POKEGAMA LAKE SUBWATERSHED ASSESSMENT REPORT - DRAFT

December 2, 2024

Prepared for:
Pine County Land and Water Conservation District & Pokegama Lake Association

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Executive Summary

The Snake River Watershed Total Maximum Daily Load (TMDL), approved by the EPA in 2014, set specific phosphorus reduction goals for the Pokegama Lake watershed: a 40% reduction for Pokegama Creek and an 88% reduction for areas outside Pokegama Creek, known as the "direct watershed". Following the TMDL, the One Watershed One Plan recommended a Subwatershed Assessment (SWA) to identify priority locations for agricultural best management practices (BMPs) to reduce phosphorus loading to Pokegama Lake.

This SWA used the PTMApp tool, which uses a geospatial approach to assess pollutant loading conditions across the watershed, prioritize BMP locations, and estimate potential pollutant reductions. Eight BMP types were evaluated, which resulted in the identification of 827 BMPs locations across the watershed (248 structural BMPs and 579 field practices). If implemented, these BMPs are estimated to reduce phosphorus loading to Pokegama Lake by approximately 2,000 pounds, with over 20% of that reduction expected from two wetland restoration projects. A cost-effectiveness analysis was then applied to further prioritize the BMPs. The prioritization analysis resulted in 32 prioritized BMPs across seven BMP categories (generally five BMPs per category). Implementing these 32 prioritized BMPs is estimated to provide 640 pounds of phosphorus reduction, which would make meaningful progress toward the TMDL's watershed reduction goals.

Overall, the SWA identified wetland restorations, WASCOBs (Water and Sediment Control Basins), and field practices as the most cost-effective strategies for reducing phosphorus; however, the total costs vary significantly per BMP type. Wetland restorations had the highest costs but also the greatest potential for phosphorus reductions, WASCOBs provide a good balance of total cost and phosphorus reductions, and field practices showed both the lowest total cost and best cost-effectiveness. Grassed waterways and filter strips were less cost-effective but could still be valuable depending on site-specific conditions.

Next steps could include staff from Pine and Kanabec Counties, along with other partners, conducting site visits to confirm BMP feasibility and collaborating with willing landowners to discuss and implement these prioritized practices. Additionally, counties and partners with additional local knowledge should assess whether there are other known areas that should be prioritized based on criteria beyond BMP cost-effectiveness, such as locations where a landowner may be willing to implement a practice and demonstrate or discuss it with other landowners in the area.

Acronyms / Abbreviations

303(d) List	A state and federal listing of Impaired Waters
BMP	Best Management Practice
BWSR	Board of Water and Soil Resources
Chl-a	Chlorophyll-*a*
DEM	Digital Elevation Model
GIS	Geographic Information Systems
gNATSGO	gridded National Soil Survey Geographic Database
HUC	Hydrologic Unit Code
Impaired Water	A waterbody that does not meet state water quality standards
mg/L	milligrams per liter
MPCA	Minnesota Pollution Control Agency
NRCS	National Resource Conservation Service
Ortho-P	Orthophosphate
PTMApp	Prioritize, Target, and Measure Application
SSURGO	Soil Survey Geographic Database
STATSGO2	The Digital General Soil Map of the United States
SWA	Subwatershed Assessment
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
µg/L	microgram per liter
EPA	United States Environmental Protection Agency
WASCOB	Water and Sediment Control Basin
WRAPS	Watershed Restoration and Protection Strategies

1 Introduction and Background

The Snake River Watershed Total Maximum Daily Load (TMDL) was approved by the EPA in 2014 and established a 74% phosphorus reduction goal for Pokegama Lake (MPCA, 2013). This goal aims to improve water quality in Pokegama Lake, which is impaired due to excess nutrients (total phosphorus; TP). It was first listed on MPCA's impaired waters list in 2004. Summer average TP concentrations in the lake have consistently exceeded the 40 µg/L water quality standard for deep lakes in the Northern Central Hardwood Forest (NCHF) region.

Following the TMDL, the Watershed Restoration and Protection Strategies (WRAPS) (Wenk, 2014) and the One Watershed One Plan (Stantec, 2023) both identified the Pokegama Lake watershed as a priority for further assessment of agricultural best management practices (BMPs). The One Watershed One Plan specifically recommended conducting a subwatershed assessment (SWA) to determine priority locations for BMP implementation (Stantec, 2023).

The purpose of this SWA is to evaluate conditions throughout the Pokegama Lake watershed using a geospatial approach to identify and prioritize sites for agricultural BMPs and their associated pollutant reductions. This framework helps to target BMP implementation in areas that are expected to provide a high benefit to downstream waters.

The outcome of the SWA is a prioritized list of the most feasible and cost-effective practices to implement across the watershed. Staff from Pine County, Kanabec County, and other partners will then be responsible for conducting site visits to confirm feasibility and collaborate with willing landowners to discuss and implement these practices.

TMDL Loads and Reductions

The Snake River TMDL (MPCA, 2013) demonstrates that reducing phosphorus loading from the watershed is an important part of achieving long-term improvement in the water quality of Pokegama Lake. The TMDL estimated the total load to Pokegama Lake at 33,275 pounds per year, with the internal load accounting for about 40% of the total load and the remaining 60% coming from the watershed (Figure 1). The TMDL estimated that a 74% reduction (25,617 pounds) would be required to meet the phosphorus water quality criteria of 40 µg/L (Table 1). Significant reductions were calculated across the following three sources (Table 1):

- Internal phosphorus loading: 90% reduction (11,847 pound reduction).
- Watershed load from Pokegama Creek: 40% reduction (3,854 pound reduction).
- Watershed load draining directly to Pokegama Lake: 88% reduction (8,108 pound reduction).

The BMPs identified in this SWA could help make meaningful progress toward achieving the watershed reduction goals for Pokegama Lake. The One Watershed One Plan acknowledges that BMP implementation will likely occur over a 10-year period (2022-2032), which emphasizes a long-term approach to BMP implementation. Continued water quality monitoring of Pokegama Lake or other stream locations can help track interim progress and contribute towards potential refinement of reduction goals through the process of adaptive management.

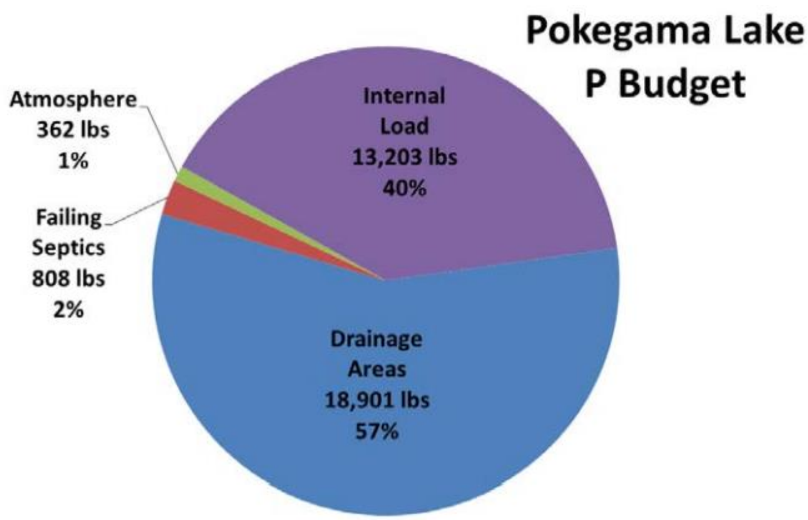

Figure 1. Pokegama Lake phosphorus budget and sources as provided in the Snake River TMDL (MPCA, 2013).

Table 1. Phosphorus loads and reductions by source as provided in the Snake River TMDL (MPCA, 2013).

Allocation	Source	Existing TP Load [1]	TP Allocations		Load Reduction	
		(lbs/year)	(lbs/year)	(lbs/day)[2]	(lbs/year)[3]	%
Wasteload Allocation	Construction & Industrial Storm water	108	108	0.3	0	0%
	ITPHS Septics	808	0	0.0	808	100%
Load Allocation	Pokegama Brook Watershed Load[4]	9,631	5,777	15.8	3,854	40%
	Direct Watershed Load[4]	9,163	1,055	2.9	8,108	88%
	Internal	13,203	1,356	3.7	11,847	90%
	Atmosphere	362	362	1.0	0	0%
MOS		--	456	1.2	--	--
TOTAL		**33,275**	**9,114**	**24.9**	**24,617**	**74%**

[1] Existing load is the average for the years 2001, 2002, 2008 and 2010.
[2] Annual loads converted to daily by dividing by 365.25 days per year accounting for leap years.
[3] Net reduction from current load to TMDL is 24,161 lbs/yr; but gross load reduction from all sources must accommodate the MOS as well, and hence is 24,161 + 456 = 24,617 lbs/yr.
[4] Watershed loads consist of all non-regulated runoff from forest land, wetlands, rural land, agricultural land and non-regulated MS4 stormwater.

1.1 Study Area

The Pokegama Lake Watershed is located in eastern Kanabec and southern Pine Counties and drains an area of nearly 85 square miles (54,140 acres). Significant tributaries include Pokegama Creek, which is a low gradient stream that flows south for approximately 19 miles to Pokegama Lake. The Pokegama Lake watershed includes three HUC12 subwatersheds. The land use in the watershed is predominantly pastured rangeland (26%) with scattered areas of forest/shrub (27%) and wetlands (34%). There is also a significant portion of cultivated crops (6%) which includes corn, soybeans, cultivated perennials, and small grains. The watershed is largely rural, with only 5% of its area consisting as urban development (Table 2, Figure 2, Figure 3).

Table 2. Land cover in the Pokegama Lake watershed and in each of the three HUC12 subwatersheds. Source: NLCD 2021.

Land Cover	**East Pokegama Creek 070300040701**		**Pokegama Creek 070300040702**		**Pokegama Lake 070300040703**		**Full Watershed**	
	Area (ac)	Percent	Area (ac)	Percent	Area (ac)	Percent	Area (ac)	Percent
Corn/Soybeans	1,322	7	885	3	898	9	3,105	6
Pasture/Grass Land	5,243	30	5,973	22	2,622	27	13,838	26
Wetlands	6,368	36	9,936	37	2,200	23	18,503	34
Urban/Developed	722	4	1,156	4	629	6	2,506	5
Forest/Shrubland	4,032	23	8,766	33	1,835	19	14,633	27
Open Water	6	0	38	0	1,512	16	1,555	3
Barren	0	0	0	0	1	0	1	0
Total Area (ac)	17,692		26,752		9,696		54,140	
Total Percent	33%		49%		18%		100%	

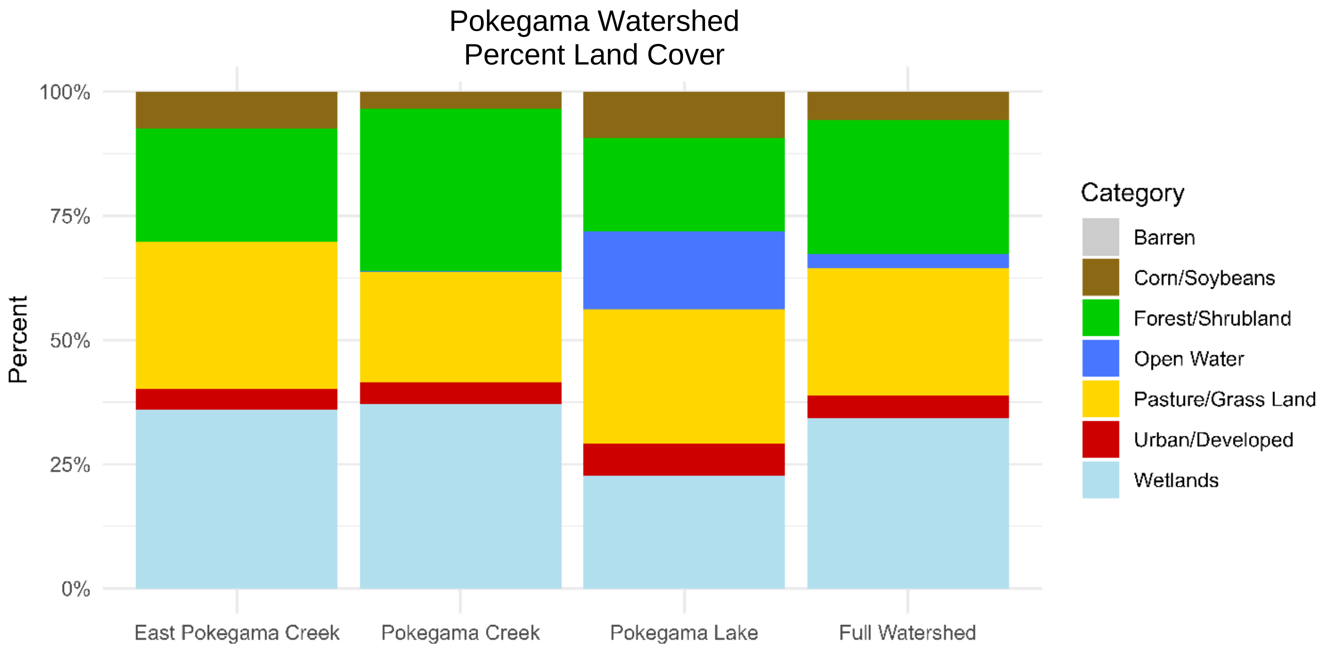

Figure 2. Percent of land cover types in the Pokegama Lake Watershed and in each of the three HUC12 subwatersheds. Source: NLCD 2021.

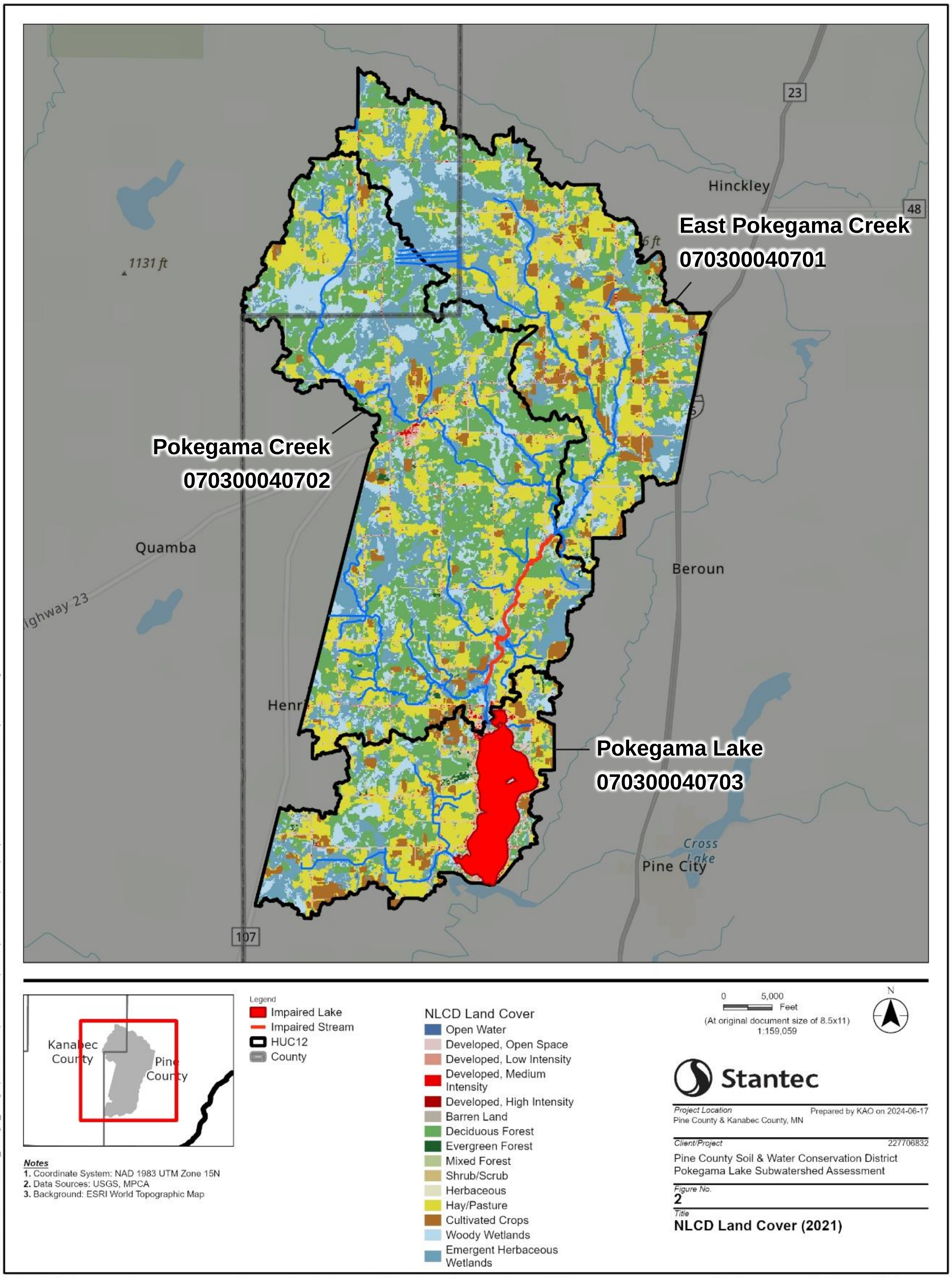

Figure 3. Map of land cover in the Pokegama Lake watershed. Source: NLCD 2021.

1.2 Impairments

Water Quality Standards

Pokegama Lake is 23 feet deep, so it is classified by the Minnesota Pollution Control Agency (MPCA) as a deep (>15 ft), warm water lake (category 2B) subject to water quality standards for the NCHF Ecoregion. These standards include:

- Summer average TP concentration of 40 µg/L or less;
- Summer average chlorophyll-a levels of 14 µg/L or less; and
- Summar average Secchi depth of 1.4 meters or greater

Pokegama Lake Impairments

In 2004, Pokegama Lake was first listed as impaired for excess nutrients, due to high concentrations of TP, which resulted in decreased aquatic recreational use (Table 3, Figure 4). Its summer average TP concentrations have consistently exceeded the 40 µg/L TP standard.

Pokegama Lake also has an aquatic life impairment related to the fish index of biotic integrity (IBI), which measures how a lake's fish community compares to that of a healthy lake. This impairment is not specifically addressed in Snake River TMDL, but addressing the nutrient impairment through reduced TP concentrations may also benefit the fish community. In addition, Pokegama Lake has a mercury impairment due to elevated mercury levels in fish tissue. This impairment is addressed by the Minnesota Statewide Mercury TMDL, which primarily focuses on reducing mercury emissions statewide.

Pokegama Creek Impairments

Pokegama Creek, a warm water stream (category 2Bg), has a 4.15-mile impaired section due to low scores in macroinvertebrate bioassessments (Table 3, Figure 4). Although this impairment is not specifically addressed by the Snake River TMDL, reducing TP runoff from the landscape could also benefit macroinvertebrate communities in Pokegama Creek.

Table 3. MPCA's 2024 303(d) list of impaired waters in the Pokegama Lake watershed.

Waterbody	Assessment ID	Year Listed	Affected Use	Pollutant or Stressor
Pokegama Lake	58-0142-00	2004	Aquatic Recreation	Nutrients
		2012	Aquatic Consumption	Mercury in fish tissue
		2020	Aquatic Life	Fish bioassessments
Pokegama Creek	07030004-532	2004	Aquatic Life	Benthic macroinvertebrates bioassessments

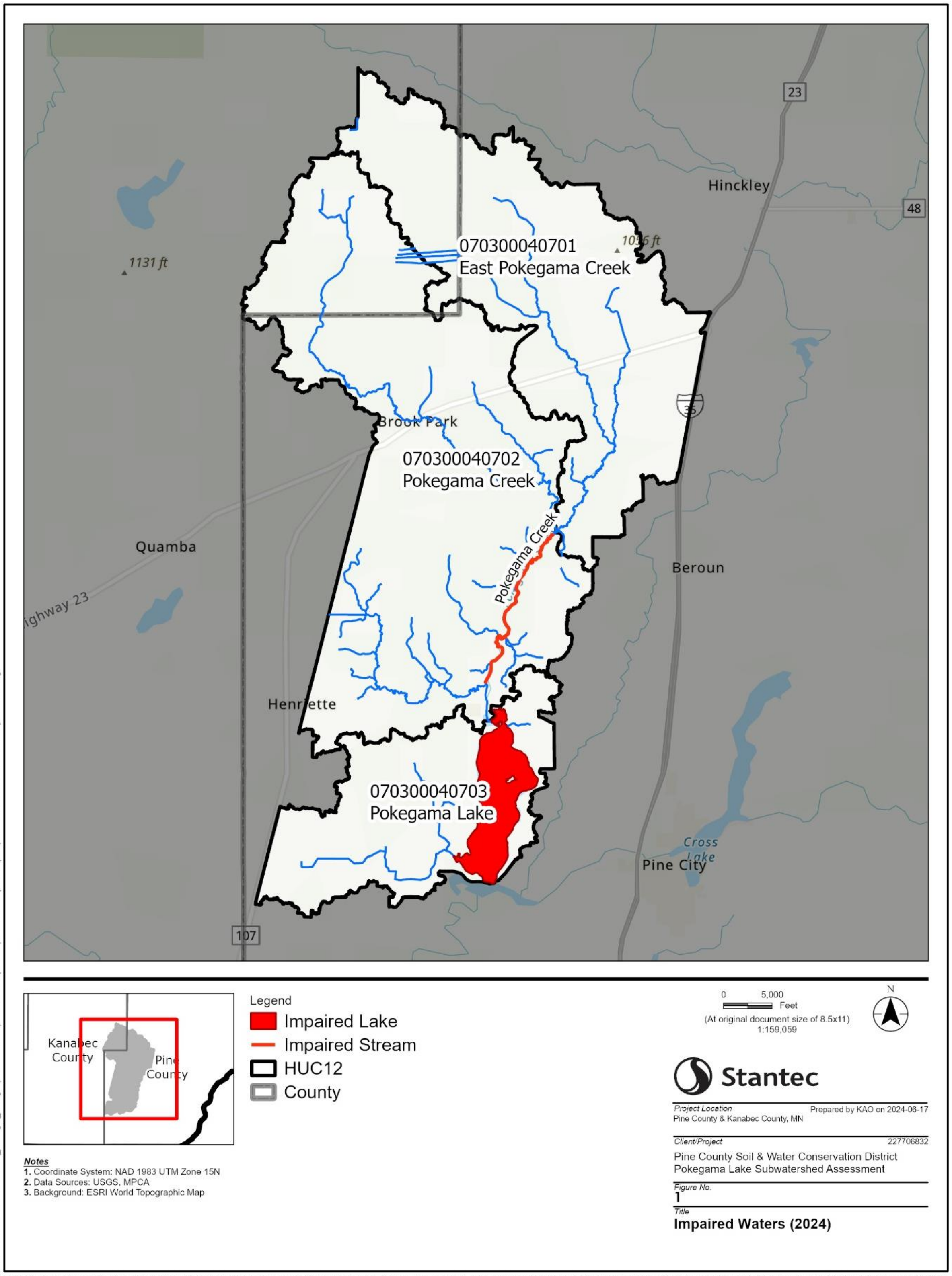
070300040701
East Pokegama Creek
070300040702
Pokegama Creek
070300040703
Pokegama Lake
Pokegama Creek
Hinckley
Brook Park
Quamba
Beroun
Henriette
Pine City
Cross Lake
1131 ft
23
48
35
107
Highway 23
Kanabec County
Pine County
Legend
Impaired Lake
Impaired Stream
HUC12
County
0 5,000 Feet
(At original document size of 8.5x11)
1:159,059
N
Stantec
Project Location
Pine County & Kanabec County, MN
Prepared by KAO on 2024-06-17
Client/Project
227706832
Pine County Soil & Water Conservation District
Pokegama Lake Subwatershed Assessment
Figure No.
1
Title
Impaired Waters (2024)
Notes
1. Coordinate System: NAD 1983 UTM Zone 15N
2. Data Sources: USGS, MPCA
3. Background: ESRI World Topographic Map
V:\2277\active\227706832\03_data\gis_cad\gis\pro\Task 6 Maps\Task 6 Report Maps.aprx Revised: 2024-06-16 By: koldenborg

Figure 4. Map of impaired waters in the Pokegama Lake watershed based on MPCA's 2024 impaired waters list.

1.3 Water Quality Conditions

In October 2024, water quality data for Pokegama Lake and two stations on Pokegama Creek were downloaded from MPCA's Surface Water Database using the links in Table 4. It is important to note that the data for Pokegama Lake includes data from all available sampling stations in Pokegama Lake. Summaries of these data are provided in the following sections.

Table 4. Links to the water quality data downloaded from MPCA's Surface Water Database and summarized in this subwatershed assessment.

Station Name	Station ID	Link to Water Quality Data
Pokegama Lake	Multiple	https://webapp.pca.state.mn.us/surface-water/search?dataType=All%20Stations&geographicType=county&specificGeoAreaCode=county__115&wuSearchString=pokegama&stationType=LAKE
Pokegama Creek at Henriette Rd	S002-582	https://webapp.pca.state.mn.us/surface-water/station/S002-582
Pokegama Creek at Beroun Crossing Rd	S002-542	https://webapp.pca.state.mn.us/surface-water/station/S002-542

1.3.1 Stream Water Quality

Water quality data from the Pokegama Creek Outlet at Henriette Road showed an average summer TP concentration of 78 µg/L in 2023 and 89 µg/L in 2022. These concentrations are similar to the long-term mean of 98 µg/L, based on sampling at both Henriette Road and Beroun Crossing Road from 1996 to 2023 (Table 5, Figure 5).

In 2022, the average concentration of bioavailable phosphorus (orthophosphate) in Pokegama Creek was 51 µg/L, indicating that 57% of the TP present was in bioavailable form. This concentration is comparable to the long-term mean of 45 µg/L for bioavailable phosphorus, based on samples collected from 1996 to 2002 at Henriette Road and Beroun Crossing Road. On average, bioavailable phosphorus makes up 45% of the TP in Pokegama Creek (Table 5, Figure 6).

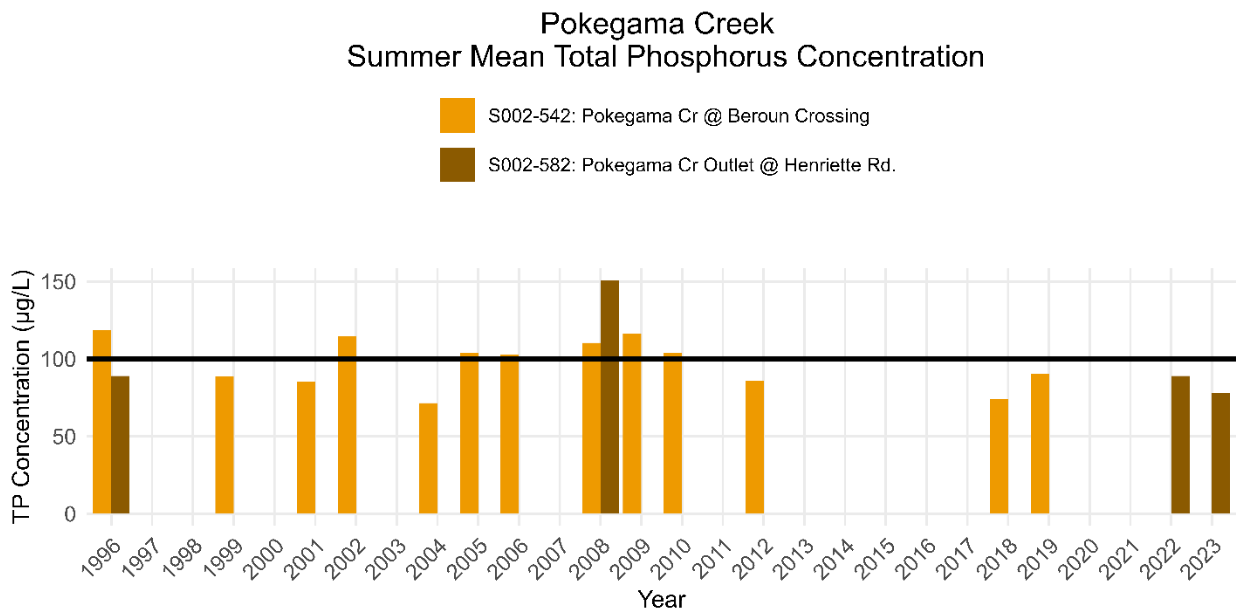

Figure 5. Mean summer (June 1 – September 30) total phosphorus concentration in Pokegama Creek based on samples collected from two sampling locations near the outlet. The solid black line at 100 µg/L represents the TP criteria for Pokegama Creek.

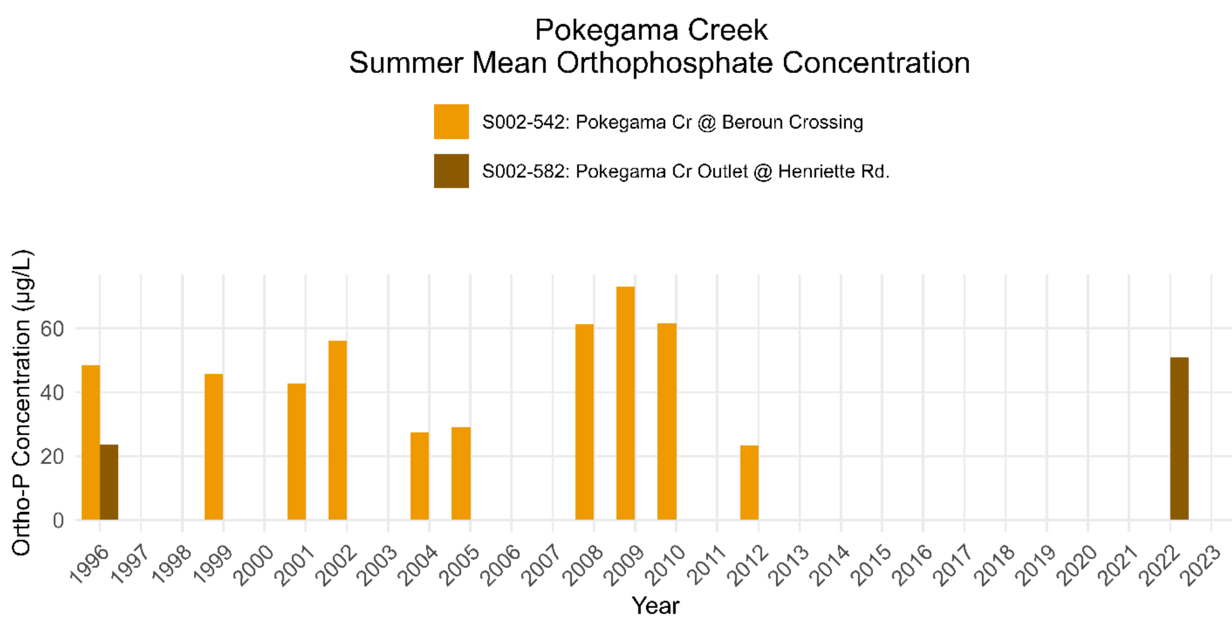

Figure 6. Mean summer (June 1 – September 30) orthophosphate concentration in Pokegama Creek based on samples collected from two sampling locations near the outlet.

Table 5. Mean summer (June 1 – September 30) total phosphorus and orthophosphate concentrations in Pokegama Creek based on sampling from two locations near the outlet.

Year	Station ID	Station Name	Average Summer Ortho-P (µg/L)	Average Summer TP (µg/L)	Average Percent of Total P that is Bioavailable
2023	S002-582	Henriette Road		78	
2022	S002-582	Henriette Road	51	89	57%
2019	S002-542	Beroun Crossing		90.6	
2018	S002-542	Beroun Crossing		74	
2012	S002-542	Beroun Crossing	23.2	85.7	27%
2010	S002-542	Beroun Crossing	61.5	103.9	59%
2009	S002-542	Beroun Crossing	73.2	116.2	63%
2008	S002-542	Beroun Crossing	61.3	110.4	55%
2008	S002-582	Henriette Road		151	
2006	S002-542	Beroun Crossing		103	
2005	S002-542	Beroun Crossing	29	103.8	28%
2004	S002-542	Beroun Crossing	27.5	71.5	38%
2002	S002-542	Beroun Crossing	56	114.7	49%
2001	S002-542	Beroun Crossing	42.8	85.1	50%
1999	S002-542	Beroun Crossing	45.6	88.8	51%
1996	S002-542	Beroun Crossing	48.5	118.5	41%
1996	S002-582	Henriette Road	23.7	89	27%
Average			45.3	98.4	45%

1.3.2 Lake Water Quality

Phosphorus

The most recent TP data for Pokegama Lake, collected in 2022, shows a mean summer near-surface TP concentration of 180 µg/L, which is above the 40 µg/L standard for deep lakes in the North Central Hardwood Forest Ecoregion. Prior sampling between 1996 and 2018 demonstrates mean near-surface summer TP concentrations consistently above the 40 µg/L standard. The summer average near-surface TP concentration from sampling conducted between 1996 and 2023 is 126 µg/L (Table 6, Figure 7).

Previous dissolved oxygen and temperature monitoring indicate that Pokegama Creek experiences summer stratification (Wenk, 2018). Typically, this results in summer bottom TP concentrations being higher than surface TP concentrations. However, bottom sampling of TP in 1996 and 2018 showed that TP concentrations at the bottom of Pokegama Lake were generally similar to those at the surface. This could be due to two factors:

1. Large storm events and changes in air temperature can weaken or disrupt stratification during the summer growing season (Wenk, 2018). This can result in mixing of high phosphorus water near the bottom with low phosphorus surface waters.

2. Pokegama Creek has a TP concentration around 100 µg/L and may supply high phosphorus water to the surface during stratification, contributing to the observed uniform TP levels.

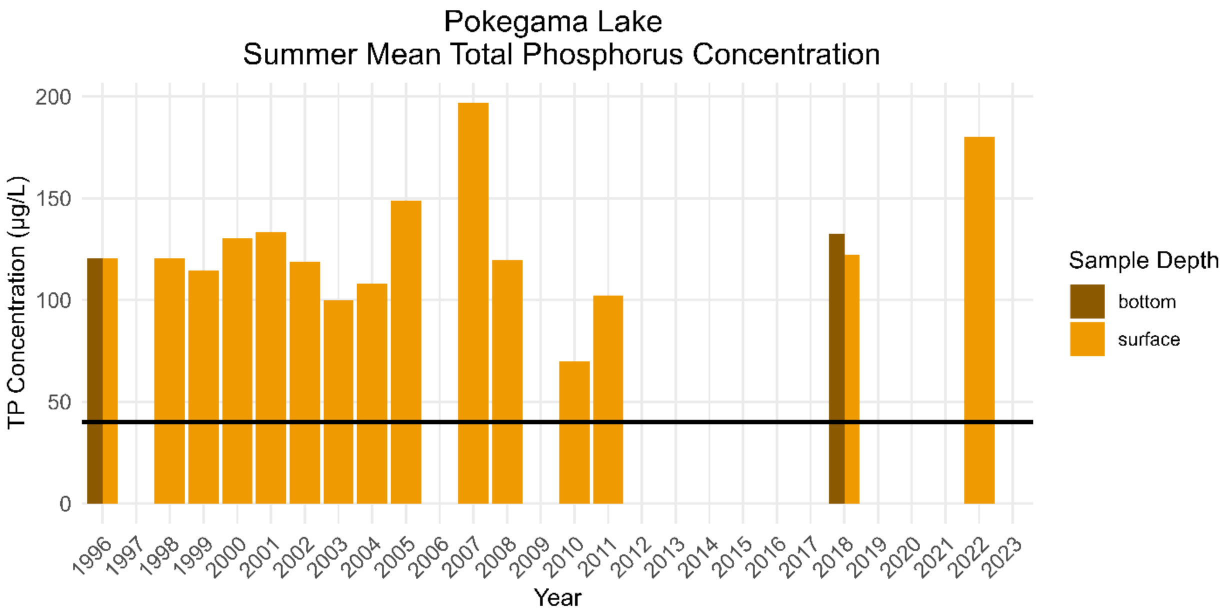

Figure 7. Mean summer (June 1 – September 30) total phosphorus concentration in Pokegama Lake based on samples collected from all available sampling locations. The solid black line at 40 µg/L represents the TP criteria for Pokegama Lake.

Table 6. Mean summer (June 1 – September 30) total phosphorus concentration in Pokegama Lake based on samples collected from all available sampling locations.

Year	Mean Surface TP Concentration (µg/L)	Mean Bottom TP Concentration (µg/L)
1996	121	120
1998	121	
1999	115	
2000	130	
2001	134	
2002	119	
2003	100	
2004	108	
2005	149	
2007	197	
2008	120	
2010	70	
2011	102	
2018	122	133

2022	180	
Average	126	126

Chlorophyll-a

Chlorophyll-a is commonly used as a proxy for algae. The most recent monitoring in 2022 showed a mean summer chlorophyl-a concentration of 49 µg/L, which is over the standard of 14 µg/L for deep lakes in the NCHF Ecoregion. Monitoring between 1996 – 2022 shows a long term mean concentration of 48 µg/L (Table 7, Figure 8).

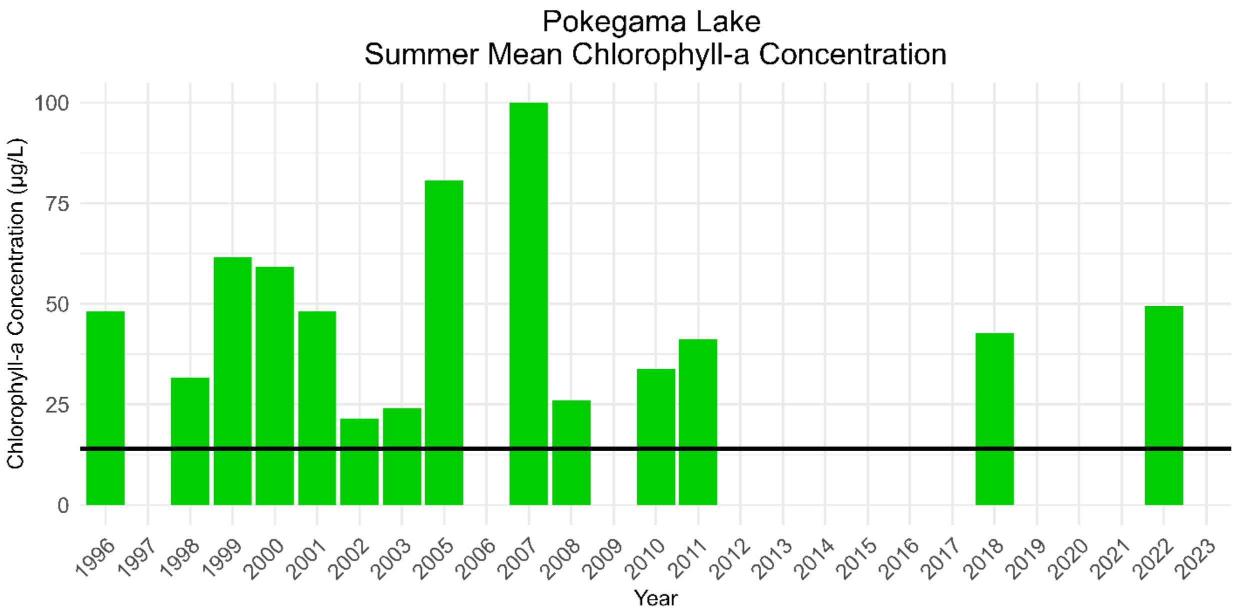

Figure 8. Mean summer (June 1 – September 30) chlorophyll-a concentration in Pokegama Lake based on samples collected from all available sampling locations. The solid black line at 14 µg/L represents the chlorophyll-a criteria for Pokegama Lake.

Table 7. Mean summer (June 1 – September 30) chlorophyll-a concentration in Pokegama Lake based on samples collected from all available sampling locations.

Year	**Mean Chlorophyll-a Concentration (µg/L)**
2022	49.4
2018	42.7
2011	41.1
2010	33.8
2008	26
2007	100

2005	80.8
2003	24
2002	21.5
2001	48.3
2000	59.3
1999	61.5
1998	31.7
1996	48.2
Average	47.7

Secchi Depth

Secchi depth measures water clarity and can be an indicator for impacts from nutrients and algae. In 2022, the average summer secchi depth value was 0.6 meters, which does not meet the standard of at least 1.4 meters for deep lakes NCHF Ecoregion. Monitoring between 1981 – 2023 shows a long-term mean summer Secchi depth of 0.9 meters (Table 8, Figure 9).

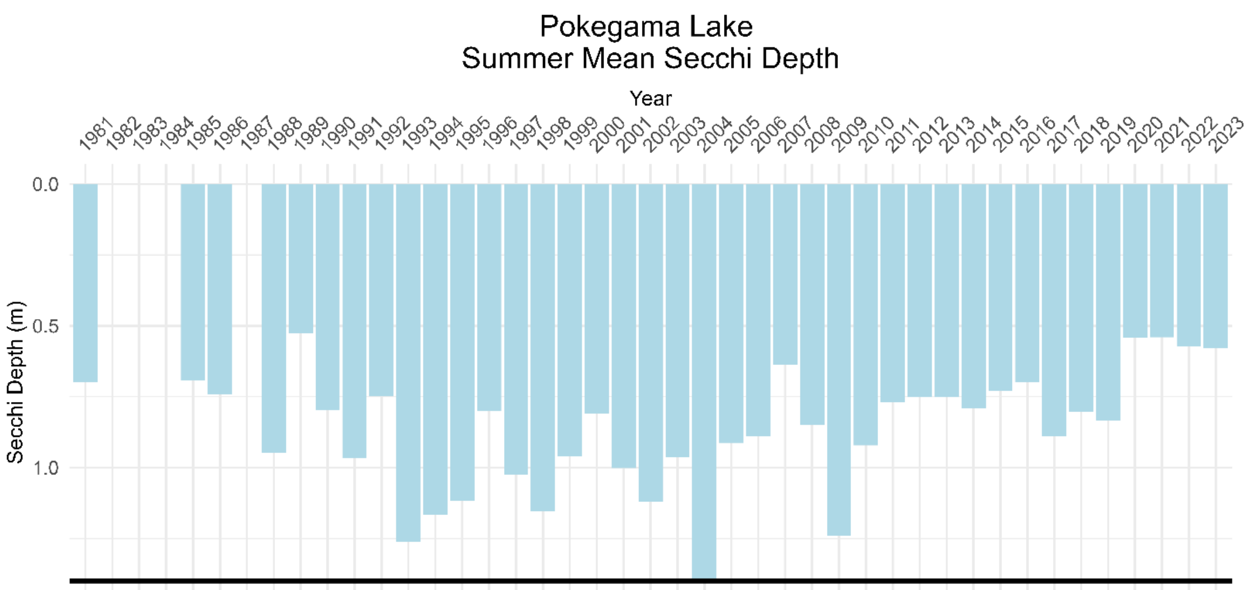

Figure 9. Mean summer (June 1 – September 30) secchi depth in Pokegama Lake based on data collected from all available sampling locations. The solid black line at 1.4 meters represents the secchi depth criteria for Pokegama Lake.

Table 8. Mean summer (June 1 – September 30) secchi depth in Pokegama Lake based on data collected from all available sampling locations.

Year	Mean Depth (m)	Year	Mean Depth (m)	Year	Mean Depth (m)
2023	0.6	2019	0.9	1997	1.0

2022	0.6	2009	1.2	1996	0.8
2021	0.5	2008	0.9	1995	1.1
2020	0.5	2007	0.6	1994	1.2
2019	0.8	2006	0.9	1993	1.3
2018	0.8	2005	0.9	1992	0.7
2017	0.9	2004	1.4	1991	1.0
2016	0.7	2003	1.0	1990	0.8
2015	0.7	2002	1.1	1989	0.5
2014	0.8	2001	1.0	1988	0.9
2013	0.8	2000	0.8	1986	0.7
2012	0.8	1999	1.0	1985	0.7
2011	0.8	1998	1.2	1981	0.7
Average = 0.9					

1.4 Livestock Counts

On September 4, 2024, Pine County staff conducted windshield surveys as part of this SWA. The primary objective of the surveys was to verify the presence of cattle and other livestock at sites listed in the MPCA feedlot dataset. This windshield survey aimed to determine whether the dataset accurately reflected the presence of livestock at 19 feedlot locations that the MPCA dataset identified in the Pokegama Lake watershed. In addition to these sites, staff surveyed one extra location.

During the surveys, staff recorded the type, count, and specific locations of observed animals. While the survey offers a valuable indication of livestock presence, the animal counts should not be considered complete. Some animals may have been housed out of sight in barns or sheltered feedlots, which would exclude them from the counts of this survey.

Results of the windshield survey showed that 12 locations had livestock present and 4 additional locations had livestock infrastructure present that appeared to be in-use despite no livestock being seen. Three locations did not appear to house livestock and one location was uncertain due to it not being visible from the road. A total of 133 cattle were inventoried during the windshield survey. However, this only reflects cattle that were visible on pasture and should not be regarded as a complete count of all cattle within the watershed.

The confirmation of livestock at these 16 locations can help further identify areas for BMPs specific to barnyard areas, which were not included as part of this subwatershed assessment. Barnyard specific BMPs could include manure management, reduction of runoff from the barnyard/feedlot, or improved management of feed leachate.

Table 9. Results of the windshield survey conducted on September 4, 2024, showing the status of livestock at the 20 locations included in the survey.

Livestock Status	Location Count
Livestock present	12

Infrastructure visible and appears in-use, but no livestock present	4
Does not appear to house livestock	3
Uncertain (location not visible from road)	1
Total	**20**

Table 10. Results of the windshield survey conducted on September 4, 2024, showing count of livestock from the 20 locations included in the survey.

Livestock Category	Number of Livestock Visible	Notes
Beef Cattle	84	Across six locations
Beef – Cow & Calf pair	38	Across three locations
Bull	1	Across one location
Dairy Cow	10	Across one location
Goat / Sheep	20	Across one location
Horse / Pony	8	Across three locations
Total	**All Livestock: 161** **All Cattle: 133**	

2 Methods

2.1 BMP Siting and Analysis

BMPs were identified and evaluated using the Prioritize, Target, and Measure Application (PTMApp). The process for siting BMPs and assessing their cost-benefit followed these steps:

1. Choose which types of BMPs to site. The BMPs selected for siting were chosen based on discussions with Pine County and the Pokegama Lake Association.
2. Estimate phosphorus and sediment loads from the landscape using PTMApp.
3. Site BMPs and estimate BMP reductions using PTMApp.
4. Eliminate unsuitable BMPs by conducting a desktop review to exclude BMPs that were identified in impractical locations.
5. Estimate BMP costs, including cost per pound of phosphorus removal.
6. Identify Priority BMPs: For each BMP type, identify the top five priority BMPs by evaluating:
    - Cost per pound of phosphorus removal
    - Total amount of phosphorus removal
    - Total estimated cost of the BMP

2.1.1 Types of BMPs Considered and Siting Criteria

This study identified potential locations for eight different BMP types. Below is a brief description of these BMPs and siting criteria used by PTMApp (Table 11). PTMApp's BMP siting criteria aims to align with the technical design criteria from NRCS practice codes and other standards such as the Minnesota Department of Agriculture's Agricultural BMP Handbook (Houston Engineering, 2018). Each BMP has multiple siting criteria, which generally focus on factors such as the volume of water draining to the site, the drainage area, and the amount of sediment delivered.

Table 11. A list of the eight BMPs included in this subwatershed assessment along with a subset of the key siting criteria used by PTMApp to locate these BMPs on the landscape.

BMP	NRCS Practice Code	Key Siting Criteria in PTMApp*
Wetland Restoration	656	• Drainage area must be larger than 200 hectares (494 acres) • Minimum fill depth greater than 0.5 ft • No more than 25% of the depression area can have a depth greater than 2.9 ft • Surface area at least 1 acre
WASCOB	638	• NLCD land cover must be Cultivated Crop • Accumulated sediment delivered to flowline percentile rank greater than the 75th percentile • Contributing drainage area less than 40 acres • Stream power index (SPI) greater than the 80th percentile.
Grassed Waterway	412	• NLCD land cover must be Cultivated Crop • Slope of the individual raster cell must be between 3-12% • Contributing drainage area less than 7 acres
Filter Strip	393	• NLCD land cover must be Cultivated Crop • Sediment mass accumulated at the catchment outlet less than 8.1 tons/year • Contributing drainage area greater than 124 acres
Cover Crop, Reduced Till, No-Till	340, 345, 329 (respectively)	• NLCD land cover must be Cultivated Crops • No drainage pathways within field are larger than 640 acres
Prescribed Grazing	528	• Key siting criteria were not provided in PTMApp documentation, but results show that prescribed grazing was sited on areas with a land

	cover of “Hay/Pasture” that were alongside flow paths that likely have water during most of the summer months.

* This is not a comprehensive list of all citing criteria. See Houston Engineering (2018) for a complete list of criteria.

Water and Sediment Control Basin (WASCOBs)

Water and sediment control basins (WASCOBs) are small earthen embankments built across the slope of field or minor waterway. This results in the temporary detainment of water which is then released through a controlled pipe outlet or through infiltration. The earthen embankments are constructed perpendicular to the flow direction and parallel to each other. Potential benefits include water volume release control and reduction of TSS and particulate phosphorus through settling or infiltration. PTMApp sites WASCOBs in crop fields that have a drainage area of less than 40 acres and an upstream storage area of at least 0.1 ac-feet, where accumulated sediment delivered to flow path ranks greater than the 75th percentile and the stream power index ranks greater than the 80th percentile (reflecting a high potential for erosion).


Source: www.nrcs.usda.gov

Wetland Restoration

Wetland restorations re-establish or repair the hydrology, plant communities and soils of a former or degraded wetland that has been drained, farmed, or otherwise modified since European settlement. Restoring wetland hydrology typically involves breaking drainage tile lines, building a dike or embankment to retain water and/or installing adjustable outlets to regulate water levels. The primary benefits of wetland restorations include water storage, groundwater recharge, nitrate removal, and TSS and particulate phosphorus reduction via settling. PTMApp sites potential wetland restoration locations based on multiple criteria related to hydrologic characteristics that would make an area suitable for a wetland including the following: a drainage area larger than 494 acres, a minimum fill depth of at least 0.5 ft, no more than 25% of the depression with a depth over 2.9 ft, and surface area of at least 1 acre.


Source: www.nrcs.usda.gov

Filter Strip


Source: Ohio State University Extension

A filter strip is a narrow band of grasses, legumes, and forbs used to limit sediment and nutrients from entering waterbodies. Filter strips are typically converted cropland immediately adjacent and parallel to a water resource (stream, ditch, concentrated flow path, pond, wetland, or groundwater recharge area). Vegetation for filter strips will generally have stiff, upright growth characteristics and include species such as Big Bluestem, Little Bluestem, Indiangrass, Switchgrass, and Canada Wild Rye. PTMApp sites filter strips in crop fields that intercept a relatively large amount of flow (more than 124 acres) and receive a sediment load of up to 8.1 tons per year.

Prescribed Grazing


Source: www.nrcs.usda.gov

Prescribed grazing involves dividing pastures into smaller paddocks, often with portable fencing, where livestock graze one paddock for a short time while others rest and recover. Prescribed grazing can improve water quality by reducing soil erosion, improving plant health, and increasing ground cover. Healthier pastures promote infiltration, reduce runoff, and improve soil structure. Additionally, prescribed grazing plans could improve water quality by fencing off streams for a period of time to reduce erosion during wet periods. While PTMApp documentation did not include criteria for siting prescribed grazing, results show that prescribed grazing was sited in areas with a land use of “Hay/Pasture” that were alongside flowlines with perennial flow.

Field Practices

The field practices of cover crops, reduced till, and no-till were all included in the PTMApp BMP siting. These practices all help to improve water quality by increasing crop residue, increasing infiltration, and reducing erosion. While implementing these practices would be helpful on any crop fields, PTMApp sited these three practices in crop fields that did not include large flow paths (where drainage areas were greater than 640 acres).

Grassed Waterway

Grassed waterways are broad, shallow constructed channels that are seeded to grass and drain water from areas of concentrated flow. The vegetative cover in the waterway helps slow the flow of water and protects the channel surface from rill and gully erosion. Water quality benefits of grass waterways include reduction of sediment and particulate phosphorus. PTMApp sites grassed waterways in crop fields that have a slope between 3% to 12%, and where the drainage area is between 5 to 100 acres. However, a grassed waterway will be excluded if an area meets this criteria but is located within 50 meters of a large flow path (drainage area over 1000 acres). It is important to note that grassed waterways will often be sited within a WASCOB; therefore, grassed waterways and WASCOBs can be used interchangably depending on site conditions.

2.1.2 BMP Siting with PTMApp

The PTMApp is a subwatershed-scale tool designed to estimate pollutant loads and identify potential BMP locations. It is managed by the Minnesota Board of Water and Soil Resources (BWSR). For the Pokegama Lake SWA, the Desktop PTMApp ArcGIS Toolbar Version 3.1.0289 (updated October 13, 2021) for ArcGIS Pro 3.0 was used. PTMApp served three main functions in this SWA: 1) predicting pollutant loads, 2) siting potential BMPs, and 3) estimating pollutant reductions at those BMP locations.

PTMApp Data Requirements

PTMApp estimates pollutant loads, sites potential BMPs, and estimates pollutant reductions at those BMPs by integrating information on land cover, soils, slope, and hydrography. PTMApp relies on many GIS-based datasets to generate its outputs. Many of the required datasets are available through downloadable “Base Data” dataset on the PTMApp website. However, some key inputs are required externally:

- **Hydrologically Conditioned Digital Elevation Model (DEM):** A high-resolution DEM corrected to accurately model water flow across the landscape, ensuring proper flow through features like roads, bridges, and low points such as wetlands. The initial DEM was a 1-meter resolution DEM sourced from MnTOPO.
- **Soil Data:** Typically, PTMApp uses soil characteristics from the NRCS Soil Survey Geographic Database (SSURGO), which is included in the PTMApp “Base Data” download. However, SSURGO data is unavailable in most of Pine County. Instead, soil characteristics were sourced from the NRCS gNATSGO dataset (version December 9, 2023), which integrates SSURGO data where available and fills gaps using the coarser STATSGO2 dataset.

Before running PTMApp, the required datasets, specifically the hydro-conditioned DEM and soil attributes list above, were prepared according to the PTMApp guidance for Creating elevation products and desktop inputs.

Pollutant Load Estimation

Using the hydro-conditioned DEM, PTMApp was used to generate catchments, catchment loads, BMP suitability, and estimated BMP reductions using the PTMApp guidance for Running PTMApp-Desktop. PTMApp’s pollutant load estimates are based on a storm-event approach where pollutant loads are calculated for both the 2-year and 10-year 24-hour storms. The results from the 2-year storm were used to estimate BMP loading reductions in this SWA, as the PTMApp guidance suggests these estimates approximate annual averages due to the event's 50% recurrence probability.

BMP Siting & Reduction Estimates

As described in Section 2.1.1, all BMPs were sited within PTMApp using PTMApp’s siting criteria. Pollutant reduction estimates were also calculated within the tool, which routes estimated pollutant loads to BMP locations and applies literature-based values to determine reductions.

Assumptions and Limitations

The BMP locations and pollutant reduction results in this SWA are based on several key assumptions:

- Default pollutant reduction estimates in PTMApp are accurate for each BMP type.
- The GIS layers used to run PTMApp are of adequate resolution.
- The subwatershed boundaries generated from elevation data accurately represent the landscape.

It is important to note that the PTMApp-predicted pollutant loads should be considered planning-level estimates. The model was not calibrated, validated, or compared to field data in the Pokegama Lake watershed. Therefore, pollutant load reduction estimates should be regarded as “edge-of-field” values, with the understanding that BMPs closer to streams or waterways might offer greater potential for reducing pollutants in downstream waterbodies.

As part of the review process, Stantec followed the PTMApp's QA/QC protocols (October 2017 version) to ensure the accuracy of the outputs. This involved systematically checking results for any discrepancies and verifying that estimates were reasonable.

Desktop Review

After PTMApp identified the first round of BMPs, the list was refined through a desktop review (Table 12). This involved analyzing multiple years of aerial imagery and removing unsuitable BMPs based on the following criteria:

- BMP located in non-agricultural areas.
- BMP sited within or potentially impacting existing infrastructure (e.g., roads, houses, barns).
- BMP was too small to provide significant benefits.

Table 12. Number of BMPs initially identified by PTMApp, after desktop review, and final prioritization.

BMP	Identified by PTMApp	Post-Desktop Review	Prioritized
Wetland Restoration	2	2	2
WASCOB	133	123	5
Grassed Waterway	109	97	5
Filter Strip	21	15	5
Cover Crop, Reduced Till, No-Till	193 (each)	193 (each)	5 (each)
Prescribed Grazing	11	11	0

2.1.3 Planning Level BMP Cost Estimates

Planning level cost estimates were developed for each BMP type based on guidance from the Agricultural BMP Handbook for Minnesota (2017). Costs were converted from 2017 dollars to 2024 dollars using a 26.6% inflation rate from 2017 to 2024. The planning level cost estimates included a review of the following components:

- Planning and design costs, which may include engineering design, coordination with property owners and municipalities, and planning costs.
- Material costs, which may include filter media, drain tile, outlet control structures and/or modifications.
- Installation costs, which may include mobilization, site preparation, structural work, excavation, seeding, and erosion control.

Cost estimates for each BMP type are summarized in Table 13. Cost estimates from the Agricultural BMP Handbook for Minnesota were split evenly across the relevant categories (Planning/Design, Materials, Installation). Cost estimates for WASCOBs are per unit (i.e. per berm), while all other BMP costs are on a per-acre basis. The estimated costs do not reflect an annual maintenance cost (typically 5% of construction cost), the potential cost of attaining easements or purchases of large tracts of land to accommodate the BMP footprint, or compensation for identified losses (i.e., payments to landowners for loss of profit).

Table 13. BMP cost estimates on a unit-basis, in 2024 dollars.

BMP Type	Unit	Cost ($)				Cost Assumptions
		Planning/ Design	Materials	Installation	Total	
Wetland Restoration	per acre	$18,062	$18,062	$18,062	$54,185	
WASCOB	per unit	$7,469	$7,469	$7,469	$22,408	Assumes 500-foot long berm
Grassed Waterways	per acre		$863	$863	$1,726	Assumes average width of 100 ft per 1 linear foot
Filter Strip	per acre		$427	$427	$855	
Cover crop	per acre		$53	$53	$105	
No-till	per acre		$13	$13	$25	
Reduced till	per acre		$13	$13	$25	
Prescribed Grazing	per acre		$34	$34	$67	

It is important to note that all the proposed projects have potential design challenges and cost considerations that need to be fully investigated prior to their implementation. During final design and monitoring, a proposed project may not meet estimated pollutant removal efficiency and/or fall within the cost estimates presented in this report due to site-specific design challenges. Additionally, BMP performance can also vary from year to year based on climatic conditions and other environmental factors. In addition, ongoing and consistent maintenance activities are required to maintain performance. This includes sediment removal, vegetation and filter maintenance, and monitoring.

2.1.4 BMP Prioritization

To prioritize BMPs, a cost per pound of phosphorus reduction value was calculated by dividing the total BMP cost by the estimated pollutant reduction. Then, the total cost, estimated pollutant removal, and cost per pound of phosphorus reduction were assessed together, offering a more comprehensive analysis than evaluating each characteristic separately. This method was used to identify the top five BMPs in each category (except for wetland restorations where only two locations were identified by PTMApp). Locations for prescribed grazing were not prioritized, as PTMApp did not provide significant reduction estimates for this practice. Instead, these areas can be considered suitable for cattle exclusion and fencing.

3 Findings

The results of the BMP prioritization process are shown in Table 14. In total, there are 32 priority BMPs identified across seven BMP categories. If all 32 BMPs were implemented, they are estimated to reduce phosphorus loading to Pokegama Lake by 640 pounds per year, which makes a significant contribution towards the Snake River TMDL watershed reduction goals. These goals include a reduction of 3,854 pounds per year from Pokegama Creek and 8,108 pounds per year from areas draining directly into Pokegama Lake.

Note that the “BMP ID” field in Table 14 corresponds with the BMP ID in the companion GIS files, and those IDs listed in the attributes of the priority BMP layers in the web interface. All BMP locations, priority BMP locations, and supporting GIS datasets are summarized in on an online interactive map. This map facilitates a better user experience for viewing individual BMPs and viewing accompanying layers.

Table 14. Priority BMPs identified in the Pokegama Lake watershed. Costs are in 2024 dollars. Priority BMPs can also be viewed in the online interactive map.

BMP Name	BMP ID	BMP Area (Acres)	Removal per Year		Cost ($)				Cost Effectiveness	
			TP (pounds)	TSS (tons)	Design Cost	Materials Cost	Installation Cost	Total Cost	Cost per Pound of TP Removal ($ / pound)	Cost per Ton of TSS Removal ($ per Ton)
Wetland Restoration	140000152_5615_1_656_2	11.3	257.8	899.7	$204,095	$204,095	$204,095	$612,284	$2,375	$681
	140000167_506051_1_656_2	8.0	174.7	390.2	$144,003	$144,003	$144,003	$432,009	$2,473	$1,107
WASCOB	120000993_505074_1_638	35.4	10.4	60.7	$7,469	$7,469	$7,469	$22,408	$2,159	$369
	120001307_506129_1_638	71.3	10.0	38.4	$7,469	$7,469	$7,469	$22,408	$2,249	$583
	120001189_505680_1_638	16.8	5.4	40.1	$7,469	$7,469	$7,469	$22,408	$4,171	$559
	120000510_502339_1_638	19.1	4.8	22.3	$7,469	$7,469	$7,469	$22,408	$4,646	$1,007
	120000045_500637_1_638	4.7	1.2	7.4	$7,469	$7,469	$7,469	$22,408	$18,556	$3,034
Grassed Waterway	230000085_502938_5_412	2.1	0.7	12.8		$1,823	$1,823	$3,647	$5,094	$285
	230000070_502339_5_412	0.9	0.3	2.4		$766	$766	$1,532	$5,097	$648
	230000024_501127_5_412	0.3	0.091	0.003		$232	$232	$464	$5,100	$156,149
	230000072_502463_5_412	0.3	0.1	0.9		$232	$232	$464	$5,101	$495
	230000053_502193_5_412	0.8	0.3	2.1		$701	$701	$1,401	$5,102	$659
Filter Strip	160000347_5518_2_393	0.8	0.8	3.9		$357	$357	$715	$904	$186
	160000110_3124_2_393	2.7	2.5	6.9		$1,150	$1,150	$2,301	$937	$332
	160000364_6013_2_393	0.5	0.2	1.5		$213	$213	$426	$1,970	$280
	160000322_5285_2_393	0.9	0.3	2.2		$364	$364	$728	$2,454	$326
	160000244_3432_2_393	5.3	0.8	8.2		$2,283	$2,283	$4,565	$5,415	$555
Field Practice (Cover Crop)	270000653_505680_6_340	33.2	7.5	40.8		$1,740	$1,740	$3,481	$464	$85
	270000552_505074_6_340	41.7	9.4	63.4		$2,188	$2,188	$4,376	$464	$69
	270000747_506129_6_340	60.5	13.7	57.9		$3,174	$3,174	$6,349	$465	$110
	270000550_505260_6_340	72.2	16.3	109.5		$3,789	$3,789	$7,579	$465	$69

BMP Name	BMP ID	BMP Area (Acres)	Removal per Year		Cost ($)				Cost Effectiveness	
			TP (pounds)	TSS (tons)	Design Cost	Materials Cost	Installation Cost	Total Cost	Cost per Pound of TP Removal ($ / pound)	Cost per Ton of TSS Removal ($ per Ton)
	270000479_504736_6_340	48.0	10.8	49.8		$2,521	$2,521	$5,041	$465	$101
Field Practice - Reduced Till	280000653_505680_6_345	33.2	6.2	35.6		$414	$414	$829	$135	$23
	280000552_505074_6_345	41.7	7.7	55.3		$521	$521	$1,042	$135	$19
	280000747_506129_6_345	60.5	11.2	50.5		$756	$756	$1,512	$135	$30
	280000550_505260_6_345	72.2	13.4	95.4		$902	$902	$1,805	$135	$19
	280000479_504736_6_345	48.0	8.9	43.4		$600	$600	$1,200	$135	$28
Field Practice - No Till	260000653_505680_6_329	33.2	8.4	46.0		$414	$414	$829	$99	$18
	260000552_505074_6_329	41.7	10.5	71.6		$521	$521	$1,042	$99	$15
	260000747_506129_6_329	60.5	15.3	65.4		$756	$756	$1,512	$99	$23
	260000550_505260_6_329	72.2	18.2	123.6		$902	$902	$1,805	$99	$15
	260000479_504736_6_329	48.0	12.1	56.2		$600	$600	$1,200	$99	$21
Total		948	649	2,464	$385,444	$413,366	$413,366	$1,212,176		

4 Summary and Recommendations

4.1 All BMPs: Phosphorus Reductions

To improve water quality in Pokegama Lake and meet water quality criteria, the TMDL estimates that the phosphorus load from Pokegama Creek requires a 40% reduction (3,854 pounds) and phosphorus loads from the remaining areas of the watershed require an 88% reduction (8,108 pounds). Below is a description of how the BMPs identified with PTMApp can contribute to these required reductions.

Of the eight BMPs categories identified; wetland restorations were estimated to provide the greatest magnitude of pollutant reduction. The two wetland restorations identified have the potential to remove 175 to 250 pounds of phosphorus annually (Table 15). Both wetland locations were sited to the west of Pokegama Lake, outside of the Pokegama Creek watershed, and would contribute towards the 88% required reduction that the TMDL estimates for areas outside of the Pokegama Creek watershed.

Similar to a wetland, WASCOBs also function by storing water and allowing for sediment and phosphorus to settle out of the water column. A total of 123 WASCOBs were sited throughout the watershed, each of which would result in an average phosphorus removal of 2.5 pounds per year. Implementing all 123 WASCOBs would provide around 310 pounds of phosphorus reduction (Table 15).

Field practices of cover crops, reduced tillage, or no-till also showed the potential for significant TP reductions. Each of these three practices ranged from 6 – 18 pounds of TP reduction per year, per field. In total, 193 fields were identified throughout the watershed where field practices could be implemented. Each of the three practices had an average TP reduction of about 3 pounds/yr per field. Therefore, implementing a combined approach of cover crops and reduced tillage (either no-till or reduced till), would amount to an average of 6 pounds per year, and if implemented across all 193 fields would provide an estimated 1,160 pounds of TP reduction to Pokegama Lake (Table 15).

The filtration-based BMPs of grassed waterways and filter strips generally have a smaller footprint than practices like wetland restorations, WASCOBs, and field practices. Therefore, they tend to demonstrate lower overall TP removals. However, their role on the landscape can still be significant at the field level and provide an important alternative if more effective BMPs, such as WASCOBs, are not feasible due to site-specific constraints.

Table 15. Summary of all BMPs included in the Pokegama Lake Subwatershed Assessment and estimated pollutant removals.

Category	Total	Average TP Reduction (lb)	Total Estimated TP Reduction if all BMPs Implemented (lb)
Wetland	2	217	433
WASCOB	123	2.5	310
Cover Crop	193	3	580
Tillage (reduced till or no-till)	193	3	580

Grassed waterway	97	0.2	19
Filter Strip	15	0.8	13
Prescribed Grazing	11	0.1	1.1
Total	**827**		**1,936**

It's also important to contextualize the PTMApp results. The estimated pollutant loads delivered to each BMP, and the estimated removals, should be evaluated with the consideration of the following limitations:

- GIS data resolution (i.e, there is a spatial limit to data products)
- Potential GIS data misclassification
- Universal Soil Loss Equation applicability and uncertainty
- Uncertainty in default PTMApp pollutant removal parameters
- Absence of tool calibration
- Undetectable hydrologic connectors (e.g., subsurface drainage not visible in elevation data)
- Uncharacterized fate and transport processes

The expectation is that PTMApp pollutant loading, and pollutant removal estimates are accurate, on average, given that it is a vetted tool, used in many applications, and based on decades of empirical research in pollutant delivery. These limitations, however, mean that the *absolute* estimates carry some uncertainty. For example, an estimated delivery of 10 pounds of phosphorus to a certain BMP, and a corresponding estimated annual removal of 6 pounds may not be the exact values for what that BMP would receive, and remove, each year. However, the *relative* pollutant loading, and corresponding pollutant removals, are a good basis for comparison across a group of BMPs given the same parameters that dictate removal within the tool.

4.2 Priority BMPs: Cost-Effectiveness

Priority BMPs were determined by evaluating total cost, total estimated removals, and cost per pollutant removal. In general, the cost-effectiveness shows that wetlands, WASCOBs, and field practices show a higher cost-effectiveness than grassed waterways and filter strips. However, the exact site conditions will ultimately determine the costs and benefits of any BMP. Table 16 provides a general cost-effectiveness determination and other considerations for each of the priority BMP types.

Table 16. General cost-effectiveness determination of the priority BMPs identified in the Pokegama Lake Subwatershed Assessment.

BMP Type	General Cost-Effectiveness Determination for the Pokegama Lake Watershed	Other Considerations
Wetland Restoration	High	• Captures and treats the largest amount of runoff of all BMP types. • Highest total cost.
WASCOBs	High	• Low maintenance costs.

		• A good alternative to higher-cost wetland restorations.
Grassed Waterway	Low	• Small footprint and easier to implement than WASCOBS
Filter Strip	Low	• Small footprint and easier to implement than WASCOBS
Field Practices: cover crops, reduced till, no-till	High	• Lowest total cost and lowest cost per pound of phosphorus reduction. • Generally, an appropriate practice for nearly all crop fields. • Staff time and resources to educate, communicate, and demonstrate practices to farmers are not captured in the cost estimate.

Wetland Restorations

Among the priority BMPs in Table 14, an 8-acre wetland restoration project stands out for its balance of cost-effectiveness and pollutant removal. This wetland (BMP ID = 140000167_506051_1_656_2) is located in an existing wetland in the southwest corner of the watershed. While PTMApp identified 8 acres for restoration, the actual wetland covers around 80 acres, which may also benefit from restoration. The wetland is on private property, and based on aerial photos, restoring hydrology through partial or complete removal of the drainage ditch running through it could increase water residence time and improve phosphorus deposition and uptake. This could also be enhanced by establishing wetland vegetation. Although the total estimated cost is nearly $400,000, making it one of the more expensive projects, its cost per pound of phosphorus removal is among the lowest for structural BMPs at $2,375 per pound of TP. Additionally, this site has the potential to capture runoff from several agricultural fields with high phosphorus loads.

The second wetland restoration identified in this SWA is an 11-acre wetland to the west of Pokegama Lake, which also offers a good balance of cost-effectiveness and pollutant removal (Table 14). This location is on private property and appears to be an area that is currently drained but not used for crops. The actual restoration area may be smaller (5-6 acres), as the full 11 acres identified by PTMApp overlaps with some existing crop fields. If the full 11 acres are restored, the estimated cost is $612,284 at $2,375 per pound of TP; however, reducing the footprint to focus on non-cropland areas would lower costs. Restoration here may involve restoring the wetland hydrology and establishment of wetland vegetation. Given this location's proximity to cropland and potential of historical cropland use, an investigation of the soils is recommended to assess the soil's phosphorus retention capacity.

Water and Sediment Control Basins

WASCOBs function similarly to wetlands and depressions but can be implemented at significantly lower costs and with a smaller footprint. On a cost-per-removal basis, WASCOBs generally perform better than grassed waterways and filter strips. Due to their low total cost and simple maintenance, multiple WASCOBs could be strategically constructed throughout the watershed as a more practical option than costly wetland restoration.

Grassed Waterways & Filter Strips

Grassed waterways and filter strips have a lower potential for sediment and phosphorus removal (generally less than 1 pound) but could still be valuable as a targeted group of BMPs. They are simpler to implement and face fewer geographic/topographic constraints than wetlands or WASCOBs, and often have smaller footprints. In some areas, grassed waterways and WASCOBs were sited together, making either practice suitable depending on field conditions.

Field Practices

The field practices of cover crops, no-till, and reduced tillage offer some of the lowest total costs and lowest cost per pound of phosphorus reduction ($100 to $500 per pound of TP), making them an excellent BMP for phosphorus reduction throughout the watershed. However, these estimates do not account for additional costs associated with outreach, education, demonstration, or incentive payments needed to increase farmer adoption. PTMApp identified field practices for 193 fields in the watershed, but nearly all crop fields could be suitable for these practices.

4.3 Next Steps

Next steps could include staff from Pine and Kanabec Counties, along with other partners, conducting site visits to confirm BMP feasibility and collaborating with willing landowners to discuss and implement the prioritized practices. Additionally, counties and partners with additional local knowledge should assess whether there are other known areas that should be prioritized based on criteria beyond BMP cost-effectiveness, such as locations where a landowner may be willing to implement a practice and also demonstrate or discuss it with other landowners in the area. A key funding source for implementing any of the BMPs in this Subwatershed Assessment includes BWSR's Watershed Based Implementation Funding Grant Program.

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