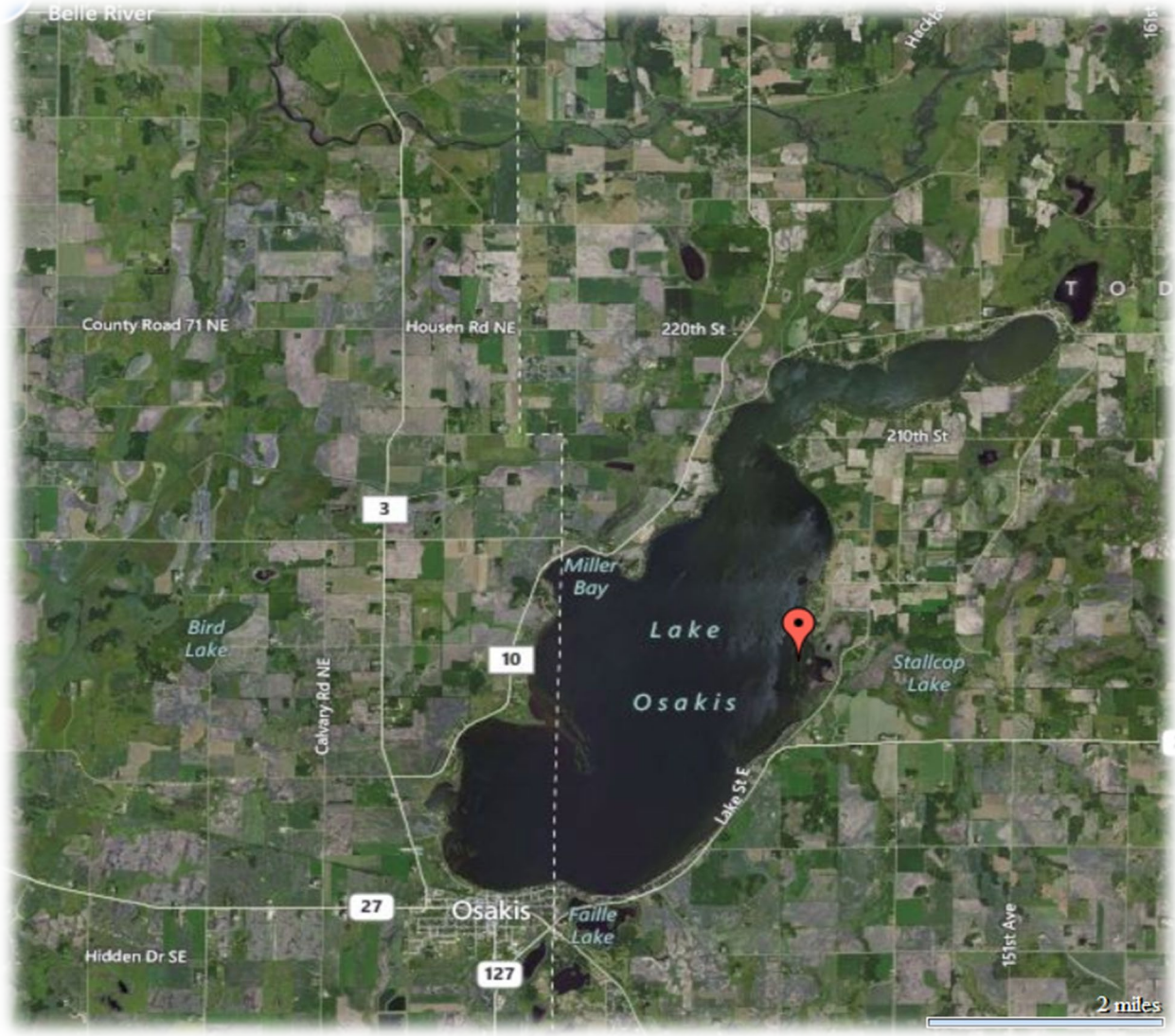
Osakis Lake Area Excess Nutrient TMDL Implementation Plan



Sauk River Watershed District
524 4th Street South
Sauk Centre, MN 56378
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CLEAN WATER LAND & LEGACY AMENDMENT

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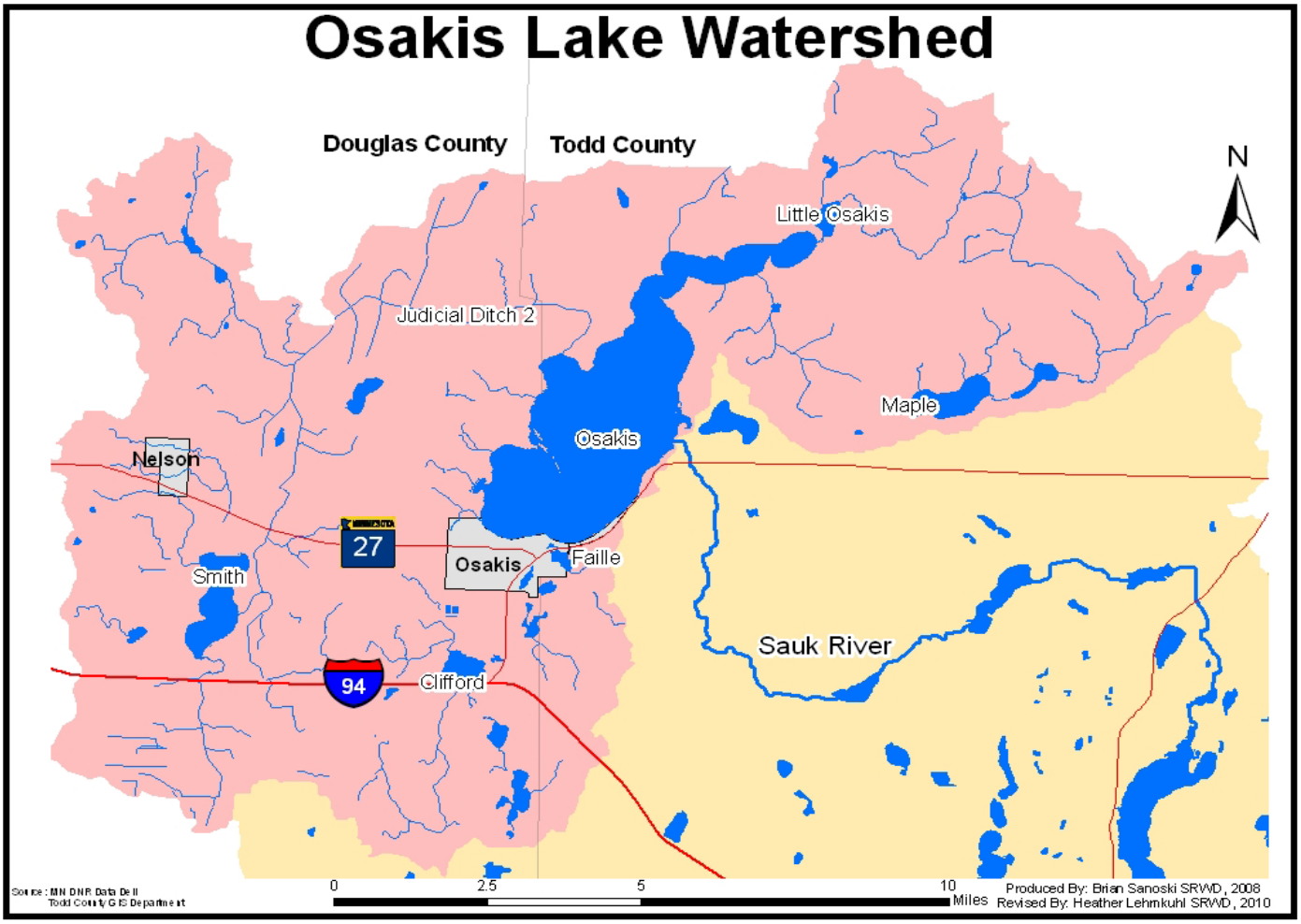
1.0 Introduction

The Osakis Lake Area Excess Nutrient TMDL Implementation Plan addresses the nutrient impairments in Osakis Lake (DNR Lake # 77-0215), Smith Lake (DNR # 21-0016) and Faille Lake (DNR # 77-0195). These lakes are located in central Minnesota in the Upper Mississippi River Basin along the border of Todd and Douglas Counties (Figure 1). Faille and Smith Lakes are located upstream of Osakis Lake, which is the headwaters of the Sauk River. Osakis Lake was placed on the 2004 State of Minnesota's 303(d) list of impaired waters. Faille Lake was placed on the 303(d) list in 2006 and Smith Lake was placed on this list in 2008. All three lakes were identified for impairment of aquatic recreation. Water quality does not meet state standards for nutrient concentration for deep (Osakis and Smith) and shallow lakes (Faille) in the North Central Hardwood Forest ecoregion (Table 1).

Osakis Lake is located in both Todd and Douglas County, Faille Lake lies solely within Todd County and Smith Lake is located in Douglas County. These lakes are recreational water bodies with primary activities being boating and fishing. Water quality degradation of these lakes has impacted recreational activities and led to efforts to improve the overall water quality within the Osakis Lake watershed. As a result, these lakes were given a priority ranking for TMDL development. Priority was also given to these water bodies to protect downstream water resources in the Sauk River.

Smith Lake, Faille Lake and Osakis Lake are located in the North Central Hardwood Forest ecoregion and are designated as class 2B waters. The Class 2B designation specifies aquatic life and recreation as the protected beneficial use of these water bodies.

Figure 1. Osakis Lake Watershed



2.0 TMDL Summary

Impaired waters are listed and reported to the citizens of Minnesota and to the EPA in the 305(b) report and the 303(d) list, named after relevant sections of the Clean Water Act. Assessment of waters for the 305(b) report identifies candidates for listing on the 303(d) list of impaired waters. The purpose of the 303(d) list is to identify impaired water bodies for which a plan will be developed to remedy the pollution problem(s).

The basis for assessing Minnesota lakes for impairment due to eutrophication includes the narrative water quality standard and assessment factors in Minnesota Rules 7050.0150. The MPCA has completed extensive planning and research efforts to develop quantitative lake eutrophication standards for lakes in different ecoregions of Minnesota that would result in achievement of the goals described by the narrative water quality standards. To be listed as impaired by the MPCA, the monitoring data must show that the standards for both total phosphorus (the causal factor), and either chlorophyll *a* or Secchi disc depth (the response factors) are not met (MPCA, 2007a). Osakis Lake, Faille Lake and Smith Lake are listed based on the eutrophication criteria for the North Central Hardwood Forest (NCHF) Ecoregion (Table 1).

Table 1. Numeric targets for deep and shallow lakes in the North Central Hardwood Forest ecoregion

Parameters	North Central Hardwood Forest (Deep Lakes)1	North Central Hardwood Forest (Shallow Lakes)2
Phosphorus Concentration (mg/L)	40	60
Chlorophyll-a Concentration (mg/L)	14	20
Secchi disk transparency (meters)	>1.4	>1.0

1 Deep lakes are defined as enclosed basins with a maximum depth greater than 15 feet.
2 Shallow lakes are defined as lakes with a maximum depth less than 15 feet, or with more than 80% of the lake area shallow enough to support emergent and submerged rooted aquatic plants (littoral zone).

2.1 Lake Summary

Smith Lake represents the headwaters of Judicial Ditch #2, which drains to Osakis Lake. Smith Lake is a relatively large, deep lake with a long residence time (1.9 years), meaning that the lake flushes about every two years (Table 2). Approximately half of Smith Lake can be expected to support submerged aquatic vegetation growth. Faille Lake is a shallow lake with an extremely short residence time (18 days) that receives drainage from Clifford Lake via Stevens Lake (Figure 2). Clifford Lake discharges to a channel that travels through a large unnamed wetland prior to discharging to Stevens Lake. Faille Lake is located in Todd County, however a majority of the watershed is located in Douglas County. Faille Lake is small in size (78 acres) and would be expected to have submerged aquatic vegetation from shore to shore. Faille Lake discharges a short distance (less than 0.5 miles) to Osakis Lake through a channel commonly referred to as Blacks Channel.

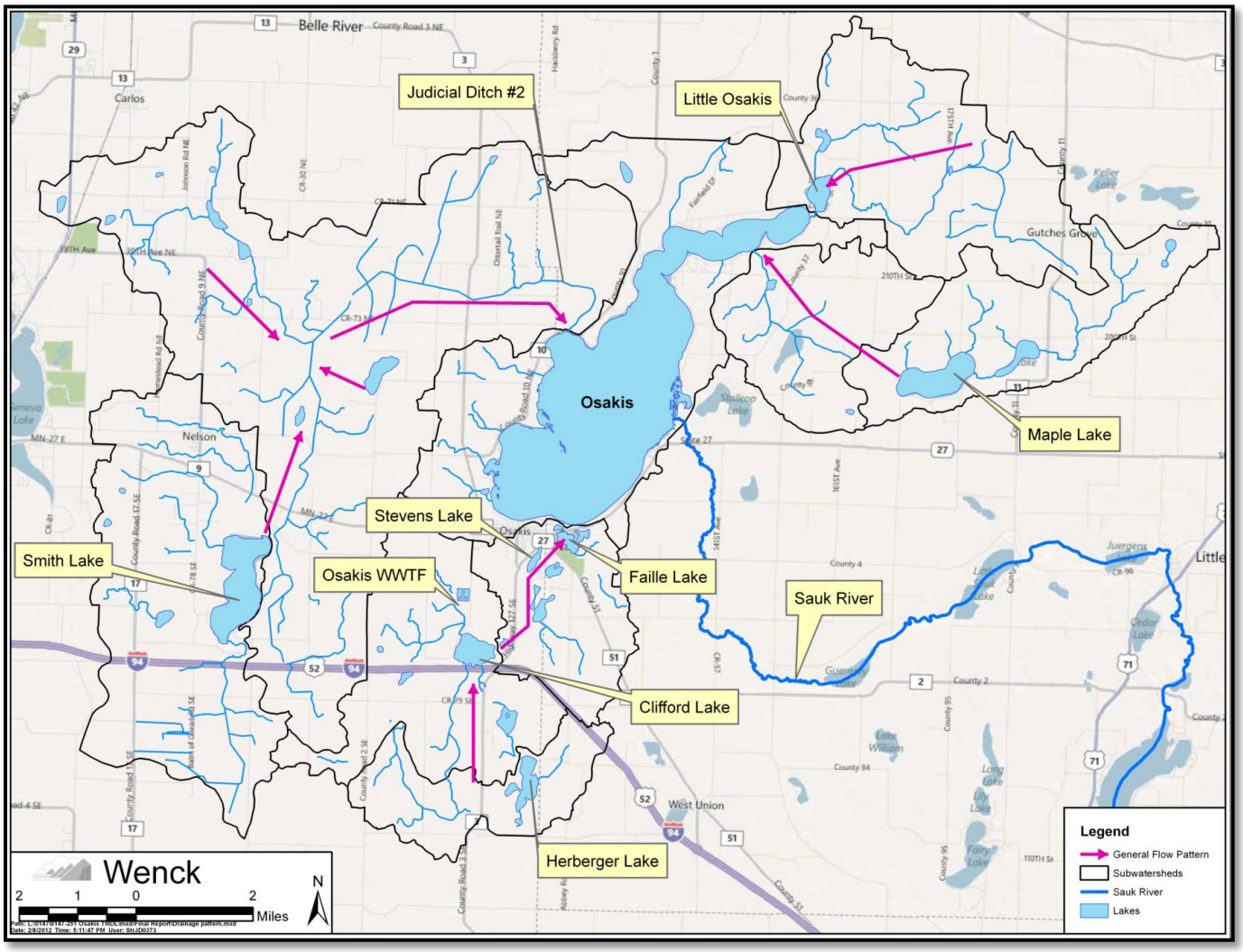
Table 2. Osakis area lakes morphometric and watershed characteristics

Parameter	Smith Lake	Faille Lake	Osakis Lake
Surface Area (acres)	550	78	6,361
Average Depth (ft)	14.4	3.6	17
Maximum Depth (ft)	30	7	73
Volume (ac-ft)	7.928	278	108,389
Residence Time (years)	1.9	0.05	5
Littoral Area (acres)	265	78	2,939
Littoral Area (%)	48%	100%	46%
Watershed (acres)	11,931	14,722	88,722

Osakis Lake has a relatively large drainage area (Table 2). As previously mentioned, the majority of Osakis Lake is located in Todd County; however most of the watershed is located in Douglas County (Figure 1). The Judicial Ditch #2 watershed west of Osakis Lake is approximately 26,702 acres and accounts for a large portion (30%) of the lake's total watershed. The remainder of the Osakis Lake watershed is made up of direct drainage to the lake (23%) and outflow from Faille Lake (17%), Smith Lake (13%), Little Osakis Lake (10%), and Maple Lake (7%)(Figure 2). Osakis Lake is a large, deep lake with an extremely long residence time of approximately five years. About half of the lake is shallow enough to support submerged aquatic vegetation. The lake is highly sought by recreationalists, particularly anglers, sail boaters and water skiers.

Osakis Lake and Smith Lake are considered deep lakes and are subject to the chlorophyll-a and Secchi depth numeric standards of 14 mg/L and 1.4 meters, respectively. Faille Lake is a shallow lake and must meet the chlorophyll-a and Secchi depth numeric standards of 20µg/L and 1.0 meters, respectively. All values are growing season means.

Figure 2. Osakis Lake subwatersheds and drainage pattern



Water quality monitoring has been conducted at several locations on each of the three impaired lakes in the Osakis watershed under a variety of efforts (Tables 3-5). Osakis Lake is a large, deep lake that has three main sampling stations situated near the deep hole of each of the three major basins/sections of the lake. Smith Lake is also considered a deep lake and has two sampling locations that are located near the lake's deep hole. Faille Lake has three monitoring locations that have been sampled periodically since 2000. During monitoring years, sampling was typically conducted bi-weekly or once per month from April/May through September. Collection efforts were coordinated and carried out by the Sauk River Watershed District (SRWD) and the Minnesota Pollution Control Agency (MPCA).

Data for each lake were combined and consolidated (averaged) by date to represent one single value for each lake. Summer (seasonal) index period (June 1 through September 30) data for each year was then averaged in order to compare each lake's data to the state's numeric standards for deep and shallow lakes in the NCHF ecoregion (Table 1).

Summer average total phosphorus (TP) concentrations in Osakis and Smith Lake consistently exceeded the deep lake TP water quality standard of 40µg/L. The highest summer average TP concentration for Osakis Lake was 84µg/L in 2000 (Table 4). Smith Lake's highest measured average summer TP concentration was 61µg/L in 2010 (Table 3). Since 2000, Faille Lake has also consistently exceeded the 60µg/L NCHF ecoregion shallow lake TP standard (Table 5). The highest average summer TP concentration for Faille Lake was 236µg/L in 2002.

Table 3. Smith Lake Monitoring Data

Year	Secchi (all site) Seasonal Average (m)	Chl-a (all sites) Seasonal Average (ug/L)	Total Phosphorus. (all sites) Seasonal Average (ug/L)
2000	1.19	37	55
2002	1.67	34	52
2004	1.89	21	46
2005	1.43	32	55
2006	1.29	43	51
2007	1.31	30	56
2008	1.53	43	46
2009	3.15	11	29
2010	1.3	35	61

Table 4. Osakis Lake Monitoring Data

Year	Secchi (all site) Seasonal Average (m)	Chl-a (all sites) Seasonal Average (ug/L)	Total Phosphorus. (all sites) Seasonal Average (ug/L)
1999	1.44	29	67
2000	3.13	9	84
2002	1.85	11	64
2003	2.59	11	87 (one data point)
2004	2.33	18	52
2005	2.66	26	51
2006	1.42	52	65
2007	1.48	30	58
2009	3.33	9	50

Table 5. Faille Lake Monitoring Data

Year	Secchi (all site) Seasonal Average (m)	Chl-a (all sites) Seasonal Average (ug/L)	Total Phosphorus. (all sites) Seasonal Average (ug/L)
1998	.71	24	123
1999	1.04	17	115
2000	.88	51	141
2001	1.27	13	158
2002	1.22	28	236
2003	1.22	13	192
2004	1.04	12	90

Overall, Osakis, Smith and Faille Lake have not met current state standards since 2000. While there is some variability in the monitoring data from year to year, trends over the past 7-10 years (Tables 3-5) show that the water quality is relatively stable in its current state.

2.2 Watershed Phosphorous Loading

Understanding the sources of nutrients to a lake is a key component in developing an excess nutrient TMDL for lakes. A unit-area load (UAL) and runoff coefficient approach was used to develop watershed runoff and phosphorus loading totals to each of the lakes. The watershed was broken into Hydrologic Response Units (HRU), a unique combination of land cover, soils, and slope. Each HRU was treated independently to estimate runoff and total phosphorus loading. A phosphorus budget was developed that depicts the current phosphorus load contributions from each potential source. A lake response model was also developed for each lake to understand how different lake variables respond to changes in nutrient loads.

Watershed runoff and phosphorus loads to Osakis Lake and Faille Lake were calculated using the runoff coefficient model and TP monitoring data. The UAL phosphorus model was used to predict watershed phosphorus loads to Smith Lake since there was no stream TP monitoring data available. For the lake outflow volumes and phosphorus loads from Smith, Clifford, Faille, Little Osakis and Maple lakes the runoff coefficient model and average monitored in-lake TP concentrations were calculated (Table 7). Runoff and phosphorus loads for each lake were calculated for each year using the BATHTUB lake modeling program (Table 6).

Table 6. Runoff and phosphorus loading by subwatershed

Watershed runoff and phosphorus load estimates do not include estimated outflow and loads from upstream lakes

Subwatershed	Years Modeled	Average Runoff (acre-ft/year)	Average TP (ug/L)	Average TP Load (lbs/year)
Smith Lake Direct[2]	04, 05, 08, 10	4,412	190	2,282
Faille Lake Direct[3]	03, 04, 07	1,407	199	762
Judicial Ditch #2[4]	04-07, 09	9,846	141	3,784
Maple Lake Downstream[5]	04-07, 09	1,673	455	2,070
Osakis Lake Direct	04-07, 09	3,351	455	4,146

1 Runoff calculated using runoff coefficient model
2 Phosphorus load calculated using UAL phosphorus model
3 Average phosphorus runoff concentration calculated using monitored data from S003-296
4 Average phosphorus runoff concentration for JD #2 calculated using monitored data from S002-647
5 Downstream and Osakis Lake Direct subwatershed runoff concentration calculated using monitored data from S003-537, S003-538, S003-539, S003-540 and S003-541.

Table 7. Lake outflow volumes and phosphorus loads

Lake	Downstream Lake	Years Modeled	Average Outflow[1] (acre-ft/year)	Average TP[2] (µg/L)	Average TP Outflow (lbs/year)
Smith	Osakis	04-07, 09	3,747	52	531
Clifford	Faille	03, 04, 07	2,973	272	2,202
Faille	Osakis	04-07, 09	4,983	161	2,180
Little Osakis	Osakis	04-07, 09	2,654	34	246
Maple Lake	Osakis	04-07, 09	1,943	81	427

1Runoff calculated using runoff coefficient model
2Average phosphorus concentrations calculated using summer monitored values

Figure 3. Land use in the Osakis Lake Watershed

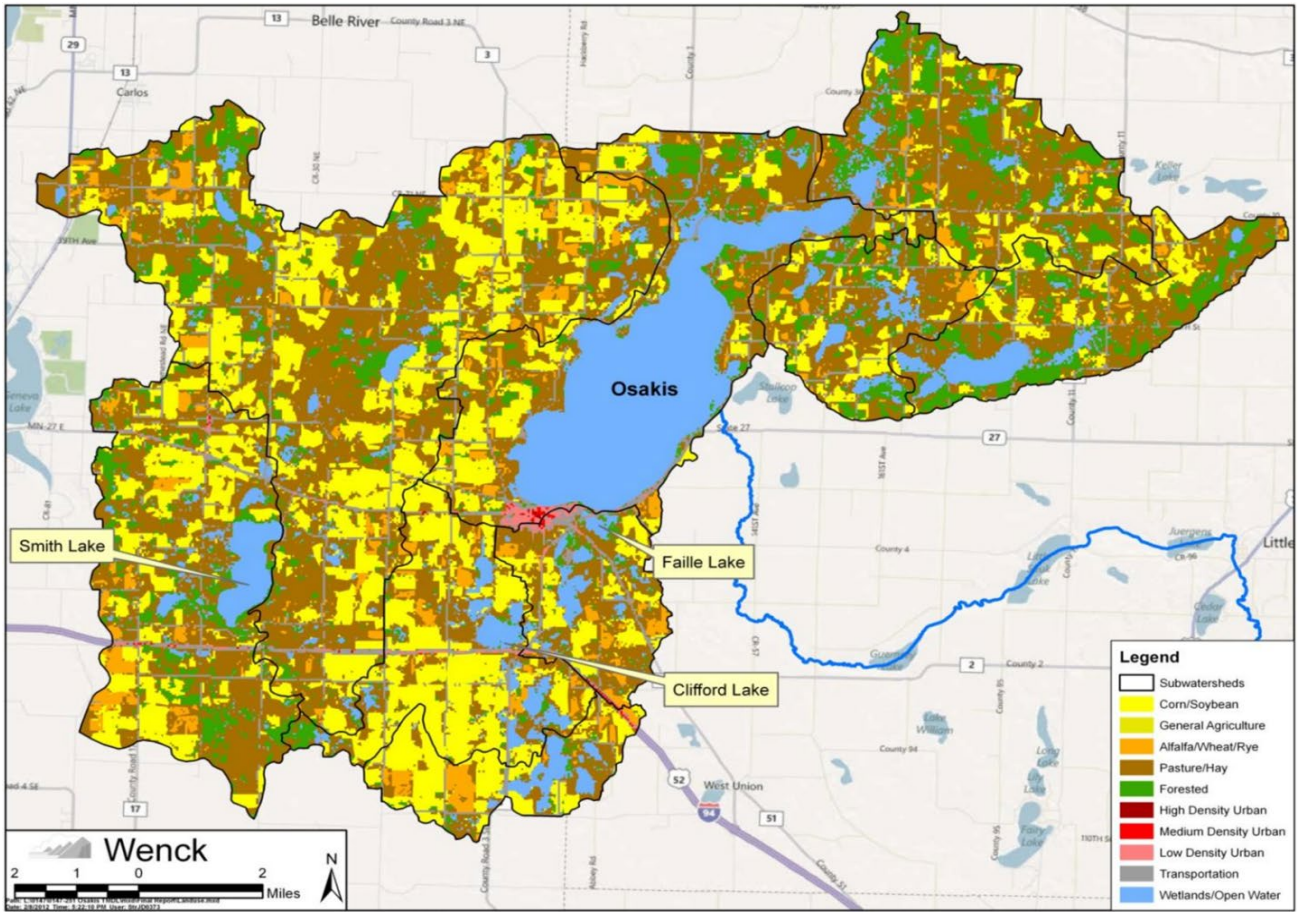


Table 8. Loading by land use

Land use	Osakis	Smith	Faille
	Percent	Percent	Percent
Pasture/Hay	40%	41%	30%
Corn/Soybean	24%	25%	38%
Wetlands/Open Water	14%	9%	13%
Forested	11%	13%	4%
Transportation	6%	6%	7%
Alfalfa/Wheat/Rye	4%	6%	7%
Low Density Urban	<1%	<1%	1%
Medium Density Urban	<1%	<1%	<1%
General Agriculture	<1%	<1%	<1%
High Density Urban	<1%	<1%	<1%
Total	**100%**	**100%**	**100%**

Table 8 summarizes average (2000-2010) annual phosphorus loading model results by land use for the entire watershed. Results indicate agricultural land practices, primarily pasture/hay and corn/soybean rotations, are the biggest contributors of watershed phosphorus loading in the Osakis Lake watershed. Runoff from roads/highways and urban areas throughout the watershed also contribute a relatively large amount of phosphorus.

Animal agriculture is a prominent use throughout the Osakis Lake watershed (Table 9). Manure produced by the animals in the watershed is applied to fields and pastures for fertilizer as well as general manure management. Manure that is applied beyond the nutrient uptake ability of the fields moves easily into surface waters adding to eutrophication and nutrient loads.

Table 9. Agricultural animal phosphorus production in the Osakis Lake watershed

Watershed	[1] Agricultural Land (Acres)	Total P (lbs/day)	Total P (lbs/year)	[2] Total P (lbs/year/acre)
Herberger Lake	2,253	30	10,793	4.8
Clifford Lake Direct	5,253	323	117,833	22.4
Faille Lake Direct	2,597	121	44,176	17.0
Smith Lake Direct	7,885	410	149,653	19.0
Judicial Ditch #2	20,568	918	335,451	16.3
Little Osakis	5,542	376	137,239	24.8
Maple Lake	3,796	184	67,127	17.7
Maple Lake Downstream	3,236	83	30,305	9.4
Osaki Lake Direct	5,695	577	210,609	37.0
Watershed total	56,825	3,020	1,103,185	19.4

1 Only includes land where manure is potentially spread (corn/soybeans and other row crops) or directly deposited (pasture)
2 Calculated by dividing total agricultural animal phosphorus production by agricultural land in each watershed

The Osakis watershed UAL model did not directly model phosphorus contributions from manure spreading, rather the data from the Judicial Ditch #2 watershed, which has 44 feedlot operations (out of 60 in Douglas County area), 4,827 total animal units (out of 7,254 in Douglas County area) and a wide range of agricultural animal types, was used to calibrated the UAL model. Since Judicial Ditch #2 is the largest tributary inflow to Osakis Lake and has been monitored extensively for water quality and flow for many years, it was used to represent the surrounding subwatersheds, assuming manure practices are similar and spreading occurs close to where the animals are contained.

Failing or nonconforming subsurface sewage treatment systems (SSTS) can be an important source of phosphorus to surface waters. In 2011, Todd County Planning and Zoning inspected over 200 SSTSs within 1,000 feet of Lake Osakis to determine which systems are in compliance or may be failing. Inspection results show that approximately 33% of the SSTSs surveyed were out of compliance or considered imminent environmental threats. Phosphorus loading to ground or surface water discharge from failing SSTS throughout the entire (inspected and non-inspected) Osakis Lake watershed was estimated assuming an average phosphorus production rate of 2.7 grams/person/day (USEPA,2002). Estimated SSTS phosphorus loads by subwatershed are presented in Table 10. These estimates are included as a separate phosphorus input load in each of the BATHTUB lake response models.

Table 10. Estimate SSTS Phosphorus Loads by Subwatersheds

Subwatershed	Total SSTS	Failing SSTS	TP Load (lbs/year)
Clifford Lake Direct	35	11	67
Faille Lake Direct	23	8	45
Herberger Lake	13	4	26
Smith Lake Direct	111	36	211
Judicial Ditch #2	235	76	447
Little Osakis	109	35	206
Maple Lake	68	22	129
Maple Lake Downstream	54	17	102
Osakis Lake Direct	816	261	1,531
Watershed Totals	1,464	470	2,764

All of the lakes were assessed for anoxia and sediment phosphorus release rates to determine the mass of phosphorus released during the summer growing season. The limited available data for Smith Lake demonstrated very little anoxia suggesting that internal phosphorus loading is not an important source of phosphorus to the lake. The five years of data, and the sediment release study conducted on Faille Lake in 2006 (Barr) determined that approximately 1% (32 pounds) of the total phosphorus load to Faille Lake each year is from internal loading through sediment release. Internal loading was found to be relatively small for Osakis Lake as well. The 2006 sediment release study on Osakis Lake and the eight years of monitoring data determined that an average of 250-300 pounds of phosphorus is released internally from the sediment each year (Table 11), which is approximately 2% of the total phosphorus load to Osakis Lake.

Table 11. Estimated internal phosphorus release for Lake Osakis.

Year	Release Rate ($mg/m^2/day$)	Anoxic Factor (days)	Phosphorus Load (kilograms)	Phosphorus Load (pounds)
1998	0.8	5.5	114	250
1999	0.8	0.4	9	20
2000	0.8	4.6	94	207
2003	0.8	0.4	7	16
2004	0.8	8.6**	166	365
2005	0.8	0.3	6	13
2006	0.8	10	193	426
2007	0.8	12	232	511
2009	0.8	12	232	511
Average	0.8	8.6	166	365

2.3 Required Load Allocation and Reduction

The Load Allocation includes all non-permitted sources including stormwater runoff not covered by a state or federal permit, atmospheric deposition and internal loading. These sources were described above. No changes are expected for atmospheric deposition because this source is impossible to control.

The Osakis WWTF is currently the only permitted wastewater discharger in the Lake Osakis watershed. This facility discharges to Clifford Lake, which is upstream of Faille Lake and Lake Osakis. Clifford Lake was placed on the 2006 State of Minnesota's 303(d) list of impaired water for nutrients. A TMDL for Clifford Lake is underway and will be addressed separately within a lake specific implementation plan. The Osakis WWTF allocations will be included in the Clifford Lake TMDL. There are no MS4 permit holders in the Lake Osakis watershed so no allocations are given for MS4 stormwater

Smith Lake

A 31% reduction in overall phosphorus loading to Smith Lake is required to meet the 40 µg/L state standard (Table12). This will require a 36% reduction in direct watershed loading to meet the TMDL for Smith Lake. This assumes that all failing SSTSs will be made compliant, eliminating phosphorus loading from SSTSs. Achieving required state phosphorus standard will benefit the downstream water bodies, Judicial Ditch2 and Osakis Lake.

Faille Lake

A 72% reduction in phosphorus loading to Faille Lake is required to meet the TMDL with large reductions required from non-point source watershed loads (Table 13). It was assumed that all of SSTSs will be made compliant, eliminating phosphorus loading from SSTSs. A large load reduction will be attained when Clifford Lake, which contributes to Faille Lake, meets the shallow lake standard of 60 µg/L. Clifford Lake will be addressed under a separate TMDL plan.

Table 12. Smith Lake Total Maximum Daily Load allocations

Allocation	Source	Existing TP Load [1]		TP Allocations (WLA & LA)		Load Reduction	
		(lbs/year)	(lbs/day)[2]	(lbs/year)	(lbs/day)[2]	(lbs/year)	%
Wasteload Allocation	Construction & Industrial Stormwater (1.5%)	27	0.1	27	0.1	0	**0%**
Load Allocation	Drainage Areas	2,255	6.2	1,647	4.5	608	**27%**
	SSTS	211	0.6	0	0.0	211	**100%**
	Atmosphere	132	0.4	132	0.4	0	**0%**
	Internal Load	0	0.0	0	0.0	0	**0%**
	MOS (5%)			95	0.3	-	**--**
	TOTAL	**2,625**	**7.3**	**1,901**	**5.3**	**819**	**31%**

[1] Existing load is the average of 2004, 2005, 2008 and 2010.
[2] Daily load is the annual load divided by 365.

Table 13. Faille Lake Total Maximum Daily Load allocations.

Allocation	Source	Existing TP Load [1]		TP Allocations (WLA & LA)		Load Reduction	
		(lbs/year)	(lbs/day)[2]	(lbs/year)	(lbs/day)[2]	(lbs/year)	%
Wasteload Allocation	Construction & Industrial Stormwater	6	<0.1	6	<.01	0	**0%**
Load Allocation	Drainage Areas	756	2.1	330	0.9	426	**56%**
	SSTS	45	0.1	0	0.0	45	**100%**
	Atmosphere	19	0.1	19	0.1	0	**0%**
	Upstream Lakes	2,202	6.0	480	1.3	1,722	**78%**
	Internal Load	32	0.1	32	0.1	0	**0%**
	MOS			46	0.1		**--**
	TOTAL	**3,060**	**8.4**	**913**	**2.5**	**2,193**	**72%**

[1] Existing load is the average of 2003, 2004 and 2007.
[2] Daily load is the annual load divided by 365.

Osakis Lake

For Osakis Lake, a 41% reduction in phosphorus loading will be required to meet the 40 µg/L state standard (Table 14). To achieve the required reduction a 34% reduction in watershed loading will be needed from the JD #2, Maple Lake downstream and Osakis Lake direct subwatersheds. It was also assumed that all failing SSTSs in these subwatersheds will be made compliant. Large reductions will be attained when Faille Lake, Smith Lake and Maple Lake, all of which contribute to Osakis Lake, meet MPCA's impairment standards for lakes.

Table 14. Lake Osakis Total Maximum Daily Load allocations

Allocation	Source	Existing TP Load [1]		TP Allocations (WLA & LA)		Load Reduction	
		(lbs/year)	(lbs/day)[2]	(lbs/year)	(lbs/day)[2]	(lbs/year)	%
Wasteload Allocation	Construction & Industrial Stormwater	107	0.3	107	0.3	0	**0%**
Load Allocation	Drainage Areas	9,893	27.1	6,520	17.8	3,373	**34%**
	SSTS	2,080	5.7	0	0.0	2,080	**100 %**
	Upstream Lakes	3,383	9.3	1,678	4.6	1,705	**50%**
	Atmosphere	1,499	4.1	1,499	4.1	0	**0%**
	Internal Load	365	1.0	365	1.0	0	**0%**
	MOS			535	1.5		**--**
	TOTAL	**17,327**	**47.5**	**10,704**	**29.3**	**7,158**	**41%**

[1] Existing load is the average of 2004-2007 and 2009.

[2] Daily load is the annual load divided by 365.

Lakes are not sensitive to short term changes in water quality, rather lakes respond to long-term changes such as changes in the annual load. Therefore, seasonal variation is accounted for in the annual loads. Additionally, by setting the TMDLs to meet targets established for the most critical period (summer), the TMDL will inherently be protective of water quality during all the other seasons.

The daily load reduction targets in this TMDL are calculated from the current phosphorus budgets for Smith, Faille and Osakis Lake. The budget is an average of four to six years of monitoring data. BMPs designed to address excess loads to the lakes will be designed for these average conditions; however, the performance will be protective of all conditions.

3.0 Monitoring Plan to Track TMDL Effectiveness

Future monitoring of water quality in Smith Lake, Faille Lake and Osakis Lake is necessary to enable assessment of whether progress is being made towards achievement of TMDL goals. Monitoring is also important to improve upon the current understanding of the lake dynamics. A better understanding of the linkages between load sources and lake response will reduce uncertainties associated with model predictions, and allow refinement of load allocations to various sources. This type of effectiveness monitoring is critical in the adaptive management approach. Results of the monitoring identify progress toward benchmarks as well as shape the next course of action for implementation.

After a substantial portion of the implementation work has been completed, effectiveness monitoring should begin and be maintained for a minimum of 3-4 years. The TMDL report recommends the following monitoring strategy.

At the EQuIS established sampling locations for Smith Lake (21-0016), Faille Lake (77-0195) and Osakis Lake (77-0215)

a .Epilimnion (surface) Sampling:
- § 10-12 times per summer (May-September) season:
- § Total phosphorus
- § Chlorophyll-a
- § Secchi depth
- § Temperature and dissolved oxygen profile, pH (1-meter depth intervals)

b. Hypolimnion (bottom) Sampling: Smith Lake (21-0016) and Osakis Lake (77-0215)
- § Total phosphorus (5-6 times per summer season)
- § Ortho P (5-6 times per summer)
- § Total Iron (5-6 times per summer)
- § Total Sulfate (5-6 times per summer)

2) At the JD2 inlet to Osakis Lake
- § Continuous flow (gaging site with electronic logger)
- § 18-20 times per year:
- § Total phosphorus
- § Chlorophyll-a
- § Temperature, pH, dissolved oxygen, conductivity (with portable sonde), t-tube
- § Ortho P
- § TSS

3) Blue-green toxicity testing if excessive algae blooms occur.

4) Flow monitoring should be done annually at established sites. Flow data will be used to determine water volume and annual loading. Electronic data loggers will be maintained to capture water elevations to be converted to flow/discharge.

Curly-leaf pondweed, which is known to increase eutrophication in North American lakes, is present in Smith Lake and Osakis Lake, but the extent and total biomass varies from one year to year. Curly-leaf pondweed is unique compared to native aquatic plants in that it grows under the ice and during the spring when water temperatures are still cold. Ice thickness and snow depth may affect the growth of curly-leaf pondweed by limiting the amount of light reaching the curly-leaf pondweed. If feasible, curly-leaf pondweed monitoring should be conducted as part of the implementation plan to document the coverage and density of curly-leaf prior to and after implementation.

Estimated Annual Cost for Monitoring: $15,000
Funding Source*:* Grant funds, Lake Associations, general funds

4.0 Implementation Plan

The Osakis Lake Area TMDL implementation plan focuses on reducing external sources of phosphorus to the watershed with some additional efforts to address internal phosphorus loading. The annual load reductions recommended in the TMDL study for the three lakes to meet state water quality standards are 819 lbs/yr. (31% reduction) for Smith Lake, 2,193 lbs/yr (72% reduction) for Faille Lake, and 7,158 lbs/yr. (41% reduction) for Osakis Lake. Load-reduction projects should be implemented following a priority ranking system for the available nutrient reduction strategies. Additional monitoring is also recommended to help determine the removal efficiency of planned watershed measures to reduce phosphorus loading to the lake. This Implementation Plan details the specific activities the stakeholders in the lake's watershed plan to undertake to attain the necessary reduction.

4.1 TMDL and Implementation Plan Process

The activities and Best Management Practices (BMPs) identified in this Implementation Plan will be carried out by the Sauk River Watershed District (SRWD) and stakeholders of the Osakis Lake watershed area to achieve water quality standards. The SRWD will begin by establishing a Technical Advisory Committee (TAC). The TAC will include stakeholder representatives from the city of Osakis, Minnesota Department of Natural Resources (MNDNR), the Board of Water and Soil Resources (BWSR), the Minnesota Pollution Control Agency (MPCA), the Todd and Douglas County Soil and Water Conservation Districts (SWCD) and Natural Resource Conservation Service (NRCS), Todd County Planning and Zoning Department, Douglas County Land and Resource Management and staff from the West Central Technical Services Area.

This implementation project will begin by utilizing technology to determine where high priority runoff areas are within the watershed of Smith Lake, Faille Lake and Osakis Lake. In 2013-14 the Sauk River Watershed District (SRWD) used Clean Water Funds to conduct an advanced sub-watershed model utilizing the MPCA's initial HSPF (Hydrologic Simulation Program in FORTRAN) watershed wide model and refining it to a smaller scale. The enhanced model will assist the SRWD and local agencies in developing a more refined focus for BMP implementation efforts thereby improving water quality more effectively. Sharing priority information, data and tracking completed BMP projects with local agencies are critical steps for a successful strategic implementation program. The new web based database and interactive mapping system developed will improve communication with local agencies and targeting restoration efforts.

Information developed from the University of Minnesota for the 39 agro-regions of Minnesota was used as a guide to develop this TMDL Implementation Plan. A list of riparian and upland management practices that appear most appropriate within the Central Till agro-ecoregion, which contains Smith, Faille and Osakis Lake watersheds, recommended for reducing nutrient and sediment transport under the Vegetative, Primary Tillage, Structural Practices, and Manure Management categories include the following:

Vegetative Practices

- Contour farming/Strip cropping
- Grassed waterways
- Grass filter strip for feedlot runoff
- Forest management practices
- Alternative crop in rotation
- Conservation Cover Crop
- Field windbreak
- Pasture management (IRG)
- Riparian restoration
- Conservation Reserve Program (CRP) or Enhancement program (CREP)29

Primary Tillage Practices

- Chisel Plow
- One pass tillage
- Ridge till
- Sustain surface roughness

Structural Practices

- Wetland restoration
- Livestock exclusion and management
- Liquid manure waste facilities
- Bank stabilization
- Stormwater retention/infiltration
- Terraces
- Water and sediment control basins
- Side inlets
- Alternative tile intakes
- Controlled drainage
- Pattern tile
- Two-stage ditch design

Livestock and Manure Management

- Manure Management plans
- Feedlot runoff control
- Agricultural waste pit closures

4.2 Implementation Plan- Activities and Cost:

The focus in implementation will be on reducing the annual phosphorus loads to the lake through structural and non-structural Best Management Practices and projects. Management alternatives and strategies have been developed for the lakes within the Osakis Lake area watershed to reduce total phosphorus from non-point sources in the watershed. The activities and practices described below have been used in the Sauk River watershed in the past and/or have been suggested as practices to be considered for reducing phosphorus in the Osakis Lake area watershed. This section describes various activities that will be undertaken to reduce nutrient loads and runoff volume to the area lakes.

4.2.1 Coordination of Efforts

One of the primary role of the SRWD is serving as a coordinator of water resource activities. The District will continue in that role in the implementation of this TMDL. General activities now undertaken by the District will be continued or expanded as the TMDL is implemented.

- Provide advice and assistance to local communities/landowners on their implementation activities;
- Research and disseminate information on changing BMP technology and practices;
- Recommend activities such as vegetation or fishery management, partnering with the DNR;
- Maintain the watershed models and database;
- Conduct public hearings on proposed projects; and
- Pursue financial assistance funds to share the cost of improvement projects.

Estimated Cost: Ongoing activity
Funding Source: General operating budget

4.2.2 Public Education and Outreach for Water Quality Protection

The District operates an ongoing education and outreach program. An extensive outreach program for the Osakis Lake area watershed will be developed to inform residents of the issues facing Smith Lake, Faille Lake and Osakis Lake and their roles in addressing these issues. This public education program will promote a community-to-community awareness and clearly identify the contribution from all communities, such as waterfront property owners and agricultural producers. This education program will integrate public relations advertising, marketing, civic engagement, public involvement, technical assistance, and training to optimize nutrient reductions from all phosphorus loading sectors within the overall watershed.

Estimated Cost: $5,500 annually
Funding Source: General operating budget and grant funding, project partners

4.2.3 Support Enforcement of Existing Regulations

Existing regulations are often sufficient to improve water quality in these watersheds, but a lack of enforcement capabilities of the regulations can result in them being less effective. Enforcement of existing regulations by entities with management authority should be supported.

Estimated Cost: $5,000
Funding Source: General operating budget and grant funding, project partners

4.3 District Initiated Activities

The Sauk River Watershed District's focus will be to improve the water quality in areas lakes within the Osakis Lake watershed, mainly Smith Lake, Faille Lake and Osakis Lake. The District will undertake the following priority implementation actions to achieve water quality standards in these lakes.

4.3.1 Activate the Management Unit Charge

The District will establish a basis for the water management unit charge (MU) and hold public hearings to establish the Osakis Lake (#1) water management unit as described in the 2013-2023 District's Comprehensive Management Plan. Funding from the established water management units (or districts) will be used to provide a financial incentive for landowners to participate in implementing BMPs to improve water quality..

Estimated Cost: $50,000
Funding Source: General operating budget and grant funding

4.3.2 Infiltration and filtration Initiative

Reducing phosphorus loading to Smith, Faille and Osakis Lakes can be accomplished by increasing infiltration and filtration in the lake watersheds. Conservation BMPs such as large scale infiltration areas, removing tile lines, native buffers, and vegetated swales can reduce nutrient loading to area lakes. The SRWD will pursue grant funds to provide a financial incentive for landowners to participate in implementation efforts. The District will require landowners to sign a financial agreement and operation and maintenance plan to ensure project integrity is maintained for the life expectancy of the BMP installed.

Estimated Cost: $45,000 annually
Funding Source: SRWD General operating budget, SWCD, and grant funding

4.3.3 Biological Management Plan

Additional attention will be given to internal phosphorus load reduction using biological treatment options. Carp and bullhead are bottom feeding fish found in Smith Lake, Faille Lake and Osakis Lake that disturb the lake sediment, causing phosphorus to be recycled back into the water column. Additional attention will be given to measuring the amount of carp present in these lakes during the next fisheries survey. Possible carp removal will be reviewed after survey results are compiled.

Curly-leaf pondweed is present in both Smith Lake and Lake Osakis at high concentrations in certain sections of these lakes. The die-back of the curly-leaf pondweed in summer can be a significant source of internal phosphorus load that often results in a late summer nuisance algal bloom. Vegetation management, such as chemical treatment, will be required to keep this exotic invasive species at non-nuisance levels. As BMPs are implemented and water clarity improves, the aquatic vegetation community will change. Surveys should be updated periodically and vegetation management plans amended to take into account appropriate management activities.

Estimated Cost: $25,000 annually
Funding Source: MNDNR, Smith Lake and Osakis Lake Associations, WMD and Grant funding

4.4 Partner Initiated Agricultural Activities:

The SRWD will partner with the Douglas and Todd County SWCDs and NRCS, University of MN Extension, and the MN Dept. of Agriculture to target nutrient management actions in the high potential delivery areas identified in Osakis Lake Area TMDL and the 2014 subwatershed HSPF model. These actions may include the following practices:

4.4.1 Soil Fertility and Manure Testing

Additional strategies that promote and support annual soil testing will be developed to provide agricultural producers with the tools necessary to make sound agronomic, economic, and environmental decisions. Incentives for agricultural producers conducting soil testing and manure testing will be considered. Enhanced education on the economic and environmental benefits of soil and manure testing will be accomplished through local SWCD and NRCS offices.

Estimated Cost: $5,000 annually
Funding Source: Local programs, Grant funding

4.4.2 Manure Application Management

Minnesota feedlot rules (MR 7020) now require manure management plans for feedlots greater than 300 animal units that do not employ a certified manure applicator. These plans require manure accounting and record-keeping as well as manure application risk assessment based on method, time and place of application. The following BMPs will be considered in all manure management plans to reduce potential nutrient delivery to surface waters:

- Immediate incorporation of manure into topsoil
- Reduction of winter spreading, especially on slopes
- Eliminate spreading near open inlets and sensitive areas
- Apply at agronomic rates
- Follow setbacks in feedlot rules for spreading manure
- Erosion control through conservation tillage and vegetated buffers

For manure stockpile runoff controls there are a variety of options that reduce nonpoint source nutrient loading, including:

- Move fences or altering layout of feedlot
- Eliminate open tile intakes and/or feedlot runoff to direct intakes
- Install clean water diversions and rain gutters
- Install grass buffers
- Maintain buffer areas
- Construct solid settling area(s)
- Prevent manure accumulations
- Manage feed storage
- Manage watering devices
- Total runoff control and storage

Estimated Cost: $75,000 annually
Funding Source: Local programs through SWCD and NRCS, Grant funding

4.4.3 Structural Practices

Structural practices generally require more site-specific planning and an engineered design. Most structural practices focus on slowing water down in the watershed to decrease nutrient and sediment loading to the receiving water. An example of this would be a wetland restoration (i.e. Crooked Lake basin) which creates a natural method of slowing runoff and storing it for a period of time, which can improve channel stability and reduce flooding downstream. The calmer conditions of a wetland can effectively settle out nutrient and sediment particles from runoff. Feedlot structures to reduce runoff from open lots will require site specific engineered designs.

Estimated Cost: $150,000 annually, depending on participation
Funding Source: SWCD and NRCS programs, SRWD WMU funds and other grant funds

4.4.4 Agricultural Drainage

An evaluation of the agricultural land drainage networks for the Smith Lake and Osakis Lake watersheds will be undertaken. This assessment will explore the feasibility of reducing the velocity of flow in agricultural drains and ditches to allow particulate nutrients an opportunity to settle out. The use of nutrient traps or settling basins along drains will be explored to determine their effectiveness in reducing nutrient loading. This activity will include a review of the feasibility of acquiring marginal land and constructing new wetlands, or restoring existing wetland areas that could serve as natural filters for drainage water.

Estimated Cost: $50,000 annually (Crooked Lake basin restoration could exceed $2 million)
Funding Source: Douglas and Todd County SWCD funds, Grant funding and SRWD WMU funds

4.4.5 Livestock Access to Riparian Areas and Waterways

Within the Osakis Lake watershed there is large number of livestock operations. Landowners having drainage from confined livestock areas will be encouraged to direct runoff to retention basins, grassed buffer strips, constructed wetlands, or other recommended nutrient-reduction feature. Manure accumulated in confined holding areas should be remove regularly and apply to crop or pasture lands during appropriate seasons and at appropriate agronomic rates. Livestock producers will be encouraged through enhanced incentives, education, and (when required) regulations to implement measures to protect riparian areas and waterways, such as managing livestock access in riparian areas and providing off-site watering structures. Agriculture extension programs, as well as other partnership programs, will be used to help agricultural producers assess the environmental risk of their operations. These programs will also be used to provide advice on how to prevent the contamination of groundwater and surface water.

Estimated Cost: $45,000 annually
Funding Source: SWCD and NRCS programs, Grant funding and SRWD WMU funds

4.5 Partner Initiated Non-Agricultural Activities

The SRWD will partner with the Douglas and Todd County regulatory and non-regulatory agencies to target nutrient management actions that are under the jurisdiction of the county agencies. These actions may include the following practices:

4.5.1 Ditch Maintenance

Public, private and roadside ditch cleaning has the potential to contribute significant nutrient loadings and exacerbate stream channel erosion due to increasing discharge rates and erosion of channel material. An assessment of the current and planned ditch cleaning activities along with a review of their best management practices will be completed and evaluated for structural and non-structural improvements. The SRWD will work with Todd and Douglas County Ditch authorities and Public Works Departments to attain information for public ditches and roadside ditches. For private ditches, the SRWD will work with the DNR and permitting agencies as landowners plan clean outs.

Estimated Cost: $5,000 annually
Funding Source: SRWD WMU and Grant funding and local partners

4.5.2. Septic System Maintenance

A focused educational campaign will be undertaken to provide guidance to homeowners on how to properly maintain septic systems and how to recognize when they are failing. The SRWD will encourage the local governing agencies to conduct mandatory inspection of private sewage treatment systems at the time of sale. The sale of the property would be conditional on a properly functioning system. The SRWD and local agencies will explore the funding options to recover the costs of conducting an ongoing comprehensive septic system field inspection program and maintaining a septic system database. County staff will conduct the septic inspections and work with local landowners for compliance. The SRWD will provide financial assistance to landowners for installation using the SRF low interest loan program.

Estimated Cost: $2500 annually for public outreach
Funding Source: County funds, WMD and SRF loan funding

4.5.3 Urban, Road and Highway Stormwater Management.

The municipalities in the Osakis Lake watershed are the cities of Osakis and Nelson. The watershed also contains approximately 5,286 acres of township, county and state roads and highways. While municipalities and roadways account for only 7% of watershed land use, they have the potential to contribute up to 22% of the phosphorus load to Osakis Lake. The following BMPs and activities will be considered to reduce phosphorus loading from these developed areas:

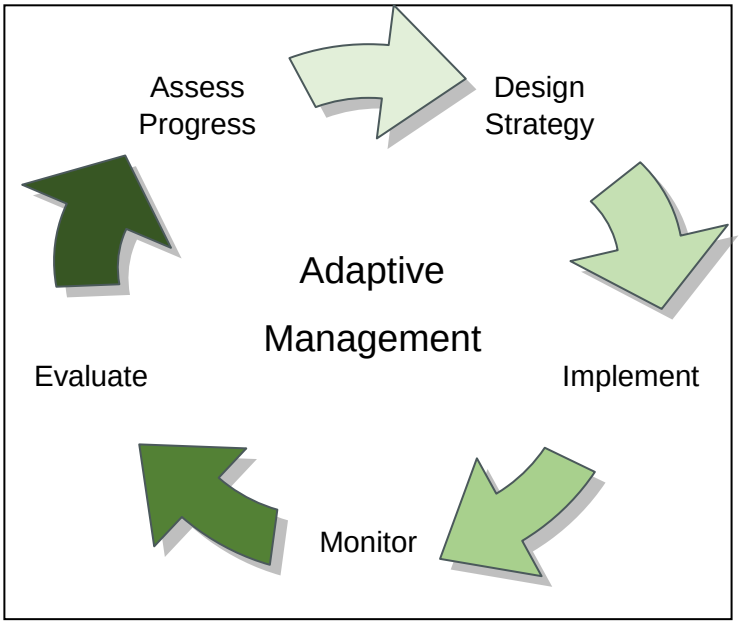
- Increase infiltration, filtration and evapotranspiration in existing developed areas through the use of rain gardens, native plantings and reforestation.
- Implement retrofit BMPs to add or increase treatment for street or highway reconstruction projects, park improvements and other road/highway projects throughout the watershed.
- Identify key areas within each municipality for street sweeping.
- Improvements/changes to WWTP and municipal stormwater ponds to ensure minimal overflow during large rain events

When dealing with impairments due to nonpoint sources, no single practice or activity will improve water quality to the point of achieving standards. It will take a number of practices in different areas to improve water quality across the watershed ranging from simple, small-scale fixes, to changes in mindsets when dealing with water and watershed management.

5.0 Adaptive Management

The implementation strategies summarized above will be implemented in order to achieve reductions in phosphorus loading necessary to achieve water quality targets in Smith Lake, Faille Lake and Osakis Lake. Overall, this implementation strategy will be adaptive as projects are completed. The implementation strategies will be reevaluated and updated as new data becomes available. Consideration will be given on how implementation of upstream phosphorus reduction strategies affects downstream phosphorus sources. The only known point sources in this project area watershed is being address as part of the Clifford Lake TMDL project. This implementation plan will focus exclusively on non-point source controls.

Figure 4. Adaptive management



The implementation activities listed will be ongoing for 20+ years. The nutrient reduction needs for the Osakis Lake area watershed identified in the TMDL require aggressive goals. Implementation activities will be conducted using an adaptive management approach. Adaptive management is based on assessment, planning, action, monitoring, evaluation and adjustment based on knowledge gained. Changes in water quality standards, technology, research, and weather may alter the course of actions listed in this plan. Continued monitoring and adjustments responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in the Osakis Lake Area Excessive Nutrient TMDL.

The SRWD will coordinate efforts to determine what best management practices would be practical, economically feasible, and environmentally effective in reducing nutrient loading in Osakis Lake and the lakes within the watershed. BMP cost-effectiveness, combined with information about local water quality impairments and nutrient delivery to the lake and leveraged funding from outside sources, will be used to finalize a priority ranking system for implementing individual nutrient reduction strategies throughout the watershed.