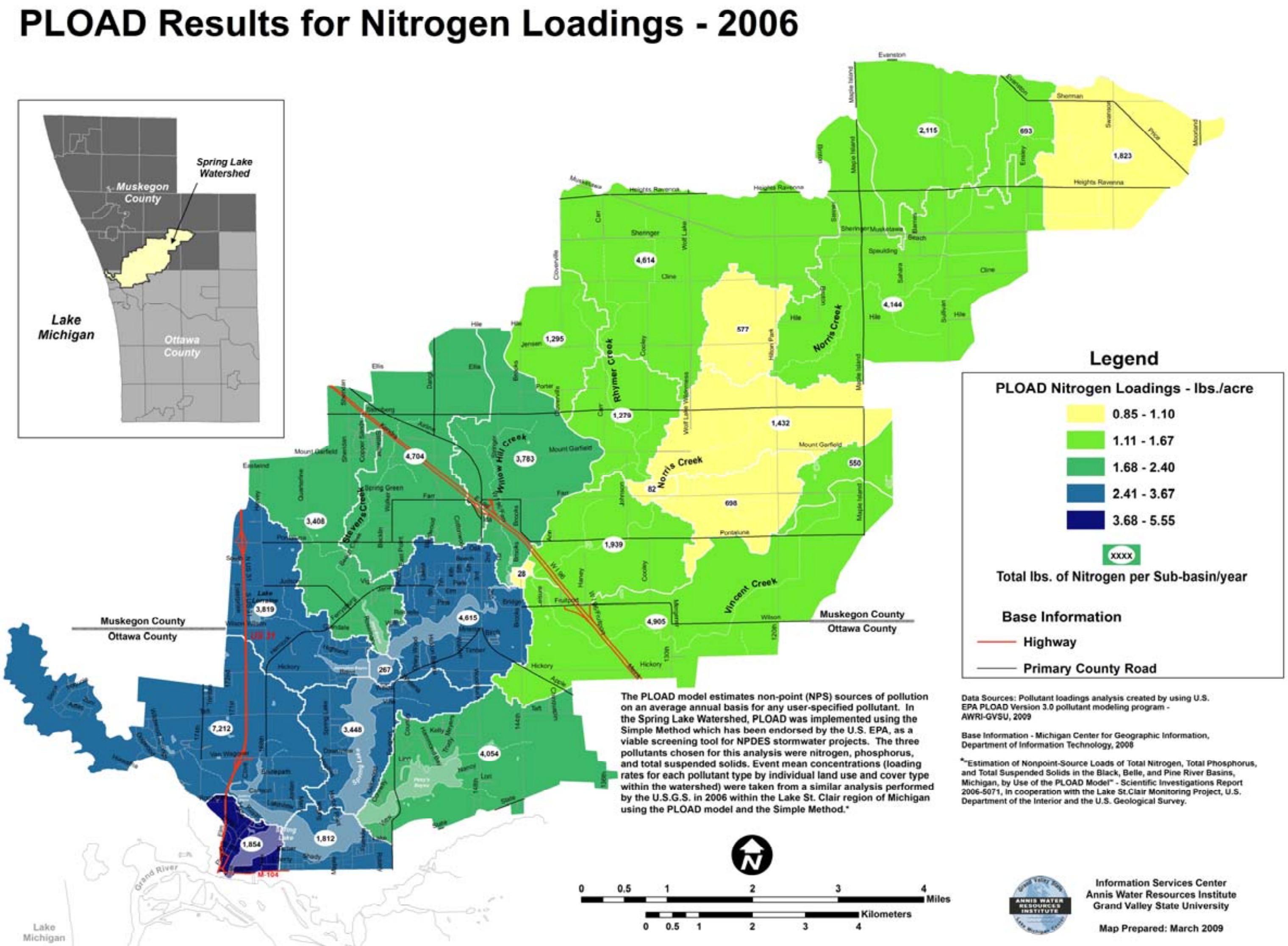

Figure 2-9. Rein in the Runoff modeling results for Total Nitrogen loadings from the Spring Lake Watershed based on 2006 land use and land cover.

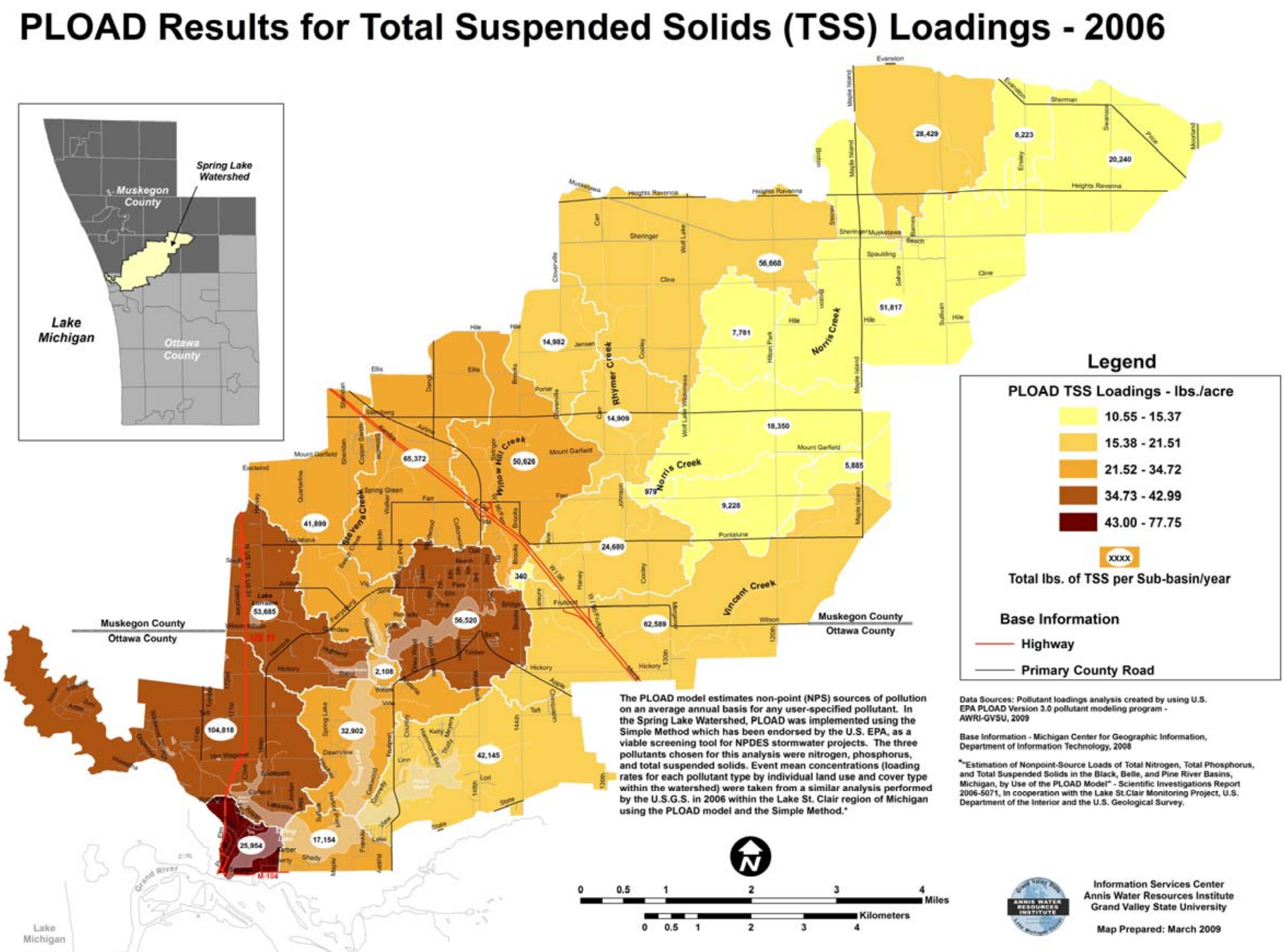

Figure 2-10. Rein in the Runoff modeling results for Total Suspended Solids loadings from the Spring Lake Watershed based on 2006 land use and land cover.

Historically, the three main external sources of TP to Spring Lake annually are tributary inflow (67%), septic tank systems (17%), and inorganic fertilizer applied to lands and agricultural lands (10%) (Lauber 1999). It is these, and other, nonpoint sources of stormwater pollution that still need to be addressed in the Spring Lake Watershed.

In addition to problems associated with water quality, stormwater runoff also affects the water quantity within the watershed. Increased storm flows associated with urban runoff have also eroded streambanks. In June 2008, severe streambank erosion resulting from persistent storm flows became evident when a 35-foot wide section of road collapsed into Norris Creek in Fruitport Township. The repair to the roadway and underlying culvert cost the Muskegon County Road Commission $144,700 in contractors, labor, and materials (Muskegon County Road Commission, personal communication, June 2009). Stormwater management practices need to be put into place throughout the Spring Lake Watershed to help minimize similar events in the future.