Walloon Lake Wetlands and Tributary Assessment 2012

By Tip of the Mitt Watershed Council

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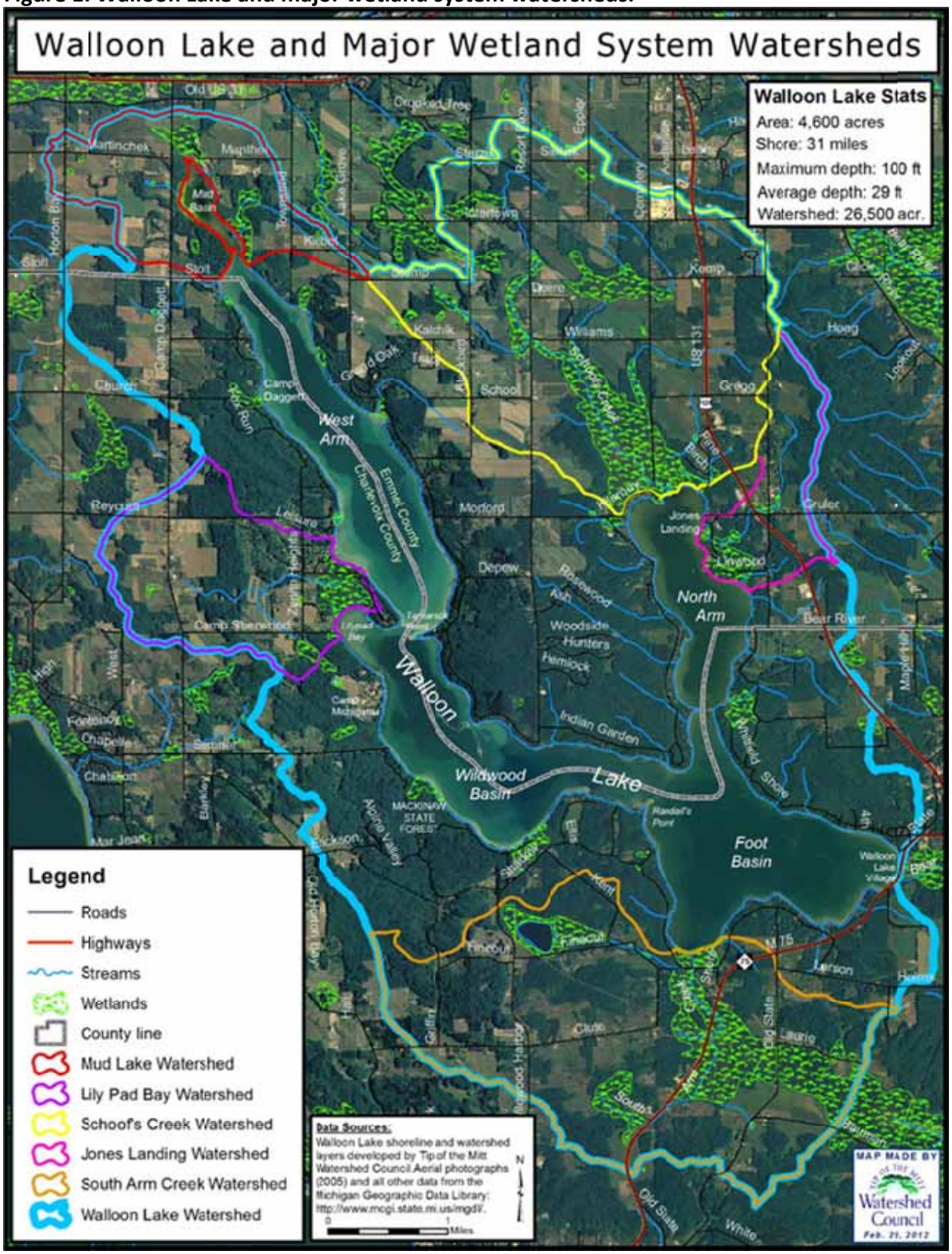
INTRODUCTION

Walloon Lake is a 4600-acre oligotrophic lake in the Northern Lower Peninsula of Michigan that drains into the Bear River and out into Lake Michigan at Little Traverse Bay. The Walloon Lake Trust and Conservancy (WLTC) has worked to permanently protect land in the Walloon Lake watershed since 1978, their mission being "to preserve and protect the quality of Walloon Lake and its watershed." To improve land protection efforts and stay true to their mission, WLTC initiated a watershed-wide assessment of the ecological value of individual properties, with a particular focus on five of the watershed's largest wetland complexes and associated inlet tributaries. The study sub-watersheds include: 1) Mud Lake, the shallow northern-most basin of Walloon Lake with abundant wetlands along its perimeter; 2) Lilypad Bay, an embayment with wetlands in the northwest end of the Wildwood Basin; 3) Fineout Creek (aka South Arm Creek), one of the largest tributaries, which drains extensive wetland areas and empties into the southernmost tip of Walloon Lake; 4) Jones Landing, wetland areas in the northeast portion of the North Arm and to the south of the Gruler Road end; and 5) Schoof's Creek, one of the largest tributaries that drains extensive wetland areas in the biggest sub-basin and flows into the lake at the northern tip of the North Arm (Figure 1).

WLTC reached out to local water resource management and land conservation partners to draw upon their expertise and develop a strategy for carrying out such an assessment. Partners in this endeavor included the Tip of the Mitt Watershed Council (TOMWC), the Little Traverse Conservancy (LTC), and the Little Traverse Bay Bands of Odawa Indians (LTBB). Following a planning meeting of project partners, WLTC submitted grant proposals to two local community foundations (the Charlevoix County Community Foundation and the Petoskey Harbor Springs) and was awarded funds to sponsor a preliminary watershed assessment consisting of the following components: 1) search for existing scientific literature and data related to the study streams and wetlands; compile information in a database or other repository, 2) delineate watershed boundaries in a Geographical Information System (GIS) for the five sub-basins associated with the study streams and wetlands, and 3) prioritize all watershed land parcels based on multiple ecological criteria to help guide land protection efforts, and 4) develop a conceptual framework for data analyses and future assessment, including best approaches and methodologies for ground truthing, filling data gaps, and performing detailed ecological assessment of the five sub-watershed areas. WLTC contracted with TOMWC to carry out the assessment.

Figure 1. Walloon Lake and major wetland system watersheds.



METHODS

Literature and Data Search:

TOMWC performed an extensive search for scientific literature and data pertaining to the five major wetland sub-watersheds of Walloon Lake, as well as associated tributaries. The following sources were consulted for relevant literature and data: TOMWC, LTBB, the University of Michigan Biological Station (UMBS), the Michigan Department of Environmental Quality (MDEQ), the Michigan Department of Natural Resources (MDNR), the Michigan Natural Features Inventory (MNFI), the United States Census Bureau (USCB), and the Walloon Lake Association (WLA). In addition, the Internet was searched at length for any other environmental data for the study area.

GIS Data Layer Development:

Prior to this study, TOMWC developed a watershed boundary layer for Walloon Lake using GIS data from the Michigan Geographic Data Library (MGDL). This watershed boundary layer was used in combination with topographical data from MGDL in a GIS to delineate watershed boundaries for the five wetland complexes included in this study. After developing map data layers for the five sub-watersheds, the acreage for each sub-watershed was calculated and included in the attribute table.

Multiple GIS layers were developed in preparation for conducting the Priority Parcel Process (see following section), the majority by isolating existing data layers to watershed boundaries. Parcel data from the Emmet and Charlevoix County GIS Departments provided the base layer for performing the assessment. Wetlands, lake shoreline, and stream channel layers were obtained directly from MGDL (National Wetlands Inventory and hydrography layers). The groundwater recharge layer had been developed during development of the Cheboygan River Watershed Habitat Partnership Conservation Area Plan using USDA county soil survey information and SSURGO soils GIS data layers. The undeveloped Walloon Lake shoreline layer was created using data from the 2010 Walloon Lake Shoreline Survey (TOMWC). Steep slopes were determined by developing a slope percentage data layer using digital elevation models available through MGDL. Determining adjacency to protected lands required equalization data from the counties, as well as preserve and conservation easement GIS data layers from WLTC and LTC. Threatened and endangered species data were downloaded from the Michigan Natural Features Inventory web site.

In addition to GIS data layer development for the Priority Parcel Analysis, land cover and impervious surface layers were developed. A 2006 land cover dataset from the National Oceanic and Atmospheric Administration Coastal Change Analysis Program was the most recent available and used to determine watershed-wide land cover. Impervious surfaces, including rooftops, roads, driveways, and sidewalks, were digitized in a few of the sub-watersheds to provide a tool for measuring development pressure. Impervious surface digitization was completed in the Jones Landing Watershed and partially in the Schoof's Creek and South Arm Creek Watersheds; impervious surface mapping was not completed for all the sub-watersheds due to time constraints.

Priority Parcel Analysis:

One of the most effective tools for long-term water quality protection is permanent protection of land, particularly sensitive lands such as those containing wetlands. Protected lands owned by the land conservancies, local governments, and private owners (conservation easements) are scattered throughout the Walloon Lake Watershed. In spite of the protected lands that currently exist in the Watershed, there remain many land parcels in sensitive areas that should be protected to safeguard the Watershed's lakes, streams, wetlands, and groundwater. In order to protect sensitive areas, a system is needed to assess land parcels in terms of ecological values.

In 2004, TOMWC worked with partners of the Cheboygan River Watershed Habitat Partnership to develop the "Priority Parcel Analysis": a GIS process that evaluates individual land parcels based on multiple ecological criteria and ranks parcels accordingly. The Priority Parcel Analysis was subsequently improved and applied to the Little Traverse Bay and Lake Charlevoix Watersheds during the update process for their respective watershed management plans. Criteria and analysis steps were again modified for the current study of Walloon Lake wetland sub-watersheds.

The end product of the analysis provides a tool to land conservancies, governmental entities, and others to assist in prioritizing land protection efforts in a manner that provides the greatest benefit to local ecosystems while also complementing existing land protection efforts. Descriptions of selection criteria and the scoring system used to determine priority parcels in the Walloon Lake Watershed are described below.

Parcel Size: Larger blocks of contiguous land typically have higher ecological value due to their potential to include a greater diversity of habitat types and species. Larger parcels are also more time and cost effective to protect than smaller parcels. The larger the parcel, the more points it received.

Ground Water Recharge Potential: Ground water discharge is essential for maintaining the healthy cold water fisheries that are so common in Northern Michigan. Land with highly permeable soils allows precipitation to percolate relatively quickly through the soils and recharge ground water supplies. Predominant soil type and associated permeability were determined for each parcel using the physical properties found in county soil surveys. Parcels were scored based on acreage containing soils with high ground water recharge potential.

Wetlands: Wetlands provide a variety of important ecological services that contribute to the health of Walloon Lake and other surface waters in the Watershed, including fish and wildlife habitat, water quality protection, flood control, and erosion prevention. National Wetlands Inventory (NWI) data layers were used to determine wetland acreage on individual parcels and scored accordingly (note that NWI only captures wetlands greater than five acres in size).

Lake Shoreline Ecosystems: Lake shorelines are the critical interface between land and water; where human activity has the greatest potential for degrading water quality. Developing shoreline properties for residential, commercial or other uses alters the riparian ecosystem and

invariably has negative impacts on the lake ecosystem. The length of shoreline was determined for individual properties using hydrography GIS data layers from the State of Michigan. Scores were based on the total shoreline distance contained within the parcel.

Undeveloped Walloon Lake Shoreline: According to the most recent Walloon Lake shore survey data (2011), approximately 85% of shoreline properties are developed. Due to the high degree of development on the shoreline, WLTC places special emphasis on permanent land protection for the remaining undeveloped shoreline properties. The location of undeveloped shoreline properties was determined using shore survey data and the length of shoreline for individual properties was measured manually in a GIS. Scores were based on the total shoreline distance found on the parcel.

Stream Shoreline/Riparian Ecosystems: Similar to lake shorelines, the stream edge is the critical interface between land and water; where human activity has the greatest potential for degrading water quality. Developing streamside properties for residential, commercial or other uses alters the riparian ecosystem and invariably has negative impacts on the stream ecosystem. The stream channel length was determined for individual properties using hydrography GIS data layers from the State of Michigan; length was measured from a line representing the center of the channel as opposed to stream edge lines (to avoid error from double counting). Scores were based on the total stream distance contained within the parcel.

Steep Slopes: Areas with steep slopes are at greater risk of erosion, particularly when developed. To prevent erosion and reduce sedimentation of surface waters in the Walloon Lake Watershed, land parcels with steep slopes merit permanent protection. GIS data from the State of Michigan was used to determine the highest percent slope on a parcel and scored accordingly.

Protected Land Adjacency: Properties adjacent to protected lands such as State forests or conservancy lands have a high ecological value because they provide a buffer to pre-existing protected lands and increase the contiguous protected area, which essentially expands the biological corridor for species migration and interaction. Protected lands include properties owned by the federal government, tribal governments, State of Michigan, local governments, universities, land conservancies, and private owners (conservation easements). Properties bordering protected lands were scored based on their potential contribution to the relative increase in the size of contiguous protected land. For example, in the case of a 40-acre parcel and a 10-acre parcel adjacent to an existing protected parcel of 20 acres, the 40-acre parcel would score higher because it would triple the size of the protected area as opposed to the lesser contribution of the 10-acre parcel. Furthermore, more points were given to parcels adjacent to conservancy preserves and private easements due to the uncertainty of the long-term protection status of public (government) lands.

Presence of State or Federally Listed Threatened or Endangered Species: Threatened and endangered species represent an important aspect of biodiversity. The Michigan Natural Features Inventory developed a probability model and rarity index based on existing threatened and endangered species information. Properties within or touching upon the model's grid cells (with a high or moderate probability of threatened and endangered species occurrence) scored

the most points. Properties intersecting with grid cells that had a low probability of occurrence were scored if the rarity index value was above three or higher.

All land parcels in the Walloon Lake Watershed were analyzed and scored using the criteria described above. The scores for each criterion were summed to produce a total score for each land parcel. Another field, "priority", was added to the attribute table that was populated with numbers from the total score field, but then were given a value of zero if among the protected lands in the watershed. GIS data layers developed during the prioritization process contain both data and scores for each criterion, as well as county equalization information, for all properties in the watershed. Therefore, GIS data can be used by WLTC and others to quickly assess individual properties in terms of total priority scores, scores for specific criteria, or statistics used to assign scores (e.g., acres of wetlands on a property).

RESULTS

Literature and Data Search:

The University of Michigan Biological Station (UMBS) provided TOMWC with a list that included 23 research papers that focused, at least in part, on Walloon Lake. Copies of a number of the research papers deemed most relevant were acquired and reviewed, including *Investigations into ecological and sociological determinants of land-use decisions - a study of inland lake watersheds in northern Michigan* (Gannon and Paddock, 1974), *Environmental Features of Walloon Lake and its Watershed* (Gold and Project Clear staff, 1978), and *CIESIN Project: Final report on sediment warming study and water quality lake survey* (DeYoe and Lowe, 1991). Although some information in the UMBS literature, such as estimated atmospheric nutrient loading, may be helpful during future assessments of the sub-watersheds associated with the five study wetland complexes, little information was found that pertained directly to the current study.

Of note, the Project CLEAR Technical Report from 1978 advocated for wetlands protection throughout the lake due to their filtering function, with particular emphasis on North Arm wetlands due to this basin's susceptibility to water quality deterioration. In regards to North Arm wetlands, the report states that "Protection of the wetlands in the North Arm is particularly vital, since their proximity to the Petoskey area makes them desirable property for residential and commercial development." Furthermore, the Project CLEAR report included some water quality data for three tributaries in the wetland complexes currently being studied: Schoof's Creek, South Arm Creek, and Skornia Creek (Lily Pad Bay). The Project CLEAR water quality data for nutrients and chloride are within typical ranges for non-impacted, high quality streams of Northern Michigan (Table 1).

Table 1. Project CLEAR water quality data for three Walloon Lake tributaries (1977).

Stream Name	Location	Date	TP* *(ppb)*	NO3-N* *(ppb)*	NH3-N* *(ppb)*	Cl* *(ppm)*
South Arm Creek	outlet	7/7/1977	32.0	13.0	16.0	3.1
South Arm Creek	outlet	7/30/1977	21.0	42.0	27.0	4.2
Schoof's Creek	outlet	5/5/1977	6.6	ND	8.6	3.4
Schoof's Creek	outlet	7/7/1977	43.0	43.0	153.0	12.0
Skornia Creek (Lily Pad Bay)	outlet	7/7/1977	27.0	40.0	17.0	3.6

*TP=total phosphorus, NO3-N=nitrate nitrogen, NH3-N=ammonia nitrogen, Cl=chloride, ppb=parts per billion, ppm=parts per million.

Much more information was found searching the TOMWC library and project files. From 1984 to 1989, the Walloon Lake Association sponsored a comprehensive assessment of Walloon Lake and its Watershed that was carried out by Limno-Tech, Inc. and called Project Vigilant. Several components of the watershed analysis performed during Project Vigilant could be incorporated into a comprehensive assessment of the watersheds of the five study wetland complexes, such as hydrogeological data and watershed loading models. The importance of preserving wetlands around the lake and throughout the watershed was repeatedly emphasized in the report as demonstrated in the following excerpts:

> "The preservation of wetlands in the watershed is extraordinarily important. The basin-wide pollutant loads and resulting water quality are very sensitive to the presence of wetlands. The degradation or loss of wetlands would be devastating to Walloon Lake."

> "The beneficial effects of wetlands in the Walloon Lake watershed on sediment and phosphorus loads from tributaries are apparent from Project Vigilant data. The loss of wetlands in the Walloon Lake watershed would result in significantly higher levels of pollutants being delivered to the lake. Protection of remaining wetlands is, therefore, and important aspect of lake protection efforts."

In addition, water quality data were collected from three tributaries on Walloon Lake as part of Project Vigilant, including Schoof's and South Arm Creeks. Monitoring was performed near the mouths of these creeks multiple times during 1986 and 1987. Averages and ranges for the parameters monitored are presented in Table 2 (complete data set available in Appendix A). The following excerpt from the report describes Project Vigilant water quality monitoring results.

> "Overall, data indicated that water quality in these tributaries was remarkably clean. During wet weather periods, however, concentrations of phosphorus increased dramatically reaching levels up to ten times higher than typical dry weather concentrations. On the average, wet weather and snowmelt impacts produced approximately twice the amount of phosphorus delivered to the lake versus dry weather loads."

Project Vigilant also included discharge (flow) measurements, which were collected multiple times during 1986 and 1987 at sites in 22 tributaries of Walloon Lake. Discharge was measured at five

locations on Schoof's Creek, two sites on a tributary of the Jones Landing wetland complex, and two on South Arm Creek. All discharge data are included in Appendix A.

Table 2. Project Vigilant water quality data for Schoof's and South Arm Creeks[†] (1987).

Parameter*	Average (Schoof's)	Low (Schoof's)	High (Schoof's)	Average (South Arm)	Low (South Arm)	High (South Arm)
TP *(ppb)*	8.2	2.9	14.6	13.4	4.6	21.8
SRP *(ppb)*	2.1	1	5.2	4	1	15.5
TKN *(ppb)*	670	420	1100	546	350	800
NH3-N *(ppb)*	400	400	400	60	60	60
NO3-N *(ppb)*	60	60	60	320	320	320
Cl *(ppm)*	7.3	5	9.3	7.3	6	9
Alk *(ppm)*	217	166	252	174	144	220
Ca *(ppm)*	69	39	83.5	55	42	64
Fecal *(#/100mL)*	0	430	95	72	0	300
Chl-a *(ppb)*	0.49	0.49	0.49	ND	ND	ND

[†]Data collected from locations near the mouth of both creeks.
*TP=total phosphorus, SRP=soluble reactive phosphorus, TKN=total Kjeldahl nitrogen, NH3-N=ammonia nitrogen, NO3-N=nitrate nitrogen, Cl=chloride, Alk=alkalinity, Ca=calcium, Fecal=fecal coliforms, Chl-a=chlorophyll-a, ppb=parts per billion, ppm=parts per million, #/100mL=number of organisms per 100 milliliters.

In 1988, the Watershed Council performed a region-wide lakeshore wetland survey, which surveyed and created shoreline wetland maps of 12 lakes and 2 rivers throughout Emmet, Charlevoix, and Cheboygan counties (Little Traverse Bay, Lake Charlevoix, Walloon, Round, Crooked, Pickerel, Burt, Mullett, Douglas, Paradise, Black, and Thumb Lakes, the Crooked River, and the Indian River). The surveys were performed by either closely following the shoreline in a boat or by driving roads that were near the shore. Sighted wetlands were categorized and maps were made by comparing field data with aerial photos. Shoreline wetlands were identified in each of the sub-watersheds being studied and included the following types.

> **Schoof's Creek:** 1) Lowland hardwoods with conifer associations; 2) Deep marshes of water lily, watershield, and others; 3) Lowland conifers with broadleaf associations; 4) Shrub swamps; 5) Shrub swamps, alder predominate; 6) Shallow marshes of bur reed, rushes, and sedges; 7) Lowland herbaceous rangeland, marshland meadow; 8) Lowland conifers, tamarack predominate; 9) Lowland hardwoods; and 10) Lowland hardwoods, ash predominate.
>
> **Jones Landing:** 1) Shrub swamps of dogwood, viburnum, and willow associations; 2) Lowland conifers with broadleaf associations; 3) Shrub swamps; 4) Lowland hardwoods with conifer associations; 5) Lowland conifers with broadleaf associations, cedar predominate; 6) Deep marshes of bur reed, bulrushes, sedges, and blue joint; 7) Lowland hardwoods, ash predominate.
>
> **Mud Lake:** 1): Lowland hardwoods with conifer associations, ash predominate; 2) Lowland hardwoods with conifer associations; 3) Deep marshes of bur reed, rushes, and sedges; 4) Deep

marshes of water lily, watershield, and others; 5) Lowland conifers with broadleaf associations, cedar predominate; 6) Deep marshes, unspecific; 7) Shrub swamps; 8) Lowland herbaceous woodland, marshland meadow; 9) Lowland conifers with broadleaf associations, tamarack predominate; 10) Lowland conifers with broadleaf associations; 11)Shrub swamps, alder predominate; 12) Shallow marshes, cattail predominate; 13) Shallow marshes of bur reed, bulrushes, sedges, and blue joint; 14) Lowland hardwoods.

Lily Pad Bay: 1) Lowland conifers with broadleaf associations; 2) Deep marshes of smartweed, mud plantain, pickerel weed, arrow arum, and arrowhead; 3) Lowland herbaceous rangeland, marshland meadow; 4) Shrub swamps of dogwood, viburnum, and willow associations; 5) Lowland hardwoods with conifer associations; 6) Shrub swamps of sweet gale and bog birch association; 7) Shrub swamps, alder predominate; 8) Shallow marshes of smartweed, mud plantain, pickerel weed, arrow arum, and arrowhead; 9) Shallow marshes, cattail predominate; 10) Deep marshes of water lily, watershield, and others; 11) Deep marshes of bur reed, rushes, and sedges; 12) Lowland conifers, cedar predominate; 13) Lowland conifers, tamarack predominate.

South Arm Creek: 1) Shrub swamps; 2) Deep marshes of bur reed, rushes, and sedges; 3) Deep marshes of water lily, watersheild, and others; 4) Shallow marshes of bur reed, bulrushes, sedges, and blue joint; 5) Shrub swamps of sweet gale and bog birch association; 6) Lowland hardwoods with conifer associations; 7) Lowland conifers with broadleaf associations, cedar predominate; 8) Lowland conifers with broadleaf associations; 9) Lowland herbaceous rangeland, marshland meadow; 10) Aspen, birch wetland with conifer associations; 11) Lowland hardwoods; 12) Lowland hardwoods, red maple predominate.

In 1994, TOMWC produced a High Value Wetlands Inventory of the Watersheds of Antrim, Charlevoix, Cheboygan, and Emmet Counties, which included the Mud Lake basin, Lily Pad Bay, Schoof's Creek and South Arm Creek. Select information gathered during the inventory is included in Table 3. Descriptions of the wetlands provided in the inventory are as follows:

South Arm Creek: Primarily forested and shrub-scrub wetland with frontage on South Arm Creek and Walloon Lake. Adjoins Haymarsh Creek wetland.

Schoof's Creek: Primarily forested, shrubby; dominated by Tamarack; two separate areas of wetland frontage on Schoof's Creek.

Lily Pad Bay: Primary conifer forested with some shrub/scrub; wetland straddles peninsula with lakeshore frontage on both north and south sides; there has been at least one large structure built on the shore recently.

Mud Lake: Three wetland areas, all with shoreline frontage on a shallow bay of Walloon Lake. Primarily forested; shallow and deep marshes on lakeshore.

Table 3. Select information from the 1994 TOMWC High Value Wetlands Inventory.

Wetland Name	Wetland Area (acres)	Shoreline Length (miles)	Soils
South Arm Creek	389	2.6 S. Arm Creek, 0.2 Walloon Lake	Carbondale muck, Markey muck
Schoof's Creek	361	4.5	Carbondale muck
Lily Pad Bay	43	0.1	Linwood muck, Leelanau-Rubicon loamy sand
Mud Lake	56	0.6	Carbondale Muck
Wetland Name	**Private Ownership**	**Structures within 500 ft.**	**Surrounding Land Uses**
South Arm Creek	14 parcels	24 outside, 7 inside wetland boundary	residential, forested
Schoof's Creek	21 parcels	19, outside of wetland boundary	residential
Lily Pad Bay	5 parcels	4, outside wetland boundary	residential
Mud Lake	3+ parcels	2, outside wetland boundary	residential, industrial, agricultural, forested

The Surface Water Information Management System (SWIMS), an on-line data and information repository maintained by MDEQ, was searched for relevant environmental data and turned up two pieces of information. It was found that a septage hauler has a land application permit for a 40-acre plot in the Jones Landing wetland complex watershed. The name of the hauler is RT Septic Service, operator license #=24-05, and the Northwest Community Health Agency is responsible for inspections. The second item is a point-source pollution discharge permit for the Manthei-Petoskey Veneer Mill located on the shores of Mud Lake (Permit Number: MI0046957). MDEQ is responsible for inspections of discharge from the mill.

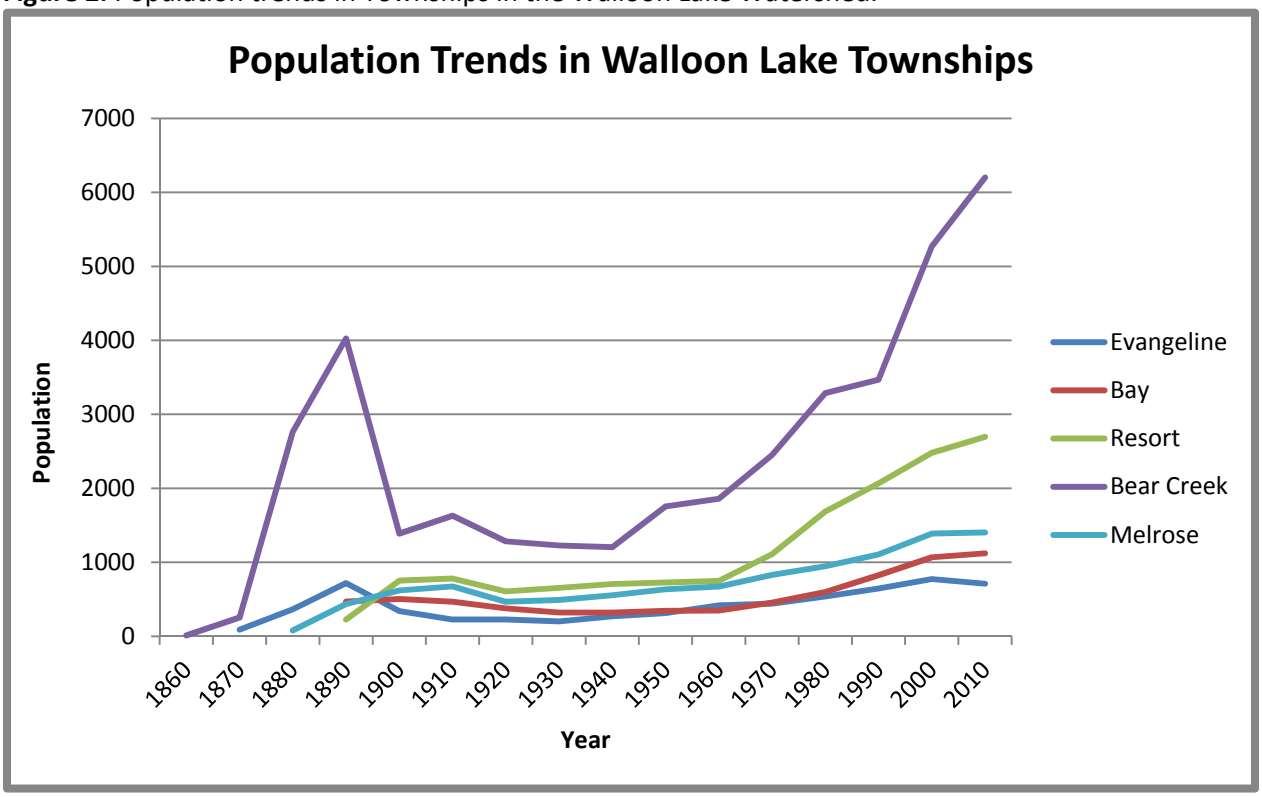
Because wetlands and feeder tributaries are important to fisheries in that they provide food, habitat, protection from predators, and spawning grounds, the MDNR was contacted to obtain fish survey results for Walloon Lake tributaries. Unfortunately, MDNR was unable to locate any fishery assessment information for the study streams, though the file search produced one good piece of information: that both Schoof's and South Arm Creeks are designated trout streams. This designation indicates that they are high-quality streams.

The Michigan Natural Features Inventory staff provided a list of seven threatened and endangered species or habitats documented in the Walloon Lake Watershed. These included the red-shouldered hawk (*Buteo lineatus*), the false violet (*Dalibarda repens*), the blunt-lobed woodsia (*Woodsia obtusa*), the woodland vole (*Microtus pinetorum*), the bald eagle (*Haliaeetus leucocephalus*), the grasshopper sparrow (*Ammodramus savannarum*) and mesic northern forest. Records for the violet, woodsia, and

vole dated from the early part of the 20th century, whereas the others were documented in the last 25 years.

Demographic data at the township level were acquired from the USCB web site to examine trends in the townships within the Walloon Lake Watershed. The population has gradually increased over time in all the townships, particularly from 1960 to 2010 (Figure 2). Bear Creek and Resort Townships have experienced the greatest population increase, which is probably a result of being located adjacent to the City of Petoskey.

Figure 2. Population trends in Townships in the Walloon Lake Watershed.



GIS Statistics:

The data layers developed in preparation for the priority parcel process revealed interesting geographical information about the Walloon Lake Watershed. Area statistics for the five major wetland sub-watersheds show the Schoof's Creek and South Arm Creek Watersheds to be the largest at over 4,000 acres each (Table 4), while Jones Landing was the smallest at 753 acres. The percentage of wetlands in the Mud Lake and Lily Pad Bay Watersheds was similar to that of the larger Walloon Lake Watershed. The percentage of wetlands in the Schoof's Creek and South Arm Creek Watersheds was more than double that of the Walloon Lake Watershed.

Table 4. Walloon Lake watershed and wetland statistics.

Basin	Watershed area (acres)	Wetland area (acres)	Wetlands (% of watershed)
Walloon Lake	26513	1705	6.43
Mud Lake	1274	96	7.54
Lily Pad Bay	1524	98	6.43
South Arm Creek	4100	651	15.88
Schoof's Creek	4401	627	14.25
Jones Landing	753	70	9.30

Steep slopes were found to be common in the Walloon Lake watershed with nearly 50% of the watershed with slopes above 10% (12,842 acres), approximately 20% with slopes above 20% (5,245 acres), and over 5% with slopes above 30% (1,520 acres). The groundwater recharge area in the watershed was also considerable at 7,322 acres (28% or the watershed). Topography (steep slopes), groundwater recharge, and soils maps are included in Appendix B.

Land cover data from 2006 showed a higher percentage of agriculture in the Walloon Lake watershed relative to other watersheds in the region (Table 5). For example, agricultural land cover in the Little Traverse Bay Watershed amounts to 16% of the watershed. The agricultural land cover is more prevalent in the northern half of the watershed (Figure 2).

Table 5. Walloon Lake Watershed land cover statistics from 2006.

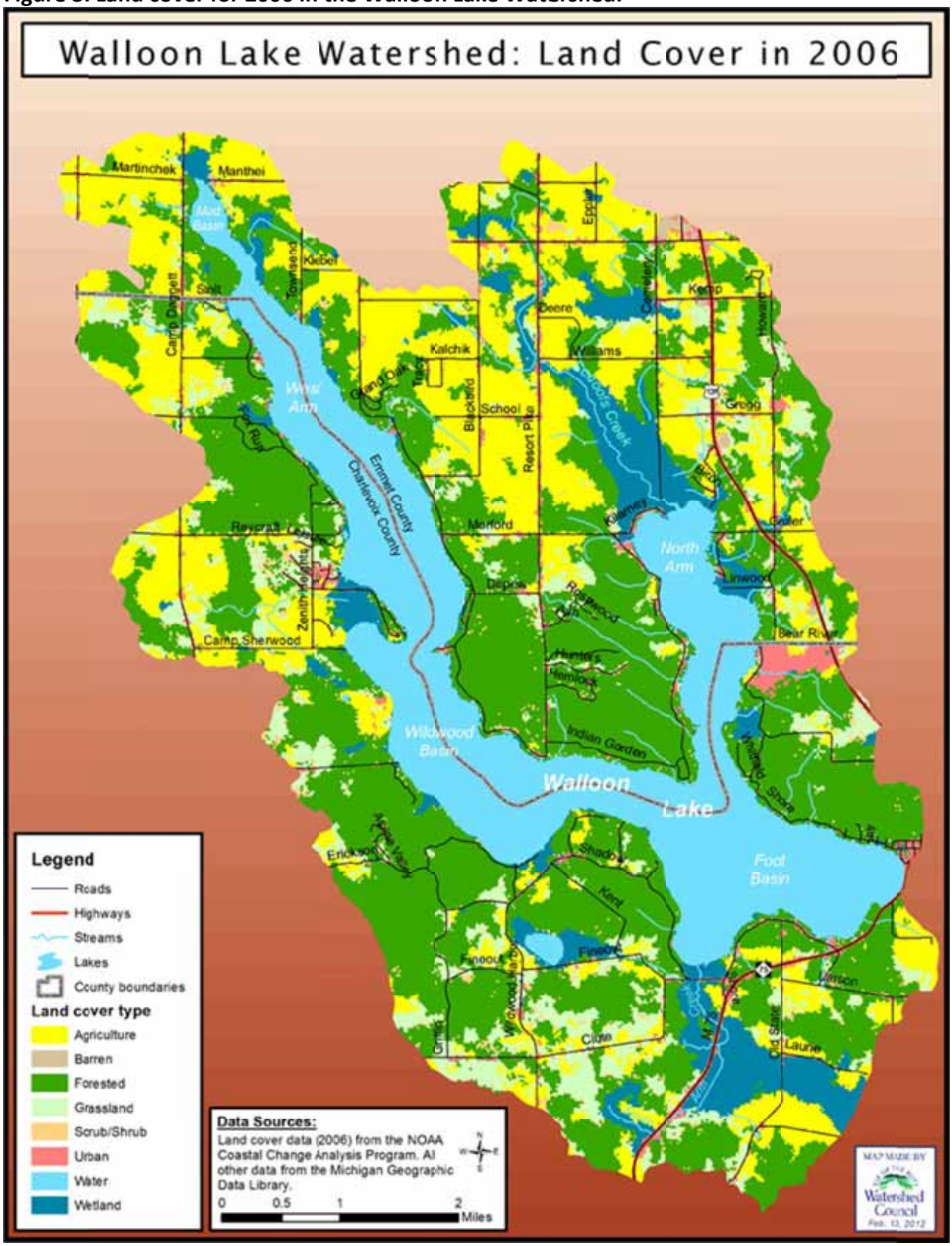
Land-cover Type	Acres	Percent
Agriculture	5835.38	21.99
Barren	47.73	0.18
Forested	10468.19	39.46
Grassland	1974.97	7.44
Scrub/Shrub	619.82	2.34
Urban	927.45	3.50
Water	4699.15	17.71
Wetland	1958.49	7.38
TOTAL	26531.17	100.00

Priority Parcel Analysis:

A total of 3,405 properties in the Walloon Lake Watershed were analyzed and scored using the nine criteria (Figure 2). Total scores ranged from zero to 29 with the following categorization system used to determine priority for protection based on natural breaks:

Score: 0-3 = very low priority
Score: 4-6 = low priority
Score: 7-10 = medium priority
Score: 11-16 = high priority
Score: 17+ = very high priority

Figure 3. Land cover for 2006 in the Walloon Lake Watershed.



Excluding protected lands, nearly 300 parcels in the Walloon Lake Watershed scored in the high priority tiers, receiving a total score of 11 or more, and are considered to be the most vital for water resource protection (Table 6). Of these, 29 parcels scored in the highest tier. Over 700 parcels scored in a second tier of medium priority, with total scores ranging from 7 to 10. The remaining parcels received a score of six or less and are considered low priority. In terms of the 5 major wetland sub-watersheds, high priority parcels were most numerous in the Schoof's and South Arm Creek Watersheds, but comprised a greater percentage of the total number of parcels in the Mud Lake Watershed (Table 7). Maps displaying priority parcel results for the sub-watersheds are included in Appendix C.

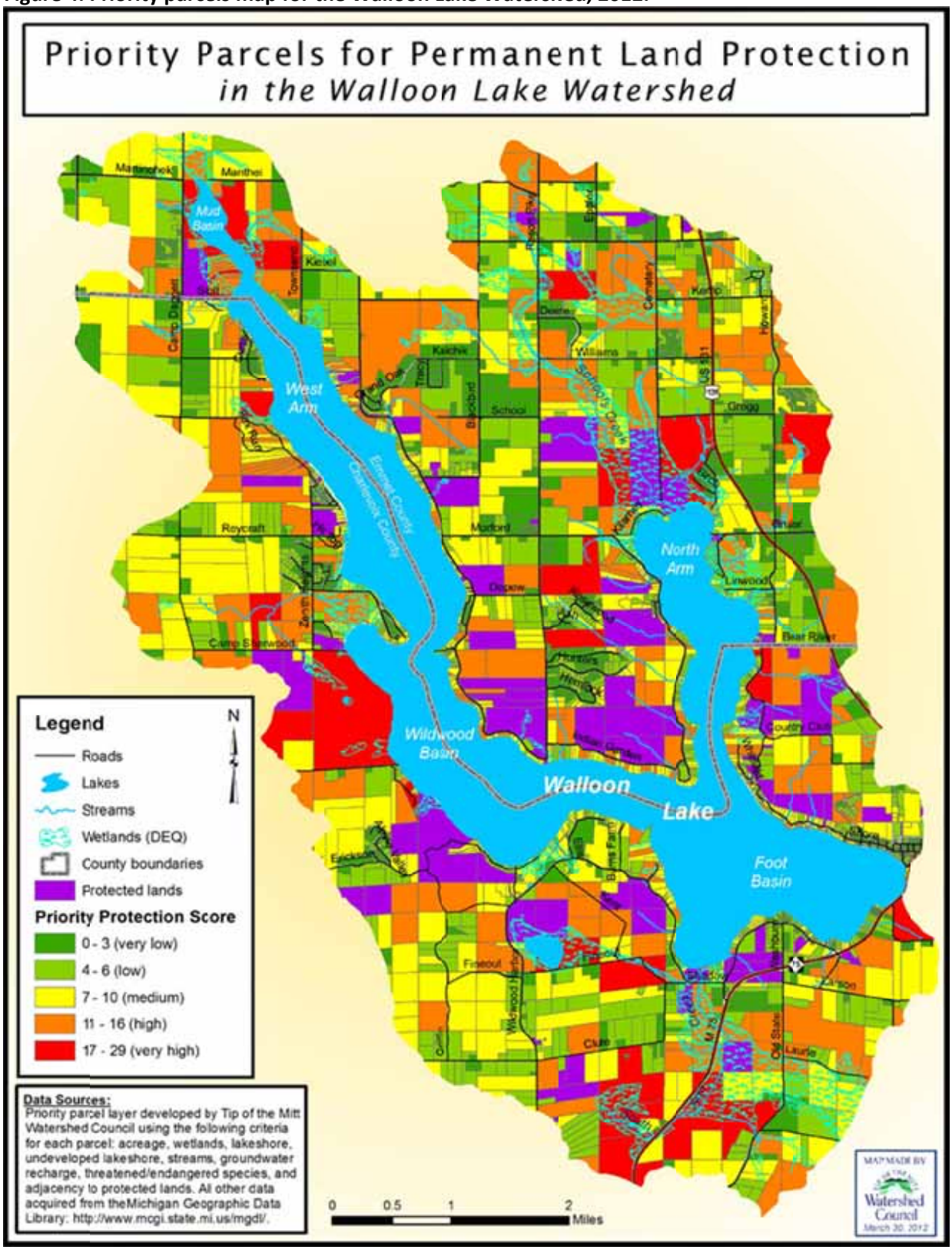
Table 6. Priority parcel ratings for the entire Walloon Lake Watershed and by county.

Priority Rating	Entire Watershed #	Entire Watershed %	Emmet County #	Emmet County %	Charlevoix County #	Charlevoix County %
Very low	1263	37.09	699	40.59	564	33.51
Low	1132	33.25	517	30.02	615	36.54
Medium	722	21.20	342	19.86	380	22.58
High	259	7.61	150	8.71	109	6.48
Very high	29	0.85	14	0.81	15	0.89
Total	3405	100.00	1722	100.00	1683	100.00

Table 7. Priority parcel ratings for the five major wetland sub-watersheds of Walloon Lake.

Priority Rating	Mud Lake #	Mud Lake %	Lily Pad Bay #	Lily Pad Bay %	South Arm Creek #	South Arm Creek %	Schoof's Creek #	Schoof's Creek %	Jones Landing #	Jones Landing %
Very low	54	46.55	86	40.76	79	27.15	257	48.95	126	56.76
Low	23	19.83	68	32.23	103	35.40	144	27.43	63	28.38
Medium	11	9.48	39	18.48	69	23.71	79	15.05	20	9.01
High	21	18.10	16	7.58	32	11.00	42	8.00	11	4.95
Very high	7	6.03	2	0.95	8	2.75	3	0.57	2	0.90
Total	116	100.00	211	100.00	291	100.00	525	100.00	222	100.00

Figure 4. Priority parcels map for the Walloon Lake Watershed, 2012.



DISCUSSION

The literature and data search for the five major wetland sub-watersheds and associated tributaries produced considerably more information than had been anticipated. Previous studies included ecological characterizations of the five wetland complexes, as well as details regarding soils, land ownership, and encroaching development. Copious data were collected from the primary inlet tributaries (Schoof's and South Arm Creeks), in addition to many of the minor tributaries. However, the information found was dated and generally limited in scope, both in terms of survey detail and geographical extent. The most recent information for the sub-watersheds dates from 1994; the majority of studies in the Walloon Lake Watershed performed during the 1980s or before. The abundant water quality and flow data from Project Vigilant represent only one period in time, over 25 years ago, and conditions have likely changed. Furthermore, biological water quality data (i.e., aquatic macroinvertebrate diversity) were not collected from the tributaries. Surveys were performed in some of the study areas, but the wetlands complexes were described in general terms as opposed to a detailed floristic inventory. Much of the Walloon Lake Watershed has never been surveyed for the presence of threatened and endangered species or habitats.

Existing data provide a good baseline dataset that can be used as a framework to both fill data gaps and examine changes over time. Detailed surveys of the flora and fauna within the wetland sub-watersheds and throughout the entire Walloon Lake Watershed will provide a more detailed assessment of the ecological value of the wetland complexes, as well as document the presence of threatened and endangered species, both of which will help prioritize land protection efforts. Future stream monitoring efforts will reveal how water quality has changed and guide efforts to protect and improve the stream ecosystems.

The following are specific recommendations:

1. Conduct field surveys in the five major wetland complexes to verify past survey results and revise as necessary. At least some of the wetland plant communities are known to be in flux due to impacts from invasive species, such as the emerald ash-borer.
2. Perform inventories of the wetlands to document detailed baseline conditions and to assess ecological value, prioritize land protection efforts, and monitor changes over time. Utilize widely used inventory and assessment methods, such as the Michigan Rapid Assessment Method (MiRAM). MiRAM is a tool to determine the "functional value" of a particular wetland and to assign a rating level to that wetland as compared to other wetlands. The goal of this rating system is to assess individual wetlands on an equal scale regardless of ecological type. MiRAM offers a relatively rapid assessment of wetland functions and values, but it is not intended to replace more detailed quantitative measures of ecosystem function, such as Indices of Biological Integrity (IBI), Floristic Quality Assessment (FQA), or other detailed ecological studies.
3. Determine the amount (acres and percentage) of wetlands lost along the Walloon Lake shoreline with particular focus on the five major wetland sub-watersheds using shore survey

and other data collected during the last 20+ years. Share information with stakeholders and the public in general; emphasize protecting the wetlands that remain.

4. Collaborate with MNFI to perform surveys of wetlands, nature preserves, and other appropriate watershed areas to document the presence of threatened and endangered species, as well as high quality habitats.
5. Collect physical and chemical water quality data from the primary inlet tributaries (Schoof's and South Arm Creeks) and other minor tributaries as resources permit. Examine changes over time, identify any sources of degradation, and address any problems that are found. Agencies and organizations with existing programs that could assist with water quality monitoring include LTBB, MDEQ, and TOMWC.
6. Conduct biological water quality monitoring of the primary inlet tributaries to establish baseline data and assess current conditions. Develop regular monitoring schedule thereafter. Biological monitoring could be performed by volunteers as part of the TOMWC Volunteer Stream Monitoring Program or by experienced professionals from a variety of local or regional agencies, organizations, and consultants.
7. Assess sediment and nutrient pollution from agricultural and urban activity in the watershed to the wetlands, streams, and lakes by building a SWAT (Surface Water Assessment Tool) model. Use model results to identify problematic areas that could be addressed to help protect and improve the water quality of the tributaries, wetlands, and open water of Walloon Lake. Governmental agencies, academic researchers, or consulting firms could help develop a SWAT model.

All information and data collected or produced as part of this study will be provided to the local land conservancies (WLTC and LTC) to be used as a tool to assist in land protection activities. In addition, it is recommended that the information be shared with local governments, state agencies, and other relevant organizations to guide landscape development planning and natural resource management decisions. Permanent protection or low-impact development in high priority areas will help maintain the ecological integrity of the most sensitive areas and protect water resources throughout the watershed. Results of the Priority Parcel Analysis will also provide valuable assistance in conservation efforts to protect threatened and endangered species, as well as improve wildlife corridors throughout the Watershed.

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Appendix A. Stream Data from 1987 Project Vigilant

Water Quality Data for Walloon Tributary Stations

Sub-Watershed	Trib Station	Sampling Date	Julian Day	Total Phosphorus (ug/L)	Soluble Reactive Phosphorus (ug/L)	TKN (ug/L)	Chloride (mg/L)	Alkalinity (mg/L)	Fecal Coliform (/100mL)	Calcium (mg/L)	Chloro phyll-a (ug/L)	Ammonia-Nitrogen (ug/L)	Nitrate-Nitrogen (ug/L)	Total Dissolved Phosphorus (ug/L)
Schoofs Ck	R25	4/13/1986	103	6.8	2.5	635	5	166	5	57				
Schoofs Ck	R25	5/6/1986	126	8.2	4.4	920	6	222	62	71				
Schoofs Ck	R25	5/28/1986	148	2.9	2.7	1100	8	200	16	78				
Schoofs Ck	R25	6/19/1986	170	11.8	1	800	6	224	20	77.6				
Schoofs Ck	R25	6/30/1986	181	8.8	2.6	900	7	222		39				
Schoofs Ck	R25	7/13/1986	194	14.6	5.2	800	6	180	430	56				
Schoofs Ck	R25	7/29/1986	210	9.6	1.1	620	7	252	95	83.5				
Schoofs Ck	R25	8/12/1986	224	9.8	2.9	650	7	235	180	79				
Schoofs Ck	R25	8/27/1986	239	10	1	460	8	248	31	80				
Schoofs Ck	R25	9/17/1986	260	9.6	1.5	500	7	222	180	71				
Schoofs Ck	R25	10/16/1986	289	4.4	1	600	8	217	0	72	0.49	400	60	
Schoofs Ck	R25	11/20/1986	324	6.4	1	420	8	224		68				
Schoofs Ck	R25	2/5/1987	401	6.8	1.4	520	9.3	228		71				
Schoofs Ck	R25	3/12/1987	436	8	2.2	450	8	220		76				5.9
Schoofs Ck	R25	4/9/1987	464	5.7	1		9	200	23	55				4.9
S. Arm Ck	M18C	4/13/1986	103	4.6	2.5	450	6	152	0	48		25	320	
S. Arm Ck	M18C	5/6/1986	126	15.1	6.8	750	6	172	28	60				
S. Arm Ck	M18C	5/28/1986	148	18	15.5	580	9	164	16	57				
S. Arm Ck	M18C	6/19/1986	170	21.2	1.8	800	6	166	208	51				
S. Arm Ck	M18C	8/30/1986	181	21.2	4.9	680	8	186	52	58				
S. Arm Ck	M18C	7/13/1986	194	21.8	9	600	6.5	179	300	60				
S. Arm Ck	M18C	8/1/1986	213	13	5.6	430	7	193	73	60				
S. Arm Ck	M18C	8/12/1986	224	13.1	6.4	520	7.9	196	86	62.6				
S. Arm Ck	M18C	8/27/1986	239	12.3	1	620	7	204	74	64				
S. Arm Ck	M18C	9/16/1986	259	14	2.4	800	7	150	60	56				
S. Arm Ck	M18C	10/13/1986	286	10	1	480	8	144	33	43				
S. Arm Ck	M18C	11/19/1986	323	7.9	1.3	380	7	162	4					
S. Arm Ck	M18C	12/16/1986	350	9.7	1	460	8	152						
S. Arm Ck	M18C	2/3/1987	399	11	2.8	350	8	180		57				
S. Arm Ck	M18C	3/12/1987	436	11	1	450	8	220						5.9
S. Arm Ck	M18C	4/8/1987	463	11.1	1	390	8	160	2	42				7.8

Walloon Tributary Flows (cfs)			* indicates wet weather during sampling												
Sub-	**Julian Day->**	**99**	**103**	**113**	**119**	**126**	**135**	**138***	**138***	**142**	**148**	**161**	**163***	**163***	**164***
Watershed	**Trib Station**	**4/9/1986**	**4/13/1986**	**4/23/1986**	**4/29/1986**	**5/6/1986**	**5/15/1986**	**5/18/86***	**5/18/86***	**5/22/1986**	**5/28/1986**	**6/10/1986**	**6/12/86***	**6/12/86***	**6/13/86***
Schoofs Ck	R23b			0.43	0.38	0.27	0.35	1.39	0.78	0.43	0.2	0.17	6*	2.5	0.69
Schoofs Ck	R23a	3.51	2.81	2.05	1.62	1.13	1.67	6.58	3.71	1.49	0.55	0.48	18.6	15.1	2.9
Schoofs Ck	R24	1.89	1.49	1.38*	1.26	1.08	1.39	4.71	2.71	1.43	0.8	0.67	13.4*	7.2	2.1
Schoofs Ck	R19				0.04							0			
Schoofs Ck	BC30	0.55	0.72		0.56	0.4	0.41	1.16	0.7		0.3	0.26	2	0.58	0.36
Jones Lan-	BC31a		0.19		0.15	0.13	0.14				0.04				
Jones Lan-	BC31b		0.2		0.17	0.14	0.15				0.13	0.12			
S. Arm Ck	M18a		1.24		1.02	0.77	1.01	2.21	1.44	0.91	0.53	0.44	5.33	4	2
S. Arm Ck	M18b		3.81	2.22	2.49	1.59	3.07	8.11	7.68	2.99	1.7	1*	19*	23.4	15.7

Sub-	**Julian Day->**	**167**	**170***	**181**	**194***	**213**	**224**	**239**	**259**	**273***	**286***	**301**	**323**	**350**	**399**
Watershed	**Trib Station**	**6/16/1986**	**6/19/1986**	**6/30/1986**	**7/13/1986**	**8/1/1986**	**8/12/1986**	**8/27/1986**	**9/16/1986**	**9/30/1986**	**10/13/1986**	**10/28/1986**	**11/19/1986**	**12/16/1986**	**2/3/1987**
Schoofs Ck	R23b	0.27	0.74	0.4	>6.5*	0.19	0.2	0.2	0.61	0.56	1.34	0.4	0.36	0.44	0.3
Schoofs Ck	R23a	0.89	2.6	0.6	24.7	1.11	1	0.63	1.92	1.63	3.83	1.26	1	1.38	1
Schoofs Ck	R24	0.85	3.15	0.78	12.7	0.93	1.06	0.69	1.58	1.43	2.62	1.14	0.97	1.15	0.95
Schoofs Ck	R19		0.09												
Schoofs Ck	BC30		0.61	0.36	0.58	0.18	0.23	0.24	0.38	0.77	0.64		0.51	0.36	0.3
Jones Lan-	BC31a		0.33	0.17	0.54	0.02	0.12	0.07	0.19	0.18	0.26		0.07	0.14	.09*
Jones Lan-	BC31b		0.33	0.12	0.19	0.13	0.04	0.12	0.13	0.13	0.18		0.12	0.14	0.12
S. Arm Ck	M18a		1.4	0.51	0.96	0.39	0.57	0.45	1.85	1.21	1.94		0.91	1.1	0.58
S. Arm Ck	M18b		3.51	1.56	2.9	1.33	2.2	1.95	4.61	5.7	6.96		2.2	2.3	1.5

			Snowmelt			Snowmelt									
Sub-	**Julian Day->**	**431**	**432**	**436**	**443**	**444**	**463**			**Standard**	**Maximum**	**Minimum**	**# of Data**		
	Trib Station	**3/7/1986**	**3/8/1986**	**3/12/1986**	**3/19/1986**	**3/20/1986**	**4/8/1986**		**Average**						
Schoofs Ck	R23b	0.92	2.5	0.3	0.51	0.51	0.31								
Schoofs Ck	R23a	2.51	4.79	1.12	1.84	1.55	1.37								
Schoofs Ck	R24	1.84	2.99	0.91	1.25	1.3	1.19								
Schoofs Ck	R19	.5*	.1*	.02*	.04*	.04*	.03*								
Schoofs Ck	BC30	1.58	1.32	0.27			0.31		0.59	0.42	2	0.18	28		
Jones Lan-	BC31a			.07*			.11*		0.14	0.13	0.54	0	0.19		
Jones Lan-	BC31b			0.11			.11*		0.14	0.05	0.33	0.04	20		
S. Arm Ck	M18a	2.41	1.82	0.79	0.8	0.72	0.94								
S. Arm Ck	M18b	2.41	1.82	0.79	0.8	0.72	0.94								

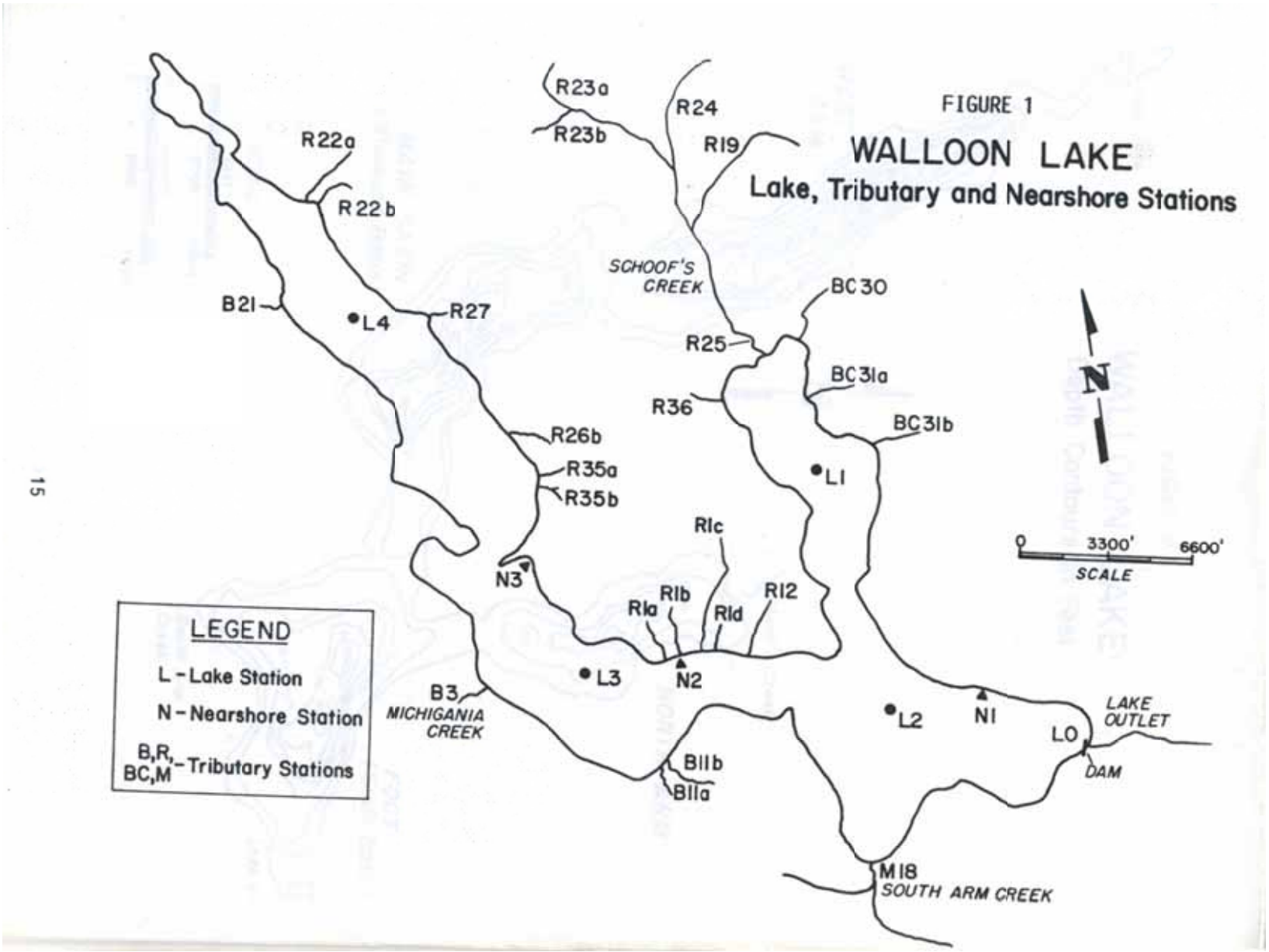
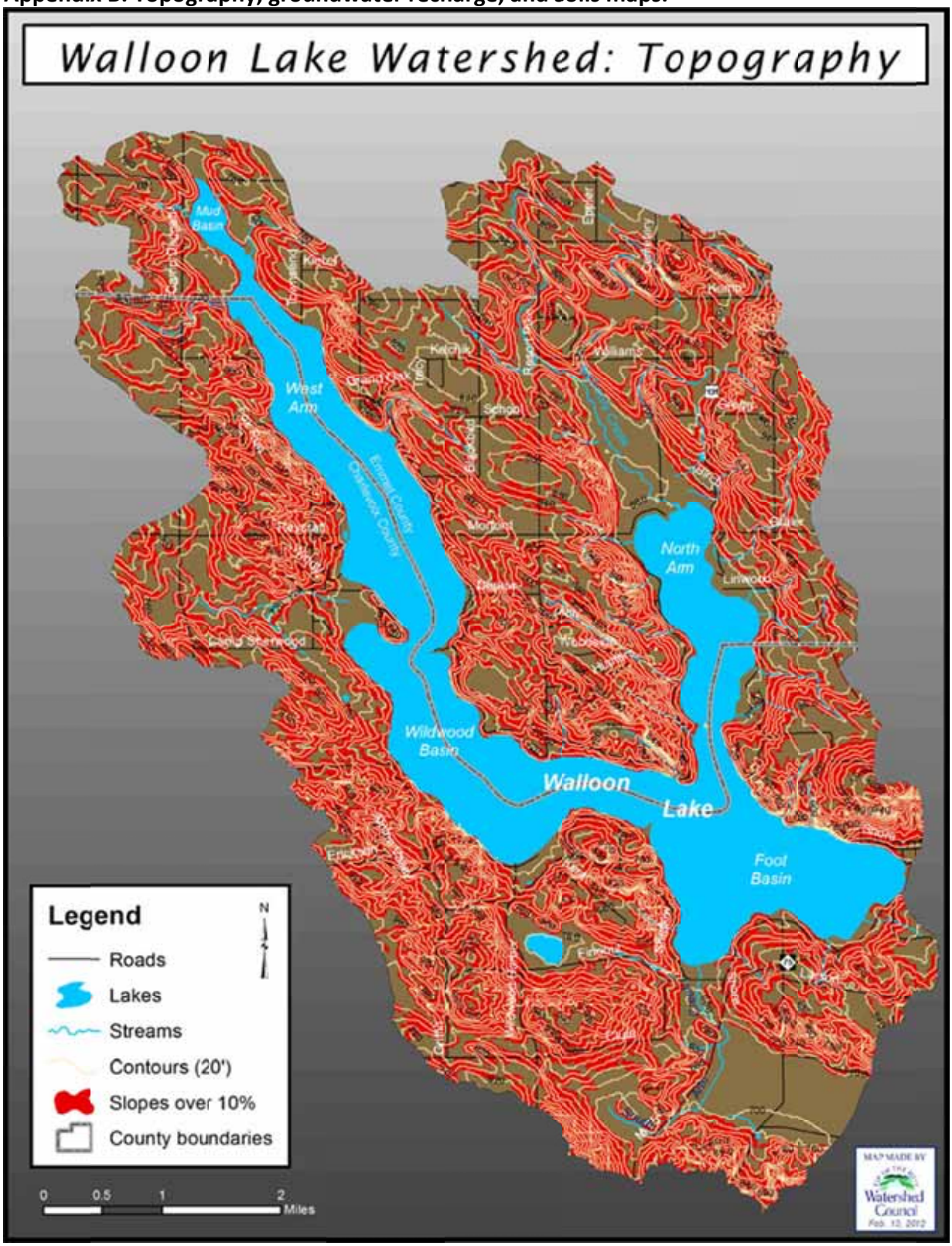
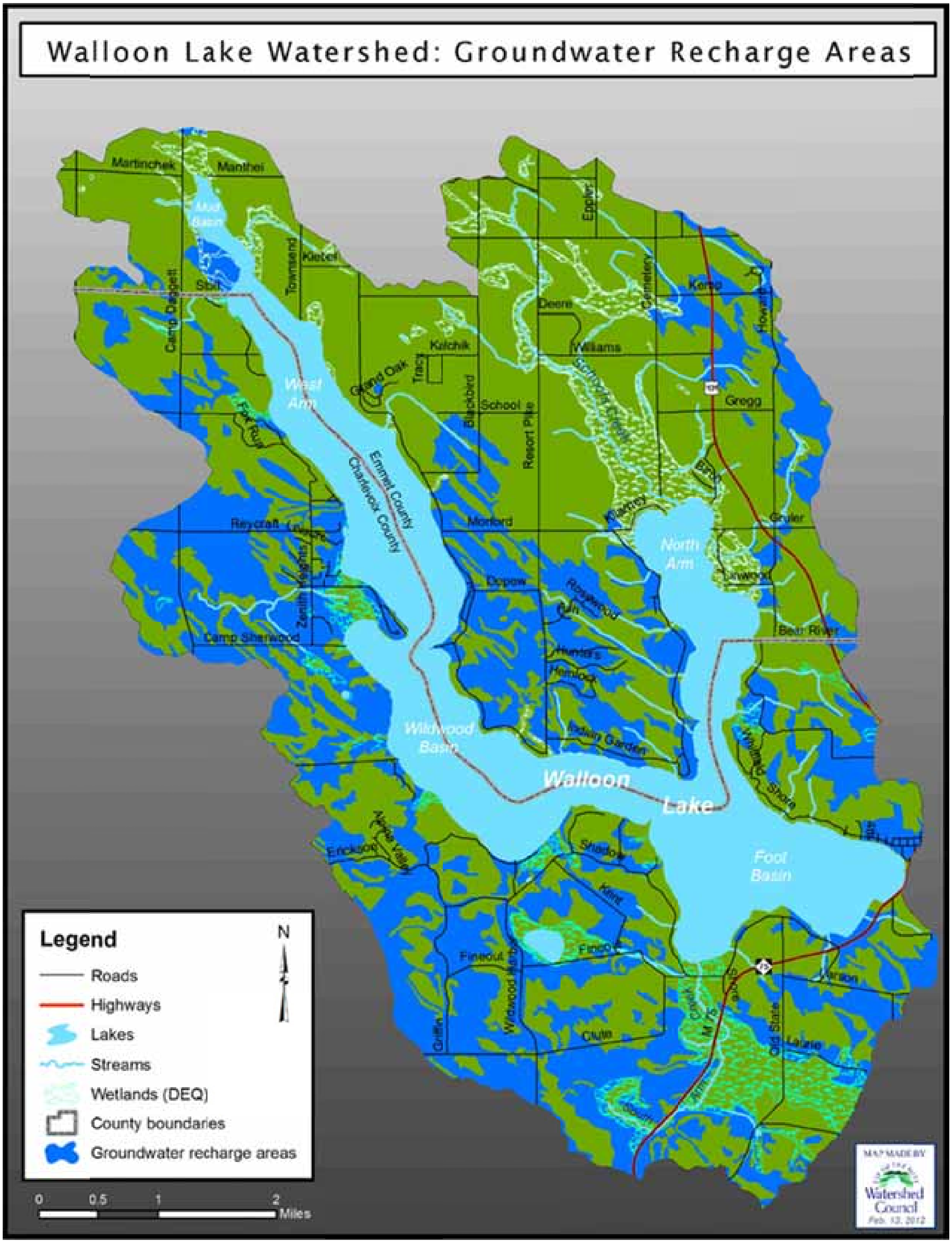
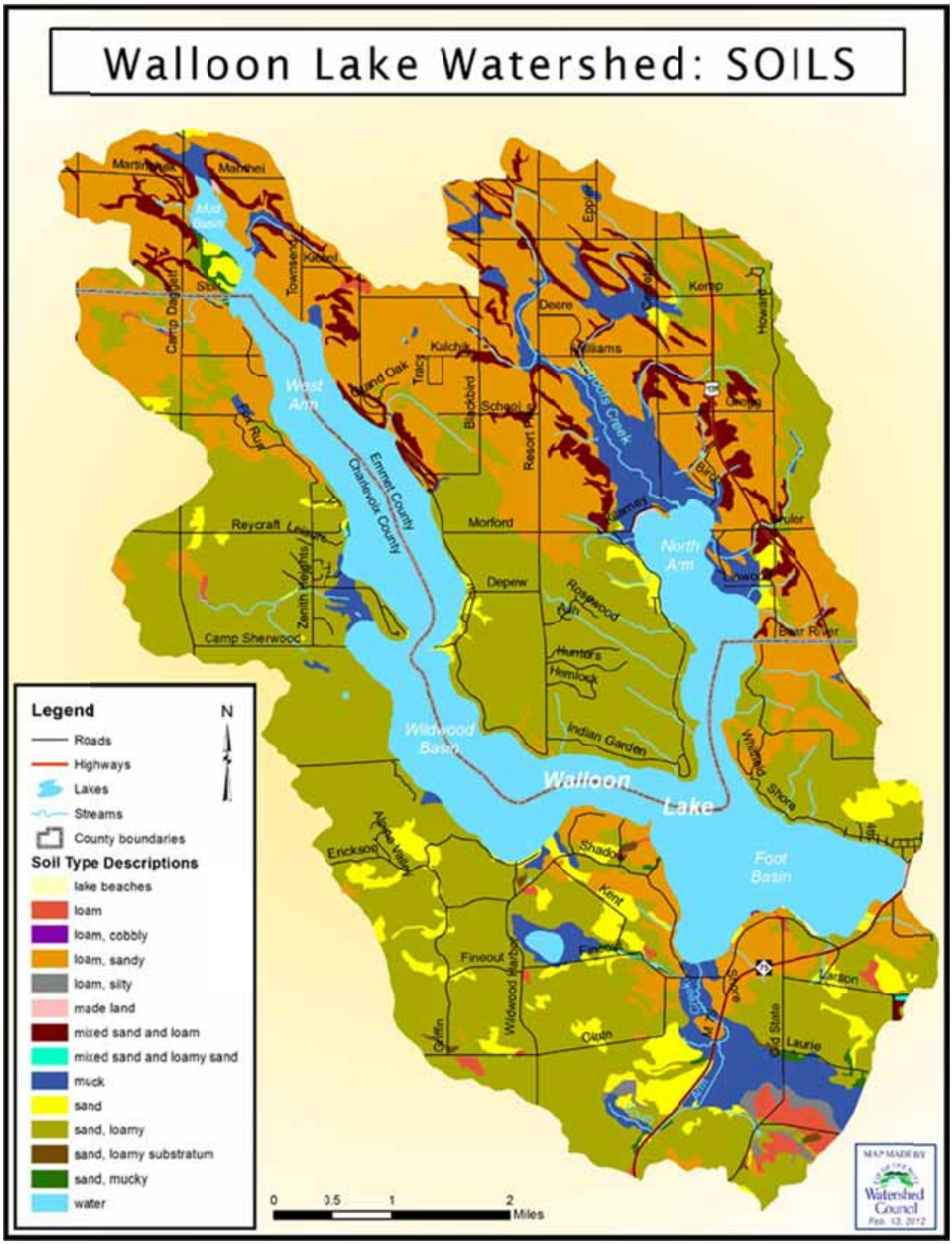


FIGURE 1
WALLOON LAKE
Lake, Tributary and Nearshore Stations
R23a
R23b
R24
R19
R22a
R22b
SCHOOF'S CREEK
BC30
B21
L4
R27
R25
BC31a
R36
BC31b
R26b
R35a
R35b
L1
R1c
N3
R1a
R1b
R1d
R12
N2
L3
B3
MICHIGANIA CREEK
L2
N1
LAKE OUTLET
LO
DAM
B11b
B11a
M18
SOUTH ARM CREEK
N
0
3300'
6600'
SCALE
LEGEND
L - Lake Station
N - Nearshore Station
B,R, BC,M - Tributary Stations

Appendix B. Topography, groundwater recharge, and soils maps.

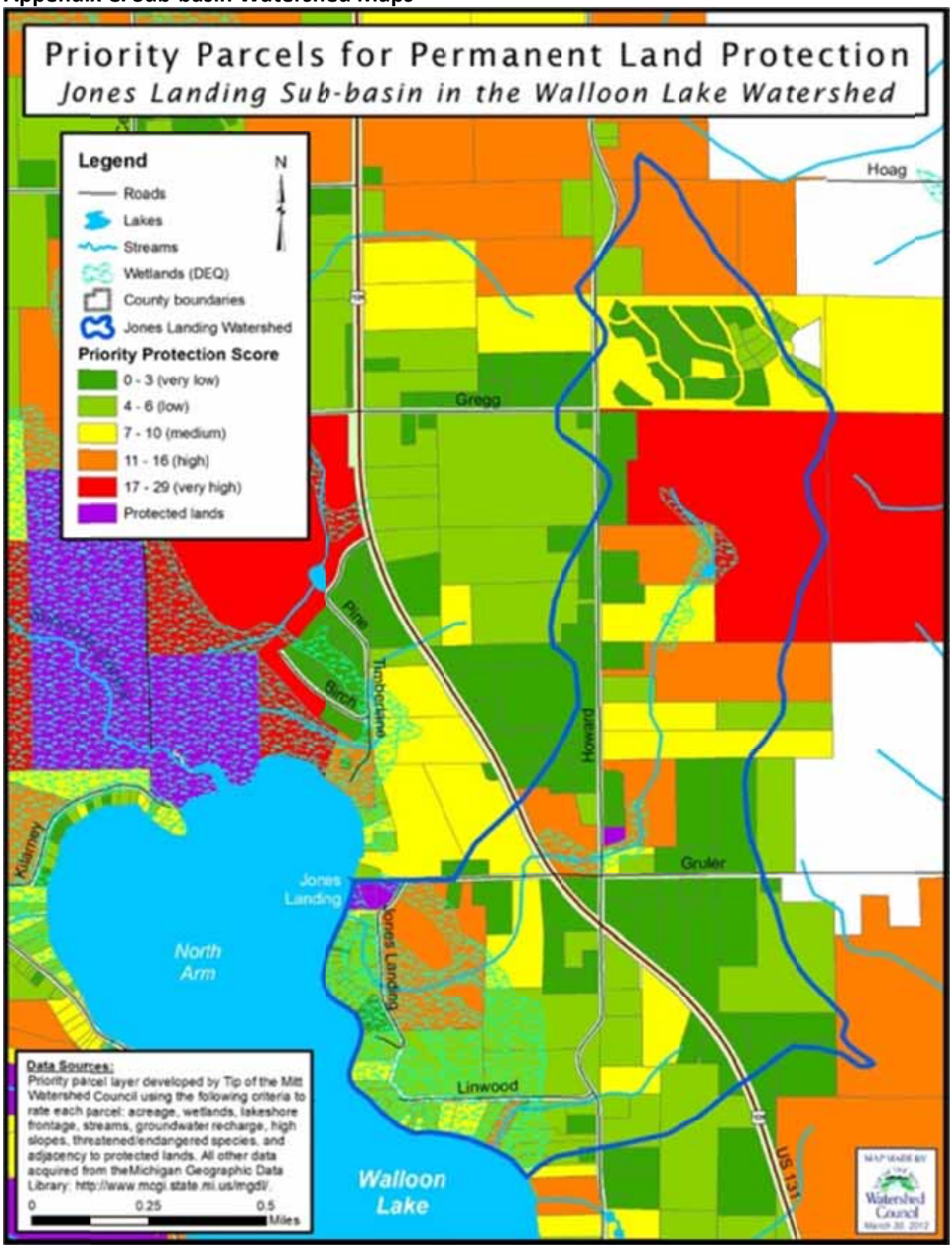


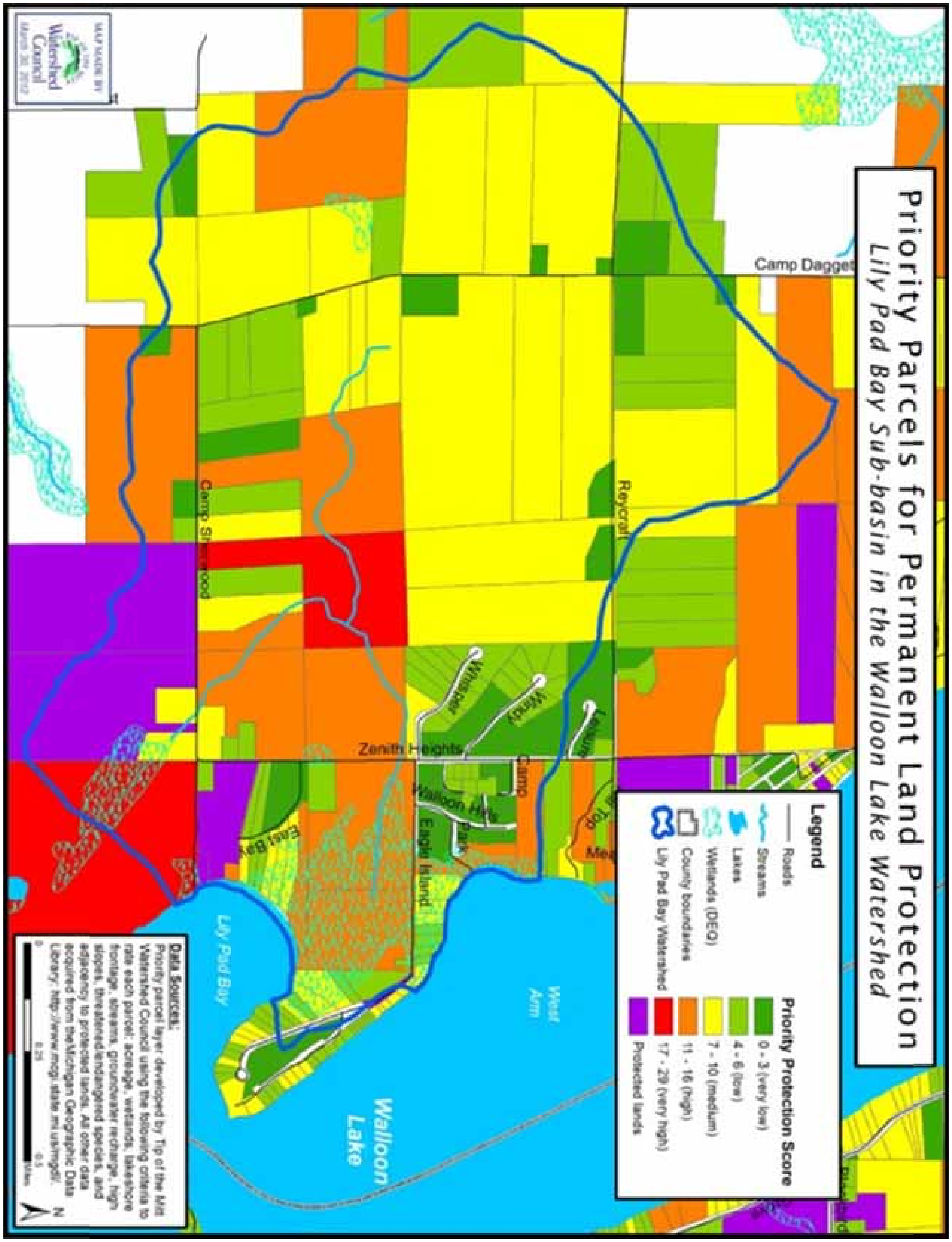

Walloon Lake Watershed: Groundwater Recharge Areas
Legend
Roads
Highways
Lakes
Streams
Wetlands (DEQ)
County boundaries
Groundwater recharge areas
N
0
0.5
1
2
Miles
West Arm
North Arm
Wildwood Basin
Walloon Lake
Foot Basin
Emmet County
Charlevoix County
Martinchek
Manthei
Townsend
Kiefer
Camp Daggett
Kilchik
Grand Oak
School
Resort Pike
Blackbird
Eppler
Cemetery
Deere
Williams
Kemp
Howard
Gregg
Monford
Reycraft
Camp Sherwood
Zenith Heights
Dopow
Rosewood
Hemlock
Indian Garden
Bear River
Shore
Erickson
Shadow
Fineout
Wildwood Harbor
Griffin
Clute
M-75
Old State
Laurie
Watershed Council



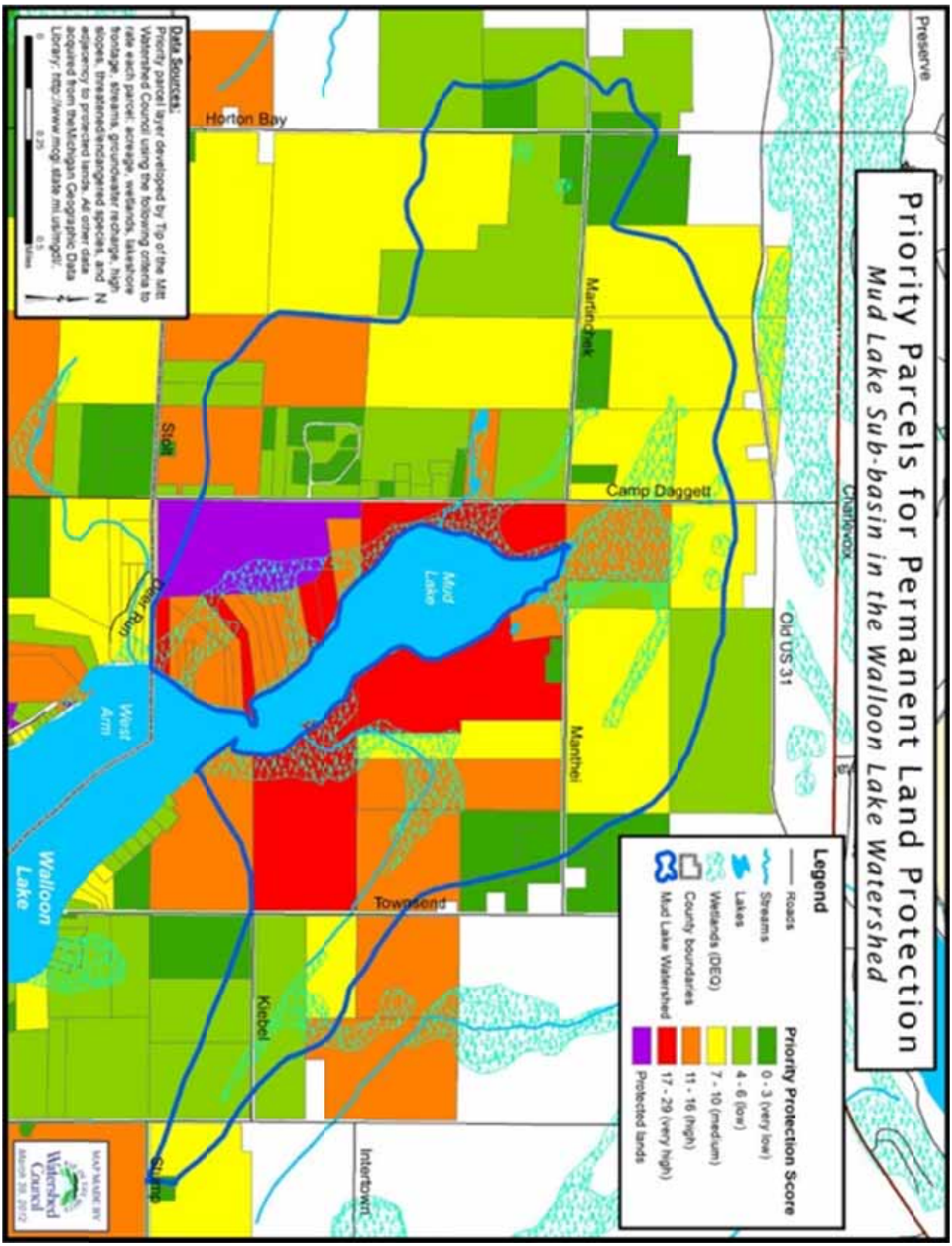
**based on 1973/1974 soil survey data.*

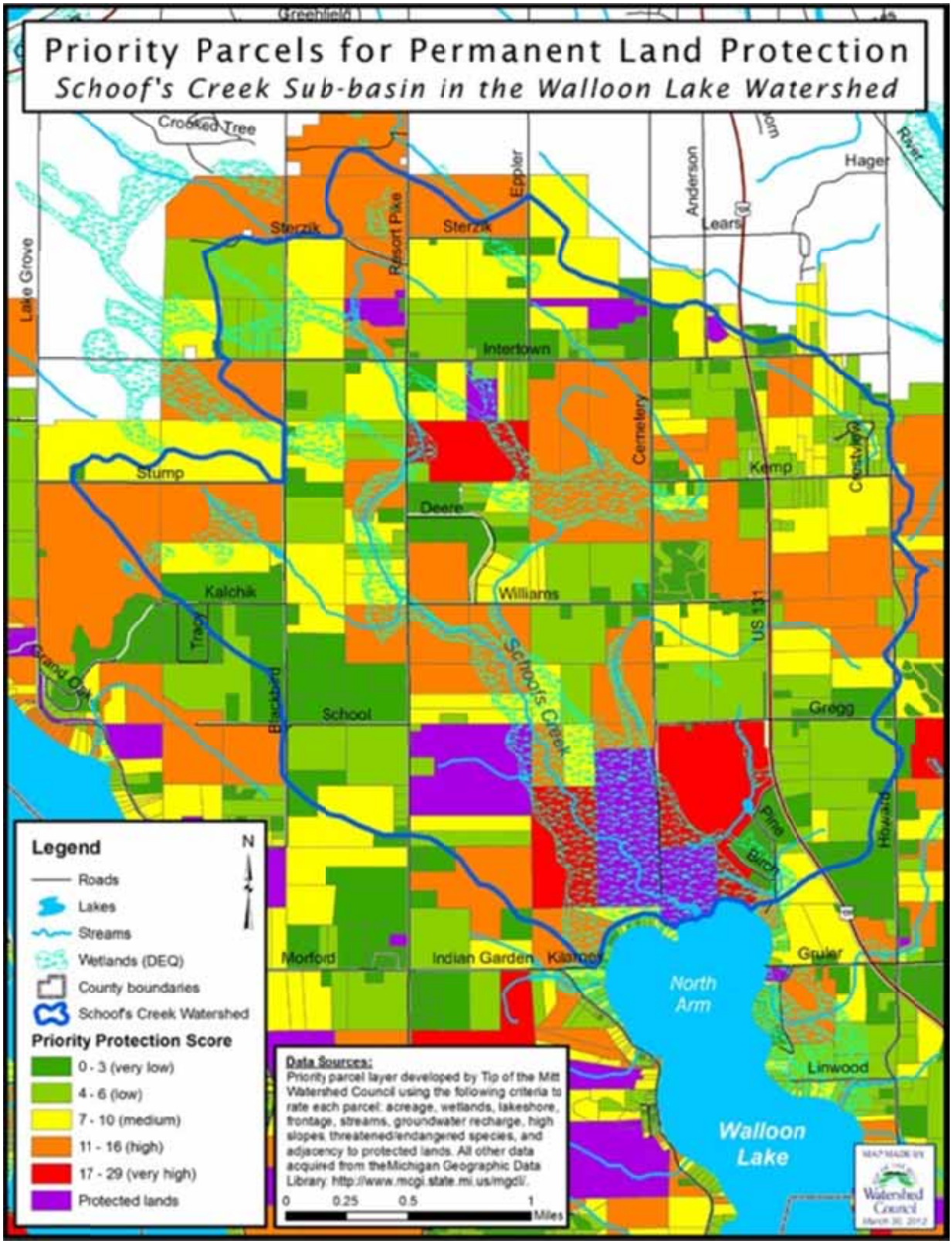
Appendix C. Sub-basin Watershed Maps

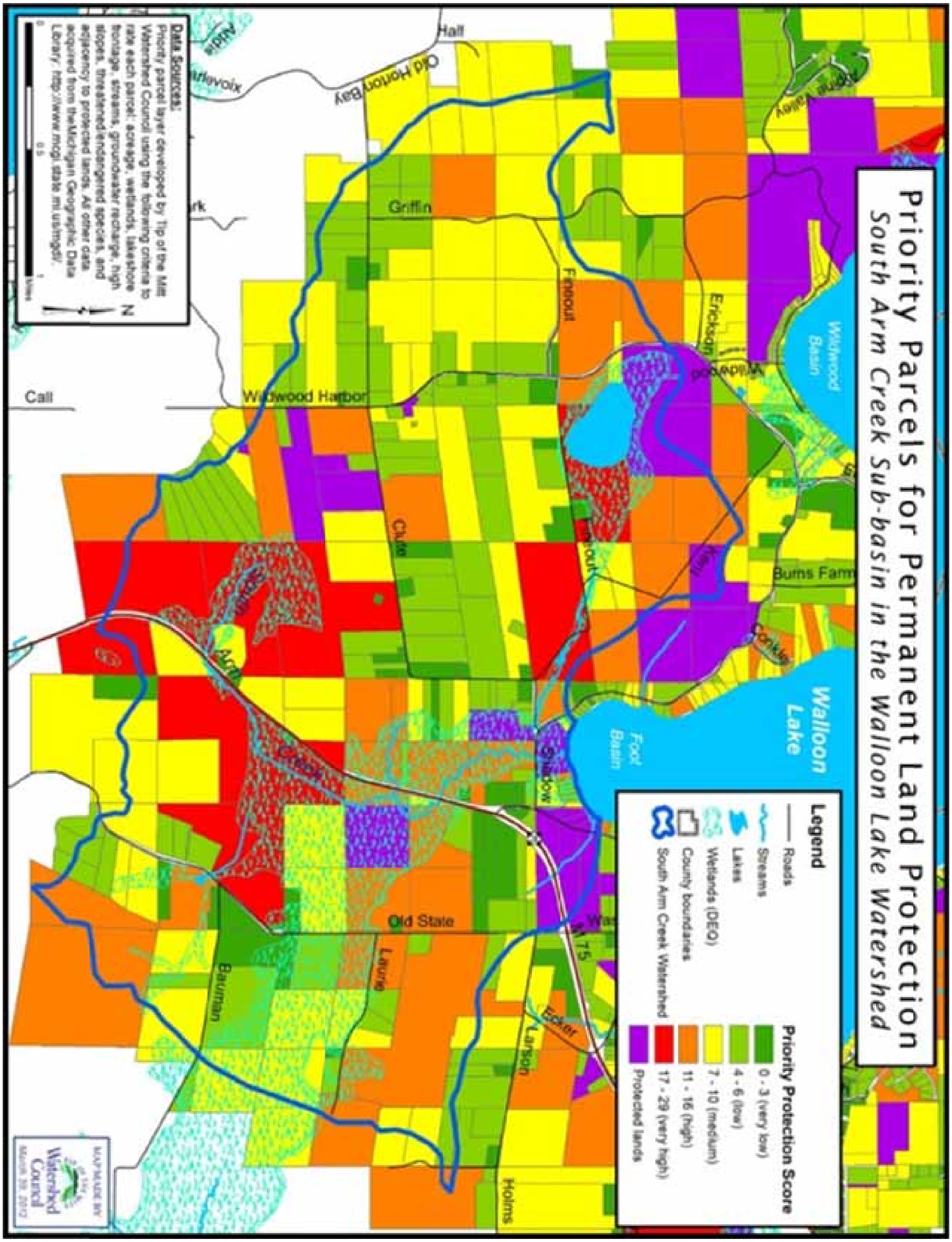




Priority Parcels for Permanent Land Protection
Lily Pad Bay Sub-basin in the Walloon Lake Watershed
Legend
Roads
Streams
Lakes
Wetlands (DEQ)
County boundaries
Lily Pad Bay Watershed
Priority Protection Score
0 - 3 (very low)
4 - 6 (low)
7 - 10 (medium)
11 - 16 (high)
17 - 29 (very high)
Protected lands
Data Sources:
Priority parcel layer developed by Tip of the Mitt Watershed Council using the following criteria to rate each parcel: acreage, wetlands, lakeshore frontage, streams, groundwater recharge, high slopes, threatened/endangered species, and adjacency to protected lands. All other data acquired from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.
Camp Daggett
Reycraft
Camp Sherwood
Zenith Heights
Whisper
Windy
Walloon Hills
Park
Eagle Island
East Bay
Lily Pad Bay
West Arm
Walloon Lake
Watershed Council


Priority Parcels for Permanent Land Protection
Mud Lake Sub-basin in the Walloon Lake Watershed
Preserve
Horton Bay
Martindale
Camp Daggett
Mud Lake
Deer Run
West Arm
Walloon Lake
Old US 31
Manthei
Townsend
Kiebel
Stutsman
Interlochen
Charlevoix
Legend
Roads
Streams
Lakes
Wetlands (DEQ)
County boundaries
Mud Lake Watershed
Priority Protection Score
0 - 3 (very low)
4 - 6 (low)
7 - 10 (med-um)
11 - 16 (high)
17 - 29 (very high)
Protected lands
Data Sources:
Priority parcel layer developed by Tip of the Mitt Watershed Council using the following criteria to rate each parcel: acreage, wetlands, lakeshore frontage, streams, groundwater recharge, high-quality woodlots, threatened/endangered species, and adjacency to protected lands. All other data acquired from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.
N
MAP MADE BY
Watershed Council
March 28, 2012


Priority Parcels for Permanent Land Protection
Schoof's Creek Sub-basin in the Walloon Lake Watershed
Greenfield
Crooked Tree
Lake Grove
Sterzik
Resort Pike
Eppler
Anderson
Hager
Lears
Intertown
Cemetery
Stump
Kemp
Deere
Kalchik
Williams
Tracy
Grand Oak
Blackbird
School
Schools Creek
US 131
Gregg
Howard
Pine
Birch
Morford
Indian Garden
Klarock
Guler
North Arm
Linwood
Walloon Lake
Legend
N
Roads
Lakes
Streams
Wetlands (DEQ)
County boundaries
Schoof's Creek Watershed
Priority Protection Score
0 - 3 (very low)
4 - 6 (low)
7 - 10 (medium)
11 - 16 (high)
17 - 29 (very high)
Protected lands
Data Sources:
Priority parcel layer developed by Tip of the Mitt Watershed Council using the following criteria to rate each parcel: acreage, wetlands, lakeshore, frontage, streams, groundwater recharge, high slopes, threatened/endangered species, and adjacency to protected lands. All other data acquired from the Michigan Geographic Data Library. http://www.mcgi.state.mi.us/mgdl/.
0 0.25 0.5 1
Miles
Watershed Council


Priority Parcels for Permanent Land Protection
South Arm Creek Sub-basin in the Walloon Lake Watershed
Legend
Roads
Streams
Lakes
Wetlands (DEQ)
County boundaries
South Arm Creek Watershed
Priority Protection Score
0 - 3 (very low)
4 - 6 (low)
7 - 10 (medium)
11 - 16 (high)
17 - 29 (very high)
Protected lands
Walloon Lake
Foot Basin
Wildwood Basin
Wildwood Harbor
Old State
Bauman
Griffin
Call
Burns Farm
Holms
Larson
Ecker
M 75
Old Horton Bay
Hall