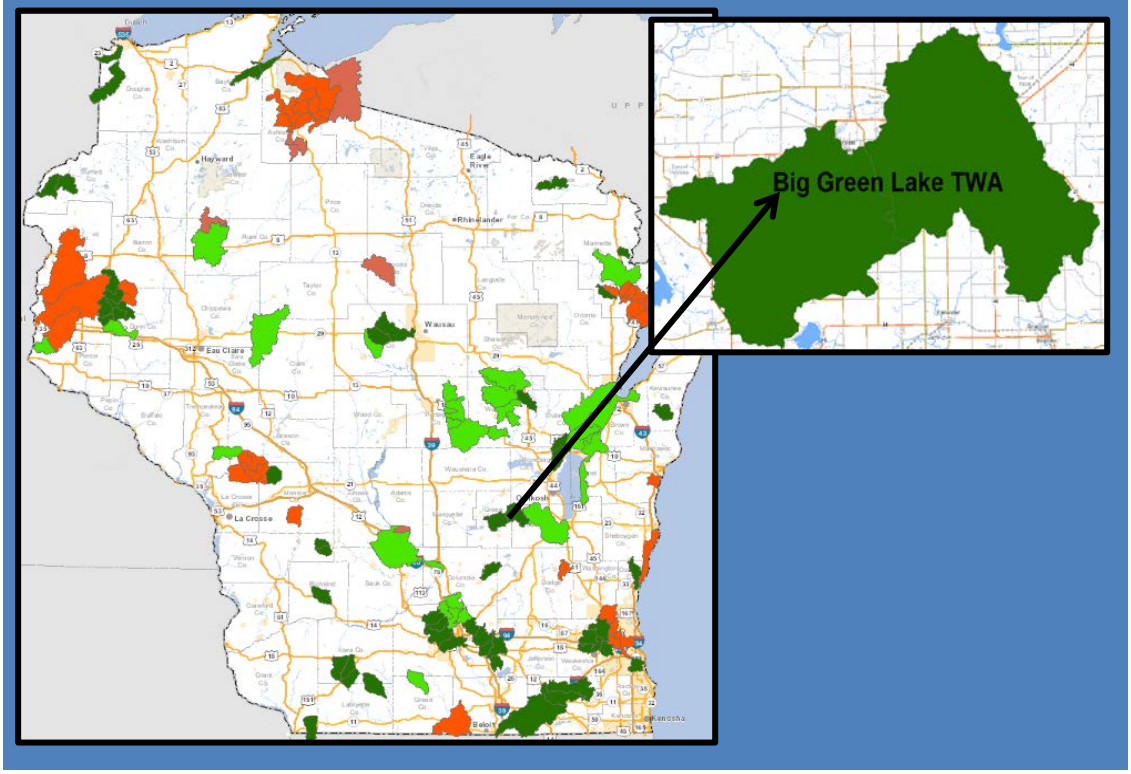
Green Lake Shoreline
Photo by DNR

BIG GREEN LAKE TWA WQM PLAN 2017

Big Green Lake (UF07)

HUC: 040302010902, Monitored 2014



A Watershed Report created by the Bureau of Water Quality in support of the Clean Water Act.

WISCONSIN
DEPT. OF NATURAL RESOURCES

EGAD # 3200-2017-14

Water Quality Bureau,

Wisconsin DNR

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Wisconsin Water Quality Monitoring and Planning

This Water Quality Management Plan was created under the state's Water Quality Management Planning and Water Resources Monitoring Programs. The plan reflects Water Quality Bureau and Water Resources Monitoring Strategy 2015-2020 goals and priorities and fulfills Areawide Water Quality Management Planning milestones under the Clean Water Act, Section 208. Condition information and resource management recommendations support and guide program priorities for the plan area.

This plan is hereby approved by the Wisconsin DNR Water Quality Program and is a formal update to the Upper Fox River Basin Wisconsin Areawide Water Quality Management Plan and Wisconsin's Statewide Areawide Water Quality Management Plan. This plan will be forwarded to USEPA for certification as a formal plan update.

Water Resources Field Supervisor - Acting — Date: 1/24/2018

Greg Searle, Water Quality Bureau Field Operations Director — Date: 2/6/18

Timothy Asplund, Water Quality Bureau Monitoring Section Chief — Date: 2/6/18

Basin/Watershed Partners

- Green Lake County LCD
- Green Lake Sanitary District
- Green Lake Association
- Natural Resource Conservation Service RCS
- USGS

Report Acknowledgements

- Dave Bolha, Primary Author and Investigator, Eastern District, Wisconsin DNR
- Victoria Ziegler, Program Support, Water Quality Bureau, Wisconsin DNR
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List of Abbreviations

AEL: Aquatic Entomology Laboratory at UW – Stevens Point. The primary laboratory for analysis of macroinvertebrate taxonomy in the State of Wisconsin.

BMP: **Best Management Practice**. A practice that is determined effective and practicable (including technological, economic, and institutional considerations) in preventing or reducing pollution generated from nonpoint sources to a level compatible with water quality goals.

DNR: **Department of Natural Resources.** Wisconsin Department of Natural Resources is an agency of the State of Wisconsin created to preserve, protect, manage, and maintain natural resources.

FHMD: Fisheries and Habitat Management Database. Wisconsin's repository for fish taxonomy and auto-calculated metrics involving fish assemblage condition and related.

FIBI: **Fish Index of biological integrity (Fish IBI).** An Index of Biological Integrity (IBI) is a scientific tool used to identify and classify water pollution problems. An IBI associates anthropogenic influences on a water body with biological activity in the water and is formulated using data developed from biosurveys. In Wisconsin, Fish IBIs are created for each type of natural community in the state's stream system.

HUC: **Hydrologic Unit Code.** A code or sequence of numbers that identify one of a number of nested and interlocked hydrologic catchments delineated by a consortium of agencies including USGS, USFS, and Wisconsin DNR.

MIBI: **Macroinvertebrate Index of biological integrity.** In Wisconsin, the MIBI, or macroinvertebrate Index of biological integrity, was developed specifically to assess Wisconsin's macroinvertebrate community (see also Fish IBI).

Natural Community. A system of categorizing waterbodies based on their inherent physical, hydrologic, and biological assemblages. Both Streams and Lakes are categorized using an array of "natural community" types.

NRCS: USDA Natural Resources Conservation Service. The federal agency providing local support and land management outreach work with landowners and partners such as state agencies.

SWIMS ID. Surface Water Integrated Monitoring System (SWIMS) Identification Code is the unique monitoring station identification number for the location where monitoring data was gathered.

TDP: Total Dissolved Phosphorus. An analyzed chemistry parameter collected in aquatic systems positively correlated with excess productivity and eutrophication in Wisconsin waters.

TP: Total Phosphorus. An analyzed chemical parameter collected in aquatic systems positively correlated with excess productivity and eutrophication in Wisconsin waters.

TSS: Total suspended solids. An analyzed physical parameter collected in aquatic systems that is frequently positively correlated with excess productivity, reduced water clarity, reduced dissolved oxygen and degraded biological communities.

TWA: **Targeted Watershed Assessment.** A statewide study design a rotating watershed approach to gathering of baseline monitoring data with specialized targeted assessments for unique and site specific concerns, such as effectiveness monitoring of management actions.

WATERS ID: The Waterbody Assessment, Tracking and Electronic Reporting System Identification Code (WATERS ID) is a unique numerical sequence number assigned by the WATERS system, also known as "Assessment Unit ID code".

WBIC: **Water Body Identification Code.** DNR's unique identification codes assigned to water features in the state. The lines and information allow the user to execute spatial and tabular queries about the data, make maps, and perform flow analysis and network traces.

WISLOH: Wisconsin State Laboratory of Hygiene. The state's certified laboratory that provides a wide range of analytical services including toxicology, chemistry, and data sharing.

Watershed Discussion & Management Recommendations

Watershed Goals

The overall goal of this plan is to improve and protect water quality in the basin. This Targeted Watershed Assessment (TWA) monitoring project provided substantial data to analyze current conditions and to make recommendations for future management actions in the area. This plan is designed to present monitoring study results, identify issues or concerns in the area found during the project and to make recommendations to improve or protect water quality consistent with Clean Water Act guidelines and state water quality standards.

Watershed Overview

The Big Green Lake Watershed (UF07) is located primarily in Green Lake County, but extends east into Fond du Lac County and edges just a bit into the southwestern corner of Winnebago County (Figure 1). The watershed is 68,676 acres in size and contains 141 miles of streams and rivers, 655 acres of lakes and 5,102 acres of wetlands. This TWA focuses on the southern and eastern portion of the watershed.

Population, Land Use

At the time of the 2010 Census, the Wisconsin Population Lab determined the Big Green Lake Watershed hosted 12,429 inhabitants. The majority of the land cover in the Big Green Lake Watershed is Agriculture (65%) followed by Open Land and Water (15.53%). Forest also covers a sizeable portion of the

Figure 1: Big Green Lake TWA.

Land Use	Acres	% of Area
Agriculture	44,639.76	65.00%
Open Land and Water	10,665.47	15.53%
Forest	6,016.07	8.76%
Wetland	3,935.17	5.73%
Suburban	2,211.38	3.22%
Urban	597.49	0.87%
Grassland	556.28	0.81%
Barren	48.07	0.07%
Total Acres in Watershed	68,676.55	

Table 1: Land use percentages in Big Green Lake Watershed (UF07).

watershed (8.76%) followed by Wetlands, which constitute approximately five and three-quarters of the watershed. The last reasonably sized land cover is Suburban (3.22%). The remainder of land cover constitutes slightly over one and a half percent of the total land cover; these include Urban (0.87%), Grassland (0.81%) and Barren (.07%) (Table 1).

Ecological Landscapes

The Big Green Lake Watershed is covered by two ecological landscapes: the Southeast Glacial Plains and the Central Sand Hills. The Southeast Glacial Plains Ecological Landscape makes up the bulk of the non-coastal land area in southeast Wisconsin. This Ecological Landscape is made up of glacial till plains and moraines.

Most of this Ecological Landscape is composed of glacial materials deposited during the Wisconsin Ice Age, but the southwest portion consists of older, pre-Wisconsin till with a more dissected topography. Soils are lime-rich tills overlain in most areas by a silt-loam loess cap. Agricultural and residential interests throughout the landscape have significantly altered the historical vegetation. Most of the rare natural communities that remain are associated with large moraines or in areas where the Niagara Escarpment occurs close to the surface.

Historically, vegetation in the Southeast Glacial Plains consisted of a mix of prairie, oak forests and savanna, and maple-basswood forests. Wet-mesic prairies, southern sedge meadows, emergent marshes, and calcareous fens were found in lower portions of the Landscape. End moraines and drumlins supported savannas and forests.

Agricultural and urban land use practices have drastically changed the land cover of the Southeast Glacial Plains since Euro-American settlement. The current vegetation is primarily agricultural cropland. Remaining forests occupy only about 10% of the land area and consist of maple-basswood, lowland hardwoods, and oak. No large mesic forests exist today except on the Kettle Interlobate Moraine which has topography too rugged for agriculture. Some existing forest patches that were formerly savannas have succeeded to hardwood forest due to fire suppression.

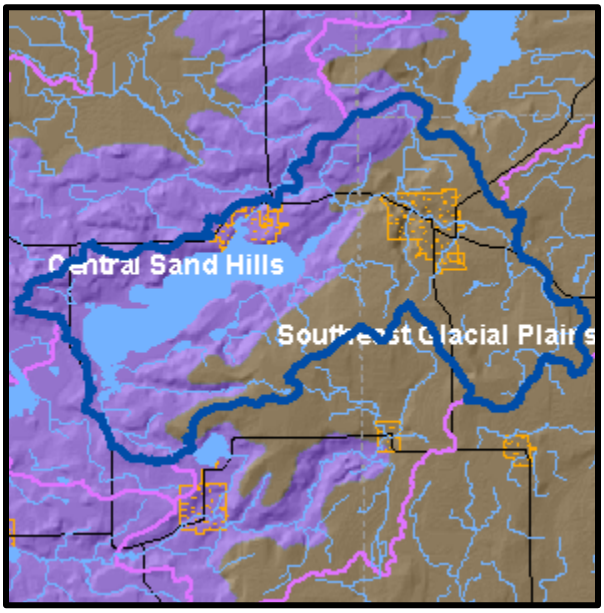

Figure 2: Ecological Landscapes in the Big Green Lake Watershed.

The Central Sand Hills Ecological Landscape is located in central Wisconsin at the eastern edge of what was once Glacial Lake Wisconsin. The landforms in this Ecological Landscape are a series of glacial moraines that were later partially covered by glacial outwash. The area is characterized by a mixture of farmland, woodlots, wetlands, small kettle lakes, and cold water streams, all on sandy soils. The mosaic of glacial moraine and pitted outwash throughout this Ecological Landscape has given rise to extensive wetlands in the outwash areas, and the headwaters of coldwater streams that originate in glacial moraines. The growing season is long enough for agriculture but the sandy soils limit agricultural productivity.
Historic upland vegetation consists of oak-forest, oak savanna, and tallgrass prairie. Fens were common in this Ecological Landscape and occurred along with wet-mesic prairie, wet prairie, and rare coastal plain marshes. Current vegetation is composed of more than one-third agricultural crops, and almost

20% grasslands with smaller amounts of open wetland, open water, shrubs, barren, and urban areas. The major forested type is oak-hickory, with smaller amounts of white-red-jack pine, maple-basswood, lowland hardwoods, aspen-birch, and spruce-fir.

Study Summary

This TWA project addressed needs for a baseline water quality assessment of the Big Green Lake Watershed. Repeatable biological, inorganic chemistry and habitat surveys provide valuable information for future comparison. This project filled data gaps from the 2011 Assessment Report of Hill, Roy, and Wuerches Creeks (Johnson et. al. 2011) (2011 Assessment). Together with the 2011 Assessment, the data collected in this project can be compared to future surveys to evaluate the effectiveness of Best Management Practices (BMPs) installed in the watershed.

Management Recommendations

- Work with landowners and county partners in the watershed to encourage restoration of stream banks and reduction of erosion is a high priority.
- Maximize buffers or protected areas along streams with steep slopes is a high priority for this area due to the nature of the steep slopes in the watershed.
- The type of vegetative buffer is also critical to reducing sediment and nutrients reaching the creeks of this project. A combination of forest and native grass buffers may have a better nutrient reduction than strictly grassed buffers.
- Implement cover crops to reduce cropland erosion during late fall and spring.
- Replace perched culverts in the watershed to increase available fish and aquatic life habitat.
- Mitigate impacts from the Gothic Mill Dam in Ripon on water temperature and fish migration in Silver Creek.
- Capitalize on the efforts of the DNR, Green Lake County LCD, Green Lake Sanitary District, Green Lake Association, NRCS, and USGS in these subwatersheds by implementing BMPs (stream bank restoration, sediment basins, vegetative buffers, etc.) where needed will likely have a significant improvement of the water quality in the creeks and Big Green Lake.

Ecological, Aquatic Resources

Outstanding and Exceptional Resource Waters

Wisconsin has designated many of the state's highest quality waters as Outstanding Resource Waters (ORWs) or Exceptional Resource Waters (ERWs). Waters designated as ORW or ERW are surface waters which provide outstanding recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. ORW and ERW status identifies waters that the State of Wisconsin has determined warrant additional protection from the effects of pollution. Two waters in the watershed are exceptional resource waters, Assemble Creek and White Creek.

Table 2: Exceptional Resource Waters in the Big Green Lake Watershed (UF07).

Waterbody Name	WBIC	ORW/ERW	Start Mile	End Mile
Assemble Creek	3000091	ERW	0	0
White Creek	146600	ERW	0	1.11

Trout Waters

DNR uses three categories to classify the different types of trout streams throughout Wisconsin. These are evident in Wisconsin Trout Stream Maps, which provides a comprehensive list of trout streams and a set of trout stream maps covering the majority of the state. Efforts have been made to list all trout streams in the State of Wisconsin, but it is recognized that this listing in not exhaustive. Trout waters in this watershed are listed in Table 3.

High quality trout waters (Class I) that have sufficient natural reproduction to sustain populations of wild trout, at or near carry capacity. Consequently, streams in this category require no stocking of hatchery trout. These streams or stream sections are often small and may contain small or slow-growing trout, especially in the headwaters. Class II streams may have some natural reproduction, but not enough to utilize available food and space. Therefore, stocking is required to maintain a desirable sport fishery. These streams have good survival and carryover of adult trout, often producing some fish larger than average size. Class III are marginal trout habitat with no natural reproduction occurring. They require annual stocking of trout to provide trout fishing. Generally, there is no carryover of trout from one year to the next.

Table 3: Trout waters in the Big Green Watershed (UF07).

Waterbody Name	WBIC	Start Mile	End Mile	Trout Class
White Creek	146600	0	1.11	CLASS I
Silver Creek	146800	12.41	14.36	CLASS II
Assemble Creek	3000091	0	0.2	CLASS I
Dakin Creek	146700	0	2.78	CLASS II

Impaired Waters

Every two years, Section 303(d) of the Clean Water Act requires states to publish a list of all waters that do not meet water quality standards. The list, also known as the Impaired Waters List, is updated to reflect waters that are newly added or removed based on new information. Impaired waters in this watershed are impaired for historical discharges, mine tailings, and runoff issues (Table 4).

Table 4: Big Green Lake Watershed (UF07) Impaired Waters.

Waterbody Name	WBIC	Start Mile	End Mile (acres)	Pollutant	Impairment	Sources	303 Status
Green Lake (Big Green)	146100			PCBs	Contaminated Fish Tissue	Non-Point Source (Rural or Urban)	303d Listed
Green Lake (Big Green)	146100			Total Phosphorus	Low DO	Non-Point Source (Rural or Urban)	TMDL Development
Hill Creek	146200	0	1.84	Sediment/Total Suspended Solids	Degraded Habitat	Non-Point Source (Rural or Urban)	TMDL Development
Hill Creek	146200	0	1.84	Total Phosphorus	Degraded Biological Community	Non-Point Source (Rural or Urban)	Addition
Puchyan River	145200	0	13.96	Unknown Pollutant	Elevated Water Temperature	Non-Point Source (Rural or Urban)	Proposed for List

Waterbody Name	WBIC	Start Mile	End Mile	Pollutant	Impairment	Sources	303 Status
Roy Creek	148200	0	7.18	Sediment/Total Suspended Solids	Degraded Habitat	Non-Point Source (Rural or Urban)	TMDL Development
Roy Creek	148200	0	7.18	Total Phosphorus	Impairment Unknown	Non-Point Source (Rural or Urban)	TMDL Development
Silver Creek	146800	0.97	12.41	Sediment/Total Suspended Solids	Elevated Water Temperature, Degraded Habitat	Non-Point Source (Rural or Urban), Sediment Resuspension, Discharges from Municipal Separate Storm	TMDL Development
Silver Creek	146800	12.4	14.36	Sediment/Total Suspended Solids	Elevated Water Temperature, Degraded Habitat	Non-Point Source (Rural or Urban), Sediment Resuspension	TMDL Development
Silver Creek Mouth	146800	0	155.98	E. coli	Recreational Restrictions - Pathogens	NA	303d Listed
Big Twin Lake	146500		78	Total Phosphorus	Excess Algal Growth	Non-Point Source (Rural or Urban)	TMDL Development
Unnamed Tributary to Silver Creek	146900	0	2.93	Total Phosphorus	Degraded Biological Community	Non-Point Source (Rural or Urban)	Proposed for List
Wuerches Creek	148300	0	4.4	Total Phosphorus	Low DO, Elevated Water Temperature	Non-Point Source (Rural or Urban)	TMDL Development
Wuerches Creek	148300	0	4.4	Sediment/Total Suspended Solids	Degraded Habitat	Non-Point Source (Rural or Urban)	TMDL Development
North Tributary to Silver Creek	147400	0	4.42	Total Phosphorus	Impairment Unknown	Non-Point Source (Rural or Urban)	Proposed for List
Unnamed Tributary to Silver Creek	147700	0	8.14	Total Phosphorus	Impairment Unknown	Non-Point Source (Rural or Urban)	Proposed for List

Monitoring Project Discussion

Purpose of Project

This study monitored the water quality of the Big Green Lake Watershed. This Targeted Watershed Assessment (TWA) involved collection of a baseline water quality assessment in the watersheds on the south side of Big Green Lake and Silver Creek, including total phosphorus (TP), habitat, fish, and aquatic macro invertebrates. Monitoring the Big Green Lake watershed will be used for comparison of future monitoring after watershed enhancements have been made to improve water quality in Silver Creek and reduce the nutrient and suspended solids load into Big Green Lake. Considerable creek restoration and watershed best management practice work was conducted and is projected for the future by multiple

agencies, including Green Lake County Land Conservation Department (Green Lake County LCD) and Natural Resource Conservation Service (NRCS).

A secondary goal of this project was to determine Wisconsin Administrative Code ch. NR 102 (NR 102) phosphorus and temperature water quality criteria exceedances and degraded biological community and habitat impairments for USEPA Clean Water Act Section 303d (CWA 303d) listing purposes for the creeks in this watershed. In 2011, an assessment was conducted by DNR Water Resources staff on creeks that discharge into Big Green Lake (Johnson et. al. 2011). Three of the creeks (Roy Creek, Hill Creek, and Wuerches Creek) in that assessment are in the HUC 12 watershed on the south side of Big Green Lake. Overall, the monitoring conducted in 2014 filled in data gaps from the 2011 assessment.

The collected data helps determine whether streams in this watershed are achieving their attainable use to update the state's Clean Water Act Section 305(b) data, identify waters that are not meeting their designated and attainable uses (CWA 303(d)), and assess the overall health of the watersheds as required by Sections 305(b) and 208 of the Clean Water Act. The data collected with observations about watershed health are used to guide planning for improvements where needed.

The following are outcomes of this study:

- Watershed was monitored with a baseline survey
- Watershed was monitoring to understand its status and any presence of and sources of impairments.
- Streams in the system were monitored as a follow up to a 2011 assessment to verify condition.
- Tributaries to Big Green Lake are the subject of the watershed plan.

Methods, Equipment and Quality Assurance

Collection of TP, habitat, fish, continuous temperature, and aquatic macroinvertebrates used standard DNR data collection methods and samples were sent to certified laboratories in the state. No specific in-field duplicates, replicates or blanks were collected for the study; however quality assurance sampling procedures were used in the collection and preservation of samples for all parameters.

Total Phosphorus (TP) and Total Suspended Solids (TSS)

All samples were collected using the standard DNR grab sampling method for a total of 90 samples (WDNR 2014). During the growing season of 2014, TP samples were collected by volunteers at 4 locations on the south side of Big Green Lake once per month from May through October (Table 5). Additionally, TP and TSS samples were collected by volunteers at 11 locations in Silver Creek once per month from May through October 2014 (Table 6). All TP and TSS samples were shipped to Wisconsin State Laboratory of Hygiene (WISLOH) for analysis. The WISLOH entered all sample analysis data into the Surface Water Integrated Monitoring System (SWIMS) database.

Macroinvertebrates

Eighteen sites were sampled for aquatic macroinvertebrates in October 2014 (Table 5-6) in the Big Green Lake watershed. All sites were sampled using the DNR Guidelines for Collecting Macroinvertebrate Samples from Wadable Streams (2000). A D-shaped kicknet with micron mesh was used at all sites by standing upstream from the net and placing it firmly on the stream bed while digging into the substrate with the heel or toe to free the macroinvertebrates from the substrate. Riffles were targeted at each of the sites, but if none were present then overhanging vegetation, woody debris, or other vegetation would be sampled. This is done by jabbing the net into the vegetation to free the invertebrates.

For a representative sample of the aquatic macroinvertebrate community, a minimum of 100 aquatic macroinvertebrates collected in each sample was targeted. The aquatic macroinvertebrates were preserved in a 70-80% ethanol solution inside quart "Mason" jars. If necessary, multiple "Mason" jars were used per sample depending upon how much sediment and organic material was collected with the aquatic macroinvertebrates. Within the next 24 hours, the samples were re-preserved with another 70-80% ethanol solution. Samples were taken to the University of Wisconsin-Stevens Point Aquatic Entomology Laboratory (UWSP AEL) for lowest possible taxonomic identification. Staff at the UWSP AEL entered the data into the SWIMS database between winter 2014 and summer 2015.

Fish Assemblage

Fifteen of the 18 sites in Table 5-6 were surveyed between July and September 2014 following the DNR *Guidelines for Assessing Fish Communities of Wadable Streams in Wisconsin* (2001). The fish assemblage was determined by a quantitative survey involving electroshocking a section of stream with a minimum station length of 35 times the mean stream width. All fish were collected, identified, and counted. All gamefish were measured for length. Stream flow and water chemistry was recorded at each site prior to conducting the fish survey. A 12 Volt, 18 Amp Hour battery-powered backpack shocker was used for 10 of 15 sites based upon the smaller stream width and depth. An otter sled stream shocker with a 4000 Peak Watt generator was used for 5 of 15 sites with appropriate stream width and/or depth. Catch per effort sampling procedures were used for this project (no particular species was targeted, all captured). A single upstream pass was made using .125 inch mesh nets to collect the fish. At the end of the station, captured fish were identified and counted and all game fish were measured for length. Once all data was collected, the fish were returned to the creek. Fish survey data was entered into the FHMD by DNR Water Resources staff.

Habitat

At 9 sites in the Silver Creek watershed, qualitative notes on average stream width and depth, riparian buffers and land use, evidence of sedimentation, fish cover and potential management options were also recorded (Table 6). Habitat assessments were conducted following the DNR *Guidelines for Evaluating Habitat of Wadable Streams (2002).* DNR staff entered the qualitative habitat data into the DNR Fisheries and Habitat Management Database (FHMD).

Figure 3: Hobo Pendant Thermistor Deployment in Silver Creek at Douglas Street/Hwy 44 in 2014 Photo by Dave Bolha, 5/2/14, DNR

On the south side of Big Green Lake, six creeks were surveyed for quantitative habitat (Table 5). Habitat assessments were conducted following the DNR *Guidelines for Evaluating Habitat of Wadable Streams (2002).* Each habitat survey station length was 35 times the mean stream width of the survey station. Following the determination of station length, the station was divided into 12 transects. At each transect, substrate, sedimentation, erosion, water depth, and riparian land use data were collected. DNR staff entered the quantitative habitat data into the DNR Fisheries and Habitat Management Database (FHMD).

Continuous Temperature

Continuous temperature data was collected at 9 sites in the Silver Creek Watershed in 2014 (Table 6, Figure 3). Temperature measurements were collected once per hour at each location from May through mid-October. Temperature measurements were taken with an Onset Hobo Pendant thermistor attached to a fence post driven into the stream bed of the creek (Figure 3). The thermistor was attached to the fence post in such a manner as to suspend the thermistor in the water column low enough to stay under water in low flow conditions and high enough to not get buried in bottom substrate (~ 6 inches above the bottom). The thermistor was placed in a shaded location when possible.

Table 5: Monitoring stations and parameters measured at each location in the Southern Big Green Lake Watershed in 2014.

SWIMS Station ID	Site Name	WBIC	Parameters Measured	Map ID
10041576	Roy Creek Downstream of County Hwy O	148200	Aquatic Macroinvertebrate, Wadable Fish Survey, Quantitative habitat survey	1
10021317	Roy Creek 200 Feet Above County Hwy O	148200	Aquatic Macroinvertebrate, Wadable Fish Survey, Quantitative habitat survey	2
243026	Spring Creek Upstream of County Hwy K	148000	TP, Aquatic Macroinvertebrate, Wadable Fish Survey, Quantitative habitat survey	3
10033838	Hill Creek Upstream of Spring Grove Road	146200	TP, Aquatic Macroinvertebrate	4
10041578	Unnamed Tributary to Hill Creek Upstream from Scott Hill Road	5027219	TP, Aquatic Macroinvertebrate, Wadable Fish Survey, Quantitative habitat survey	5
10042146	Unnamed Tributary to White Creek Upstream from Scott Hill Rd	5027243	TP, Aquatic Macroinvertebrate	6
243059	White Creek Upstream Spring Grove Road	146600	Aquatic Macroinvertebrate, Wadable Fish Survey, Quantitative habitat survey	7
10012583	Wuerches Creek Upstream County Road B	148300	Aquatic Macroinvertebrate, Wadable Fish Survey, Quantitative habitat Survey	8

Table 6: Monitoring stations and parameters measured at each location in the Silver Creek Watershed in 2014.

SWIMS Station ID	Site Name	WBIC	Parameter Measured	Map ID
10037918	Dakin Creek E of FDL County Line	146700	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey, Continuous Temperature	A
10041508	Unnamed Trib to Silver Creek at Hwy 23	146900	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey, Continuous Temperature	B
10041507	Unnamed Trib to Silver Creek at Murray Rd	147000	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey, Continuous Temperature	C
203080	Silver Creek at Koro Rd	146800	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey, Continuous Temperature	D

Waterbody Name	WBIC	Start Mile	End Mile (acres)	Pollutant
10016330	Unnamed Trib to Silver Creek at Trail (County FF)	147400	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey, Continuous Temperature	E
10040834	Unnamed Trib to Silver Creek US Arcade Rd	5026964	TP, TSS	F
10015911	Silver Creek DS Scott Street Dam	146800	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey, Continuous Temperature	G
10021299	Silver Creek at Douglas St (Hwy 44)	146800	TP, TSS, Continuous Temperature	H
10041506	Unnamed Trib to Silver Creek at Hwy 23	5027015	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey	I
10041510	Silver Creek at County KK	146800	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey, Continuous Temperature	J
10041509	Unnamed Trib to Silver Creek at County KK	147700	TP, TSS, Wadable Fish Survey, Qualitative Habitat Survey, Continuous Temperature	K

Example of Streambank Restoration on Roy Creek near County O Photo by Dave Bolha

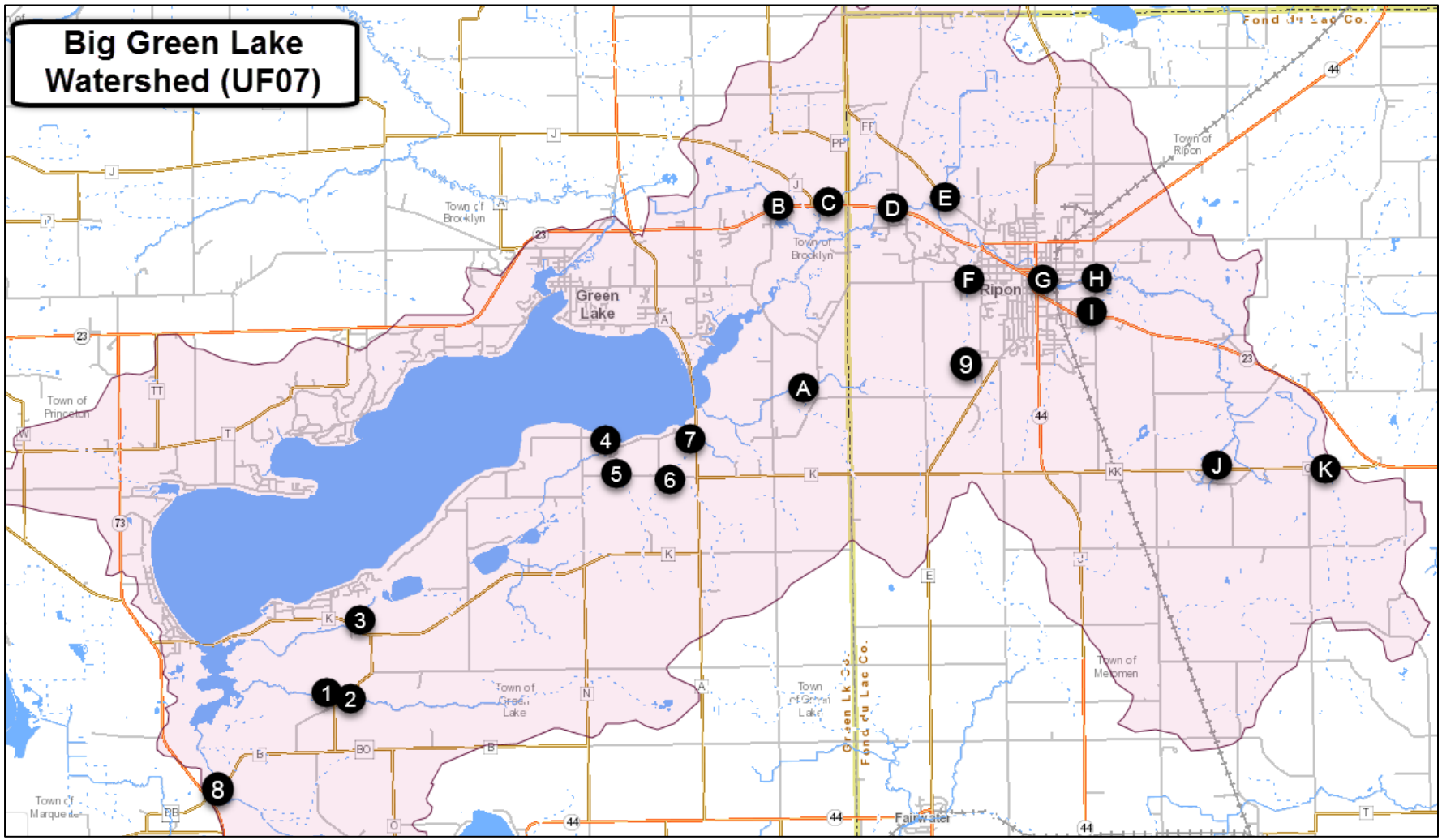

Figure 4: Monitoring station locations in the Big Green Lake watershed (UF). Locations 1-7 are in the Southern Big Green Lake watershed and locations A-K are in the Silver Creek watershed.

Project Results

Total Phosphorus

All inorganic chemistry samples were sent to the WISLOH in Madison for analysis. Two of the four creeks' samples in the Southern Big Green Lake watershed had an average TP concentration (mg/L) exceeding the NR 102 water quality criteria (WQC) for creeks and rivers of 0.075 mg/L (Table 7, Figure 5).

Table 7: Total Phosphorus Concentrations and Averages in 4 Creeks Sampled in the Southern Big Green Lake Watershed in 2014.

Month of Sampling Event	Hill Creek (mg/L)	Spring Creek (mg/L)	Unnamed Trib to White (mg/L)	Unnamed Trib to Hill (mg/L)
May	0.149	0.0141	0.0846	0.0165
June	0.2	0.0253	0.0765	0.0542
July	0.147	0.0218	0.0645	0.0493
August	0.175	0.0187	0.0589	0.0655
September	0.104	0.0198	0.163	0.0841
October	0.0971	0.0174	0.15	0.0785
Average	0.14535	0.0195	0.0996	0.05802

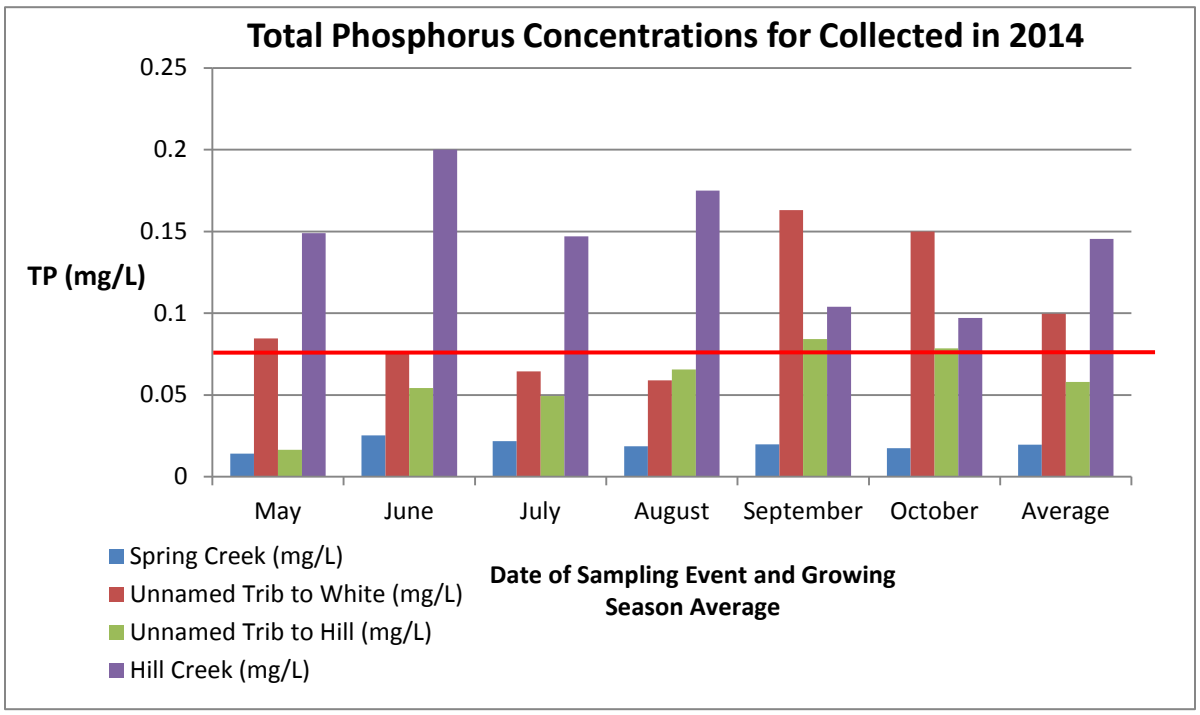

Figure 5: Total Phosphorus Concentrations and Averages in Creeks Sampled in 2014 (with 0.075 mg/L WQC red line) in the Southern Big Green Lake Watershed in 2014.

Eight of the 11 sites (Table 6) in the Silver Creek watershed had an average TP concentration (mg/L) exceeding the NR 102 WQC for creeks at 0.075 mg/L (Table 8-9, Figure 6-7). Three of the 11 sites had

average TP concentrations less than the WQC. The average TP concentrations for the 11 sites in this project ranged from 0.0268 mg/L at Site J to 0.2057 mg/L at Site E.

Table 8: Total Phosphorus Concentrations (mg/L) and Averages of Samples Collected in the Silver Creek Mainstem from Upstream to Downstream in 2014.

Sample Event Month	Silver Creek at Hwy KK Site J (mg/L)	Silver Creek Above Gothic Millpond at Hwy 44 Site H (mg/L)	Silver Creek Below Gothic Mill Pond Site G (mg/L)	Silver Creek at Koro Rd Site D (mg/L)
May	0.0227	0.123	0.0533	0.0694
June	0.0189	0.109	0.13	0.158
July	0.0284	0.194	0.135	0.139
August	0.0233	0.165	0.105	0.135
September	0.028	0.0769	0.0338	0.0553
October	0.0394	0.0664	0.0584	0.07
Average	0.0268	0.1224	0.0859	0.1045

Table 9: Total Phosphorus Concentrations and Averages of Samples Collected in the Tributaries of the Silver Creek Watershed in 2014.

Sample Event Month	Unnamed Site B (mg/L)	Unnamed Site C (mg/L)	Unnamed Site E (mg/L)	Unnamed Site F (mg/L)	Unnamed Site I (mg/L)	Unnamed Site K (mg/L)	Dakin Creek Site A (mg/L)
May	0.0418	0.0629	0.0742	0.112	0.0209	0.101	0.0743
Jun	0.107	0.0838	0.333	0.0381	0.0614	0.0924	0.108
Jul	0.124	0.0814	0.247	0.0687	0.0264	0.125	0.056
Aug	0.132	0.171	0.163	0.195	0.0418	0.103	0.0353
Sep	0.132	0.0656	0.303	0.175	0.023	0.129	0.037
Oct	0.102	0.0439	0.114	0.131	0.0293	0.108	0.0351
Ave	0.1065	0.0848	0.2057	0.1200	0.0338	0.1097	0.0576

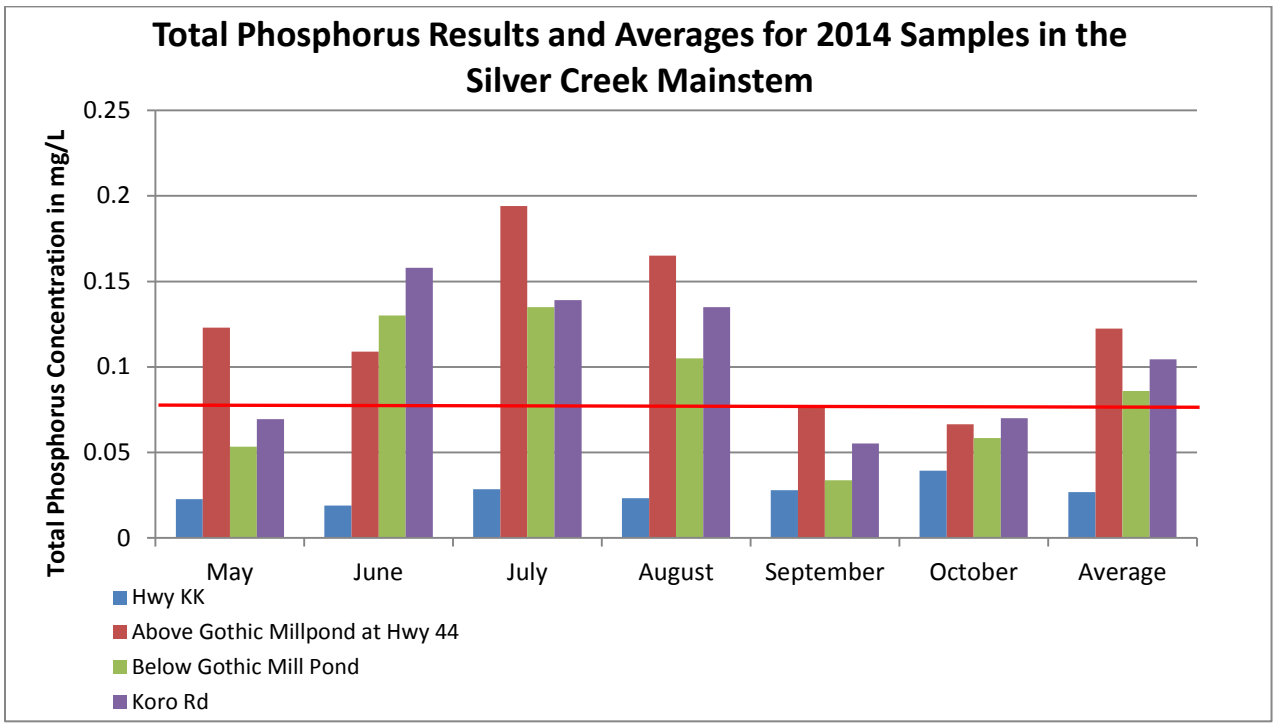

Figure 6: Total Phosphorus Concentration Results and Averages in Silver Creek Mainstem (with 0.075 mg/L WQC red line) in 2014.

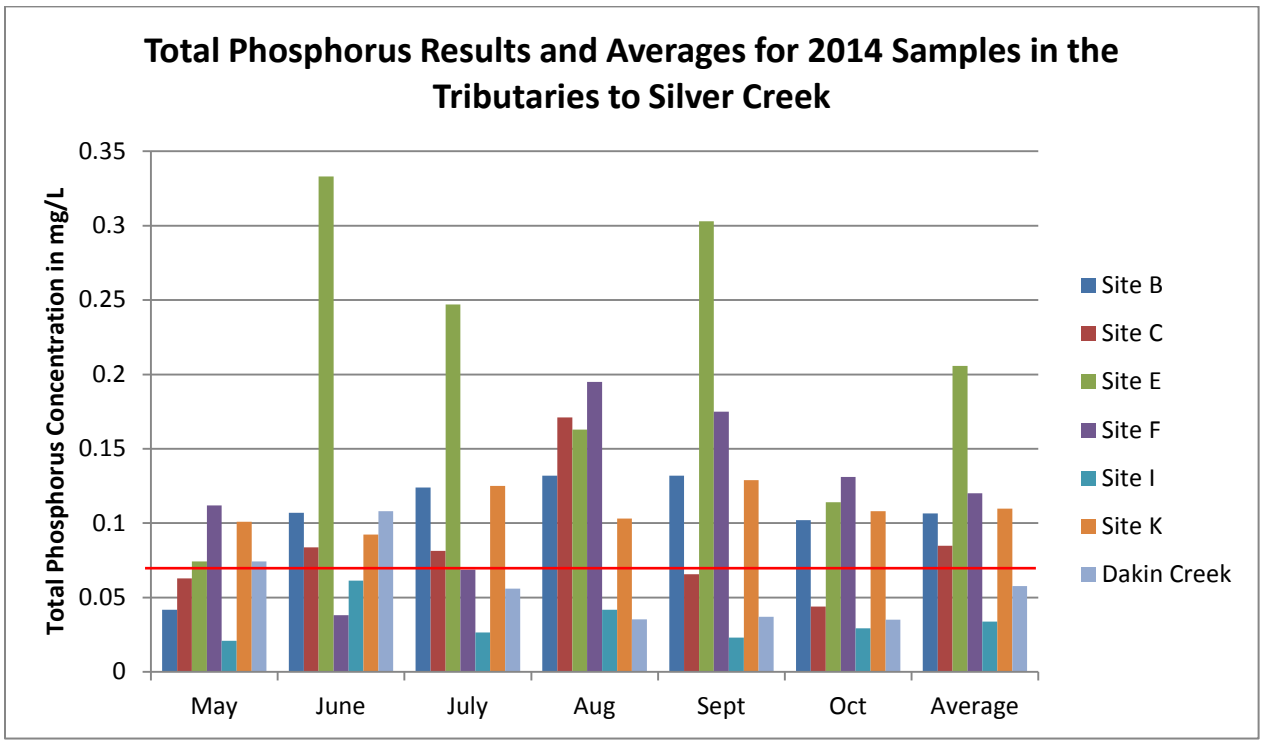

Figure 7: Total Phosphorus Concentration Results and Averages in the Tributaries to Silver Creek (with 0.075 mg/L WQC red line) in 2014.

Wisconsin Consolidated Assessment and Listing Methodology (WisCALM 2018) requires a parametric statistical approach to assess creek TP data against the applicable water quality criterion found in NR 102. This approach involves the calculation of a 90% confidence limit around the median of a TP sample dataset. If the lower 90% confidence limit (LCL) exceeds the criterion for TP, then that creek segment (assessment unit) is considered to be exceeding the criterion. The LCLs were calculated for each creek's TP samples in the Southern Big Green Lake watershed (Table 10). Three of the 4 creeks' samples LCLs met the water quality criterion for TP, while 1 exceeded (Table 10, Figure 8).

Table 10: Total Phosphorus Lower 90% Confidence Limits and Water Quality Criteria Exceedance Status of 4 Creeks in the Southern Big Green Lake Watershed in 2014.

	Hill Creek	Spring Creek	Unnamed Trib to White Creek	Unnamed Trib to Hill Creek
LCL (90%) mg/L	0.0894	0.0172	0.0465	0.0433
Exceedance Level	Exceeds	Meets	Meets	Meets

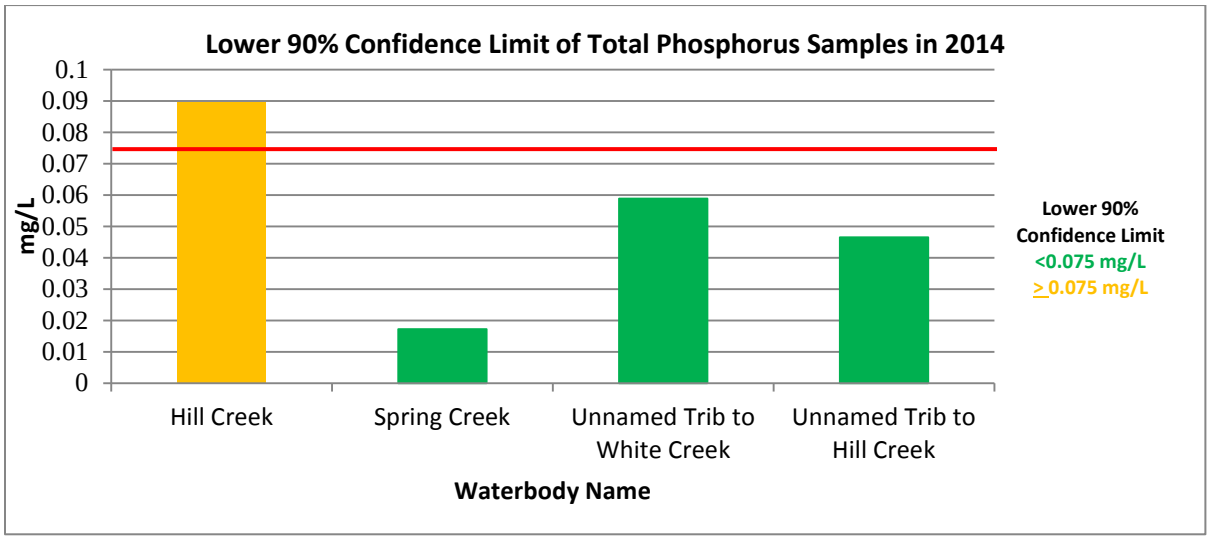

Figure 8: Total Phosphorus Lower 90% Confidence Limit in Creeks Sampled in 2014 (with 0.075 mg/L WQC red line) in the Southern Big Green Lake Watershed in 2014.

Two of the 4 Silver Creek sites' TP LCLs exceeded the WQC (≥ 0.075 mg/L) while two met the WQC (< 0.075 mg/L) (Table 11, Figure 9). The headwaters of Silver Creek at County Hwy KK met the WQC. Just upstream of the Gothic Millpond at Hwy 44 the Silver Creek TP LCL exceeded the WQC. Below the Gothic Millpond, the Silver Creek TP samples met the WQC. At Koro Road, the WQC was exceeded by the Silver Creek TP samples. None of the Silver Creek TP LCLs overwhelmingly exceeded the WQC (≥0.15 mg/L). The Silver Creek TP LCLs ranged from 0.0225 at County Hwy KK to 0.0925 mg/L above the Gothic Millpond.

Table 11: Total Phosphorus Lower 90% Confidence Limit and Water Quality Criteria Exceedance Level of Samples Collected in the Silver Creek Mainstem from Upstream to Downstream in 2014.

	Silver Creek at Hwy KK Site J	Silver Creek Above Gothic Millpond at Hwy 44 Site H	Silver Creek Below Gothic Mill Pond Site G	Silver Creek at Koro Rd Site D
LCL (90%) mg/L	0.0225	0.0925	0.0605	0.077
Exceedance Level	Meets	Exceeds	Meets	Exceeds

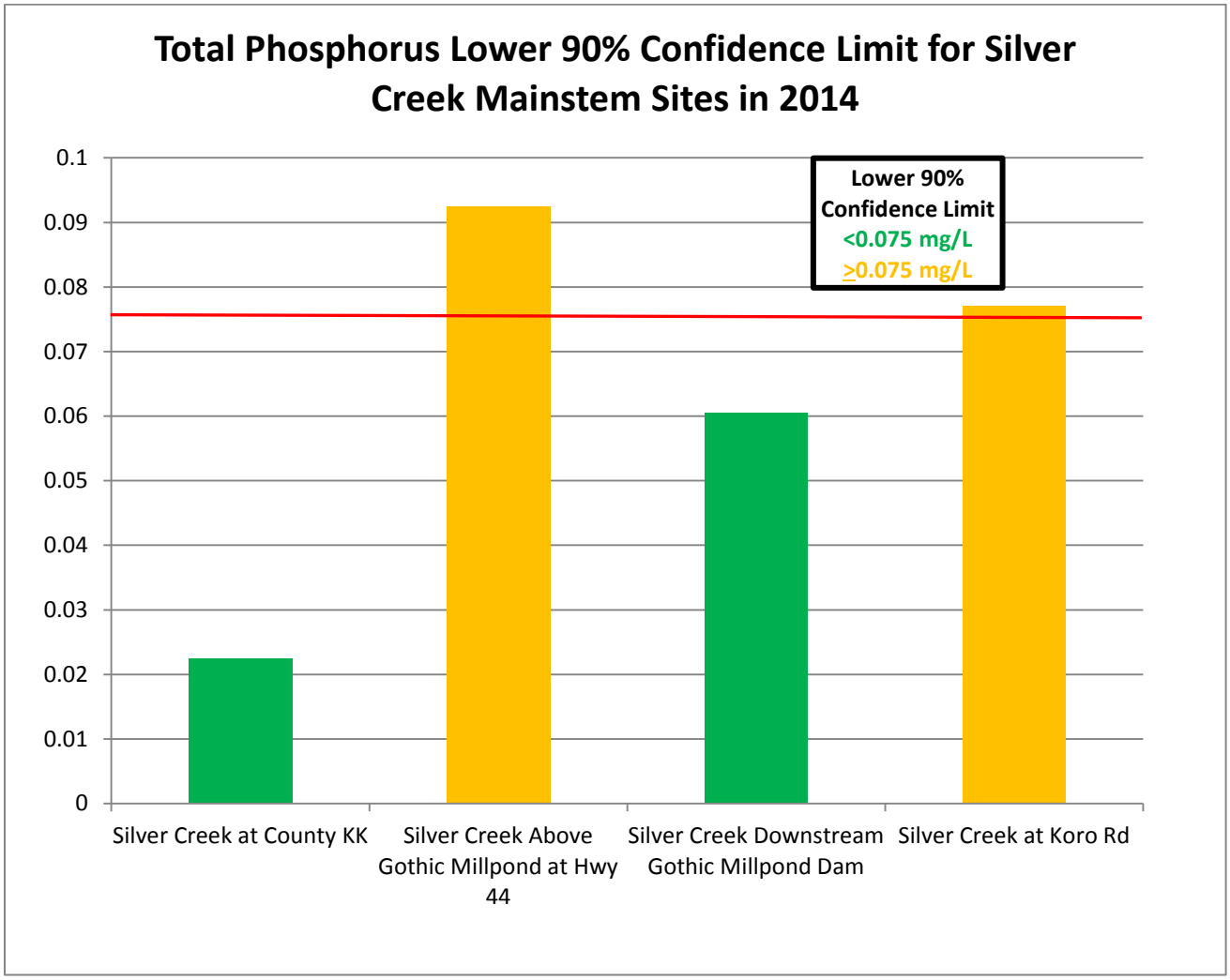

Figure 9: Total Phosphorus Lower 90% Confidence Limit and Water Quality Criteria Exceedance Level of Samples Collected in the Silver Creek Mainstem from Upstream to Downstream in 2014 (with 0.075 mg/L WQC red line).

Four of the 7 tributary sites' TP LCLs exceeded 0.075 mg/L while 3 met the WQC (Table 12, Figure 10). The tributary LCLs ranged from 0.0245 mg/L at Site I to 0.1426 mg/L at Site E. None of the tributary TP LCLs overwhelmingly exceeded the WQC (≥0.15 mg/L).

Table 12: Total Phosphorus Lower 90% Confidence Limit and Water Quality Criteria Exceedance Level of Samples Collected in the Tributaries of the Silver Creek Watershed in 2014.

	Unnamed Site B	Unnamed Site C	Unnamed Site E	Unnamed Site F	Unnamed Site I	Unnamed Site K	Dakin Creek Site A
LCL (90%) mg/L	0.0859	0.0576	0.1426	0.0836	0.0245	0.1011	0.0401
Exceedance Level	Exceeds	Meets	Exceeds	Exceeds	Meets	Exceeds	Meets

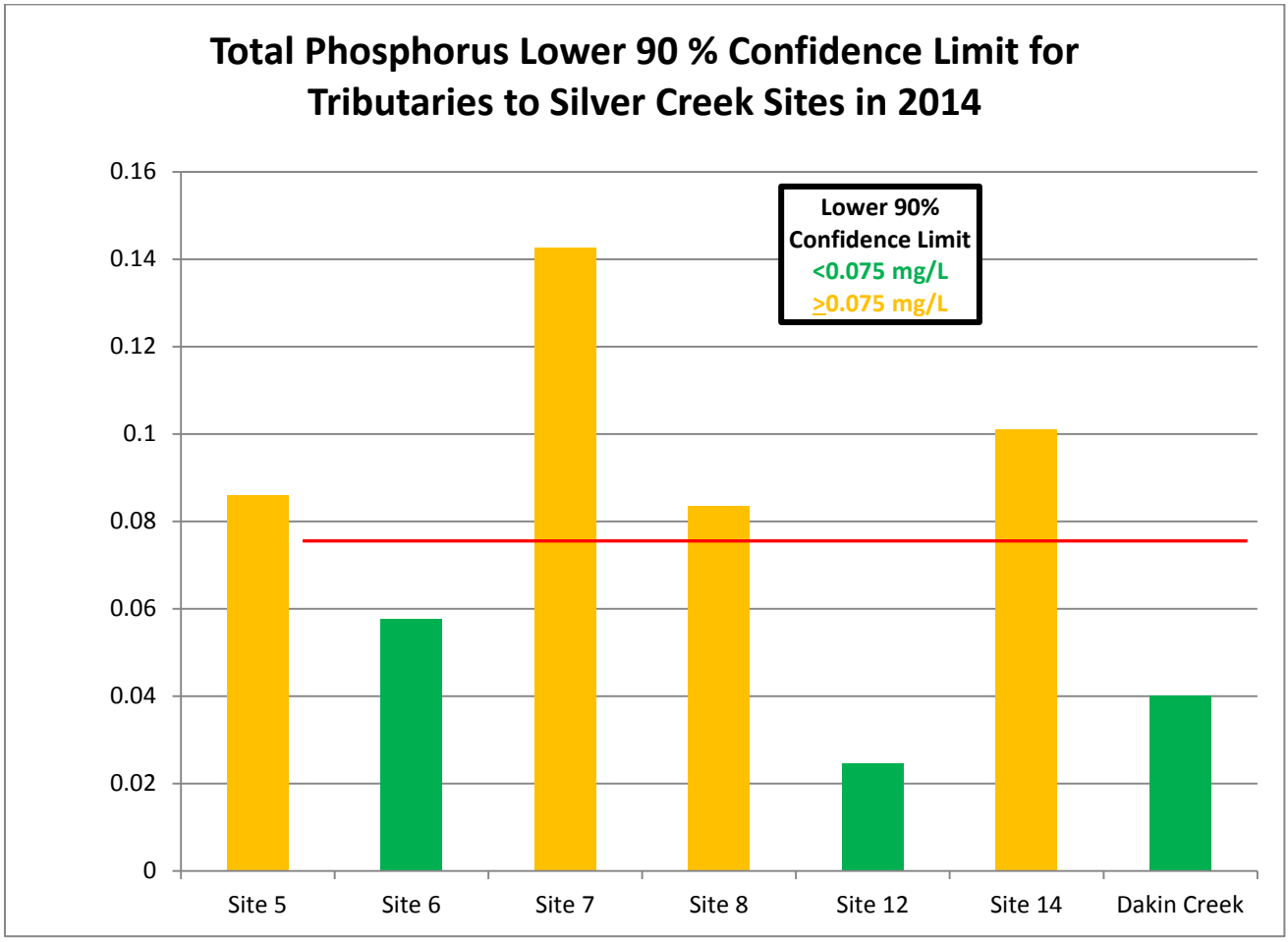

Figure 10: Total Phosphorus Lower 90% Confidence Limit and Water Quality Criteria Exceedance Level of Samples Collected in the Tributaries of the Silver Creek Watershed in 2014 (with 0.075 mg/L WQC red line).

Total Suspended Solids

TSS samples were collected at each of the 4 Silver Creek Mainstem project sites during the same sampling events as TP. TSS samples were collected once per month from May through October 2014 (Table 13, Figure 11). Wisconsin does not have a water quality standard for TSS; however, this data provides useful information about the watershed, background information for future comparison, and additional support for adding these systems to the CWA 303d list for habitat degradation. The average TSS concentration for the Silver Creek Mainstem ranged from 5.3 mg/L at County Hwy KK to 33.3 mg/L at Hwy 44.

Table 13: Total Suspended Solids Concentrations and Averages (mg/L) of Samples Collected in the Silver Creek Mainstem from Upstream to Downstream in 2014.

Month of Sampling Event	Silver Creek at County Hwy KK	Silver Creek Above Gothic Millpond at Hwy 44	Silver Creek Below Gothic Millpond	Silver Creek at Koro Rd
May	3.8	66	5.4	9
June	2.2	12.5	8.67	14.7
July	2.2	31.3	10.8	17
August	2.6	47.7	10	10.2
September	3.8	N/A	N/A	N/A
October	17	9	4.4	8.4
Average	5.27	33.3	8.72	11.86

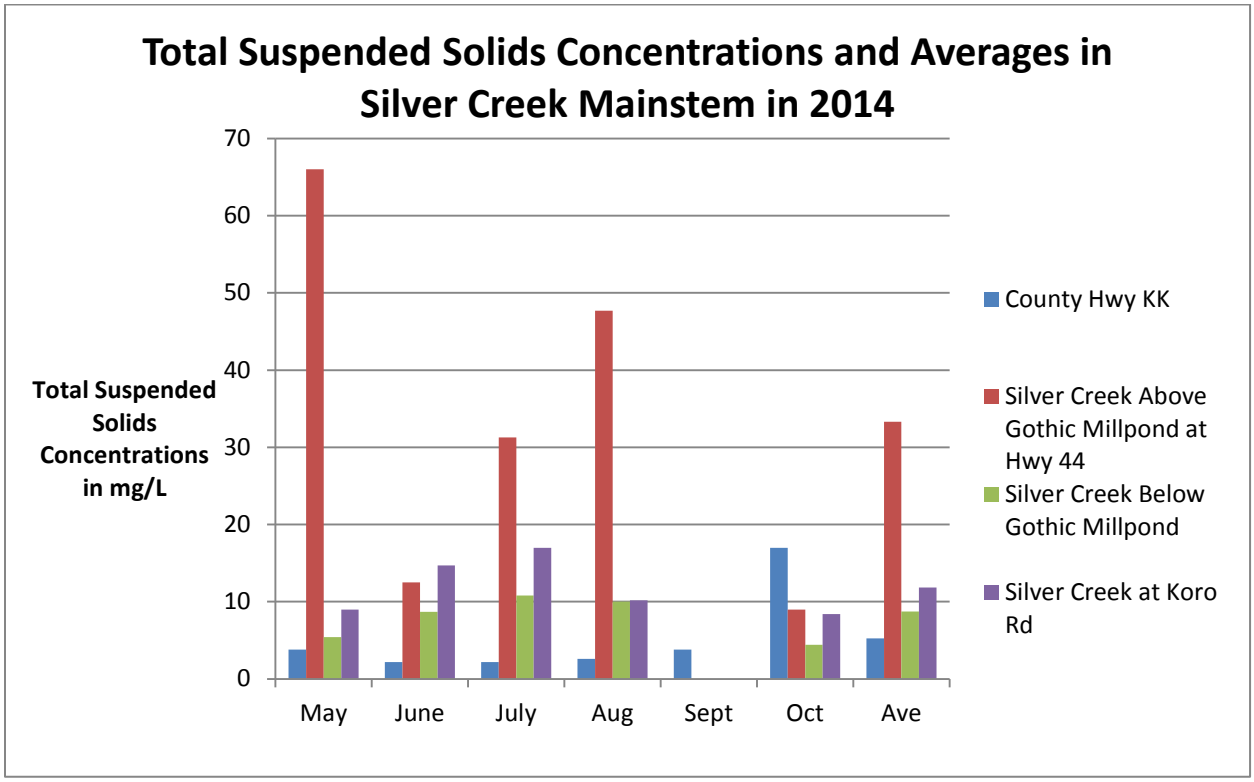

Figure 11: Total Suspended Solids Concentrations and Averages (mg/L) of Samples Collected in the Silver Creek Mainstem from Upstream to Downstream in 2014.

TSS samples were collected at each of the 7 Silver Creek tributary sites during the same sampling events as TP. TSS samples were collected once per month from May through October 2014 (Table 14). The average TSS concentration for the Silver Creek tributaries ranged from 4.1 mg/L at Site I to 26.65 mg/L at Site C (Table 14, Figure 12).

Table 14: Total Suspended Solids Concentrations and Averages (mg/L) of Samples Collected in Tributaries of Silver Creek in 2014 (2.0 mg/L = Limit of Detection).

Sample Event Month	Unnamed Site B	Unnamed Site C	Unnamed Site E	Unnamed Site F	Unnamed Site I	Unnamed Site K	Dakin Creek Site A
May	3	13.4	2	2	2	3	35.2
June	24	19.7	7	5.25	13	2	18.2
July	20.6	19.7	6	9	3.4	2	10.4
August	11.2	92.3	7	2	2	9.6	2
September	10.4	2	5.6	3.8	2	52.5	2
October	7.6	12.8	3.8	N/A	2	49	2
Average	12.8	26.65	5.23	4.41	4.07	19.68	11.63

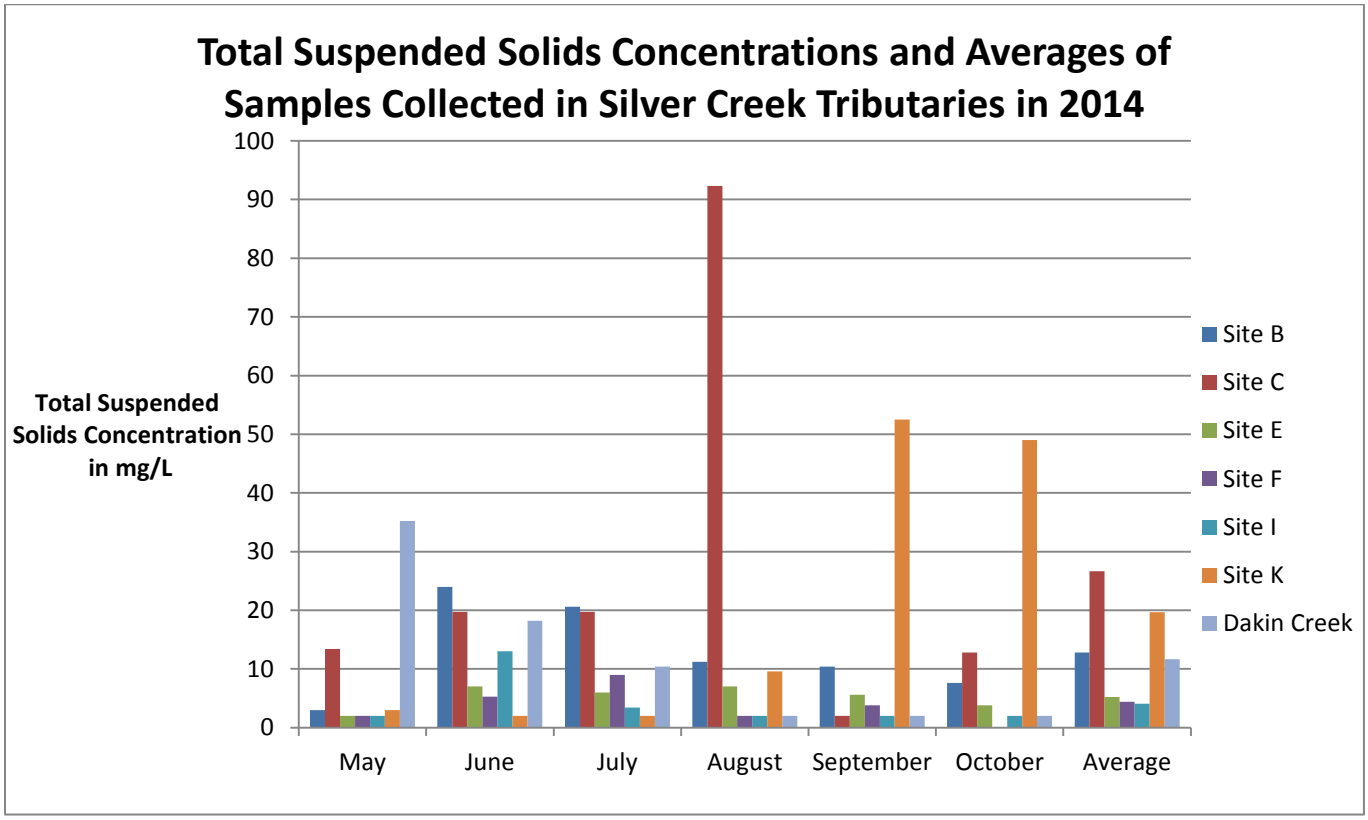

Figure 12: Total Suspended Solids Concentrations and Averages (mg/L) of Samples Collected in Tributaries of Silver Creek in 2014 (2.0 mg/L = Limit of Detection).

Macroinvertebrates

In October 2014, each of the 7 streams in Table 5 was sampled for aquatic macroinvertebrate communities in the Southern Big Green Lake watershed. Some aquatic macroinvertebrate species are tolerant of environmental degradation, while some species are moderately tolerant, and some others are intolerant. Based upon the representative macroinvertebrate sample collected and their associated tolerance to environmental degradation, a Macroinvertebrate Index of Biotic Integrity (MIBI) was calculated to indicate the water quality condition of the stream (Table 15, Figure 13). The MIBI scores ranged from 3.17 at Roy Creek upstream of County Hwy O to 4.65 at White Creek upstream of Spring Grove Road. The Condition Categories for the 8 sites were all Fair (Table 15, Figure 13). All 7 streams demonstrated a macroinvertebrate community significantly impacted by environmental degradation.

Additionally, 11 streams were sampled for aquatic macroinvertebrate communities in the Silver Creek Watershed. The MIBI scores ranged from 1.71 at the Unnamed Tributary to Silver Creek upstream of Arcade Road to 4.54 at Silver Creek at Douglas Street (Table 16, Figure 14). The condition categories for 10 sites were Fair, while Site F's demonstrated a condition category of Poor. All 11 streams demonstrated a macroinvertebrate community significantly impacted by environmental degradation.

Table 15: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Southern Big Green Lake Watershed in October 2014.

SWIMS Station ID	Stream Name and Location	Macroinvertebrate IBI Score	Condition Category
10033838	Hill Creek Upstream of Spring Grove Road	4.42	Fair
10041576	Roy Creek Downstream of County Hwy O	3.36	Fair
10021317	Roy Creek 200 Feet Above County Hwy O	3.17	Fair
243026	Spring Creek Upstream of County Hwy K	4.3	Fair
10041578	Unnamed Tributary to Hill Creek Upstream from Scott Hill Road	2.74	Fair
10042146	Unnamed Tributary to White Creek Upstream from Scott Hill Rd	4.57	Fair
243059	White Creek Upstream Spring Grove Road	4.65	Fair
10012583	Wuerches Creek Upstream of County Hwy B	3.18	Fair

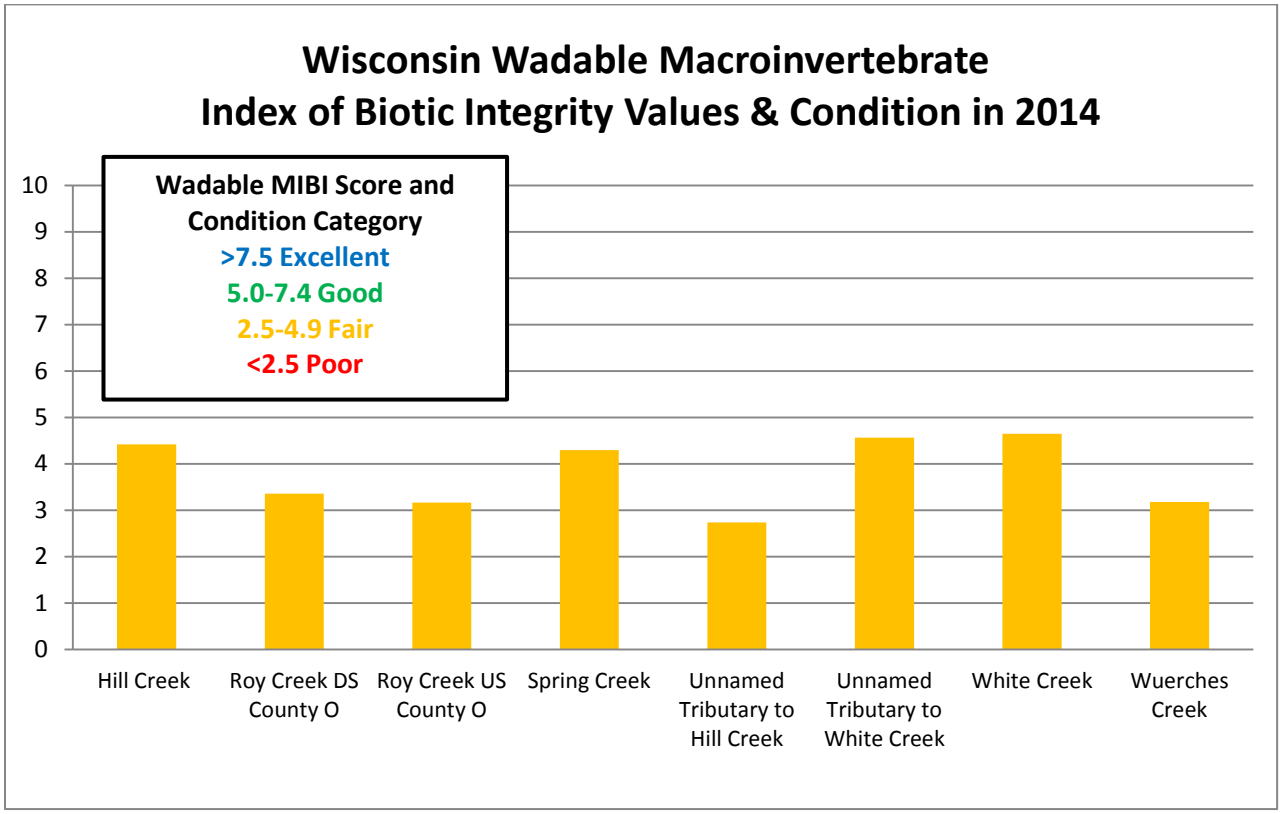

Figure 13: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Southern Big Green Lake Watershed in October 2014.

Table 16: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Silver Creek Watershed in October 2014.

SWIMS Station ID	Stream Name and Location	Map ID	Macroinvertebrate IBI Score	Condition Category
10041510	Silver Creek at County KK	J	3.57	Fair
10021299	Silver Creek at Douglas St (Hwy 44)	H	4.54	Fair
10015911	Silver Creek DS Scott Street Dam	G	3.77	Fair
203080	Silver Creek at Koro Rd	D	4.07	Fair
10037918	Dakin Creek E of FDL County Line	A	4.33	Fair
10041508	Unnamed Trib to Silver Creek at Hwy 23	B	3.85	Fair
10041507	Unnamed Trib to Silver Creek at Murray Rd	C	3.05	Fair
10016330	Unnamed Trib to Silver Creek at Trail (County FF)	E	4.34	Fair
10040834	Unnamed Trib to Silver Creek US Arcade Rd	F	1.71	Poor
10041506	Unnamed Trib to Silver Creek at Hwy 23	I	3.52	Fair
10041509	Unnamed Trib to Silver Creek at County KK	K	2.80	Fair

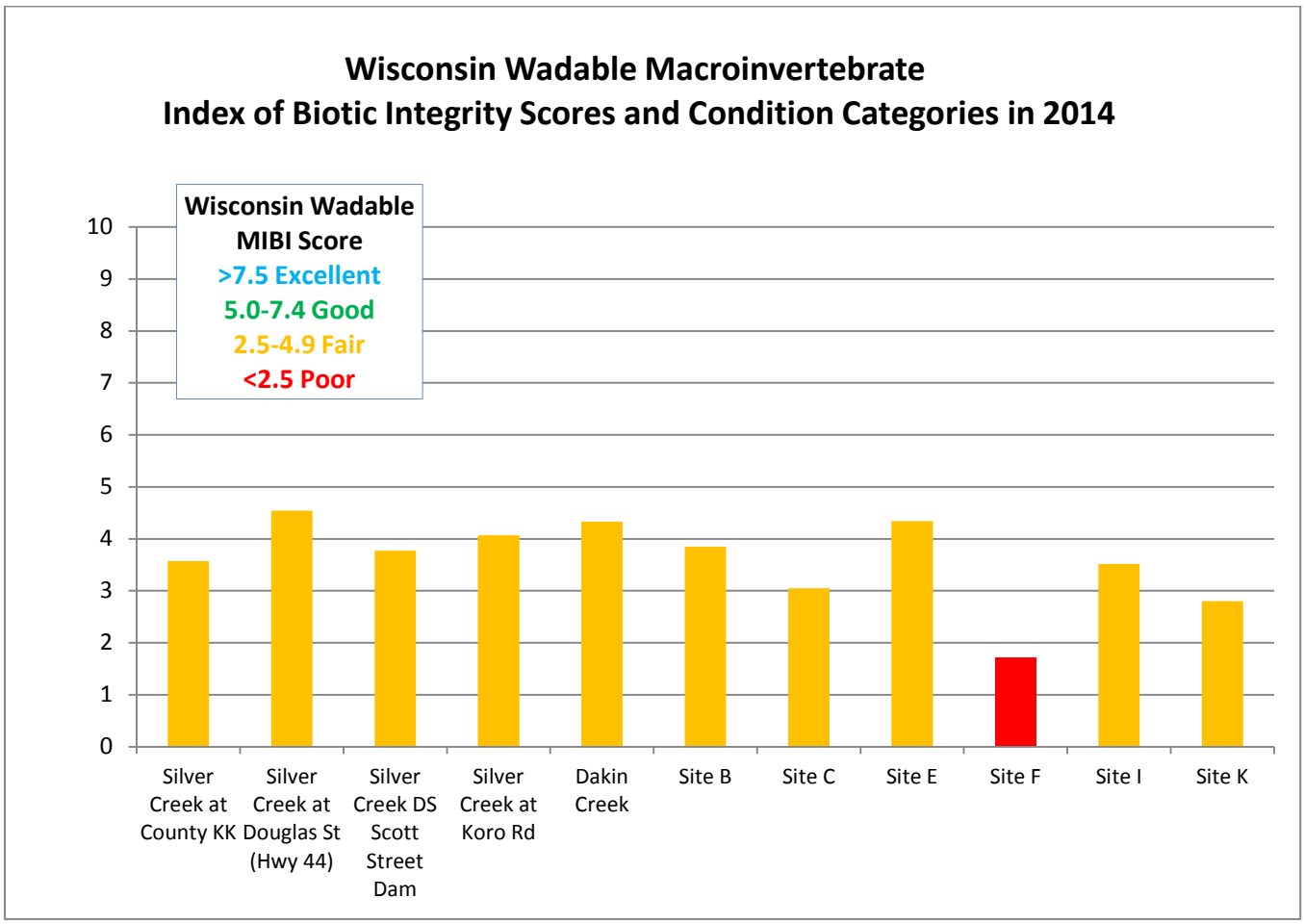

Figure 14: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Silver Creek Watershed in October 2014.

Habitat Survey

Between August and September 2014, quantitative habitat surveys were conducted at the 6 creeks listed in Table 5 (7 sites) in the Southern Big Green Lake watershed. Quantitative habitat assessments evaluate a representative stream reach (35 X Mean Stream Width) for the quantity and quality of habitat for game fish and compare the habitat to reference streams in Wisconsin. Based upon the assessment data collected during the 2014 surveys, a habitat rating was calculated for the 6 creeks (Table 17, Figure 15). The habitat rating scores were relatively similar for all creeks. The habitat rating scores ranged from 48 at the Unnamed Tributaries to White and Hill Creeks to 53 at Roy and Spring Creek (Table 18, Figure 16). Five of the 7 surveys demonstrated a Condition Category of Good, with scores ranging from 50-53. The remaining survey stations (the two Unnamed Tributaries) scored a Fair Condition Category, with a score of 48 (Table 17, Figure 15).

Table 17: Qualitative Habitat Survey Scores and Rating Conditions for 7 Creeks in the Southern Big Green Lake Watershed in 2014.

SWIMS Station ID	Stream Name and Site Location	Quantitative Habitat Score	Condition Category
10041576	Roy Creek Downstream of County Hwy O	50	Good
10021317	Roy Creek 200 Feet Above County Hwy O	53	Good
243026	Spring Creek Upstream of County Hwy K	53	Good
10041578	Unnamed Tributary to Hill Creek Upstream from Scott Hill Road	48	Fair
10042146	Unnamed Tributary to White Creek Upstream from Scott Hill Rd	48	Fair
243059	White Creek Upstream Spring Grove Road	50	Good
10012583	Wuerches Creek Upstream from County Road B	50	Good

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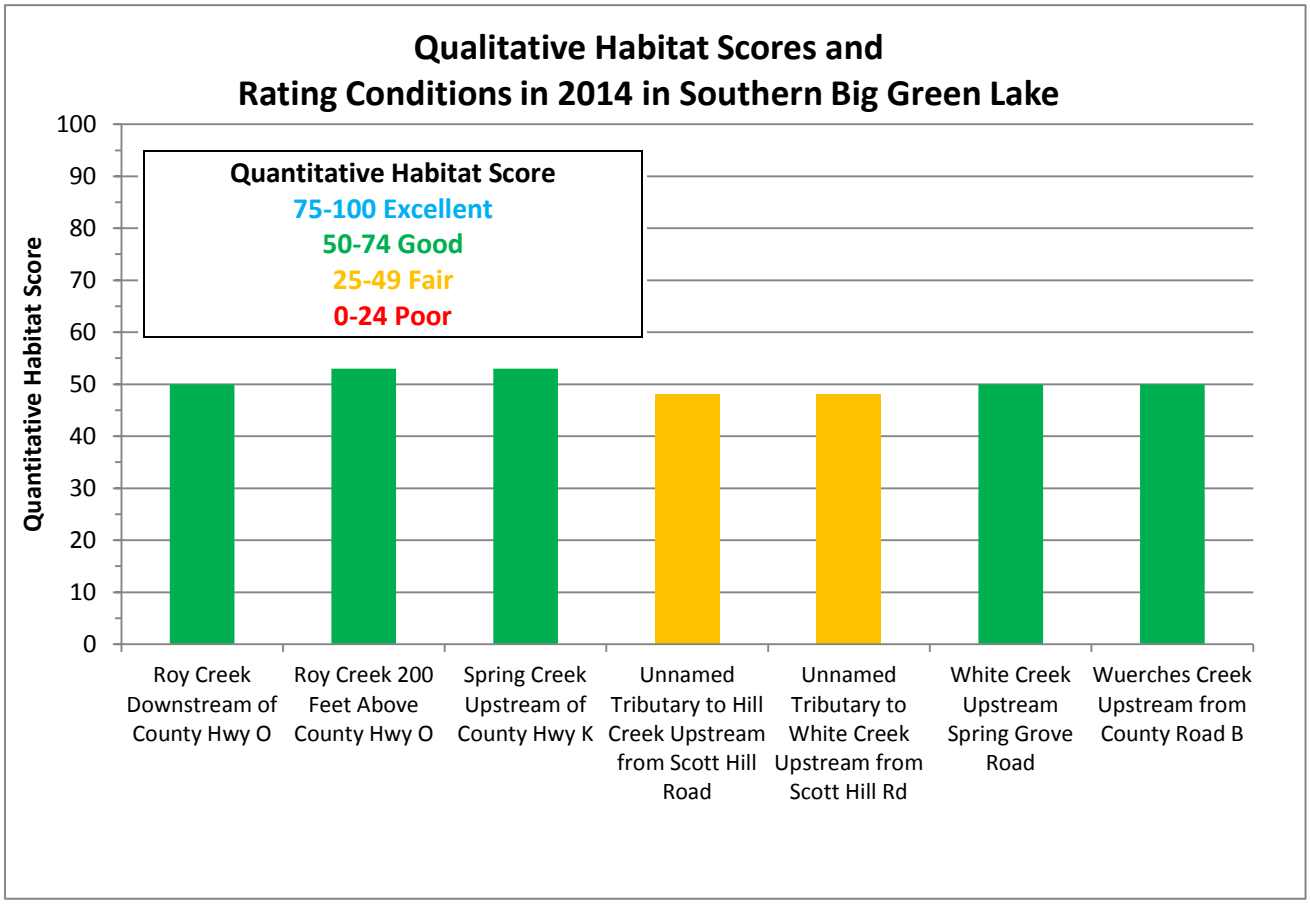

Figure 15: Quantitative Habitat Survey Scores and Rating Conditions for 6 Creeks in the Southern Big Green Lake Watershed in 2014.

Between July and September 2014, qualitative habitat surveys were conducted at 9 locations in the Silver Creek watershed (Table 6). Based upon the assessment data collected during the 2014 surveys, a

habitat rating was calculated for all sites. The habitat rating scores ranged from 50 at tributary Sites E and I to 73 at the headwaters site of Silver Creek at County Hwy KK (Table 18, Figure 16). All 9 surveys demonstrated a Condition Category of Good (Table 18, Figure 16).

Table 18: Qualitative Habitat Survey Scores and Rating Conditions for 9 Sites in the Silver Creek Watershed in 2014.

SWIMS ID	Stream Name and Site Location	Qualitative Habitat Score	Condition Category
10041510	Silver Creek at County Hwy KK	73	Good
10015911	Silver Creek Below Gothic Millpond	63	Good
203080	Silver Creek at Koro Rd	52	Good
10037918	Dakin Creek E of FDL County Line	72	Good
10041508	Site B	55	Good
10041507	Site C	63	Good
10016330	Site E	50	Good
10041506	Site I	50	Good
10041509	Site K	55	Good

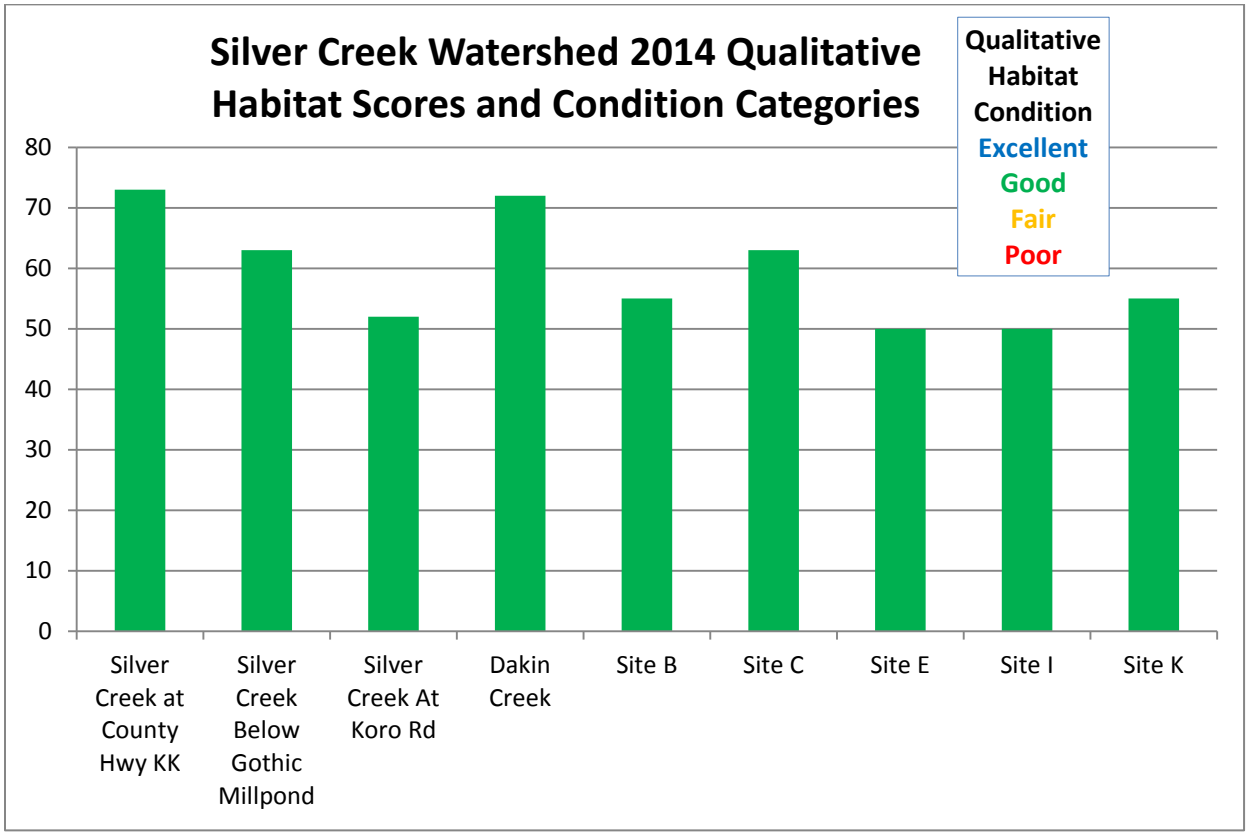

Figure 16: Qualitative Habitat Survey Scores and Condition Categories for 9 Sites in the Silver Creek Watershed in 2014.

Fish Survey

Between July and September 2014, each of the creeks were surveyed for representative fish communities in the Southern Big Green Lake Watershed (Table 5). Some fish species are tolerant of environmental degradation, while some species are moderately tolerant, and some others are intolerant. Based upon the representative fish collected during the survey and their associated tolerance to environmental degradation, an Index of Biotic Integrity (FIBI) was calculated to indicate the water quality of the creek (Table 19, Figure 17). The FIBI scores ranged from 0 at the Unnamed Tributary to Hill Creek, to 50 at Spring Creek. The Condition Category for the 6 sites ranged from Poor to Fair. Four of the 6 surveys had a Condition Category of Poor, while the remaining 2 surveys had a Condition Category of Fair (Table 19, Figure 17).

Table 19: Wisconsin Wadable Fish Index of Biotic Integrity Scores and Condition Categories for 6 Creeks in the Southern Big Green Lake Watershed in 2014.

SWIMS Station ID	Stream Name and Site Location	Fish IBI Score	Condition Category
10041576	Roy Creek Downstream of County O	10	Poor
10021317	Roy Creek Upstream of County O	20	Poor
243026	Spring Creek Upstream of County K	50	Fair
10041578	Unnamed Tributary to Hill Creek Upstream of Scott Hill Road	0	Poor
243059	White Creek Upstream of Spring Grove Road	40	Fair
10012583	Wuerches Creek Upstream of County B	20	Poor

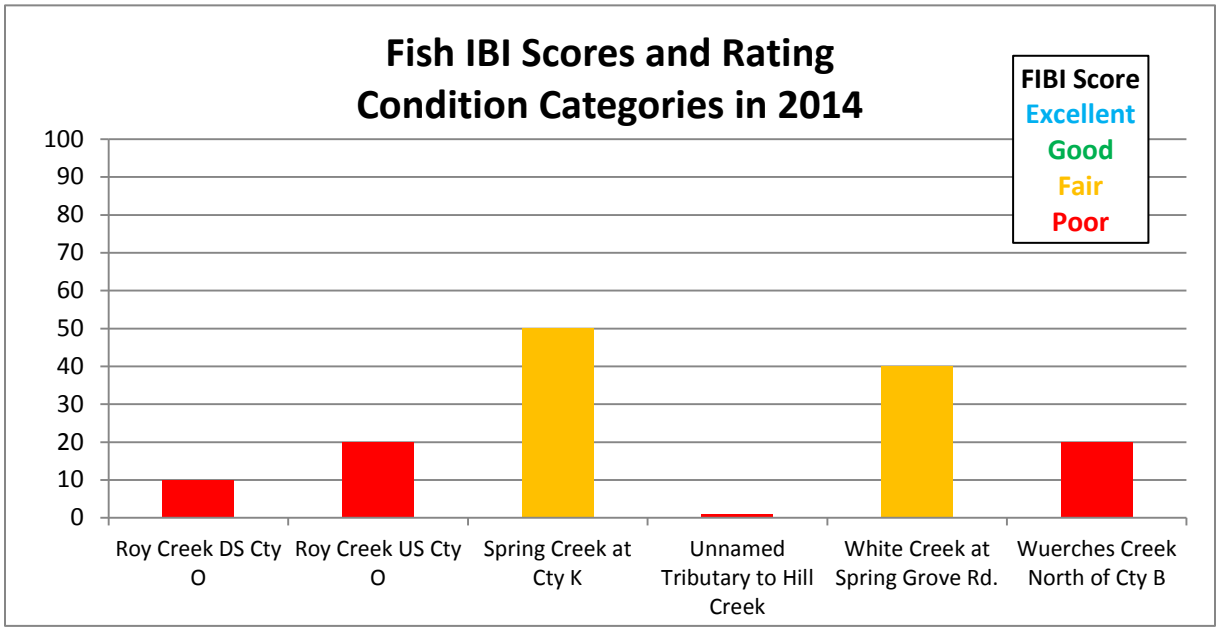

Figure 17: Wisconsin Wadable Fish Index of Biotic Integrity Scores and Condition Categories for 6 Creeks in the Southern Big Green Lake Watershed in 2014.

Additionally, between July and September 2014, the 9 sites (Table 6) were surveyed for representative fish communities in the Silver Creek Watershed. The FIBI scores ranged from 20 in the headwaters of Silver Creek to 100 in the Unnamed Creek at County Hwy FF (Table 20, Figure 18). The condition category for the 9 sites ranged from Poor to Excellent. The fish survey in the Unnamed Creek at County Hwy FF had a condition category of Excellent, with the highest number of fish species (11) and total number of fish caught (1341) (Table 20, Figure 18). The Silver Creek fish survey below Gothic Millpond had a condition category of Good, with 10 species caught (Table 20, Figure 18). Three of the 9 fish surveys indicated creeks having a condition category of Fair. The remaining four sites had a condition category of Poor based upon the fish surveys.

Each fish community in the Silver Creek Watershed surveyed was used to verify or update the modeled Natural Community for that stream segment. The modeled Natural Community for Silver Creek changes as you move from upstream to downstream. The headwater area of Silver Creek is modeled as a Cool-Warm Headwater Natural Community downstream to the west side of the City of Ripon. The modeled Natural Community changes to Cool-Warm Mainstem on the west side of Ripon until Silver Creek discharges into Big Green Lake.

Each of the 6 tributary streams' Natural Community was verified or changed based upon the fish caught in the survey (and any historical known surveys in that stream segment). Verifying or changing the modeled Natural Community was important since the Natural Community determines what FIBI was used to determine the water quality of that stream segment. The results of the calculated FIBI calculations displayed in Table 20 and Figure 18 are based upon the verified or changed Natural Community.

Table 20: Fish Survey Results in the Silver Creek Watershed Conducted in July through September 2014.

SWIMS Station ID	Site Name	FIBI Score	Condition Category	Verified or Updated Natural Community
10041510	Silver Creek at County KK	20	Poor	Cool-Warm Headwater
10015911	Silver Creek DS Scott Street Dam	80	Good	Cool-Warm Headwater
203080	Silver Creek at Koro Rd	30	Fair	Cool-Warm Mainstem
10037918	Dakin Creek E of FDL County Line	50	Fair	Cool-Cold Headwater
10041508	Unnamed Trib to Silver Creek at Hwy 23	30	Poor	Cool-Cold Headwater
10041507	Unnamed Trib to Silver Creek at Murray Rd	20	Poor	Cool-Cold Headwater
10016330	Unnamed Trib to Silver Creek at Trail (County FF)	100	Excellent	Cool-Warm Headwater
10041506	Unnamed Trib to Silver Creek at Hwy 23	20	Poor	Cool-Cold Headwater
10041509	Unnamed Trib to Silver Creek at County KK	60	Fair	Cool-Warm Headwater

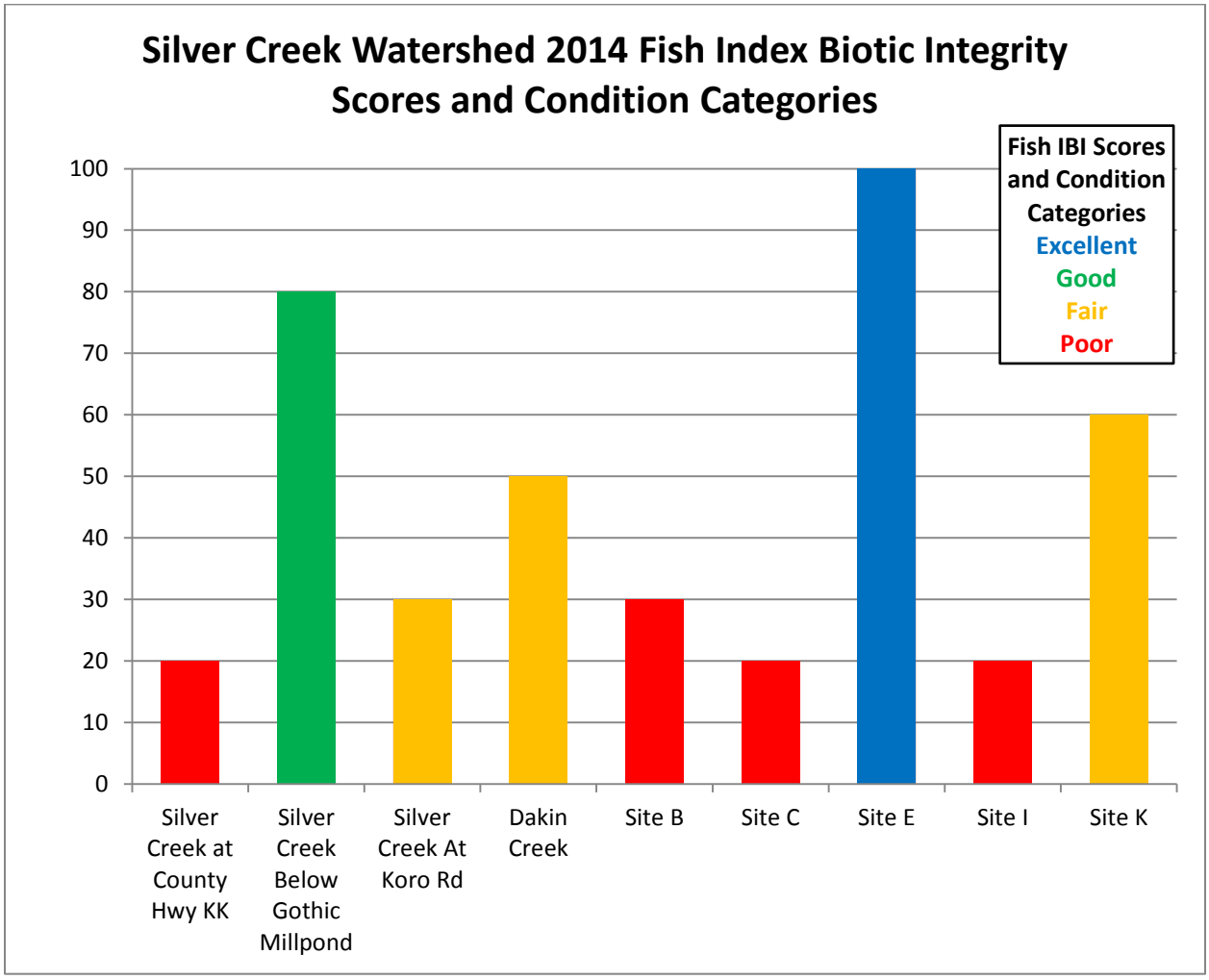

Figure 18: Fish Survey Results in the Silver Creek Watershed Conducted in July through September 2014.

Continuous Temperature

Temperature data was collected from May through mid-October in 2014 at 9 locations in the Silver Creek Watershed (Table 6). Four locations were monitored hourly in the Silver Creek mainstem. The temperatures in Silver Creek in general increased from upstream to downstream, except between the Gothic Millpond outlet and Koro Rd which showed a slight decrease in monthly average and maximum daily average temperatures. The decrease in temperature at Koro Rd is likely due to higher inputs of cooler groundwater into the creek as it flows through the City of Ripon. The upper portions of Silver Creek, in reference to the County Hwy KK location, are cold enough to support a Cool-Cold transitional fish community (Table 21, Figure 19). This section of Silver Creek upstream of Hwy 23 on the east side of Ripon is currently identified as Class 2 Trout Waters, which means some trout reproduction may occur but stocking is necessary to maintain a desirable fishery (WDNR 2002). The maximum daily average temperature of Silver Creek at County Hwy KK increased from 59.6°F to 74.5°F at Hwy 44 upstream of the Gothic Millpond (Table 21, Figure 19). The maximum daily average temperature of Silver Creek increased from 74.5°F to 76°F from upstream of the Gothic Millpond to downstream. The average monthly temperature increased on average 4°F from upstream of the millpond to downstream between June and September 2014.

Table 21: Average Monthly and Maximum Daily Average Temperatures in degrees Fahrenheit in Silver Creek Mainstem in 2014 (Fahrenheit).

Location	June Average Temperature	July Average Temperature	August Average Temperature	September Average Temperature	Maximum Daily Average Temperature
Silver Creek at County Hwy KK	50.4	50.2	50.5	50.3	59.6
Silver Creek Above Gothic Millpond	68.5	68	68.7	61.3	74.5
Silver Creek Below Gothic Millpond	70.7	71.6	73.8	66.2	76
Silver Creek at Koro Rd	68	68	69.3	63.1	73.1

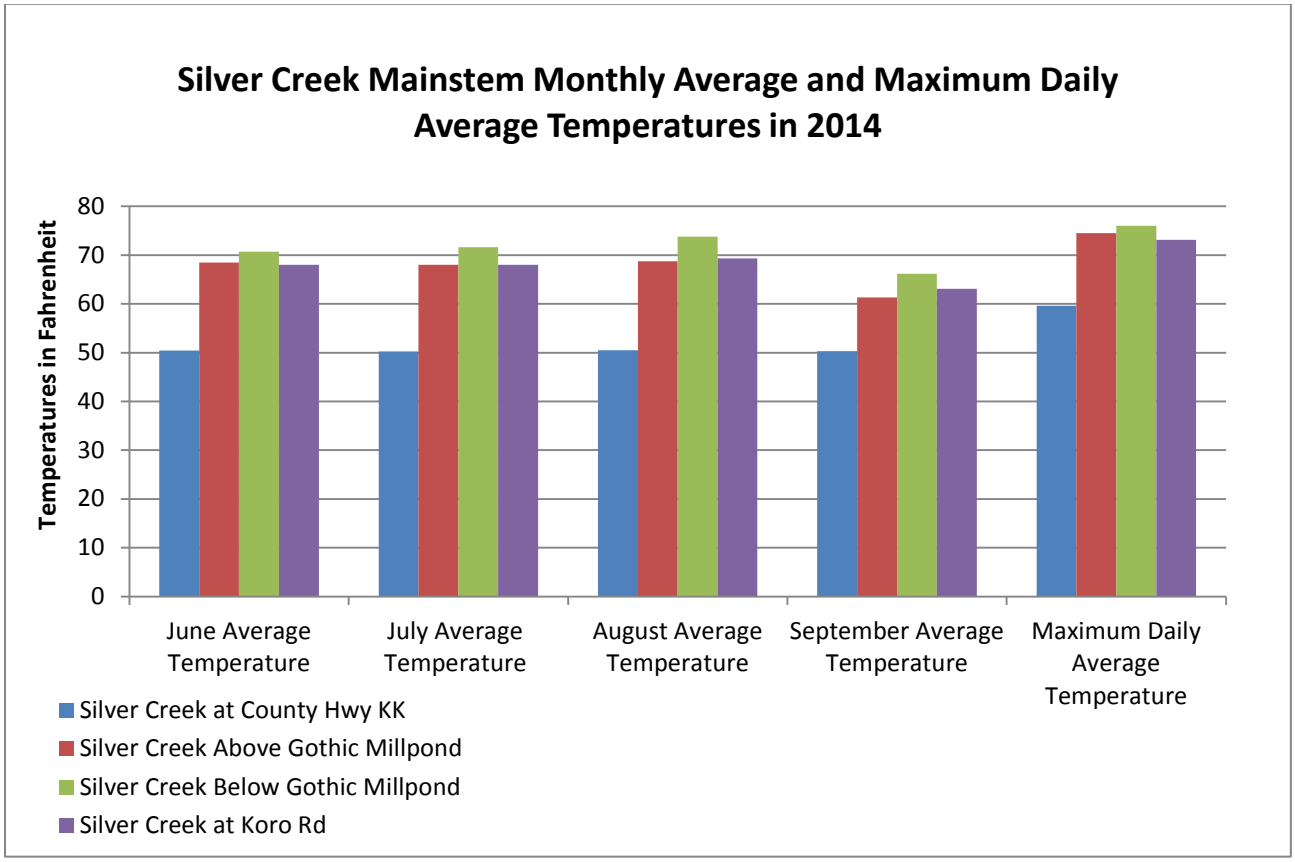

Figure 19: Average Monthly and Maximum Daily Average Temperatures degrees Fahrenheit in Silver Creek Mainstem in 2014.

Four Unnamed Creeks and Dakin Creek were monitored for temperature in the Silver Creek Watershed in 2014 (Table 6). Each location was monitored once per hour from early May through mid-October.

Dakin Creek recorded the lowest temperatures of the tributaries to Silver Creek (Table 22, Figure 20), with a Maximum Daily Average (MDM) of 65.7F. Unnamed Creek at County KK recorded the highest temperatures of the 5 tributaries in this project, with a MDM of 75F (Table 22, Figure 20).

Table 22: Average Monthly and Maximum Daily Average Temperatures in degrees Fahrenheit in Silver Creek Tributaries in 2014.

Location	June Average Temperature	July Average Temperature	August Average Temperature	September Average Temperature	Maximum Daily Average Temperature
Site B	62.2	61.2	61.7	56.5	66.6
Site C	67.8	68.4	69.1	61.3	74.5
Site E	68.7	66.6	66.9	60.1	74.7
Site K	67.8	66.4	64.8		75
Dakin Creek	57.2	55	56.5	54.3	65.7

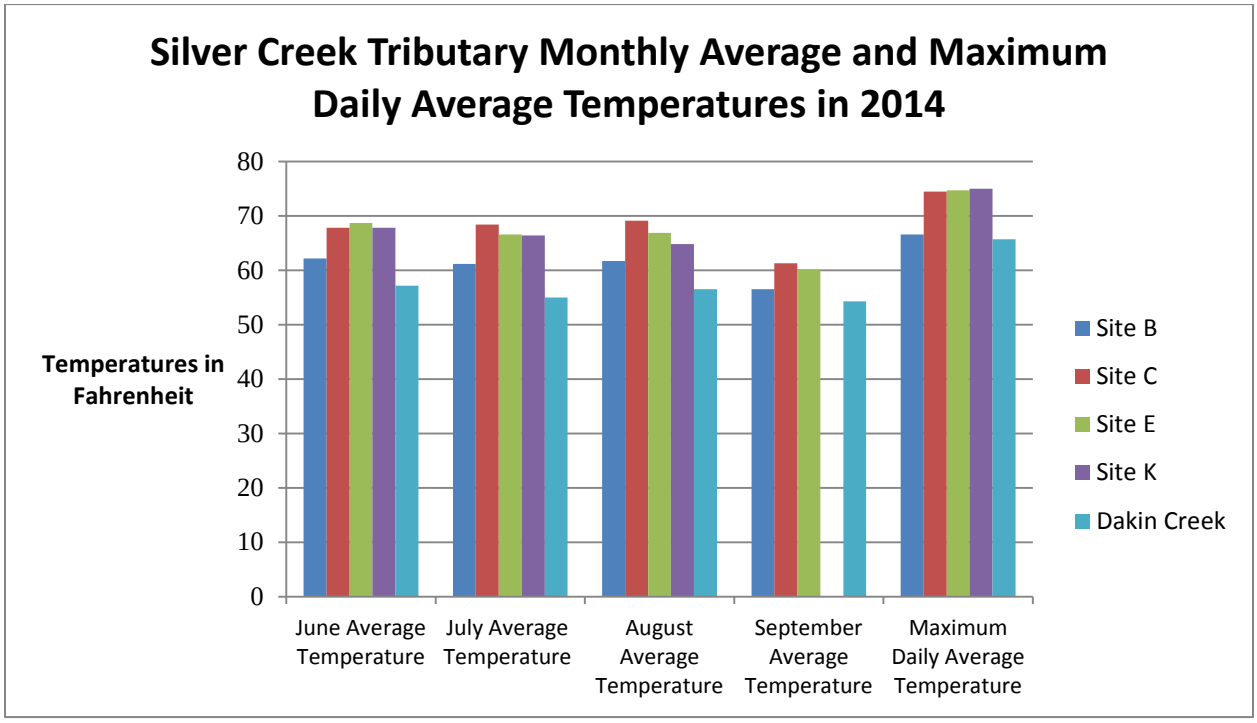

Figure 20: Average Monthly and Maximum Daily Average Temperatures in degrees Fahrenheit in Silver Creek Tributaries in 2014.

Discussion

River/Stream Health

Silver Creek watershed and the Southern Big Green watershed are associated with the Southeast Glacial Plains. The land use for the Southeast Wisconsin Till Plains (SWTP) is dominated by cropland. The creeks in this study have low to high clay soil content and are low to high in gradient, which is likely the driver behind cropland-dominated land use. The clay content of the soils in the SWTP has had a strong effect on the water quality of Midwestern streams (USGS 2006). Typically, as increases in agricultural land use occur, there is a correlating increase in TP concentration in creeks in the watershed. Water clarity

(secchi depths) decreases and chlorophyll a concentration (which is an indication of algae populations) increases as TP and TDP increases. Water clarity and chlorophyll a concentration are indicators of water quality in Wisconsin lakes (WisCALM 2018).

Reference average stream conditions for the SWTP ranged from 0.080 mg/L (USEPA 2000-2001) to 0.042 mg/L TP (USGS 2006). Three of the four average TP concentrations in the Southern Big Green watershed were above the modeled reference conditions (USEPA 2000-2001 & USGS 2006) (Table 7, Figure 5). Eight of the 11 average TP concentrations in the Silver Creek watershed were above the modeled reference conditions (USEPA 2000-2001 & USGS 2006) (Table 8 and 9, Figure 6 and 7). The land use in this study area has had a significant impact on the TP in 3 of the 4 creeks. Response thresholds of water quality to changes in nutrient concentrations for macroinvertebrates in Wisconsin wadable streams are 0.088 mg/L for TP (USGS 2006). In general, that means a small increase in nutrient concentration before reaching that threshold concentration results in a relatively large change to the macroinvertebrate and fish communities.

Two of the 4 sites in the southern Big Green Lake watershed demonstrated TP concentrations over response thresholds of water quality (USGS 2006) (Table 7, Figure 5). Eight of the 11 sites in the Silver Creek watershed demonstrated TP LCL concentrations over response thresholds of fish (USGS 2006) (Table 11 and 12, Figure 9 and 10). Three of the 11 Silver Creek sites demonstrated TP LCL concentrations over response thresholds of macroinvertebrates (USGS 2006). Water quality has been impacted by the TP concentrations in the creeks of this project.

This TWA project addressed needs for baseline water quality monitoring in the Southern Big Green Lake and Silver Creek watersheds. Repeatable biological, inorganic chemistry and habitat surveys provide valuable information for future comparison. This project filled data gaps from the 2011 Assessment Report of Hill, Roy, and Wuerches Creeks (Johnson et. al. 2011) (2011 Assessment). Together with the 2011 Assessment, the data collected in this project can be compared to future surveys to evaluate the effectiveness of Best Management Practices (BMPs) installed in the watershed.

Due to the nature of watershed water holding capacity, flood events, soil types, creek habitat, sediment deposition, and many other factors, BMPs may have an immediate and identifiable water quality impact while others may take years (20+) to see any kind of positive impact. Therefore, some short-term (3-year period) comparison of the data collected in this project can be done to the 2011 Assessment Report of Hill, Roy, and Wuerches Creeks (Johnson et. al. 2011) and data collected by USGS at Roy and White Creeks (USGS 2012-2014) (Table 23, Figure 21).

Since 2011, BMPs have been installed in the southern Big Green Lake HUC 12 watershed to mitigate some of the sediment and nutrient loading into the creeks and Big Green Lake. First, the average growing season TP concentrations from 2011-2014 are listed in Table 23 and Figure 21 (available data taken from the DNR SWIMS and USGS databases). Some sub-watersheds (individual creek watersheds) have more available data than others (ex. Roy Creek 3 years, Spring Creek 1 year).

Table 23: Average Total Phosphorus (mg/L) of All Data May through October 2011-2014 for Creeks in the Southern Big Green Lake Watershed.

Stream and Data Year	Roy Creek 2011	Roy Creek 2013	Roy Creek 2014	Spring Creek 2014	Hill Creek 2011	Hill Creek 2014	Trib to Hill Creek 2014	Trib to White Creek 2014	White Creek 2011	White Creek 2012	Wuerches Creek 2011
Avg. TP mg/L	0.193	0.289	0.867	0.0195	0.107	0.145	0.058	0.1	0.0491	0.0435	0.178

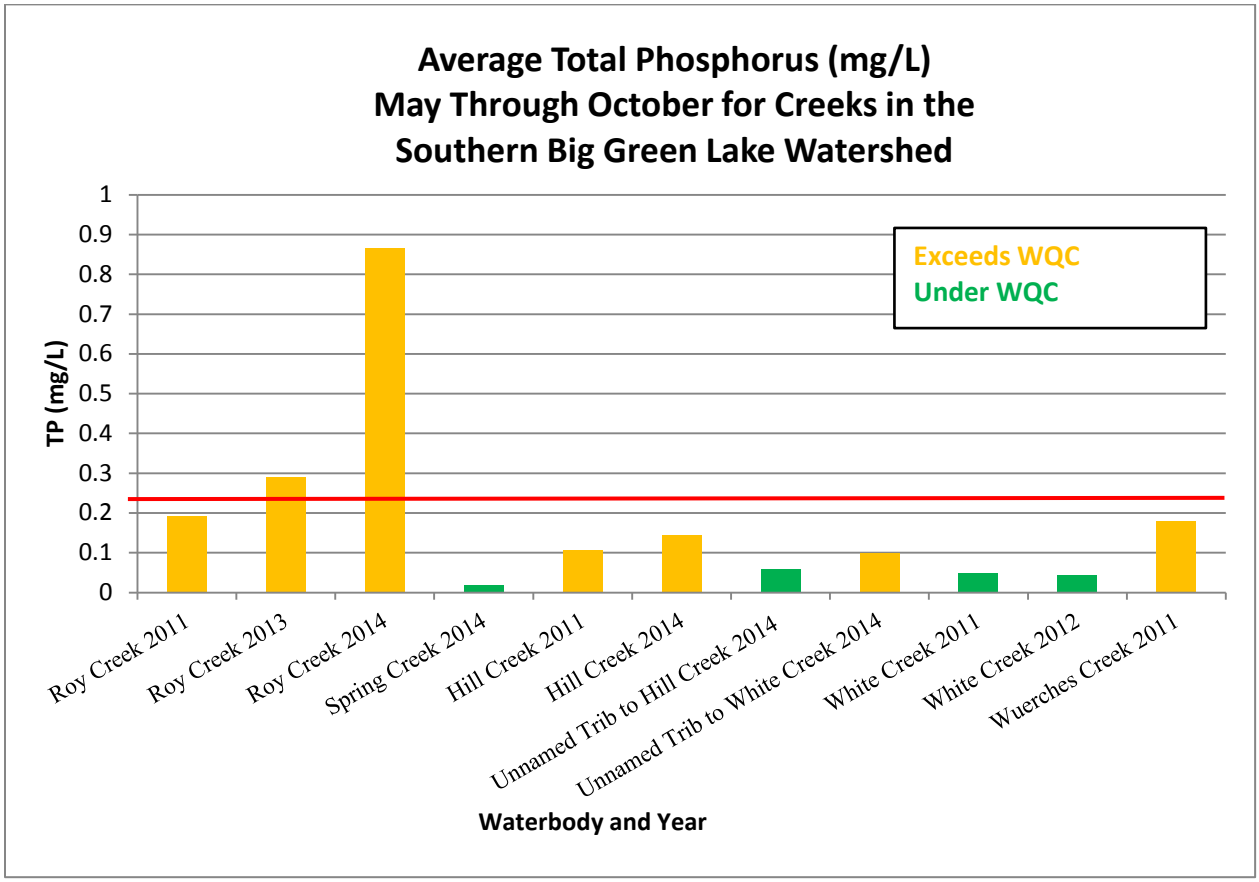

Figure 21: Average Total Phosphorus (mg/L) of All Data May through October 2011-2014 for Creeks in the Southern Big Green Lake Watershed (red line WQC at 0.075 mg/L).

Wuerches, Roy, Hill and White Creeks had historic TP data prior to this project. Wuerches, Roy, and Hill Creeks were monitored for TP by Johnson in 2011. Roy Creek has had a USGS Gauge Station 04073458 collecting TP and flow data since 2012 through 2014 and White Creek had a USGS Gauge Station 04073462 through the 2012 growing season. Spring, Hill, and the two Unnamed Tributaries to Hill and White Creeks were monitored as part of this 2014 project. The two Hill Creek data years are comparable due to the similar number of sampling events and dates. The Hill Creek TP average concentration increased from 0.107 mg/L to 0.145 mg/L in 2011 and 2014, respectively. There was also less variability in the TP concentrations during the growing season of 2014 versus 2011 in Hill Creek. Both years' average TP data on Hill Creek exceeded the WQC of 0.075 mg/L.

Hill Creek was added to the 2016 CWA 303d Impaired Waters List for degraded biological community due to the pollutant phosphorus on 4/1/2016. White Creek 2011 data is fairly comparable to the 2012

data. There were significantly more sampling events in 2012 than 2011 in White Creek in the DNR SWIMS database, but the average concentration was about the same. The 2014 Roy Creek data is difficult to compare to other years as a significant (~80%) portion of the sampling events occurred during June when there was high runoff and flow. The average TP concentration in the available data for 2014 at Roy Creek was significantly higher than 2011 and 2013 due to the high number of sampling events in June.

A summary of historical macroinvertebrate results was listed for 4 locations in 2011 in the Big Green Lake Watershed (Johnson et. al. 2011). Three of 4 of the 2011 streams were monitored as part of this project: Roy Creek, Hill Creek, and Wuerches Creek. The MIBI scores from 2014 are fairly similar to historical surveys (Figure 22). The largest difference between historical scores and 2014 scores was a 2.7 decrease in biotic integrity at Roy Creek upstream of County Hwy O (Figure 22). That difference may be the result of recent habitat improvement work where the sample was collected. The macroinvertebrate community may not have recovered yet from the disturbance and changes made to the habitat in early 2013. In the 2011 Assessment, Johnson reports the macroinvertebrate survey results in the form of Hilsenhoff's Biotic Index (HBI) score which refers to William H. Hilsenhoff's 1987 "An improved biotic index of organic stream pollution". One of the basic differences between reading the HBI scores versus the MIBI scores is that the higher the MIBI the better condition while the higher the HBI the poorer the condition. One of the fundamental differences between the HBI and MIBI is that the HBI focuses more on impacts to the macroinvertebrate community from organic pollution and increased nutrients while the MIBI also ties in impacts from habitat degradation. The historical HBI scores were fairly similar to the 2014 HBI scores, with the largest difference 0.6 (Figure 23).

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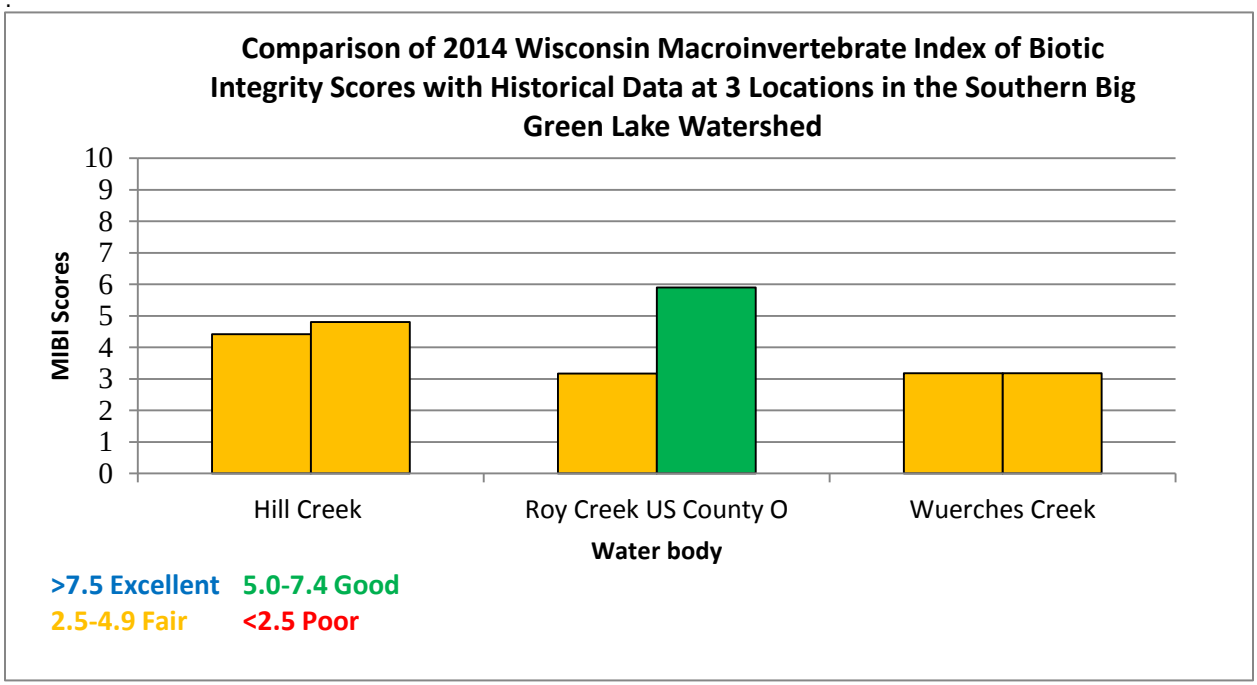

Figure 22: Comparison of 2014 Wisconsin MIBI (Left Column) Scores to 2007-2009 Wisconsin MIBI (Right Column) Scores at 3 Locations in the Southern Big Green Lake Watershed

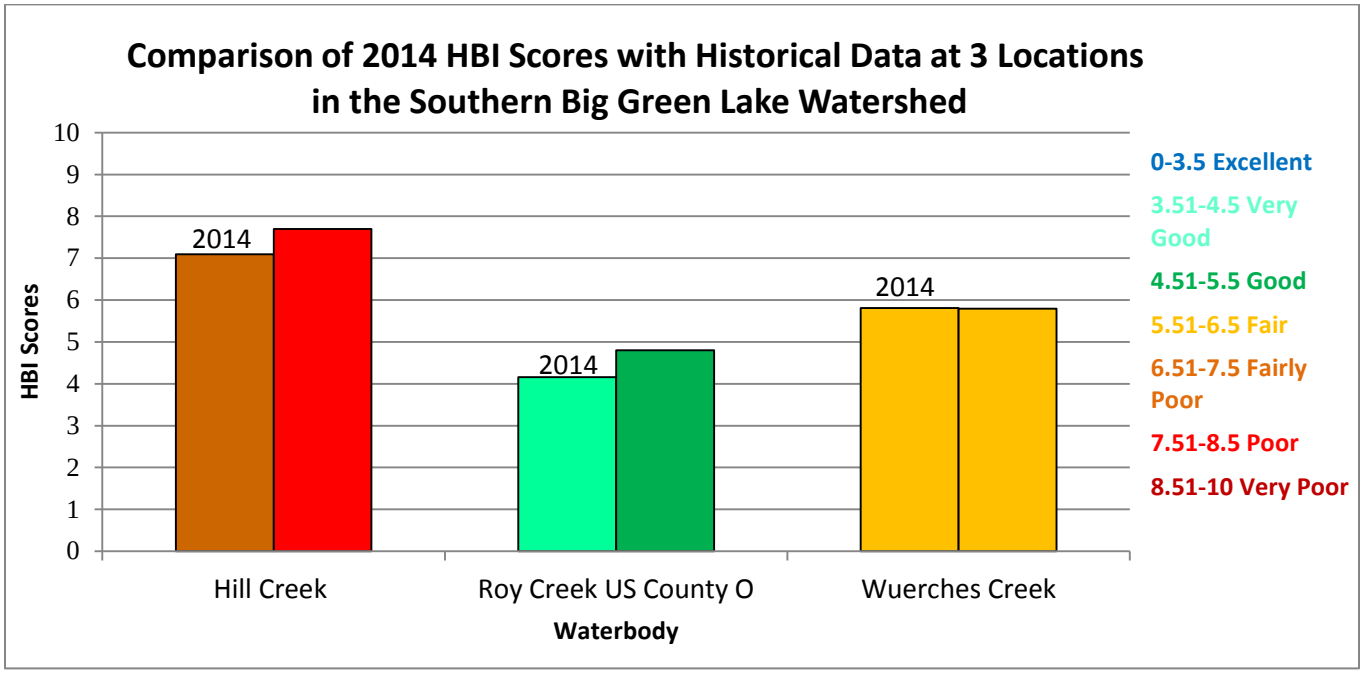

Figure 23: Comparison of 2014 HBI (Left Column) Scores to 2007-2009 HBI (Right Column) Scores at 3 Locations in the Southern Big Green Lake Watershed.

Fish Community

Fish surveys were conducted in 2011 by the DNR in Roy and Wuerches Creeks (Johnson et. al. 2011). This TWA project also conducted fish surveys at those two locations. The FIBI were similar from 2011 to 2014 with all condition categories listed as Poor (Figure 24).

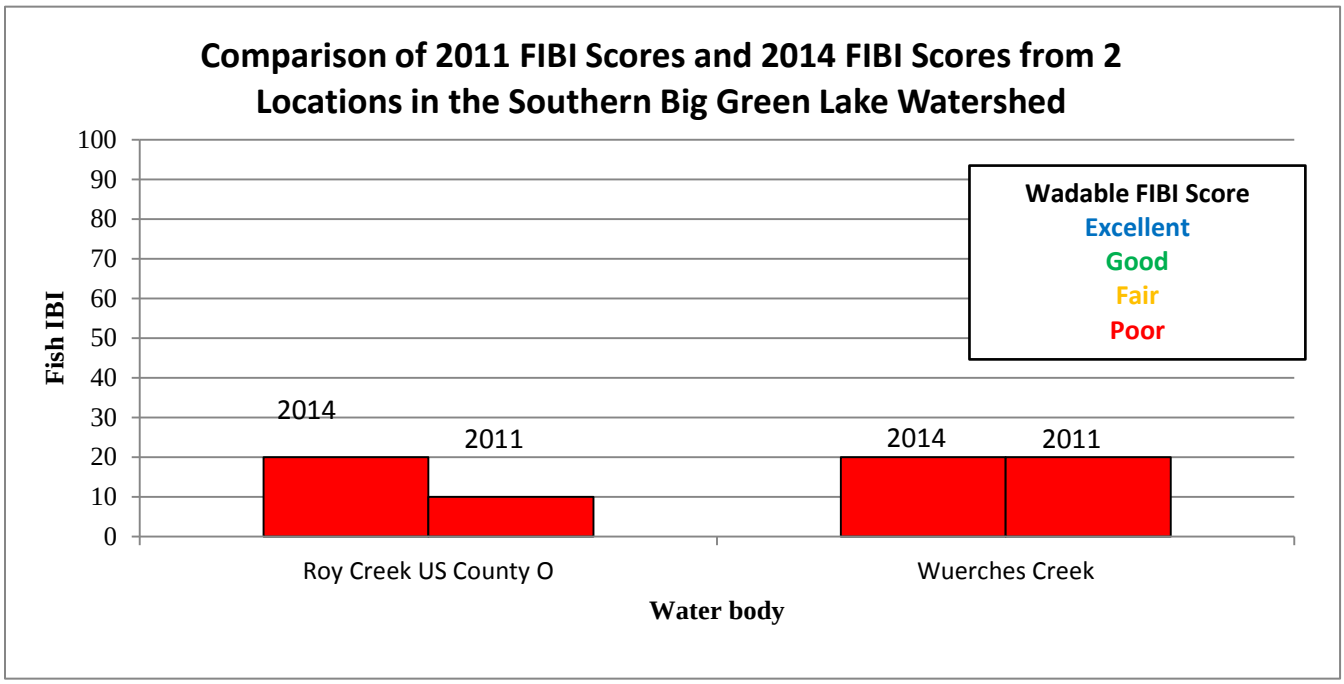

Figure 24: Comparison of 2014 FIBI (Left Column) Scores to FIBI (Right Column) Scores at 2 Locations in the Southern Big Green Lake Watershed.

Natural Community Analysis

Most of the streams in this watershed are modelled to be coldwater or cool-cold headwater (Lyons, 2008). The department has recently developed a draft method to determine whether or not the modeled natural community is accurate based on the fishery assemblage and climate conditions (Lyons, 2013). Natural community validation work indicated that the following streams were verified:

- Roy Creek DS Cty O, Modeled Coldwater
- White Creek at Spring Grove Rd, Modeled Coldwater
- Wuerches Creek at County Road B, Modeled Coldwater
- Dakin Creek at Brooklyn G Road, Modeled Cool-Cold Headwater
- Silver Creek at County KK, Modeled Cool-Warm Headwater
- Silver Creek below Gothic Millpond, Modeled Cool-Warm Headwater
- Silver Creek at Koro Road, Modeled Cool-Warm Mainstem
- Unnamed Tributary (WBIC 5026964) to Silver Creek at Arcade Rd, Modeled Coldwater
- Unnamed Tributary (WBIC 147400) to Silver Creek at County FF, Modeled Cool-Warm Headwater
- Unnamed Tributary (WBIC 146900) to Silver Creek at Hwy 23, Modeled Cool-Cold Headwater
- Unnamed Tributary (WBIC 147700) to Silver Creek at County KK, Modeled Cool-Warm Headwater
- Unnamed Tributary (WBIC 147000) to Silver Creek at Murray Rd, Modeled Cool-Cold Headwater

Proposed Change to the Modeled Community

- Spring Creek US Cty K, modeled Warm Headwater change to Cool-Warm Headwater

Total Phosphorus

The inorganic chemistry data collected during this project established that instream TP concentrations were above reference conditions; therefore, an impairment assessment was conducted to evaluate if NR 102 WQC were being met or if the creeks should be placed on the CWA 303d Impaired Waters List. The requirements to demonstrate if WQC for TP were being met, clearly exceeded, or overwhelmingly exceeded were accomplished through this project. WisCALM 2018 requires that a minimum of 6 monthly samples for TP from May through October occur within two years to have sufficient data to calculate the LCL.

None of the 4 creeks in Southern Big Green watershed overwhelmingly exceeded (LCL 2X 0.075 mg/L) the TP WQC. One of the 4 creeks exceeded the TP WQC, but did not overwhelmingly exceed. According to impairment assessment protocol (WisCALM 2018), biological confirmation was needed to determine which CWA 303d listing was necessary. The 2011 aquatic macroinvertebrate sample scored in the Poor condition category (Figure 12). The Poor HBI score together with the TP LCL exceeding the WQC indicates that Hill Creek should be CWA 303d listed for degraded biological community due to pollutant TP (Category 5A) (Table 23). The two Unnamed Tributaries and Spring Creek should not be CWA 303d listed for TP.

Two of the 4 locations sampled from the Silver Creek Mainstem exceeded the TP WQC, but did not overwhelmingly exceed. None of the macroinvertebrate and fish surveys in Silver Creek Mainstem indicated a condition category of Poor (besides the FIBI at County KK). Therefore, the requirements for listing Silver Creek as Impaired due to degraded biological community from the pollutant phosphorus was not met (Table 26). None of the seven tributaries' TP LCLs overwhelmingly exceeded the WQC (>0.15 mg/L TP). Four of the 7 TP LCLs exceeded the WQC but did not overwhelmingly exceed ($\geq$0.075<1.5 mg/L). Biological confirmation was needed to determine which CWA 303d listing was

necessary for the 4 tributaries. The 2013 fish survey and the 2014 macroinvertebrate survey (Table 16, Figure 14) at the Unnamed Tributary to Silver Creek (WBIC 5026964) at Arcade Rd scored in the Poor condition category. The 2014 fish survey at the Unnamed Tributary to Silver Creek (WBIC 146900) scored in the Poor condition category (Table 19, Figure 18). The Poor IBI scores together with the TP LCLs exceeding the WQC indicate that the two Unnamed Tributaries to Silver Creek (WBIC 5026964 & 146900) should be CWA 303d listed for degraded biological community due to pollutant TP (Category 5A). The Unnamed Tributary to Silver Creek at County FF and County KK were recommended for the 2016 Impaired Waters List due to the pollutant phosphorus. The phosphorus levels in 2014 (Table 9 and 12, Figure 7 & 10) led to that recommendation for listing.

Table 24: Assessment of Phosphorus and Biology in Combination to Determine Impairment Status and Pollutant (WisCALM 2018).

	Biological Response Indicators	**Overall Assessment Result & EPA Listing Category**	**Pollutant**
Meets TP Criteria	None indicate impairment	Not Impaired (Fully Supporting) **Category 2**	NA
	One or more indicate impairment	Impaired—Biology Only (Not Supporting) **Category 5A**	Unknown
Exceeds TP Criteria (not an overwhelming exceedance)	One or more indicate impairment	Impaired—TP & Bioconfirmation (Not Supporting) **Category 5A**	TP
	None indicate impairment	Impaired—Exceeds TP but has insufficient or conflicting biological data (Not Supporting) **Category 5P**	TP
Exceeds TP Criteria by an Overwhelming Amount	None needed	Impaired—TP Only (i.e. Overwhelming exceedance (Not Supporting) **Category 5A**	TP

Habitat Degradation

Habitat degradation by sedimentation is also a common driver of fish and aquatic life use impairments due to the nature of the land use in the SWTP. Sediment (specifically TSS) is the pollutant that must be addressed to attain the designated use. Fine sediment covers the creek substrate and fills in pools, reducing the suitable habitat for fish and macroinvertebrate communities. Filling-in of pools reduces the amount of available cover for juvenile and adult fish. Sedimentation of riffle areas reduces the reproductive success of fish by reducing the exposed gravel substrate necessary for appropriate spawning conditions. Suspended sediment also increases turbidity, reducing light penetration necessary for photosynthesis in aquatic plants. Increased turbidity also reduces the feeding efficiency of visual predators and filter feeders, and lowers the respiratory capacity of aquatic invertebrates by clogging their gill surfaces.

To conduct an impairment assessment of each of these creeks based upon habitat degradation by sedimentation, biological and quantitative habitat surveys were conducted in 2014. Roy, Wuerches, and Hill Creeks were previously CWA 303d listed for habitat degradation due to sedimentation. The FIBI calculation in the Unnamed Tributary to Hill Creek indicated a Condition Category of Poor when compared to reference Wisconsin Coldwater fish communities. The fish survey conducted on 7/09/2014 captured no fish in a representative survey station.

Quantitative habitat survey was conducted on 09/10/2014 which indicated an overall score of 48, which is in the Fair condition category. The habitat survey indicated specific aspects of the tributary's habitat which contributed to the Poor FIBI. The habitat score was brought down due to no available game fish cover, high percentage of fine sediment, moderate bank erosion, and low bend to bend ratio. Based upon the Poor FIBI score, poor/fair instream habitat, and my best professional judgment, the Unnamed Tributary to Hill Creek should be listed as Impaired (Category 5A) with the impairment degraded habitat and the pollutant TSS (Table 25). In addition, three of the Unnamed Tributaries to Silver Creek were recommended to be added to the CWA 303d list for degraded habitat (Category 5A) (Table 26).

Table 25: 2016 Impaired Waters Listing Cycle 303d Pollutant and Listing Category Recommendations for Creeks in the Project Area.

Creek	Pollutant	Listing Category
Hill Creek	TP Exceeds-Bioconfirmation	5A
Unnamed Tributary to Hill Creek	TSS Degraded Habitat-Sedimentation	5A

Table 26: Impaired Waters Listing 303d Pollutant and Listing Category Recommendations for Creeks in the Project Area.

Creek	WBIC	Pollutant	Listing Category
Tributary to Silver Creek	146900	TSS Degraded Habitat-Sedimentation	5A
Tributary to Silver Creek	146900	TP Exceeds-Bioconfirmation	5A
Tributary to Silver Creek	5026964	TSS Degraded Habitat-Sedimentation	5A
Tributary to Silver Creek	5026964	TP Exceeds-Bioconfirmation	5A
Tributary to Silver Creek	147000	TSS Degraded Habitat-Sedimentation	5A
Tributary to Silver Creek	147400	TP Exceeds-No Bioconfirmation	5P
Tributary to Silver Creek	147700	TP Exceeds-No Bioconfirmation	5P

Sediment and Phosphorus Sources

Some of the sources of sedimentation, phosphorus, increased temperatures, and decreased biotic integrity in Silver Creek and the Unnamed Tributaries are streambank erosion, agriculture tile drainage, urban and construction site runoff, fish barriers, minimal buffer widths, and stream channelization (Appendix C). The poor to fair FIBI and MIBI scores reflect the effects of habitat degradation, sedimentation, and high nutrient loads from the subwatersheds.

One of the largest sources of sedimentation and phosphorus in Roy, Wuerches, Hill, and White Creeks, and their associated Unnamed Tributaries is excessive stream bank erosion. The poor to fair FIBI scores reflect the effects of sedimentation and high nutrient loads in the Southern Big Green Lake watershed (Figure 25).

Green Lake County LCD conducted an inventory of Roy, Wuerches, Hill, and White Creeks, and their associated Unnamed Tributaries to assess the condition of their riparian buffers, stream bank erosion, and instream habitat. The Green Lake County Soil Conservation Technician (D. Kavanaugh) completed a summary report of the 2014 buffer assessment, "Green Lake Buffer Assessment Project" (*Buffer Assessment Report, Kavanaugh, 2014*). In the report Roy, Wuerches, Hill, and White Creek subwatersheds averaged 11.25% of their stream length had unstable banks with active erosion (Buffer Assessment Report 2014) (Appendix C, Table 27, Figure 25).

According to data collected at the USGS Gage Station 04073458, Roy Creek discharged a total of 240 tons of suspended sediment and 740 lbs. of TP in 2013 (USGS 2013). The majority of this sediment and nutrient discharge occurred in early spring during snowmelt and rain events. Rain events and snowmelt carry sediment and TP into the creek in addition to increasing water velocity and discharge volume. The increased velocity and discharge during this period increases the potential for bank erosion on the unstable banks in the subwatersheds.

Table 27: Percentage of Unstable and Actively Eroding Streambanks in Creeks in the Southern Big Green Lake Watershed (Green Lake County LCD 2014).

Creek Name	Roy Creek	Wuerches Creek	Hill Creek	White Creek	Average
Percent Unstable Banks	11%	3%	15%	16%	11.25%

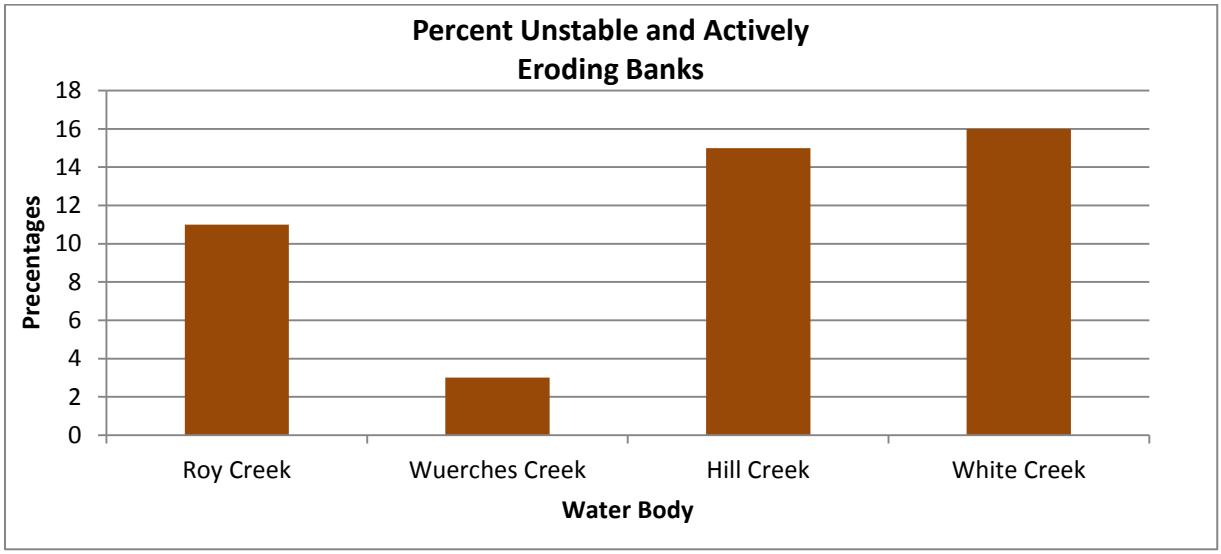

Figure 25: Percentage of Unstable and Actively Eroding Stream banks in Creeks in the Southern Big Green Lake Watershed (Green Lake County LCD 2014).

Management

There are many options available to reduce the pollutants, phosphorus and sediment in Silver Creek and the Unnamed Tributaries. One option to reduce the sediment and nutrients is to conduct streambank restoration on eroding banks (Appendix C). Another option to reduce the cropland runoff is to increase flood storage capacity in the watersheds. Creating sedimentation ponds which capture runoff from cropland/uplands will provide flood storage, reduce sediment and nutrients reaching the creeks, and reduce high creek flow velocities which cause erosion. A third option to reduce nutrient and sediment loading while creating fish and aquatic life habitat is to re-meander channelized ditches which contain large amounts of organic material (Appendix C).

Perched culverts and the Gothic Millpond Dam are partial or complete barriers to fish migration (Appendix C). Fish barriers, whether complete or partial, can limit the biotic integrity of a watershed. Replacing perched culverts with properly sized and designed culverts increases the available fish and aquatic life habitat and limits any risk to fish migration. Adding a fish passage component to the Gothic Millpond Dam would encourage fish migration by fish species such as brown trout and northern pike to

spawning habitat upstream of the millpond. Increasing vegetative and forested buffer widths along the creeks in the Silver Creek Watershed can also have a positive impact on the sediment and nutrient load reaching the creeks (Appendix C). Recommended buffer widths vary significantly in published research (there is no one-size-fits all), but the majority of research recommends vegetative buffers >35', with 35' being on the lower end of recommended buffer widths. In general, as the land slope along a creek increases, the riparian buffer width recommendation increases. The type of vegetative buffer is also critical to reducing sediment and nutrients reaching the creeks of this project. A combination of forest and native grass buffers may result in greater nutrient reduction than strictly grassed buffers.

Several partnering agencies and organizations including Green Lake County LCD, Fond Du Lac County LWCD, Green Lake Sanitary District, Green Lake Association, the City of Ripon, Ripon College, Ripon High School, NRCS, and USGS are working together to reduce the overall load of sediment and nutrients into Big Green Lake downstream of Silver Creek. Implementing BMPs (streambank restoration, sediment basins, vegetative buffers, stormwater management, ect.) will likely have a significant improvement of the water quality in Silver Creek, its tributaries, and Big Green Lake.

Another option to reduce the sediment and nutrient loading into Roy, Wuerches, Hill, and White Creeks is to increase flood storage capacity in the watersheds. Creating sedimentation ponds which capture runoff from cropland/uplands will provide flood storage, reduce sediment and nutrients reaching the creeks, and reduce high creek flow velocities which cause erosion.

Increasing vegetative and forested buffer widths along the creeks in this project can also have a positive impact on the sediment and nutrient load reaching the creeks (Photo 4). Roy, Wuerches, Hill, and White Creek subwatersheds averaged 22.25% of their stream length with less than 35' buffer width (Buffer Assessment 2014) (Table 28, Figure 26).

Table 28: Percentage of Riparian Buffer Width Less Than 35 Feet of Creeks in the Southern Big Green Lake Watershed (Green Lake LCD 2014).

Creek Name	Roy Creek	Wuerches Creek	Hill Creek	White Creek	Average
Percent Riparian Buffer Widths < 35 Feet	21%	47%	11%	10%	22.25%

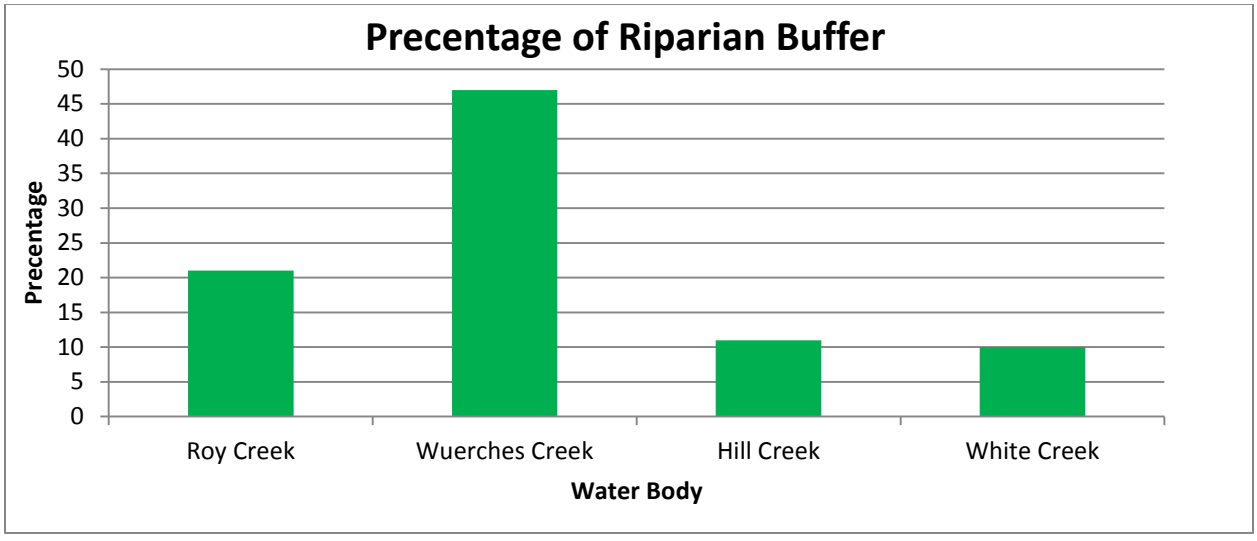

Figure 26: Percentage of riparian buffer width less than 35 feet of creeks in the Southern Big Green Lake Watershed (Green Lake LCD 2014).

Management Actions

Management Priorities

- Work with landowners and county partners in the watershed to encourage restoration of stream banks and reduction of erosion is a high priority.
- Maximize buffers or protected areas along streams with steep slopes should be a high priority for this area due to the nature of the steep slopes in the watersheds of the creeks in this project.
- Explore the use of forested and native grass buffers compared to grassed buffers to increase nutrient reduction.
- Capitalize on the efforts of the Wisconsin DNR, Green Lake County LCD, Green Lake Sanitary District, Green Lake Association, NRCS, and USGS in these subwatersheds by implementing BMPs (stream bank restoration, sediment basins, vegetative buffers, etc.) where needed will likely have a significant improvement of the water quality in the creeks in this project and Big Green Lake.

Management Goals

- Restore the streambanks in the watershed along the studied streams (Wuerches, Roy and Hill, White Creek).

Monitoring and Assessment Recommendations

- Hill Creek should be added to the state's impaired waters list as the total phosphorus exceeds standards and there is biological confirmation (Category 5A water) based on WisCALM 2016.
- The unnamed tributary to Hill Creek should also be added to the state's impaired waters list as the total phosphorus exceeds standards and there is biological confirmation (Category 5A water) based on WisCALM 2016.
- Continue monitoring of phosphorus, macroinvertebrate and fisheries values in streams of the Big Green Lake watershed as funding and volunteer efforts allow.

Natural Community Recommendations

- Spring Creek US Cty K, modeled Warm Headwater change to Cool-Warm Headwater

Management Recommendations for DNR

- The department should work with watershed organizations on outreach efforts with landowners in the watershed, environmental programs in Big Green Lake watershed, and research opportunities for stream bank stabilization opportunities.
- The department should work to increase buffer widths in all of the subwatersheds which will likely reduce nutrient loading and sedimentation.

Management Recommendations for External Partners

- DNR, county and local partners should work to obtain funds or grants to restore the identified unstable stream banks to reduce sedimentation and erosion in the watershed (Wuerches, Roy and Hill, White Creek).
- Management agencies and landowners in the watershed should work toward enhancing a combination of forest and native grass buffers, which may better reduce nutrients than strictly grassed buffers.
- Implement cover crops to reduce cropland erosion during the late fall and spring.
- Replace perched culverts in the watershed to increase available fish and aquatic life habitat.
- Mitigate impacts on water temperature and fish migration in Silver Creek from the Gothic Mill Dam in Ripon.

Appendix A: References

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Appendix B: Stream Narratives

Assemble Creek

Assemble Creek, in the Big Green Lake Watershed, is a river that falls in Green Lake County. This river is outstanding/exceptional resource water under NR102 as well as a Class I Trout Water under the Fisheries Program. This river is managed for fishing and swimming and is not impaired.

Big Green Lake

Big Green Lake is without doubt, the most important single water resource in Green Lake County. At 229 feet it is not only the deepest natural inland lake in the state but, also between the Finger Lakes of New York and the Rocky Mountains (Frey, 1963). A hydrographic map of Big Green Lake is shown in Figure 13. Big Green Lake is situated in a large preglacial valley formed by the action of some forgotten river. The Cary glacier scoured this valley depositing a large recessional moraine across its western end and was successful in damming a glacial river causing it to flood the scoured valley and overflow into the present day Puchyan-Fox drainage system. In reality Big Green Lake is a natural impoundment (Juday, 1914).

The watershed of Big Green Lake is mostly in agriculture and covers some 115 square miles. Silver Creek on the east end of the lake is the largest tributary but Spring Creek on the west also contributes significantly. Roy Creek, Hill Creek, Dakin Creek, and White Creek, also drain into Big Green Lake but are minor tributaries. The outlet is the Puchyan River which drains into the Fox River six miles northwest of the City of Green Lake. A dam constructed on the outlet maintains the water level about five feet higher than the natural lake basin. Littoral bottom materials consist primarily of sand and gravel. Bedrock, silt, and muck are also present to a more limited extent. Fish cover is provided primarily by rocks and boulders and sparse aquatic vegetation. Big Green is an oligotrophic (Figure 14) lake managed for both cold and warm water fish. Cold water species include brown and rainbow trout, splake, cisco, and lake trout. Most common warm water species are northern pike, walleye, perch, largemouth and smallmouth bass, bluegill, black crappie, rock bass, white bass, channel catfish, and black bullhead. Pumpkinseed, carp, and white sucker are also present. The lake is well known for the excellent summer and winter fishing it offers. Source: 1971, Surface Water Resources of Green Lake County Big Green Lake, T-15, 16-N, E-12, 13-E Surface Acres = 7,325; S.D.F. = 1.77 Maximum Depth = 229 feet.

Big Green Lake (146100) was placed on the impaired waters list in 2002 for PCBs in fish tissue and 2014 for total phosphorus/low DO. This water was assessed during the 2016 listing cycle; chlorophyll sample data were clearly below 2016 WisCALM listing thresholds for the Recreation use and Fish and Aquatic Life use. Total phosphorus data did not exceed REC or FAL thresholds. This water was also assessed for chlorides and sample data were clearly below 2016 WisCALM chronic and acute listing criteria for the Fish and Aquatic Life use. This water remains listed for total phosphorus because data were not clearly below listing thresholds.

Big Twin

Big Twin is one of two small lakes located one mile south of Big Green Lake. There is an intermittent inlet and a ditch that connects it with Little Twin Lake. Littoral bottom materials consist of marl, muck, sand, and gravel. Peat is also present. Access is available via a county park with picnic area, parking, and improved boat ramp. Twin Lake supports a sport fishery of largemouth bass, walleye, northern pike, perch, bluegill, and white sucker. Prior to 1963, it was over populated by carp causing turbid water and poor fishing. Following rehabilitation fishing improved. Many ducks use the lake for nesting and as a resting area during migration. Geese, grebes, and muskrats also use the lake extensively. A local ordinance prohibits the use of motors larger than 71/2 horsepower on either lake. A 21/2 m.p.h. speed

limit has been established in the channel connecting Big and Little Twin. Source: 1971, Surface Water Resources of Green Lake County Twin Lake, Big T-15-N, R-13-E, Sections 5, 8 Surface Acres = 78.3; S.D.F. = 1.73 Maximum Depth = 46 feet.

Big Twin Lake, in the Big Green Lake Watershed, is a 73.90 acre lake that falls in Green Lake County. This lake is managed for fishing and swimming and is currently not considered impaired. Big Twin Lake (146500) was placed on the impaired waters list for total phosphorus in 2014. The 2016 assessments showed continued impairment by phosphorus; total phosphorus and chlorophyll sample data exceeded 2016 WisCALM listing thresholds for the Recreation use. Total phosphorus and chlorophyll data do not exceed Fish and Aquatic Life thresholds. Based on the most updated information, no change in existing impaired waters listing is needed.

Puchyan River

Puchyan River, in the Big Green Lake and Fox River - Berlin Watersheds, is a 16.30 mile river that falls in Green Lake County. This river is managed for fishing and swimming and is not impaired.

This water was assessed during the 2014 listing cycle; phosphorus sample data nearly met (May Meet) 2014 WisCALM listing thresholds for the Fish and Aquatic Life use and biological sample data, macroinvertebrate or fish Index of Biotic Integrity (IBI), scored in the fair to excellent condition categories. Further monitoring may be recommended. Puchyan River (145200) was assessed during the 2016 listing cycle; temperature data exceeded 2016 WisCALM listing thresholds for the Fish and Aquatic Life use. Total phosphorus and biological (macroinvertebrate or fish Index of Biotic Integrity (IBI) scores) sample data clearly met 2016 WisCALM listing thresholds for the Fish and Aquatic Life use.

Dakin Creek

Dakin Creek, in the Big Green Lake Watershed, is a 6.16 mile river that falls in Green Lake County. This river is a Class II Trout Water under the Fisheries Program. This river is managed for fishing and swimming and is currently not considered impaired.

Hill Creek

Hill Creek, in the Big Green Lake Watershed, is a 2.29 mile river that falls in Green Lake County. This river is managed for fishing and swimming and is currently considered impaired. Hill Creek, from Little Twin Lake to Green Lake, was assessed during the 2016 listing cycle; total phosphorus sample data exceed 2016 WisCALM listing criteria for the Fish and Aquatic Life use and biological impairment was observed (i.e. at least one macroinvertebrate or fish Index (IBI) scored in the poor condition category).

Spring Lake

Spring Lake is a hard water marl lake separated from Big Green Lake by a narrow ridge. The lake is spring fed and the outlet, Spring Creek provides a continual flow into Big Green Lake. Marl and sand are the major bottom materials present. Muck is also present in lesser amounts. Developments consist of one organizational camp and a public access with parking and cement plank boat ramp. The land along the access road has been subdivided. One boat rental is located on the south shore. The fishery consists of northern pike, walleye, perch, largemouth bass, bluegill, black crappie, rock bass, pumpkinseed, yellow bullhead, carp, and white sucker. Due to the heavy marl areas and corresponding lack of vegetation the lake does not support a large fish population, although those present do attain desirable size. Interested residents are attempting to preserve the lake in its present, relatively undeveloped state. Game values are limited and no hunting is allowed in the area of the private camp. Source: 1971, Surface Water

Resources of Green Lake County Spring (Spirit) Lake T-15-N, R-13-E, Section 7 Surface Acres = 75.0; S.D.F. = 1.24 Maximum Depth = 39 feet. Spring Lake (Spirit), in the Big Green Lake Watershed, is a 62.19 acre lake that falls in Green Lake County. This lake is managed for fishing and swimming and is not impaired.

Roy Creek

Roy Creek, in the Big Green Lake Watershed, is a 7.18 mile river that falls in Green Lake County. This river is managed for fishing and swimming and is currently considered impaired. Roy Creek (148200) was placed on the impaired waters list for sediment/total suspended solids in 2002 and total phosphorus in 2014. The 2016 assessments showed continued impairment by phosphorus; total phosphorus sample data exceed 2016 WisCALM listing criteria for the Fish and Aquatic Life use, however, available biological data do not indicate impairment (i.e. no macroinvertebrate or fish Index of Biotic Integrity (IBI) scored in the "poor" condition category). Based on the most updated information, no change in existing impaired waters listing is needed.

Silver Creek

The dam in Ripon causes very heavy slime growth below the dam during warm periods of the year as well as eliminates fish migration resulting in several related problems like clam distribution and migration of trout. It also causes excessive warming. Silver Cr. has been classified Class II trout water from the Origin down to the impoundment. Silver Creek (146800) has been on the impaired waters list for Sediment/Total Suspended Solids since 1998 with elevated water temperature as impairment. This water was assessed during the 2016 listing cycle; temperature data exceeded 2016 WisCALM listing thresholds for the Fish and Aquatic Life use.

Spring Creek

Spring Creek, in the Big Green Lake Watershed, is a 2.47 mile river that falls in Green Lake County. This river is managed for fishing and swimming and is currently not considered impaired.

Wuerches Creek

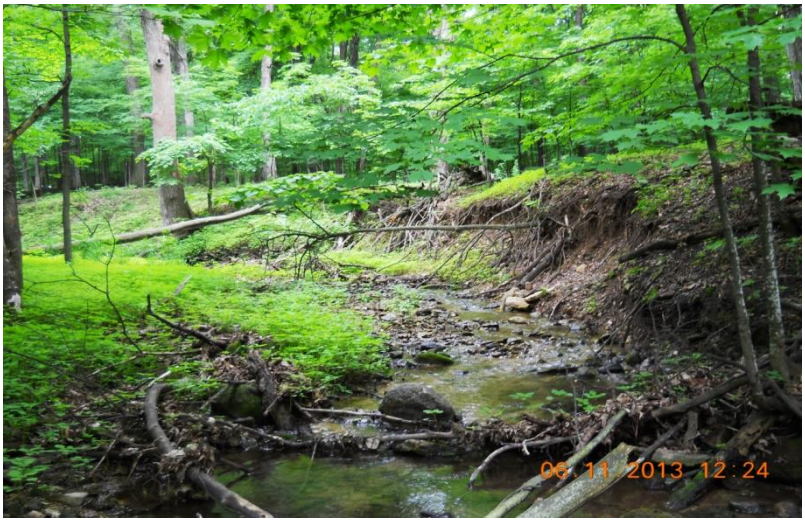
Wuerches Creek, in the Big Green Lake Watershed, is a 4.40 mile river that falls in Green Lake County. This river is managed for fishing and swimming and is currently considered impaired.
Wuerches Creek (148300) was placed on the impaired waters list in 1998 for sediment/total suspended solids and in 2008 for total phosphorus. The 2016 assessments showed continued impairment by phosphorus; total phosphorus sample data exceed 2016 WisCALM listing criteria for the Fish and Aquatic Life use, however, available biological data do not indicate impairment (i.e. no macroinvertebrate or fish (IBI) scored in the "poor" condition category). This water was also assessed for temperature and sample data did not exceed 2016 WisCALM listing criteria for the Fish and Aquatic Life use. Based on the most updated information, no change in existing impaired waters listing is needed.

Gothic Mill Pond

A shallow, silt bottomed impoundment of Silver Creek by a dam at Ripon. The fishery consists primarily of common suckers and carp, along with a variety of panfish species including bullheads, northern pike are present. Shore fishing access is provided by a city park which borders the pond, but facilities do not exist for boat launching or swimming. Source: 1969, Surface Water Resources of Fond du Lac County Ripon (Gothic) Pond, T16N, R14E, Section 21 Surface Acres = 24.0, S.D.F. = 2.04, Maximum Depth = 8 feet Gothic Mill Pond, in the Big Green Lake Watershed, is a 15.45 acre lake that falls in Fond du Lac County. This lake is managed for fishing and swimming and is currently not considered impaired.

Appendix C: Photos

Unstable Banks in Roy Creek near County Road O (Green Lake County LCD 2012)



Unstable banks in White Creek (Green Lake County LCD 2013)

Stream bank restoration on Roy Creek near County Road O

Dakin Creek Facing Upstream of County Hwy KK. Photo taken by D. Bolha on April 10th, 2014

Unnamed Tributary to Silver Creek (WBIC 147900) Facing Downstream of County Hwy KK. Photo taken by D. Bolha on April 10th, 2014.

Unnamed Tributary to Silver Creek (WBIC 147700) Facing Upstream of County Hwy KK. Photo taken by D. Bolha on April 10th, 2014.

Silver Creek Facing Upstream at the Gothic Mill Dam and Gothic Millpond Upstream of Scott Street in Ripon. Photo taken by M. Rief in Summer 2000.

Silver Creek Facing Upstream at the Perched Culvert Under South Koro Road. Photo taken by D. Bolha on April 10th, 2014.

Dakin Creek Facing Upstream at the Perched Culvert Under Skunk Hollow Road. Photo taken by D. Bolha on March 14th, 2013

Appendix D: Monitored Stations

WBIC	Waterbody Name	Station ID	Station Name	Earliest Date	Latest Date
148200	Roy Creek	10021317	Roy Creek 200 Feet Above Cth O	04/06/2007	11/01/2016
146600	White Creek	243047	White Creek At Mouth Of Green Lake	10/16/1996	11/01/2016
146100	Green Lake	10021521	Green Lake - at CTH A	05/09/2002	10/27/2016
146100	Green Lake	10021521	Green Lake - at CTH A	05/09/2002	10/27/2016
146100	Green Lake	10017340	Silver Creek at Spaulding Road	12/20/2005	10/27/2016
146100	Green Lake	10021525	Green Lake - E	02/25/1998	10/27/2016
146400	Little Twin Lake	243023	Little Twin Lake - Deep Hole	01/31/2005	10/25/2016
148100	Spring Lake	243019	Spring Lake - Deepest Part-Ep	06/23/1987	10/25/2016
146500	Twin Lakes	243018	Big Twin Lake - Deepest Part	06/23/2004	10/25/2016
146515	Unnamed	10033607	Unnamed Creek at County Road K	05/18/2011	10/25/2016
148000	Spring Creek	243026	Spring Creek at Cth K (Bi)	05/08/1979	10/25/2016
146200	Hill Creek	10015830	Hill Creek - Above Lake View 100 Yards	05/09/1991	10/25/2016
146800	Silver Creek	10039443	Silver Creek SE of Redman Dr	05/21/2013	10/19/2016
146800	Silver Creek	10015911	Silver Creek Ds Scott Street Dam	10/02/2002	10/19/2016
146100	Green Lake	10019589	Green Lake -- County Park Access (Dodge Memorial Park)	06/03/2008	09/04/2016
146100	Green Lake	10019701	Green Lake -- Sunset Park Access	07/11/2004	09/02/2016
146100	Green Lake	10019701	Green Lake -- Sunset Park Access	07/11/2004	09/02/2016
146800	Silver Creek	203080	Silver Creek At Koro Rd	05/08/1979	08/29/2016
146100	Green Lake	10017326	Green Lake - Pilgrim Camp Beach	05/29/2007	08/29/2016
146100	Green Lake	10017325	Green Lake - Sunset County Park	05/29/2007	08/29/2016
146100	Green Lake	10007622	Green Lake at American Baptist Assembly Beach	05/29/2001	08/29/2016
146100	Green Lake	10017326	Green Lake - Pilgrim Camp Beach	05/29/2007	08/29/2016

WBIC	Waterbody Name	Station ID	Station Name	Earliest Date	Latest Date
146100	Green Lake	10007650	Green Lake - Hattie Sherwood Park Beach	05/29/2001	08/29/2016
146100	Green Lake	10017325	Green Lake - Sunset County Park	05/29/2007	08/29/2016
146100	Green Lake	10007650	Green Lake - Hattie Sherwood Park Beach	05/29/2001	08/29/2016
146100	Green Lake	10007752	Green Lake at Dodge County Park Beach	05/29/2007	08/29/2016
146100	Green Lake	10007752	Green Lake at Dodge County Park Beach	05/29/2007	08/29/2016
146100	Green Lake	10019219	Green Lake -- Deacon Mills Park (Near Park Drive)	05/02/2004	08/26/2016
146100	Green Lake	243021	Green Lake - East End Basin - Deep Hole (USGS)	04/17/1986	08/25/2016
148100	Spring Lake	10002714	Spring Lake / Spirit Lake (Township of Green Lake)	07/27/1999	08/22/2016
146500	Twin Lakes	10019477	Big Twin Lake -- Access	01/31/2005	08/18/2016
146100	Green Lake	10002700	Big Green Lake	07/01/1969	06/30/2016
146100	Green Lake	10002700	Big Green Lake	07/01/1969	06/30/2016
146100	Green Lake	243049	Green Lake - West Basin Deep Hole (	05/05/1986	04/12/2016
5027243	Unnamed	10042146	Unnamed Trib to White Creek US Scott Hill Rd (WBIC 5027243)	05/17/2014	10/28/2015
146100	Green Lake	10044125	County K Marsh - Big Green Lake	09/17/2015	09/17/2015
146800	Silver Creek	203100	Silver Creek At Union St	02/06/1997	09/03/2015
146100	Green Lake	10017324	Green Lake - Camp Grow Beach	05/29/2007	08/31/2015
5026108	Unnamed	10044319	Unnamed stream (WBIC=5026108) at Tri County Rd E of Oak Haven Rd	08/31/2015	08/31/2015
146100	Green Lake	10017324	Green Lake - Camp Grow Beach	05/29/2007	08/31/2015
146100	Green Lake	10019170	Green Lake -- Horners Landing (Nr Homer Rd)	07/11/2004	08/02/2015
146100	Green Lake	10042258	Green Lake - West Basin	07/28/2014	07/15/2015
146100	Green Lake	243046	Green Lake - Mid Lake	07/25/1996	07/15/2015

WBIC	Waterbody Name	Station ID	Station Name	Earliest Date	Latest Date
146100	Green Lake	10042257	Green Lake - East Basin	07/28/2014	07/15/2015
3000531	Unnamed	10042054	Green Lake - Beyer's Cove - North [Herbicide Monitoring Site 3]	05/22/2014	06/04/2015
146100	Green Lake	10042072	City Millpond -Channel Mid	05/31/2014	05/29/2015
146100	Green Lake	10042071	City Millpond - Eddy South	05/31/2014	05/29/2015
146100	Green Lake	10042070	City Millpond - Channel South	05/31/2014	05/29/2015
146800	Silver Creek	10021299	Silver Creek At Douglas St (Hwy 44)	06/03/2003	10/27/2014
146200	Hill Creek	10033838	Hill Creek upstream Spring Grove Rd	08/30/2011	10/27/2014
5026964	Unnamed	10040834	Unnamed Trib (5026964) to Silver Creek US Arcade Rd	07/23/2013	10/14/2014
146900	Unnamed	10041508	Unnamed Trib to Silver Creek at HWY 23 (WBIC 146900)	05/02/2014	10/13/2014
147000	Unnamed	10041507	Unnamed Tributary to Silver Creek at Murray Rd (WBIC 147000)	05/02/2014	10/13/2014
5027015	Unnamed	10041506	Unnamed Trib to Silver Creek at HWY23 (WBIC 5027015)	05/21/2014	10/13/2014
147400	Unnamed	10016330	Unnamed Trib. To Silver Creek At Trail	11/04/1998	10/13/2014
5027219	Unnamed	10041578	Unnamed Trib to Hill Cr US Scott Hill Rd (WBIC 5027219)	05/17/2014	10/12/2014
146800	Silver Creek	10041510	Silver Creek at County KK	05/02/2014	10/09/2014
146700	Dakin Creek	10037918	Dakin Creek E of Fond du Lac County	05/11/2012	10/09/2014
147700	Unnamed	10041509	Unnamed Trib to Silver Creek at County KK (WBIC 147700)	05/02/2014	10/09/2014
146600	White Creek	243059	White Creek -At Spring Grove Rd Near Mouth Of Green Lake WI	05/31/2011	10/07/2014
148200	Roy Creek	10041576	Roy Creek DS County Hwy O	10/07/2014	10/07/2014
146500	Twin Lakes	10002713	Big Twin Lake	07/27/1999	09/22/2014
146400	Little Twin	10002712	Little Twin Lake	07/27/1999	09/22/2014
146100	Green Lake	10019604	Green Lake -- Canal Street Launch	06/10/2008	08/30/2014
146100	Green Lake	10019479	Green Lake -- Duering's Landing (Nr Klaver St)	06/08/2011	08/23/2014
146100	Green Lake	10019585	Green Lake -- Hattie Sherwood Park	05/27/2013	08/17/2014
148300	Unnamed	10012583	(Wuerches Creek North Side Of Cty B Near State Hwy 73	08/30/2006	07/10/2014
146100	Green Lake	10030947	Green Lake -- Beyers Cove Boat Launch	06/08/2011	07/06/2014
5563251	Unnamed	10032954	Unnamed	06/28/2009	07/04/2014
5026964	Unnamed	10037507	Unnamed (WBIC= 502694) US State St	10/16/2012	10/16/2012
146800	Silver Creek	10034898	Green Lake inlet Silver Creek (USGS 2)	05/03/2006	09/27/2012

Appendix E: Watershed Report[i]

WBIC	Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Impaired Status
145200	Puchyan River	0	13.96	FAL	WWSF	Not Supporting	Default FAL	Elevated Water Temperature	Non-Point Source (Rural or Urban)	Monitored	303d Listed
145200	Puchyan River	14.3	15.03	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA
145900	Puchyan Millpond	0	5.28	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA
146100	Hattie Sherwood Beach, Green Lake	0	0.01	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Monitored	NA
146100	Green Lake	0	231.4	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA
146100	Dodge County Park Beach, Green Lake	0	0.04	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Monitored	NA
146100	Green Lake (Northern Lobe)	0	43.71	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA
146100	Sunset County Park, Green Lake	0	0.1	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Monitored	NA
146100	Silver Creek -- Spaulding Road, Green Lake	0	0	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA
146100	Pilgrim Center Beach, Green Lake	0	0.01	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Monitored	NA
146100	Camp Grow Beach, Green Lake	0	0	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Monitored	NA

WBIC	Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Impaired Water Status
146100	Aba Beach, Green Lake	0	0.02	Two-Story	FAL	Not Assessed	Default FAL	NA	NA	Monitored	NA
146100	Green Lake (Big Green)	0	7485.65	Two-Story	FAL	Not Supporting	Default FAL	Low DO	Non-Point Source (Rural or Urban)	Monitored	TMDL Development, 303d Listed
146200	Hill Creek	0	1.84	LFF	LFF	Not Supporting	Default FAL	Degraded Biological Community, Degraded Habitat	Non-Point Source (Rural or Urban)	Monitored	TMDL Development, 303d Listed
146400	Little Twin Lake	0	33	Deep Headwater	FAL	Supporting	Default FAL	NA	NA	Evaluated: Modeled Data	NA
146500	Big Twin Lake	0	78	Deep Headwater	FAL	Fully Supporting	Default FAL	NA	NA	Monitored	TMDL Development
146600	White Creek	0	1.11	Cold (Class I Trout)	Cold (Class I Trout)	Fully Supporting	Cold	NA	NA	Monitored	NA
146700	Dakin Creek	0	2.78	Cold (Class II Trout)	Cold (Class II Trout)	Supporting	Cold	NA	NA	Monitored	NA
146700	Dakin Creek	2.78	6.16	FAL	FAL	Fully Supporting	Default FAL	NA	NA	Monitored	NA
146800	Silver Cr Spaulding, Kmart Beach	0	0.4	Cold (Class II Trout)	Cold (Class II Trout)	Not Assessed	Cold	NA	NA	Evaluated: Older Data	NA
146800	Silver Creek Mouth	0	155.98	FAL	FAL	Supporting	Default FAL	NA	NA	Monitored	303d Listed
146900	Unnamed Trib to Silver Creek	0	2.93	FAL	FAL	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source (Rural or Urban)	Monitored	303d Listed

WBIC	Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assess	Impaired Water Status
146800	Silver Creek	0.97	12.41	FAL	FAL	Not Supporting	Default FAL	Elevated Water Temperature, Degraded Habitat	Non-Point Source Sediment Resuspension (Contaminated Sediment)Municipal Separate Storm Sewer Systems (MS4)	Mon itored	TMDL Development
146800	Silver Creek	12.41	14.36	Cold (Class II Trout)	Cold (Class II Trout)	Not Supporting	Cold	Elevated Water Temperature, Degraded Habitat	Non-Point Source Sediment Resuspension (Contaminated Sediment)	Monitored	TMDL Development
147000	Unnamed Trib to Silver Creek	0	2.11	FAL	FAL	Fully Supporting	Default FAL	NA	NA	Monitored	NA
147200	Un Lake	0	0.75	Small	FAL	Not Assessed	Default FAL	NA	NA	No Assessment on File	NA
147400	North Tributary to Silver Creek	0	4.42	FAL	FAL	Not Supporting	Default FAL	Impairment Unknown	Non-Point Source (Rural or Urban)	Monitored	303d Listed
147600	Gothic Mill Pond	0	15.46	Impounded Flowing Water	FAL	Supporting	Default FAL	NA	NA	Monitored	NA
147700	Unnamed Trib to Silver Creek	0	8.14	FAL	FAL	Not Supporting	Default FAL	Impairment Unknown	Non-Point Source (Rural or Urban)	Monitored	303d Listed
148000	Spring Creek	0	3	FAL	FAL	Fully Supporting	Default FAL	NA	NA	Monitored	NA
148100	Spring Lake (Spirit)	0	75	Deep Headwater	FAL	Supporting	Default FAL	NA	NA	Monitored	NA

WBIC	Waterbody Name	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Impaired Water Status
148200	Roy Creek	0	7.18	LFF	LFF	Not Supporting	Default FAL	Degraded Habitat, Impairment Unknown	Non-Point Source (Rural or Urban)	Monitored	TMDL Development
148300	Wuerches Creek	0	4.4	LFF	WWSF	Not Supporting	Default FAL	Low DO, Elevated Water Temperature, Degraded Habitat	Non-Point Source (Rural or Urban)	Monitored	TMDL Development
3000091	Assemble Creek	0	0.2	Cold (Class I Trout)	Cold (Class I Trout)	Not Assessed	Cold	NA	NA	No Assessment on File	NA
5561558	Green Lake - Canal North	0	1.48	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA
5562408	Green Lake - Beyers Cove; West Channel	0	4.3	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA

[i] The watershed assessment table reflects the condition of waters in the study area watershed. This table data is stored in the Water Assessment Tracking and Electronic Reporting System (WATERS) and is updated on an ongoing basis via monitoring data and assessment calculations. The following definitions apply:

- Current Use – current condition of water based on monitoring data.
- Attainable Use – "ecological potential" of water based on water type, natural community, lack of human-induced disturbances.
- Supporting Attainable Use – decision on whether the water's current condition is supporting its designated use under "water quality standards".
- Designated Use – the water's classified use under NR102, Wisconsin Water Quality Standards, for Fish and Aquatic Life.
- Impairments – documented impacts on water condition due to pollution sources or changes in hydro-geomorphological changes.
- Assessment – field indicates what type of data or information supports the decisions in the table (current, attainable, and supporting attainable).
- Impaired Water Status – This column indicates the status of the impaired water for TMDL development.