Prepared for

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Lauderdale Lakes Watershed Plan

Lauderdale Lakes
Walworth County, WI

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1 INTRODUCTION

The Lauderdale Lakes Chain (Lauderdale Lakes) is a collection of three interconnected groundwater drainage lakes, Green, Middle and Mill Lakes, located in Walworth County, Wisconsin. These lakes are approximately 6.5 miles north of Elkhorn, Wisconsin and 9 miles southeast of Whitewater, Wisconsin. The Lauderdale Lakes are ground-water drainage lakes; that is, inflow is primarily from ground water and outflow is by a surface outlet. The lakes reside in the greater Upper Fox (IL, WI) watershed and more defined at the local level as residing in the headwaters of the Honey Creek watershed (HUC 0712000605). The drainage area of the lakes measured from the outlet is 16.1 square miles. The lake is classified as mesotrophic (USGS, 1996). An overview map of Lauderdale Lakes can be seen in Figure 1 below.

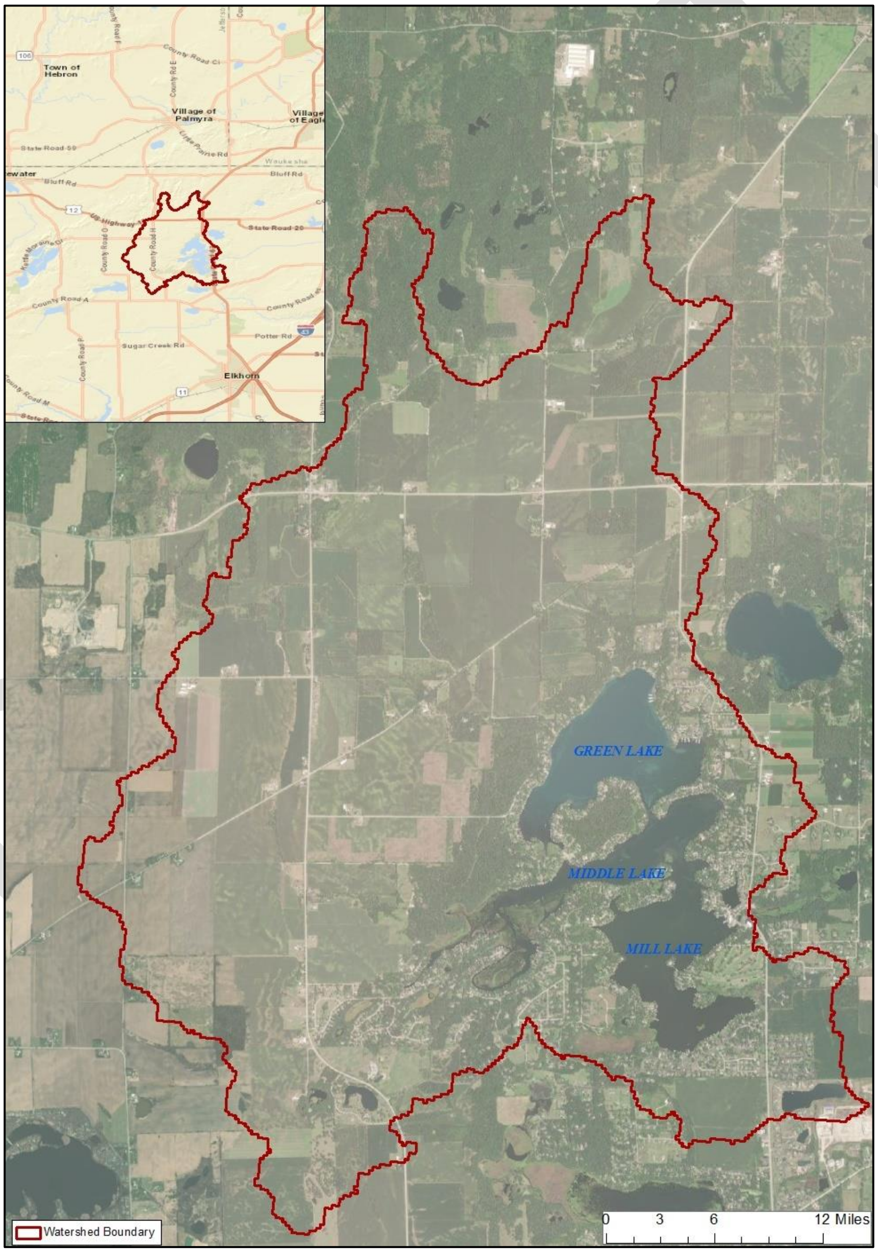

Figure 1. Lauderdale Location Map

1.1 Purpose of Report

Lauderdale Lakes is faced with a number of ongoing challenges tied to invasive species, infrastructure, stormwater runoff leading to both point and nonpoint pollution, and long-term planning. In 1991 the Lauderdale Lakes Lake Management District (LLLMD or "Management District") was created with the primary purpose of protecting and rehabilitating Lauderdale Lakes. The lakes remain a highly sought recreational destination and the quality of the water protects property value and sustains a diverse fishery and is the host to several identified sensitive areas (WDNR, 1990, 2004).

As early as 1990, residents along the shoreline began expressing concerns about the lake chain water quality. While the Lauderdale Lakes Improvement Association (LLIA) has been conducting periodic lake monitoring since the late 1970s, heavy aquatic plant growth was occurring in 90s and approximately 565.6 tons (wet weight) of plant material was removed from the lakes, something that hadn't been necessary since the 1950's. As a result, the LLLMD understood the need for developing a nutrient reduction plan that would help limit the input of phosphorus into the lake. As a result, in 1993 the Management District worked with the U.S. Geological Survey (USGS) to develop a report that describes the water budget of the lakes, then lake water quality, major phosphorus loads and a phosphorus budget for the lakes.

In 1997 The Wisconsin Department of Natural Resources (WDNR) along with the Department of Agriculture, Trade and Consumer Protection (DATCP) partnered with Walworth County and a number of local stakeholders to draft the *Nonpoint Source Control Plan for the Sugar-Honey Creeks Priority Watershed Project Plan* under the Wisconsin Nonpoint Source Water Pollution Abatement Program. While this document provided framework for both the Sugar and Honey Creek watersheds at the time, the plan provided only limited context for Lauderdale Lakes and has become outdated as a planning tool and as a funding mechanism.

In 1998, with the assistance of a Lake Planning Grant from the DNR and technical assistance from Walworth County, LLLMD hired Hey and Associates to complete a surface runoff study to better identify nonpoint source issues and abatement projects. This resulted in the implementation of the most prioritized project identified in that study, a wetland treatment facility in the Gladhurst Subdivision which continues to serve the North watershed to Green Lake.

The LLLMD has realized they need to continue to move these initiatives forward with an updated plan and revisit how best to move forward. This report encompasses an updated watershed plan intended to be part of the WDNR Surface Water Grants program and build upon the previously mentioned studies.

This report will address 4 of the 9 key elements of a typical EPA 9 Element Watershed Based Plan (WBP) as negotiated with WDNR. The four key elements for a WBP to be addressed by this report include:

- An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan. Sources that need to be controlled are identified at the significant subcategory level with estimates of the extent to which they are present in the watershed.
- A description of the nonpoint source (NPS) pollution management measures that will need to be implemented to achieve the load reductions, and an identification of the critical areas in which those measures will be needed to implement in the plan.
- An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan.

- An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

1.2 Background and Overview of Prior Studies

Previous studies have taken place within the Lauderdale Lakes watershed, several date back prior to 2000. Of these studies, two have provided a backdrop regarding existing watershed data and work completed. These studies and reports will serve as base information sources for updating initiatives:

1. Hydrology and Water Quality of Lauderdale Lakes, Walworth County, Wisconsin 1993-94 (USGS, 1996) – Herein referred to as "USGS Report".
2. Surface Water Runoff Study for the Lauderdale Lakes Lake Management District (Hey and Associates, 1998) – Herein referred to as the "Hey and Associates Report".

The USGS Report completed in 1996 provided context for various lake water quality parameters, specifically by identifying near lake septic systems and nearby surface water runoff as primary culprits and leading issues driving the phosphorus budget. This report detailed the phosphorus budget as 51% surface water runoff, 25% from septic systems, 13% from groundwater, and 11% from the atmosphere due to precipitation. Of the percentage of phosphorus from surface water runoff, 75% was identified as coming directly from sheet flow and private property with the remaining 25% coming from tributaries.

The Surface Water Runoff Study completed by Hey & Associates (1998) focused on water quality impacts from reviewing volumetric stormwater runoff loading on an annual basis. It was a focused study meant to follow up on the identified 51% of total phosphorus entering the lake via direct runoff and tributary flow. In addition, it provided a number of potential improvement best management practices (BMPs) that might be employed to help address these issues and successfully led to the implementation of the Gladhurst Subdivision wetland treatment facility. Per conversation with WDNR staff, updating these findings would be a preference for the State as part of any watershed planning effort.

2 EXISTING CONDITIONS ASSESMENT

The previous two studies assessed the lake chain using two different methods. The USGS Report was more empirically based and supported by water quality monitoring data taken from the lake chain. The Hey and Associates report used a window-based program Source Loading and Management Model (SLAMM) and Universal Soil Loss Equation (USLE). SLAMM is an urban nonpoint source water quality model that simulates the pollutant loading based on a specific rainfall file, event-based or annual rainfalls. SLAMM focuses on identifying specific pollutant and runoff control practices from developed urban areas – i.e., roofs, streets, parking areas, landscaped areas, etc.

Additionally, Hey and Associates used USLE to calculate total soil loss from agricultural fields. To enable a watershed analysis that assesses all of the existing land covers for the lake chain within one platform/model, a U.S. EPA Spreadsheet Tool for Estimating Pollutant Loads (STEPL) model was developed. This model utilizes standard USLE calculations but incorporates a larger array of land covers than SLAMM to quantify the phosphorus and TSS loading for the Lauderdale Lake Chain. As part of the updates, the tributary area was delineated for each lake (Mill Lake, Middle Lake, and Green Lake) to enable the LLMD to identify projects that best suit each lake. The delineation process also incorporated the direct runoff area the USGS report defined, and the revised tributary areas plus the delineated direct runoff areas were the basis for this analysis.

The watershed as delineation by USGS and the individual lakes watersheds as delineated as part of this study are shown in Figure 2. For the purpose of this study the USGS defined watershed serves as a boundary condition for the revised individual lake watersheds.

2.1 Pollutant Loading Analysis

2.1.1 STEPL Model Development

STEPL model version 4.4 was utilized to assess the phosphorus and TSS loading within the Lauderdale Lakes watershed. The STEPL spreadsheet model simulates annualized estimates of total runoff volume for nutrient and TSS loads based on the USLE, watershed characteristics (both default and user-specified), BMP implementation, and meteorology at a planning level scale. STEPL models are un-calibrated, and pollutant load estimates are based on event mean concentrations (EMC) for a given land use. The EMC is a flow weighted average based on a single runoff event, defined as the total pollution loading for a given land use divided by the respective total runoff volume. The runoff volume is based on the average rainfall depth per storm event and the land use's curve number (CN). Curve numbers are a characteristic developed by the USDA to estimate the range of runoff produced based on the drainage basins soils, plant cover, number of impervious areas, and land cover. The model results provide a planning-level tool to compare the potential relative reduction of pollutants between two alternatives. The reported values should not be used as absolute quantities.

2.1.2 Watershed Hydrology

Since previous reports were completed prior to 2000, the tributary area to the lakes was reassessed. Since the original reports have been published, new technologies have been developed that provide higher topographic resolution for these areas. Walworth County's 1-foot digital contour data was derived from 2015 Orthophotography multi-resolution seamless image database to conduct the existing condition watershed hydrology analysis. The tributary area for each Lake (Mill Lake, Middle Lake, and Green Lake) was delineated, which will allow the LLMD to identify projects that may best suit individual Lakes.

The Lauderdale Lakes watershed was delineated into drainage areas using desktop GIS to assess the watershed's hydrology. GIS has tools which can helps automate watershed delineation by defining overland flow paths and drainage boundaries based on topographic data. Figure 3, located in Appendix A provides an overview of the calculated overland flow paths. Figure 4 (Appendix A) provides an overview of the individual drainage areas for Green, Middle, and Mill Lakes and a fourth drainage area that is not immediately tributary to the lake chain but was previously identified as tributary to the lakes in the USGS report. This area is north of the watershed tributary to Green Lake; however, the overland flow path has been determined to go north across Highway 12 based on the more recent, detailed topography. This area was not included as part of the Lauderdale Lakes watershed hydrology.

The results of the GIS analysis were further compared to the direct runoff area of the USGS Report. The USGS report acknowledges that portions of the topographically defined watershed area have closed depressional contours and regions that do not contribute runoff to the lakes. USGS delineated the direct runoff area based on field observations and quadrangle maps predating 1990. The direct runoff boundary was used to redefine the tributary areas developed during the GIS analysis and serve as the input boundary for the STEPL analysis. Figure 5 (Appendix A) shows a comparison between the GIS defined watershed and the USGS direct runoff area. Table 1 below shows a comparison of the direct runoff area (based on a digitized USGS map) and tributary area for Green, Middle, and Mill Lakes calculated in GIS.

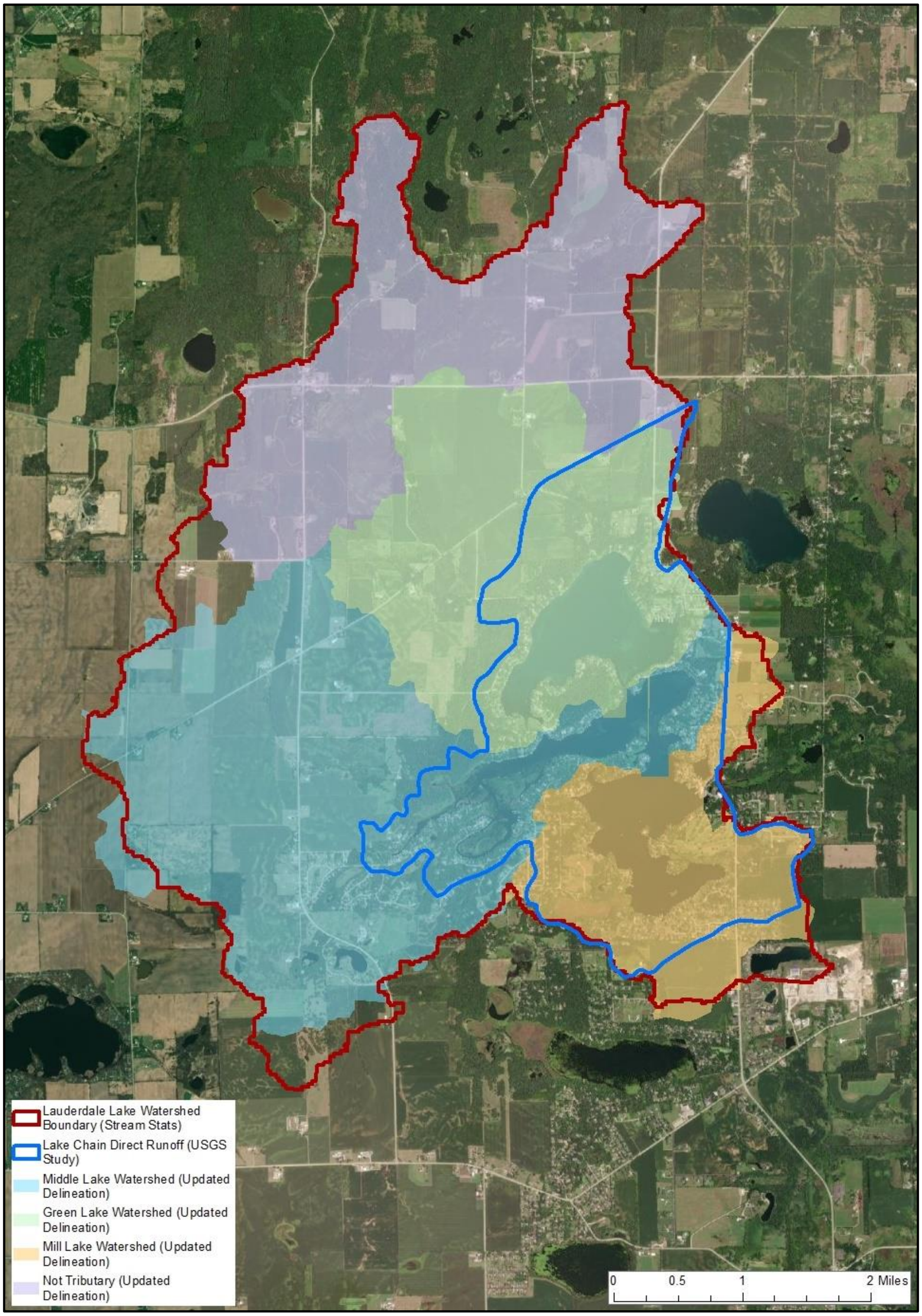

Figure 2. Existing Hydrology – Overview of watershed boundaries from different studies

Table 1: Lauderdale Lake Direct Runoff Area and Tributary Area (See Figure 2)

Drainage Area	USGS Direct Runoff Area (ac)*	GIS Delineated Tributary Area (ac)**
Green Lake	950	1149
Middle Lake	685	3053
Mill Lake	877	2010
Not Tributary	-	1963
Total	2,512	8,175

*USGS Direct Runoff Area (Figure 2 – Blue Line): Area defined by 1992 USGS Study as providing direct runoff to the Lauderdale Lakes Chain. Areas represented above reflect the the 2022 individual lake watersheds (shaded areas) within the blue line only.

**GIS Delineated Tributary Area (Figure 2 – Shaded Areas): Tributary areas recalculated as part of this current study (2022). Acreage shown represents entire watershed area (inside and outside of the USGS direct runoff area).

The GIS delineated watershed was ground-truthed during a Site visit in September 2021. The photolog is located in Appendix B. Based on the site visit, the overland flow routes generally appear correct. The acreage presented column 2 of Table 1 above reflects the individual watershed area for each lake bounded by the USGS delineated direct runoff area (blue line) and column 3 indicates the acreage for the ArcHydro delineated watersheds. Thes USGS direct runoff areas are used to analyze the ultimate loading determinations to the individual lakes. Figure 8 (Appendix A) provides a more definitive illustration of the individual watershed trimmed to the USGS study boundary.

2.1.3 Soils

Soils data for the watershed was extracted using the Web Soil Survey (WSS) application by USDA NRCS (USDA, 2019). The soils data was used to identify the type of soil and assign potential for runoff. The majority of the watershed consists of soils in hydrologic soil group B (87.1%) as shown on Figure 6 (Appendix A). Consistent with the Hey and Associates analysis, hydrologic soil group B was assumed for the STEPL analysis for the entire watershed. Table 2 provides a breakdown of the hydrologic soil groups within the direct runoff tributary area.

Table 2: Direct Runoff Tributary Area Soil Summary

Hydrologic Soil Group or Soil Type	Total Area (ac)
A	148
B	1,447
C	66
Water	809
Marsh	41
Gravel Pit	1
Total	2,512

2.1.4 Watershed Land Cover

Land cover data was downloaded from the National Land Cover Database (NLCD, 2016), and an overview of the data for the surrounding area is shown on Figure 7 (Appendix A). Table 3 shows the breakdown of the land use in the watershed in fifteen (15) categories, and a spatial overview of the land cover is illustrated on Figure 8 (Appendix A).

Table 3: Lauderdale Lake Chain Direct Runoff Land Cover, NLCD 2016

Land Cover (NLCD 2016)	Combined Area (ac)	Percent Area
Open Water	811	32%
Developed, Open Space	262	10%
Developed, Low Intensity	153	6%
Developed, Medium Intensity	13	1%
Developed, High Intensity	1	0%
Barren Land	0	0%
Deciduous Forest	569	23%
Evergreen Forest	5	0%
Mixed Forest	58	2%
Shrub/Scrub	0	0%
Herbaceous	10	0%
Hay/Pasture	171	7%
Cultivated Crops	307	12%
Woody Wetlands	78	3%
Emergent Herbaceuous Wetlands	74	3%
Total	**2,512**	**100%**

The land cover data were lumped into seven (7) categories to provide inputs for the STEPL model. The lumped land cover data for the watershed is presented in Table 4. Review of the land cover data shows that 12% of the watershed is cropland and 7% pasture. Various forest types cover an additional 25%. Suburban and commercial development cover 17% of the total watershed area. Wetlands cover 6% of the total watershed area. Other land use (open water and barren land) covers 32% of the total watershed area. The acreage for open water was not included in the watershed model as open water was assumed to not contribute to pollutant loading.

Table 4: Lumped Land Cover

Lumped Land Cover	Combined Area (ac)	Percent Area
Developed	167	7%
Developed Open Space	262	10%
Forest	632	25%
Pastureland	181	7%
Cropland	307	12%
Wetland	152	6%
Area Not included	811	32%
Total	**2,512**	**100%**

2.1.5 Meteorology

For the watershed, the STEPL model uses meteorological data from the weather station located in Whitewater, Walworth County, Wisconsin.

2.1.6 Septic Systems

The USGS report identified septic systems as a key contributor to the phosphorus budget in the Lauderdale Lakes. Realizing this significance, the LLLMD developed a septic pump-out program that provides homeowners a free septic pumping on a 3-year rotational basis. While this is an excellent service to provide their constituents, the LLLMD also recognizes that there are more year-round residents than ever before, and home improvements/additions are typically made without consideration for impact to the capacity of the home's system. For this reason, we have included septic loading as part of the overall analysis.

STEPL models the nutrient load from human populations that use a septic system based on the number of septic tanks, the failure rate (percentage), and the ratio of people per septic system. As part of the analysis, the default values for failure rates (10%) was reduced to 2% with consideration of the pump out program. There are 974 septic systems around the lakes, with generally even distribution to each of the 3 lakes. The approximate loading is indicated in Table 6.

2.2 Baseline Loading from STEPL (Total Suspended Solids and Phosphorus)

Baseline unit loads (per unit acre per year) were estimated using the STEPL watershed model for each of the subwatersheds as described in the following sections. Total suspended solids and phosphorus are typically analyzed together due to phosphorus making up a small percentage of the suspended solids. For this plan, the STEPL nutrient loading analysis assumed 0.031% of soil is phosphorus. This is assumed to be a median value for the possible ranges of the respective land use represented.

2.2.1 Total Suspended Solids (TSS)

Major sources of TSS within the watershed include cultivated areas and highly impervious land uses such as roads and developed areas.

Yearly TSS unit loads simulated using the STEPL model are mapped on Figure 9 – enlargements for each Lake are shown on Figures 9A, 9B, and 9C (Appendix A). The STEPL TSS by land cover unit loads for Green, Middle, and Mill Lake are summarized in Table 5. It should be noted that the acreage as shown in Table 5 for the individual lakes matches the USGS watershed boundaries shown in Table 1.

Table 5: Total Suspended Solids Loading by Land Cover*

	Green Lake - Total Area Model 622.51 ac		**Middle Lake - Total Area Model 369.39 ac**		**Mill Lake - Total Area Model 555.58 ac**	
Land Cover	**Sediment Loading (lb/yr)**	**Sediment Loading (%)**	**Sediment Loading (lb/yr)**	**Sediment Loading (%)**	**Sediment Loading (lb/yr)**	**Sediment Loading (%)**
Urban	8,000	0.8%	6,000	4.1%	16,000	3.4%
Cropland	982,000	93.5%	84,000	57.5%	340,000	72.6%
Pastureland	40,000	3.8%	38,000	26.0%	100,000	21.4%
Forest	20,000	1.9%	18,000	12.3%	12,000	2.6%

Septic	0	0.0%	0	0.0%	0	0.0%
Total	1,050,000	-	146,000	-	468,000	-

*Wetlands and Open Water are not included in loading calculations

2.2.2 Total Phosphorus

Total phosphorus (TP) serves as the primary nutrient source for aquatic plant species growth. Major sources of TP within the watershed include fertilizer lost from croplands, agricultural fields, on-site wastewater systems (septic), urban runoff, and animal agriculture.

Yearly TP unit loads simulated using the STEPL model are mapped on Figure 10 – enlargements for each Lake are shown on Figures 10A, 10B, and 10C (Appendix A). The STEPL TP unit loads by land cover for Green, Middle and Mill Lake are summarized in Table 6. Subwatersheds with maximum loading for TP typically have pastureland and cropland as their dominant land cover.

Table 6: STEPL Total Phosphorus Loading by Land Cover*

	Green Lake - Total Area Model 622.51 ac		**Middle Lake - Total Area Model 369.39 ac**		**Mill Lake - Total Area Model 555.58 ac**	
Land Cover	**Phosphorus Loading (lb/yr)**	**Phosphorus Loading (%)**	**Phosphorus Loading (lb/yr)**	**Phosphorus Loading (%)**	**Phosphorus Loading (lb/yr)**	**Phosphorus Loading (%)**
Urban	25	3.00%	19	10.1%	47	10.0%
Cropland	675	80.94%	57	30.3%	234	49.8%
Pastureland	33	3.96%	32	17.0%	85	18.1%
Forest	26	3.12%	22	11.7%	16	3.4%
Septic	75	8.99%	58	30.9%	88	18.7%
Total	834	-	188	-	470	-

*Wetlands and Open Water are not included in loading calculations

2.3 Bulk Loading

Bulk loading analysis was also completed to obtain a perspective of the annual volume of sediment transported to the Lakes. Based on the general soil conditions of the watershed, the bulk loading analysis assumed a hydrologic soil group B, silt loam. The Minnesota Pollution Control Agency Stormwater Manual indicates the bulk density values for silt loam range from 1.2 to 1.5. A bulk density of 1.35 was therefore assumed to calculate the volume of TSS that could potentially be lost into the Lake Chain annually. The volume can either be used to size sediment basins/sediment traps designed to capture TSS before entering the Lake Chain or develop a dredging plan that identifies the frequency and volume of sediment that would need to be removed.

For the analyzed watershed, a total sediment load of 832 tons/year would result in approximately 731 cubic yards (CY) of sediment being eroded into the lakes per year. Individual lakes volumes would be smaller. Table 8 provides an overview of the loading for Lauderdale Lake Chain and each Lake. Middle Lake has the smallest loading, 64 CY/yr, while Green Lake has the largest loading, 461 CY/yr.

Table 8: Bulk Loading

Drainage Area	TSS Loading (tons/yr)	TSS Loading (CY/yr)
Lauderdale Lake Chain	832	731
Mill Lake	234	206
Middle Lake	73	64
Green Lake	525	461

2.4 Wave Analysis

A wave analysis was completed using Wisconsin DNRs wave height calculator. As part of this study, areas exposed to maximum wave heights were reviewed. The four maximum wave height potential locations are presented in Figure 12 (Appendix A). The wave heights are presented in Table 9. The areas graphically indicated should warrant occasional inspection if in a natural state. Furthermore any bulkheads should be regularly inspected to ensure they are working as intended. Bulkhead repairs can take a considerable time to repair and permit if a remedy is required. Natural solutions are always preferred as they provide habitat to fish and aquatic invertebrates.

The objective of the wave analysis was to identify shorelines with maximum wave energy and recommend shoreline restoration, stabilization or enhancement. The wave heights should not be confused with boat generated wake height.

Table 9: Maximum Wave Height Potential

Maximum Wave Height Potential Location	Maximum Wave Height (ft)
Green Lake	1.1
Middle Lake	1.2
Mill Lake	0.92
Don Jean Bay	0.92

As part of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) 2010 Aquatic Plant Management Plan for Lauderdale Lakes, a shorelines inventory was developed to identify the shoreline's protection techniques and condition. Techniques include; beach, bulkhead, natural, revetment, and riprap. It is worth noting, the report indicates no severe erosion-related problems were observed during the inventory in 2008. The information provided was not available electronically and was therefore digitized to be used in GIS for this plan. For this reason, some ground truthing may be necessary to validate the presented data. Figure 11 (Appendix A) provides an overview on where the different shoreline techniques exist, and Table 10 breaks down the total length of each technique for the three lakes.

While the wave height analysis was primarily focused on shoreline protection it also brings to light the concern over shoreline encroachment due to man induced wakes. Of growing concern to the LLLMD and shoreline property owners is the need to understand the impact of artificial waves and recreational boating on shorelines, including the numerous islands that exist within the Lauderdale Lakes Chain. Islands, both inhabitated and uninhabitated, along with shallow mid lake environments provide unique habitat opportunities for fish, plants, aquatic invertebrates, and birds. For the purpose of this watershed plan, lake islands are included in the overarching goals of the LLLMD to protect and restore the shorelines of the lakes. During watershed planning meetings, stakeholders had expressed concern over areas of the lakes subject to shoreline erosion not consistent with modeled wave impact locations. These areas could very well be the result of wake induced erosion.

Table 10: Summary of Southeastern Wisconsin Regional Planning Commission Shoreline Protection Structures

Lake	Beach - ft (% of total shoreline)	Bulkhead - ft (% of total shoreline)	Natural - ft (% of total shoreline)	Revetment - ft (% of total shoreline)	Riprap - ft (% of total shoreline)	Total Shoreline-ft
Green	1,937 (6.34)	6,407 (20.96)	10,451 (34.19)	112 (0.37)	11,665 (38.16)	30,573
Middle	698 (2.15)	4,959 (15.27)	16,362 (50.39)	60 (0.19)	10,391 (32.00)	32,470
Mill	1,052 (4.67)	6,166 (27.35)	7,101 (31.50)	58 (0.26)	8,166 (36.22)	22,543

2.5 Local Drainage

One component of the watershed plan that may not be directly reflected in watershed plan are local drainage hotspots. The STEPL model incorporates land use to reflect the impact of impervious cover land uses from development, however aging local infrastructure and unmaintained drainage are not included. These aspects which are impacted due to stormwater events are impacted on a storm by storm basis. STEPL does not acknowledge extreme event impacts but rather an estimated average trendline. Therefore local drainage will need to be reviewed and addressed for contributing impact on a case by case basis.

3 PROPOSED ALTERNATIVES

3.1 Summary of Recommended Projects from Previous Studies

Below is a summary of the recommended remedial alternative actions developed from the Hey and Associates Report. This list is presented as a reminder of what was previously recommended and additional identified opportunities based on the updated watershed review in Section 3.2. Several of these were modified to some degree to make them more pertinent to today, particularly Alternative 9 which was converted to an overall education process.

- Alternative 1 – Do Nothing
- Alternative 2 – Detention/Wetland Treatment
- Alternative 3 – Conservation Cover
- Alternative 4 – Residue Management
- Alternative 5 – Contour Farming/Contour Strips

- Alternative 6 – Grassed Waterway
- Alternative 7 – Conservation Easements
- Alternative 8 – Lake Buffer Strips
- Alternative 9 – Public Education on Lawn Care
- Alternative 10 – Development Controls

These remedial alternatives would have varying degrees of effectiveness and ease of implementation, with a wide range of capital and long-term operation and maintenance (O&M) costs. However, at a minimum, these remedial alternatives were developed to mitigate current and future phosphorus loadings into the Lauderdale Lakes Watershed. Remedial alternatives for the Site are presented in subsequent subsections.

3.1.1 Alternative 1 – Do Nothing

Alternative 1 is to do nothing. Under this approach sediment and nutrient inputs into the lakes will remain the same, sediments will continue to build up, and nutrients washed in from runoff will continue to feed algae and nuisance aquatic vegetation.

3.1.2 Alternative 2 – Detention/Wetland Treatment

Alternative 2 involves construction of a wet detention basin or wetland treatment system to remove sediment and nutrients. Ideally the system would be sized to treat the tributary watershed for a % effectiveness.

3.1.3 Alternative 3 – Conservation Cover

This alternative entails placing all agricultural land in conservation cover, meaning that all agricultural land is retired from production and a perennial vegetive cover is maintained over the soil.

3.1.4 Alternative 4 – Residue Management

Residue management is managing the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops in narrow slots or tilled strips in previously untilled soil and residue.

3.1.5 Alternative 5 – Contour Farming/Contour Strips

Contour farming is sloping the land in such a way that preparing land, planting, and cultivating are done on the contours. Contour strips are narrow strips of perennial, herbaceous vegetative cover established across the slope and alternated down the slope with wider cropped strips.

3.1.6 Alternative 6 – Grassed Waterway

A grassed waterway is a wide, shallow, sod lined channel designed to safely convey water during heavy rainfall. Grassed waterways are used to prevent the formation of gullies. Gully erosion is not estimated by the Universal Soil Loss Equation (USLE). Therefore, the exact sediment and phosphorus reductions by implementing this management practice are unknown. To protect the grass waterway from high flows during heavy rains, a detention basin is recommended to be constructed at the upstream area.

3.1.7 Alternative 7 – Conservation Easements

Just upstream of Green Lake, a tributary channel drains through a steep wooded ravine. The ravine is located within a residential development, known as the Gladhurst subdivision and runs along several lots. The ravine is located in a very steep forested area where erosion was identified. A20-foot drainage easement currently exists on some of the lots. If the easement was encroached upon and the trees were cut down it could make the banks very unstable and susceptible to erosion. To protect the ravine a conservation easement should be acquired on all of the steep slope areas. It is possible a conservation easement does exist in this instance; however, this serves as an example of where such an easement is practical and necessary. The following is a list of activities that should be prohibited in the easement:

- Removal of any vegetation, including trees and shrubs.
- Runoff from driveways, roofs, and patios should not be drained into the ravine, except through a engineered waterway or pipe to prevent gully erosion.
- The stream channel should not be relocated. The channel has stabilized itself through years of self-armoring. Disturbance of the channel could damage the natural protection features and cause severe erosion.

3.1.8 Alternative 8 – Lake Buffer Strips

Lake buffer strips are grassed areas along the lake that are allowed to be left un-mowed. The strip of taller grass has the ability to absorb more nutrients than mowed turf and allows the grass to establish a deeper root system, decreasing shore erosion. For the purpose of this alternative, the vegetation is assumed to be native to the State of Wisconsin.

3.1.9 Alternative 9 – Public Education on Lawn Care

An education program focused on lawn care was recommended as part of the Hey and Associates 1998 report which hinged largely on fertilizer recommendations. While still important, some of the recommendations are now secondary as a ban on phosphorus-based fertilizers are now statewide and even farmers are required to perform testing indicating that phosphorus is necessary prior to obtaining approval to use as a soil additive.

In an effort to continually provide educational opportunity to stakeholders, the LLLMD has provided an open forum for watershed residents to fully participate in the watershed planning process. The LLLMD hosted four (4) meetings during the watershed planning process. Due to the pandemic, the meetings were all held virtually. The meetings held are recognized below:

1. Kickoff Meeting (6/30/2021): Provided participants with a snapshot of the watershed planning process, anticipated future meetings and topics, and the need for watershed planning and the purpose of the LLLMD.
2. Background Data Review (8/31/2021): The meeting reviewed the previous studies and background assessment performed to look at baseline loading to the lake from the watershed. The information introduced the stakeholders to management actions and the impact of development and land use on the lakes.
3. Project Implementation (10/26/2021): During this meeting attendees were introduced to beneficial land use practices and management actions which can mitigate existing land use impacts and current ongoing lake practices and proposed objection of the LLLMD.

4. Project Review, Summary, and Closeout (12/14/2021): The closeout was used to provide attendees a recap of the process, provide resources to the watershed plan and how they can participate in future actions undertaken by the LLLMD and other lake and watershed partners.

All presentations have been provided in Appendix D. The LLLMD is also hosting the presentations on the District's website. Meetings 2-4 were recorded and are also hosted on the District's website.

3.1.10 Alternative 10 – Development Controls

While conversion of the agricultural area to residential land use should reduce the amount of sediment and phosphorus entering the lake, other pollutants associated with urban development may increase. Petroleum hydrocarbons, heavy metal, and fecal coliforms are examples of pollutants that may increase without adequate stormwater controls. A stormwater management system that addresses water quality should be installed with any proposed development. If the area is developed as low density residential on large lots, the stormwater system should include grassed waterways and infiltration systems. If a clustered development of higher density lots is developed, wet detention may need to be incorporated into the design. The LLLMD should work with Walworth County and the Town of Sugar Creek/Town of LaGrange to assure that adequate stormwater controls are incorporated into the final design of any proposed development.

3.1.11 Summary of Hey and Associates Recommendations

Table 11 below highlights the Hey and Associates Report's specific recommendations and implementation schedule from the 1998 watershed study. At the time of this report, it was unclear whether the recommended activities had been implemented and their effectiveness at reducing TSS and phosphorus from entering the Lauderdale Lake Chain. It is know that the wet detention facility was installed within the Gladhurst subdivision. The LLLMD also reimburses a private land owner to keep a 0.55 acre filter strip undeveloped along the south end of Don Jean Bay which helps to filter runoff. Additional implementation projects from the plan are not known to have been completed.

Table 11: Summary for Hey and Associates Recommendations

Recommendation	**Schedule**
North Watershed	
Wet Detention Facility	Spring 1999
Grassed Waterway/detention basin	Spring 1999
Conservation easements	Fall 1998
Conservation tillage	Spring 1999
South Watershed	
Conservation tillage	Spring 1999
Zoning restriction and stormwater management requirements for new residential development	As development is proposed
Education program on lawn care	Spring 1998
Education program on the establishment of lake buffer strips	Summer 1998

The installation of the wet detention facility in the Gladhurst subdivision in 2001 was the first designed BMP to be implemented as part of the Hey and Associates study effort. The BMP is still in place and working as intended. The LLLMD will continue to monitor the facility to determine its effectiveness in capturing pollutants.

3.2 Current Recommended BMP Selection

A BMP is defined as an environmental protection practice used to control pollutants. For the critical areas identified using the methodology described above, the BMPs assessed for implementation in the watershed are provided below in this section. Section 3.3 further considers the BMP recommendations identified in Figure 13. These recommendations are for specific locations where the BMPs mentioned below should be implemented. This section deviates from Section 3.1. It provides additional BMP measures to the LLLMD that are practical, economically feasible, and well suited to the layout of today's identified highly residential footprint.

3.2.1 Target Urban Road ROWs

BMPs such as bioswales, infiltration trenches, and vegetated swales are recommended for target road ROWs. These BMPs are designed to reduce the quantity and improve the quality of stormwater runoff from impervious surfaces in urban areas. These linear features can work well within a limited footprint, are easy to access for maintenance, typically disguise well in the ditchline, and have a relatively low to medium cost per lineal foot.

3.2.1.1 Bioswales

Bioswales are vegetated, shallow, landscaped depressions designed to capture, treat, and infiltrate stormwater runoff as it moves downstream. These swales consist of a soil bed planted with suitable native vegetation. Stormwater runoff entering the bioretention system is filtered through the soil planting bed before being discharged downstream. These have the ability to function well in the watershed due to the natural permeability of the soils.

3.2.1.2 Infiltration Trenches

An infiltration trench is a stormwater management practice that collects and stores runoff until it can infiltrate into the subsurface soil. Infiltration trenches typically are longer than they are wide, are less than 15 feet in width, and are intended to promote subsurface infiltration. Trenches are commonly filled with properly graded media that will promote infiltration and reduce pollutants discharged to surface waters, such as sediment, debris and nutrients. Infiltration trenches may be used as a detention feature in a stormwater management plan. Infiltration trenches also have the ability to be a well-suited match for the Lauderdale Lakes watershed.

3.2.1.3 Vegetated Swales

Vegetated swales are constructed storm water conveyance systems designed to achieve water quality and quantity benefits. The purposes of this practice are to filter and trap pollutants, improve water quality, attenuate peak flow, and/or promote infiltration while limiting groundwater contamination. Vegetated swales are also cheaper to construct and maintain than bioswales, however may lack the ability to promote infiltration at the same scale.

3.2.1.4 Detention ponds

Detention ponds hold stormwater runoff and allow pollutants to settle to the bottom. The water is then released slowly into controlled conveyance feature, reducing flooding and POCs in the discharge. Unlike the other options provided above, these ponds do not promote infiltration to the degree as the other options mentioned above.

3.2.2 Upgradient of Sensitive Areas

Sensitive areas may include waterways, wetlands, sloping land, Karst features, floodways, setback areas and areas of the lakes that are designated as Critical Habitat Areas in Wisconsin or Areas of Special Natural Resources Interest (ASNRI). These areas may be comprised of aquatic vegetation identified by the WDNR as offering critical or unique fish and wildlife habitat, including seasonal or life stage requirements, or offering water quality or erosion control benefits to the body of water. Infiltration wetlands and sediment traps are feasible for subwatersheds upgradient of sensitive areas.

3.2.2.1 Infiltration Wetland

An infiltration wetland is a site-specific combination of practices using physical and biological processes to remove sediment, nutrients, bacteria, pesticides, and organic matter from runoff. Site selection is key to the success of this practice and therefore would be limited to only a few locations within the watershed but can have multiple benefits for both runoff control and habitat function.

3.2.2.2 Temporary Sediment Trap

A temporary sediment control device formed by the excavation and/or embankment to intercept sediment-laden runoff and to retain the sediment. This feature is used to detain sediment-laden runoff from disturbed areas for sufficient time to allow the majority of the sediment to settle out. Traps need to be maintained for storage to ensure they function as intended. If not appropriately maintained these features can actually become a pollutant source by resuspending settled constituents during intense rain/flow events.

3.2.3 Agricultural Land

Cropland BMPs are feasible for subwatersheds with a more significant proportion of cropland land use. Cover crops, nutrient management, and conservation tillage, can generally be implemented in cropland areas of the watershed without space constraints since these BMPs do not reduce the existing footprint of the cropland.

3.2.3.1 Agricultural Runoff Treatment Systems (ARTS)

ARTS is a relatively new technology that has been implemented primarily in Outagamie and Brown Counties, WI where it has been applied in the Ashwaubenon and Dutchman Creek Watersheds. Preliminary monitoring by USGS and UWGB have shown downstream water quality benefits including 40% TP and 80% TSS load reductions. The ARTS currently have an estimated 10 to 20 year life of practice and can be sized based on the available treatment area.

Enhanced Agricultural Runoff Treatment Systems (eARTS), is a recently adapted version of the ARTS with included filter technology to better addressed dissolved phosphorus. The cost is approximately

15% greater than the base cost ARTS equivalent, however the maintenance upkeep is approximately 30% greater due to the need to increase monitoring and maintain the effectiveness of the filtration media.

3.2.3.2 Conservation Tillage

Conservation Tillage involves the planting, growing, and harvesting of crops with minimal disturbance to the soil. This practice uses seeders and techniques that are more precise and require fewer passes, reducing the amount of fuel used for farm equipment.

3.2.3.3 Cover Crops

Cover Crops are short-term crops grown after the primary cropping season to reduce nutrient and sediment loss from the farm fields. This ensures roots are in the ground for more days within the year and less likely to be mobilized during a particular rain event. Use of cover crops in the State of Wisconsin has grown greatly in the last 20 years.

3.2.3.4 Vegetative Buffers

Vegetated buffers are areas along the perimeter of crop fields maintained in permanent vegetation to help reduce nutrient and sediment loss from croplands. These features are popular as they do not typically entail the sacrifice of significant land but rather better incorporate the use of property that is already fallow. This is also has a very low cost per unit for installation and maintenance.

3.2.3.5 Nutrient Management

Nutrient Management helps the farmer maximize profits by balancing crop yields and nutrient inputs. Using a nutrient management plan, farmers can optimize the economic returns from nutrients used in production and minimize nutrient loss and water quality at the same time. These are typically required by farmers in the State of Wisconsin in order to apply various types of fertilizer or obtain any sort of cost share agreements.

3.2.3.6 Terraces

Terraces are earth embankments and/or channels constructed across the slope of the field to intercept runoff and trap sediment contained in the runoff. Terraces need to be appropriately vegetated and constructed to ensure they are stable and not prone to erode during rain events.

3.2.3.7 Enhanced Argricultural Runoff Treatment System (eARTS)

The eARTS is an improved phosphorus targeted system originally developed by Outagamie County as ARTS to focus on sediment and particulate phosphorus (Outagamie County LCD, 2020). While highly effective in controlling particulate phosphorus and sediment, the facility also has a secondary storm water volume control element. The eARTS was further improved to include a non-proprietary phosphorus system is included in the eARTS which also addressed dissolved phosphorus making it a highly effective phospohorus sponge, the eARTSs also bosts an impressive 20:1 watershed to treatment ratio. While the cost per acre is much greater than traditional agricultural land practices, the effectiveness is up to 10X greater with upkept maintenance.

3.2.4 Pastureland BMPs

Five types of pastureland BMPs were assessed for implementation in the pasture areas of the Lauderdale Lake Chain. Some of these BMPs limit the source of pollutants from feeding operations and others reduce the pathways for the pollutants to enter the adjacent waterbodies. While not a significant land practice in the watershed, the measures can be generally passive making they somewhat attractive for consideration.

3.2.4.1 Manure Management

Manure Management or animal waste management systems involve manure storage, transportation off-site, and improvements in manure recoverability. This practice reduces the source of nutrients and bacteria in the runoff. Acitve pastures can be reviewed to see if current manure (if used) is stored appropriately.

3.2.4.2 Grazing Management

Grazing Management involves controlling the movement of animals on the field. Grazing, movement and manure deposition by the animals encourages growth of pasture vegetation. However, animals can overgraze a pasture if they are not moved to a fresh area frequently enough. By rotating animals to other areas or pastures, the recently grazed vegetation has an opportunity to regrow, which improves the soil nutrient content. This reduces the need for fertilizer application in the field and reduces nutrient loading. The procedure seems straightforward, but it is not uncommon to see overgrazed portions of agricultural plots leading to exposed soils which are prone to suspension and transport.

3.2.4.3 Fencing

Fencing of main overland flow paths and other waterbodies is designed to prevent livestock from entering the waterbody. This prevents livestock from depositing manure directly into the waterway. This is likely not an issue in the watershed since there are few intersections with surface water and agriculture within the watershed.

3.2.4.4 Vegetative Filter Strips

Vegetative Filter Strips are vegetated areas that receive stormwater runoff from a pastureland with animal feeding operations. The can be incorporated much like vegetative buffers.

3.2.4.5 Wetland restoration or creation

Wetland restoration or creation projects on pastureland provides numerous crucial environmental functions such as wildlife habitat, flood protection, and water quality improvements. These opportunities also may be minimal within the watershed, however where practical they can be highly sought after by collaborators like the USDA-NRCS as they serve multiple functions and are therefore available for cost share opportunities.

3.2.5 Forestry BMPs

There are isolated pockets of forest along the Lauderdale Lakes Chain. As a result, suitable forestry BMPs, including pre-harvest planning, road management, and improved harvesting practices, can reduce the nutrient and sediment load from runoff in forestry subwatersheds in the lake chain. Harvested lands that are not appropriately managed during tree removal can contribute sediments to waterways for a significant time until vegetation can fully reestablish.

3.2.6 Shoreline Restoration/Stabilization/Enhancement

Shoreline restoration/stabilization/enhancement are recommended at locations identified in the wave height study and analysis. BMPs are installed along the banks of lakes to reduce sediment in-lake resuspension and overland loadings into the receiving lakes, improve water quality, and improve the biological condition along the shoreline. The techniques also help to minimize the potential for the shoreline to destabilize and migrate horizontally, avoiding the unnecessary loss of critical nearshore habitat.

3.2.6.1 Shoreline Restoration

Shoreline restoration is recommended when the shoreline is in disrepair, heavily eroded, potentially overrun with invasives, or otherwise inadequately protected. Shoreline restoration typically involves working closely within the existing footprint of the shoreline, requires minimal armoring or protective measures, and can be mostly restored with softer erosion control practices and vegetative reestablishment.

3.2.6.2 Shoreline Stabilization

Shoreline stabilization is recommended when shoreline is compromised structurally, leading to a condition of mass wasting or eroded to a point of inclination where conventional erosion control measures cannot be applied. This typically can involve armoring or implementation of geostructural measures but may provide opportunities to introduce hybrid geotechnical measures with vegetative components to inegrate rooted mass to support a well contemplated design. While armoring should not be the first choice, it is at times necessary to resupport an existing failed structurally armored feauture. Dilapidated structures should be reviewed on a case per case basis to see when and if alternative options exist which may be better suited to the end goals of the LLLMD, this plan and if cost share agreements may exist to implement a shared solution.

3.2.6.3 Shoreline Enhancement

Shoreline enhancement refers to improvements to address vegetative spottiness, invasive blight, or ecological underperformance. Additionally, this may include installing forest or grass buffers to improve the biological condition of the shoreline.

3.3 Overview of Potential Pollutant Load Reductions Based on BMP

The effectiveness of load reduction and feasibility of implementation of the BMP types discussed in Section 3.2 are described below.

3.3.1 BMP Pollutant Load Reduction Effectiveness

Percent load reduction efficiency data was extracted from literature review to estimate the load reduction of potential BMPs for the waatershed. The literature review includes a summary of paired watershed case studies, watershed plans for similar watersheds and agricultural BMP reference guides. Percent load reduction was extracted for each BMP to reduce the load total phosphorus and TSS.

3.3.1.1 Literature Review

A literature review was conducted to estimate the BMP percent removal efficiencies for total phosphorus and TSS. Due to the limited performance data available, no single source of data covers the performance of all types of BMPs discussed in Section 3.2. Six sources of data were analyzed, from which BMP performance data is extracted:

a) Spring River Nonpoint Source Watershed Plan

This plan was written for the Spring River Watershed in Minnesota to address impairments caused by nutrients and sediment (MDNR, 2015). The list of considered BMPs in the Spring River Watershed study is similar to the discussed in Section 3.2, including urban, agricultural, shoreline and on-site wastewater system (septic) BMPs. The BMP removal efficiency data for nutrients and sediment from this WBP was utilized for this project, where applicable.

b) International Stormwater BMP Database 2016 Summary Statistics

The International Stormwater BMP Database (the Database) is a publicly accessible repository for BMP performance, design, and cost information. Since the initial development of the BMP Database in 1996, a portfolio of more than $200 million in water quality research is represented in the Database. The 2016 summary statistics of the Database include treatment performance of urban BMPs for TP and TSS (Clary. J. et al. 2017). The median removal percentage for each BMP-pollutant pairing for all case studies in the Database was extracted from the report and used in this evaluation to estimate load reductions.

c) Effectiveness of BMPs for Bacteria Removal Developed for the Upper Mississippi River Bacteria TMDL

A literature review was conducted to inform the selection of the most practical and effective implementation strategies to improve water quality in the Upper Mississippi River Bacteria TMDL project area in the state of Minnesota (Tilman, L. et al., 2011). This literature review evaluated research findings regarding the effectiveness of various BMPs to reduce bacteria loading to surface waters. Only a limited number of BMPs were reviewed in this data source, but multiple studies were analyzed for each type of BMP. The median load reduction performance for indicator bacteria from all studies included in the data source for each type of BMP was extracted and used in this project for determining *E. coli* load reduction.

d) The Agricultural BMP Handbook for Minnesota

This literature review, published by the Minnesota Department of Agriculture (MDA), included empirical research on the effectiveness of 30 conservation practices, i.e., agricultural BMPs (MDA, 2012). Nutrient, sediment, and limited bacteria removal performance data for the 30 BMPs is available in this data source.

e) Chesapeake Bay Quick Reference Guide for BMPs

The Chesapeake Bay Program (CBP) is a regional partnership that leads and directs Chesapeake Bay restoration and protection. This reference guide provides summarized profiles for each CBP-approved BMP, including the effectiveness in pollutant load removal, cost and feasibility of implementation (CBP, 2018). In this data source, BMP load reduction percentages are often summarized for specific land use, crop types, or sub-type of the BMP. For the purpose of this project, the median value of the load reduction for each BMP-POC pairing was extracted from this reference guide.

f) **Efficiencies of Forestry BMPs for Reducing TSS and Nutrient Losses in the Eastern United States**

Compared to urban and agricultural BMPs, the available performance data for forestry BMPs is limited. This study from 2010 included three paired forested watershed studies in the eastern United States through an exhaustive literature search. No individual practices were isolated in the study. Instead, the combined effectiveness of multiple forestry BMPs in each paired forested watershed study to reduce TSS and TP was summarized in this study and used in this project (Edwards, P. J. et al., 2010).

3.3.1.2 Pollutant Load Reduction Efficiencies

Table 12 summarizes the load reduction percentage of example BMPs for TP and TSS and the corresponding source of data from the six sources listed in Section 3.3.1.1. The table includes BMPs that are not mentioned in Section 3.2 and that is to provide the LLLMD as many implementation options as possible.

Table 12: BMP Pollutant Load Reduction Efficiencies Used for Calculating Load Reductions through BMP

BMP Type	BMP	TP	TSS
Cropland	Cover Crops	0.07 [e]	0.1 [e]
	Nutrient Management	0.05 [e]	0.25 [b]
	Conservation Tillage	0.35 [e]	0.47 [e]
	Terrace	0.3 [b]	0.36 [b]
	Vegetated Buffer	0.5 [b]	0.5 [b]
	Retention Pond	0.5 [b]	0.5 [b]
Pastureland	Grazing Management	0.24 [d]	0.3 [d]
	Fencing	0.42 [e]	0.56 [e]
	Vegetative filter strip	0.5 [b]	0.56 [e]
	Wetland	0.4 [e]	0.31 [e]
Forestry	Pre-Harvest Management, Road Management, Improved Harvesting	0.85 [f]	0.6 [f]
Shoreline	Shoreline Stabilization	0.068 lbs/ft/yr [e]	248 lbs/ft/yr [e]
	Shoreline Buffer	0.42 [e]	0.56 [e]
Urban	Bioretention	0 [a]	0.75 [a]
	Grass Swale	0 [a]	0.16 [a]
	Wetland Basin	0.25 [a]	0.55 [a]
	Detention Pond	0.17 [a]	0.64 [a]
On-site Septic System	Repair/Replace program	TP and TSS removal based on percent of on-site wastewater system repaired/replace	

The data source for the load reduction rate for each BMP-POC pairing is from one of the six data sources listed in Section 3.3.1.1:

a - International Stormwater BMP Database 2016 Summary Statistics;

b – Spring River Nonpoint Source Watershed Plan;

c - Effectiveness of BMP for Bacteria Removal Developed for the Upper Mississippi River Bacteria TMDL;
d – The Agricultural BMP Handbook for Minnesota;
e – Chesapeake Bay Quick Reference Guide for BMP;
f – Efficiencies of Forestry BMP for Reducing Sediment and Nutrient Losses in the Eastern United States.

3.4 Critical Area for BMP Implementation

This plan focused on identifying critical areas within the Lakes direct runoff area (as defined by USGS) where BMPs should be implemented. The goal was to select their locations based on their effectiveness for reducing TSS and phosphorus loading into the lakes – see Table 12 BMP Pollutant load reduction efficiencies. Specific criteria for identifying critical areas are based on the following:

- High loading watersheds/land cover
- Contours/drainage areas
- "Open space" based on land cover, aerials (low conflict areas with existing infrastructure)
- Protection of sensitive areas
- Areas vulnerable to wave erosion – as identified by the wave height analysis

Identified critical areas within the Lauderdale Lake Chain for BMP implementation are shown on Figure 13. As part of the process for providing recommendations for implementing BMPs, both alternatives previously recommended by earlier studies and new options were evaluated. To develop a holistic watershed plan, each subwatershed was analyzed with the goal of recommending a BMP even if it was not identified as a critical area. Table 13 below indicates what BMP is best suited for a subwatershed and the applicable land use for implementing said BMP. Subwatersheds are listed from highest phosphorus loading to smallest.

Table 13: Watershed-Wide BMP Recommendations

Subwatershed ID*	Watershed-Wide BMP Recommendation	Applicable Land Cover
Gre_6	Conservation Tillage , Filter Strip, eARTS	Cultivated Crops
Gre_1	Conservation Tillage, Filter Strip, eARTS	Cultivated Crops
Mil_5	Bioswales and Infiltration trenches	Road Right-of-ways
Gre_2	Conservation Tillage, Filter Strip, eARTS	Cultivated Crops
Mil_3	Vegetative filter strip	Cultivated Crops
Mid_2	Bioswales	Road Right-of-ways
Mil_4	Linear BMP	Shoreline
Mid_1	Bioswales and Infiltration trenches	Road Right-of-ways
Gre_3	Linear BMP	Shoreline
Gre_4	Bioswales and Infiltration trenches	Road Right-of-ways
Mid_3	Infiltration Wetland	Emergent Wetland
Mil_1	Linear BMP	Shoreline
Mid_4	Bioswales	Road Right-of-ways
Mil_2	Linear BMP	Shoreline or Road Right-of-ways
Gre_5	Forestry BMP	Forest

*Gre_ indicates the subwatershed is in the Green Lake watershed, Mid_ indicates the subwatershed is in the Middle Lake watershed, and Mil_ indicates the subwatershed is in the Mill Lake watershed.

3.5 Prioritized Action Plan (PAP) – Watershed BMP Implementation

The Prioritized Action Plan (PAP) consists of project prioritization and the development of an implementation schedule based on BMP estimated unit costs, the likelihood for funding, and most importantly, its potential beneficial impact on the Lauderdale Lakes Chain. As can be seen from Table 5 in Section 2.2.1, the determined loading into Green Lake is significantly higher than Middle and Mill lakes, however, the opportunity will always need to be weighed against property ownership and obtaining easements, the LLLMD's proposed budget and ability to acquire associated funding to offset costs and ongoing maintenance needs.

Primary funding would come via the LLLMD available budget, the WDNR Surface Water Grant (SWG) Program or other similar sources. The schedule is intended to prioritize subwatersheds listed at the top of Table 13 and implement projects that will provide the highest load capture while being cost-effective.

Within the first 5-years after plan approval, a recommended milestone is to reduce loading into the Lake Chain by 10%. Table 14 provides an example implementation schedule, and Table 15 provides a cost breakdown for different BMP technologies, including a visual aid representing a number of the practices.

The primary goal should be to implement projects that impact a high likelihood of success. Therefore, based on the loadings and project implementation review, the LLLMD should continue to undertake practices that focus on Green Lake first, targeting TSS and phosphorus. Once this has been accomplished, projects can subsequently begin on Mill Lake and Middle Lake. The LLMD can also look to implement projects based on load prevention per dollar invested, however, this will be very project-specific and difficult to implement if land use agreements become difficult to acquire. Finally, while not always the most efficient method, the LLLMD can review property availability against opportunity and continue investing in projects based on the ability to acquire easements and low-cost projects. While not necessarily as efficient, the process typically ensures more projects get installed.

Table 14: Prioritized BMP Recommendations

Schedule	Subwatershed	BMP Recommendation	Units	Target Phosphorus Reduction (lbs)	Cost
Year 1	Gre_1	eARTS	20 acres	24	60K
Year 2	Gre_2	eARTS	20 acres	24	60K
	Gre_3	Shoreline	300 ft	20	45K
Years 3-5	Mil_1	Shoreline	500 ft	34	75K
	Mil_3	Vegetative Buffer	650 ft*	24	26K
	Mil_4	eARTS	20 acres	24	60K
Maintenance (10%)					30K
Total				150**	356K

*Assumes 25-foot width, which is the recommended design minimum
**Target based on Table 6, 10% of total annual load = 149.2 lbs

Any combination of practices and projects as indicated in Table 6 can be mixed and matched to accomplish the goal. LLLMD can develop a higher or lower goal based on land availability and funding. The PAP is meant to jumpstart the LLLMD's restoration and preservation missions. Since the lakes are not considered impaired, there is no target to meet, and the goal is arbitrarily set. Additional monies should be set aside for maintenance which is assumed at 10%, and additionally contingency for construction. Using the possible schedule indicated above, 2022 should be considered the year of plan completion and acceptance by the WDNR. First-year (Year

1) improvements may not be constructed until 2023 since many project improvements require design and permitting take anywhere from 6-10 months.

Table 15: Approximate BMP Implementation Cost

BMP Technology	Examples of BMP Technology	Unit Cost
ARTS or eARTS		$30,000/acre
Shoreline Resotoration – Hard Practices (rip rap)		$150-$200 per Linear foot (LF)
Shoreline Resotoration – Hard Practices (bio logs, sandbags, prevegetated fabrics)		$75-$150 per LF
Detention Facility (Wet or Dry)		$70,000 per acre

Catch Basin		$5,000 Per structure
Sediment Trap	 Image courtesy of KY DOT	$7,500 per 500 Square Foot(SF)
Vegetative Filter/Buffer Strip		$4,000 per 2,500 SF
Bioswale		$350 per LF
Vegetated Swale	 Image courtesy Pittsburgh Post Gazette	$100-$150 per LF

Infiltration Trench		$100 per LF
Native Vegetation		$12 per SF

4 LAUDERDALE LAKE DISTRICT CONTINUED EDUCATION

As mentioned earlier, as part of the development of the watershed plan, bi-monthly meetings were held with the LLLMD, interested stakeholders, collaborators, and open to members of the public. The meetings were intended to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented. Appendix D includes the slides from each meeting and the LLLMD has provided access to the slides and various presentation videos online:

https://www.lauderdalelakedistrict.com/

The LLLMD continues to host quarterly meetings which are open to the public. The LLLMD also hosts an annual meeting which will be used to inform those in attendance a platform to review the progress of the plan implementation.

5 CONCLUSION

The LLLMD has undertaken this watershed planning initiative for the Lauderdale Lakes (Green, Middle, Mill) in an effort to update previous planning efforts and remain eligible for priority funding through the State of Wisconsin DNR programs. This planning effort was partially paid for by a lake planning grant through the WDNR Surface Water Grant (SWG) program. The primary goal of this effort is to update previous studies by the LLLMD, and USGS in reviewing the baseline pollutants (primarily TSS and phosphorus) impacting the lake chain and assess the pathways in which they enter Green, Middle, and Mill lakes. The baseline assessment has identified that most watershed constituents enter the lake chain through Green Lake and are primarily associated with agricultural land use.

From the baseline assessment, this document further provides a review of BMP resources that may be implemented to reduce runoff-related pollutants from entering the lakes. The BMPs listed within this plan are meant to provide flexibility to the LLLMD as they carry out the implementation of this plan, however, a prepared Prioritized Action Plan (PAP) is also provided to serve as an example of how a series of projects may be executed in a preplanned manner and budgeted for accordingly.

The LLLMD also provided a public forum for stakeholder education and input. During the development of this watershed plan, four (4) meetings were held online. Presentation materials are made available via the LLLMD's website with limited video coverage to assist those interested in revisiting the content or continuing to remain engaged or network with the LLLMD and the numerous lake stakeholders.

Geosyntec consultants

APPENDICES

Appendix A: Supporting Figures

Appendix B: September 2021 Site Visit

Appendix C: Previous Studies

Appendix D: Lauderdale Lake Meeting Summaries