Vadnais Lake Area WMO Total Maximum Daily Load (TMDL) Implementation Plan

Nutrient TMDL: Gem Lake, Gilfillan Lake, East Goose Lake, West Goose Lake, Wilkinson Lake
Bacteria TMDL: Lambert Creek

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1.0 INTRODUCTION

1.1 PURPOSE

This Implementation Plan addresses 303(d) impairments for aquatic recreation based on high bacteria concentrations in Lambert Creek and high nutrient concentrations in five lakes within Vadnais Lake Area Water Management Organization (VLAWMO). These waterbodies are located in Ramsey and Anoka Counties in the northern Twin Cities Metro Area (see Figure 1.1). Table 1.1 lists the impairments addressed in this report.

Table 1.1. Impairments Addressed in this Report.

Listed Reach Name/ AUID	Listed Pollutant	Impaired Use	State Standard	Year Placed on 303(d) Impaired Waters List	TMDL Target Start	TMDL Target Completion
Unnamed Creek (Lambert Creek); Highway 96 to Vadnais Lk #07010206-801*	Pathogens, *(E. coli*)	Aquatic Recreation	Chronic: 30-day geometric mean is not to exceed 126 cfu/100mL (n≥5 samples) Acute: 10% of values are not to exceed 1,260 cfu/100 mL	2008	2010	2014
Gem Lake #62-0037-00	Nutrient/ Eutrophication Biological Indicators	Aquatic recreation	≤60 μg/L TP ≤20 μg/L Chlorophyll-*a* ≥1.0 m Secchi depth	2010	2010	2014
Goose Lake East #62-0034-00	Nutrient/ Eutrophication Biological Indicators	Aquatic recreation	≤60 μg/L TP ≤20 μg/L Chlorophyll-*a* ≥1.0 m Secchi depth	2010	2010	2014
Goose Lake West #62-0126-00W	Nutrient/ Eutrophication Biological Indicators	Aquatic recreation	≤60 μg/L TP ≤20 μg/L Chlorophyll-*a* ≥1.0 m Secchi depth	2010	2010	2014
Gilfillan #62-0027-00	Nutrient/ Eutrophication Biological Indicators	Aquatic recreation	≤60 μg/L TP ≤20 μg/L Chlorophyll-*a* ≥1.0 m Secchi depth	2010	2010	2014
Wilkinson #62-0043-00	Nutrient/ Eutrophication Biological Indicators	Aquatic recreation	≤60 μg/L TP ≤20 μg/L Chlorophyll-*a* ≥1.0 m Secchi depth	2010	2010	2014

*Previously AUID#'s 07010206-639 and 07010206-637

1.2 VADNAIS LAKE AREA WMO

VLAWMO's mission is to protect and enhance the water resources within the watershed. Activities include water quality monitoring, wetland protection, and water quality enhancement projects. As such VLAWMO is well-suited to coordinate implementation in concert with stakeholders.

VLAWMO was formed in 1983 to protect the Vadnais Lake watershed. VLAWMO is governed by a six member Board of Directors that is represented by an elected official from the cities of North Oaks, White Bear Lake, Gem Lake, Vadnais Heights, and White Bear Township.

VLAWMO has a Watershed Management Plan (available at www.vlawmo.org) which addresses the entire VLAWMO watershed and all water bodies included therein. The Plan, which has been approved by the Minnesota Board of Water and Soil Resources (BWSR), guides water management through goals, policies, management strategies and an implementation program for the watershed. Work done for the Total Maximum Daily Load (TMDL) Protection Study and this Implementation Plan is an extension of the Watershed Management Plan. The TMDL Protection Study was approved by the US Environmental Protection Agency (EPA) on April 3, 2014. More information on the TMDL Protection Study can be found at: http://www.pca.state.mn.us/dada34q.

Because VLAWMO's specific mission is protection and improvement of water quality, it is in the ideal position to coordinate implementation efforts of the member cities. Each city is a Municipal Separate Storm Sewer System (MS4) permit holder and is affected by the TMDL process in that each MS4 received a Waste Load Allocation (WLA) from the TMDLs addressed in this study (as applicable). Further, each city has in place a Local Water Management Plan to address watershed and city goals and objectives; those local plans are periodically updated to reflect resource management plans and adopt or revise strategies for water resource management. In addition to the member cities, Anoka County, Ramsey County, Minnesota Department of Transportation (MNDOT), and White Bear Lake Township are MS4 permit holders affected by this TMDL.

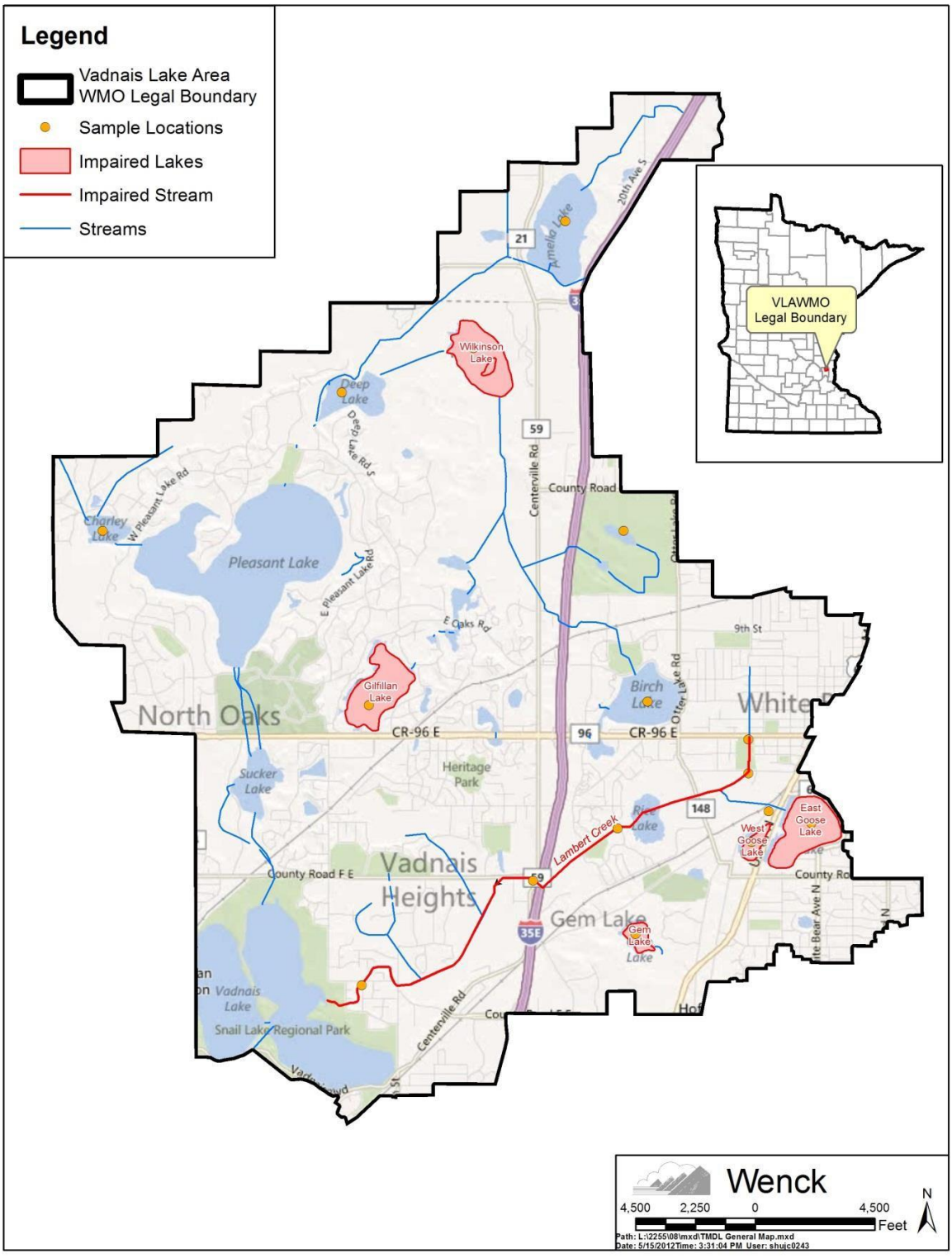


Figure 1.1. Location of Impaired Waters.

1.3 WATER QUALITY STANDARDS AND NUMERIC TARGETS

Gem, East Goose, West Goose, Gilfillan, and Wilkinson Lakes are shallow lakes classified as class 2B waters for which aquatic life and recreation are the protected beneficial uses. Wilkinson is also listed as 1C, 2B, and 3C and Gem, Gilfillan, East Goose and West Goose are also listed as 3C, 4A, 4B, 5 and 6 waters. These four lakes were placed on the State of Minnesota's 303(d) impaired waters list in 2010. These lakes are impaired by excess nutrient concentrations, which inhibit aquatic recreation.

Under Minnesota Rules 7050.0150 and 7050.0222, Subp. 4, Gem, Gilfillan, East Goose, West Goose and Wilkinson lakes are considered to be shallow lakes located within the North Central Hardwood Forest ecoregion with a numeric target of ≤60 μg/L for total phosphorus. These standards are considered the water quality goals that each of the lakes must meet (see Table 1.2).

Table 1.2. TMDLs Numeric Targets for Lakes in the North Central Hardwood Forest Ecoregion.

Parameters	Shallow Lakes in the North Central Hardwood Forest Ecoregion[1]
Total phosphorus concentration (μg/L)	**≤60**
Chlorophyll-*a* concentration (μg/L)	**≤20**
Secchi disk transparency (meters)	**≥1.0**

[1] Shallow lakes are defined as lakes with a maximum depth of 15 feet or less, or with 80% or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants (littoral zone) (Minnesota Rules 7050.0150, Subp.4).

Lambert Creek is classified as 2B, 3C, 4A, 4B, 5 and 6 waters. For Lambert Creek, the standards for bacteria are evaluated by the use of *E. coli* measurements. Under Minnesota Rules 7050.0150 and 7050.0222, "*Escherichia (E.) coli* bacteria shall not exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31." Therefore, the goal is not to exceed these standards in the index period.

2.0 TMDL SUMMARY

2.1 NUTRIENT TMDL

The numerical TMDLs for Gem, East Goose, West Goose, Gilfillan, and Wilkinson Lakes were calculated as the sum of the Wasteload Allocation (WLA), Load Allocation (LA) and Margin of Safety (MOS) and are expressed as phosphorus mass per unit time. Results are presented daily and annually. Nutrient loads in this TMDL were set for phosphorus since this is typically the limiting nutrient for nuisance aquatic algae. This TMDL was written to solve the TMDL equation for a numeric target of 60 μg/L of total phosphorus as a summer growing season average.

The tables below are from the TMDL report and represent the reductions necessary to meet the required TMDLs for each waterbody. The TMDL for each lake is presented in Tables 2.1 and 2.2. The allocation to MS4s and other sources are presented in Tables 2.3 and 2.4. More information on the TMDL can be found at: http://www.pca.state.mn.us/dada34q.

Table 2.1. Nutrient TMDLs (as annual loads).

Annual TP Loading (lb/yr)	TMDL =	LA +	WLA +	MOS
Gem	54.9	5.2	47.0	2.7
Goose - East	187.9	99.8	78.7	9.4
Goose - West	224.2	173.0	40.0	11.2
Lake Gilfillan	164.7	139.4	17.0	8.3
Lake Wilkinson	321.8	126.4	179.4	16.1

Table 2.2. Nutrient TMDLs (as daily loads).

Daily TP Loading (lb/day)	TMDL =	LA +	WLA +	MOS
Gem	0.150	0.014	0.129	0.008
Goose - East	0.514	0.273	0.215	0.026
Goose - West	0.614	0.474	0.109	0.031
Lake Gilfillan	0.451	0.382	0.047	0.022
Lake Wilkinson	0.881	0.346	0.491	0.044

Table 2.3. Nutrient WLA by MS4 (as annual loads).

			MS4s									
Lake	WLA (lbs/yr)	M-Foods Dairy, LLC.(1)	Anoka County	Gem Lake City MS4	Lino Lakes City MS4	MNDOT	North Oaks City MS4	Ramsey County	Vadnais Heights City MS4	White Bear Lake City MS4	White Bear Township MS4
Gem	47.0	-	-	23.9	-	5.2	-	9.0	-	8.9	-
Goose - East	78.7	-	-	2.2	-	7.9	-	3.9	-	64.7	-
Goose - West	40.0	24.7	-	2.8	-	3.6	-	1.6	-	7.3	-
Lake Gilfillan	17.0	-	-	-	-	-	14.7	0.5	0.1	-	1.7
Lake Wilkinson	179.4	-	0.1	-	1.2	47.2	26.4	1.8	-	35.1	67.6

(1) WLA may be expanded in the future. See Section 6.1.3

Table 2.4. Nutrient WLA by MS4 (as daily loads).

			MS4s								
Lake	WLA (lbs/day)	M-Foods Dairy, LLC.(1)	Anoka County	Gem Lake City MS4	Lino Lakes City MS4	MNDOT	North Oaks City MS4	Ramsey County	Vadnais Heights City MS4	White Bear Lake City MS4	White Bear Township MS4
Gem	0.129	-	-	0.065	-	0.014	-	0.025	-	0.025	-
Goose - East	0.215	-	-	0.006	-	0.022	-	0.011	-	0.176	-
Goose - West	0.109	0.068	-	0.007	-	0.010	-	0.004	-	0.020	-
Lake Gilfillan	0.047	-	-	-	-	-	0.041	0.001	<0.001	-	0.005
Lake Wilkinson	0.491	-	<0.001	-	0.003	0.129	0.072	0.006	-	0.096	0.185

(1) WLA may be expanded in the future. See Section 6.1.3

The sections below summarize the existing nutrient sources to the lake, the TMDL and the required load reductions and describe the allocation approach for each lake. The percent reductions for each MS4 are listed below. These percent reductions apply ONLY to the watershed area that drains to the impaired water (not reductions needed from internal phosphorus loading); these areas are shown in Appendix D of the TMDL and Protection Study.

- 24% reduction in watershed phosphorus loading to Gem Lake applies to
  - Gem Lake
  - MNDOT
  - Ramsey County
  - White Bear Lake City
- 63% reduction in watershed phosphorus loading to East Goose Lake applies to
  - Gem Lake
  - MNDOT
  - Ramsey County
  - White Bear Lake City
- 86% reduction in watershed phosphorus loading to West Goose Lake applies to
  - Gem Lake
  - MNDOT
  - Ramsey County
  - White Bear Lake City
- 0% reduction in watershed phosphorus loading to Gilfillan Lake applies to
  - North Oaks
  - Vadnais Heights

    - White Bear Lake Township
- 76% reduction in watershed phosphorus loading to Wilkinson Lake applies to
    - Anoka County
    - Lino Lakes
    - MNDOT
    - North Oaks
    - Ramsey County
    - White Bear Lake City
    - White Bear Township

2.1.1 Gem Lake

As shown in Figure 2.1, the dominant phosphorus loading in Gem Lake is from watershed sources (permitted MS4s). As such, the primary nutrient load reduction must come from watershed sources (Table 2.5). Eliminating load from septic systems will also be required. In order to meet the TP goal in Gem Lake, approximately an overall 24% reduction in TP is required.

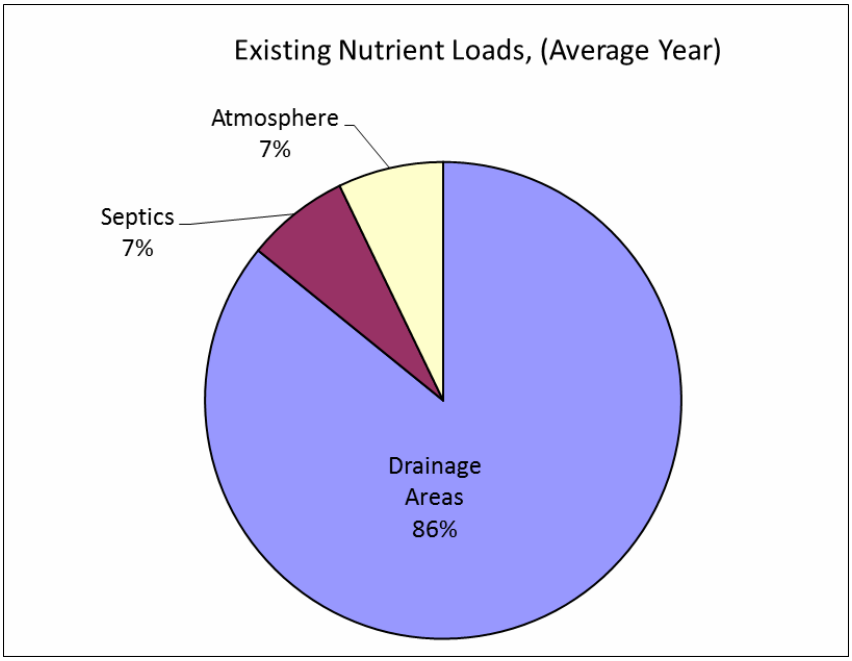


Figure 2.1. Gem Lake Existing Phosphorus Load Breakdown by Source.

Table 2.5. Gem Lake Existing Nutrient Load, TMDL and Required Reductions.

		Existing TP Load		TP TMDL		Load Reduction	
Allocation	Source	(lbs/year)	(lbs/day)	(lbs/year)	(lbs/day)	(lbs/year)	%
WLA	Drainage Areas	62.1	0.170	47.0	0.129	15.1	24%
LA	Septics	5.1	0.014	0.0	0.000	5.1	100%
LA	Atmosphere	5.2	0.014	5.2	0.014	0.0	0%
LA	Internal Load*	0.0	0.000	0.0	0.000	0.0	NA
MOS			0.000	2.7	0.007		
	TOTAL	72.4	0.198	54.9	0.150	17.5	24%

*The Gem Lake model did not require the addition of internal load in excess of the load that is implicit in the model.

Note: The margin of safety was deducted from the modeled allowable drainage area load and the total load reduction values (lbs/yr and %) account for the margin of safety.

2.1.2 Gilfillan Lake

The dominant phosphorus loading in Gilfillan Lake is from internal loading (Figure 2.2). As such, the primary nutrient load reduction must come from a reduction of the internal load (Table 2.6). Eliminating load from septic systems will also be required. In order to meet the TP goal in Gilfillan Lake, an overall 62% reduction in TP is required. The existing areal export rate for TP from the subwatershed is 0.03 lbs/acre. Since watershed loading is below expected background levels, a reduction from the watershed load is not anticipated to be achievable. The majority of the watershed is located in the City of North Oaks, which has developed in such a way that most of the impervious areas are disconnected from the drainage system (reflected by the low areal export from the watershed). The watershed area outside of the City of North Oaks drains through a series of ponds and wetlands that increase infiltration and evapotranspiration and reduce runoff conveying pollutant loads to the lake. Even though a load reduction from the watershed has not been explicitly called for, the implementation recommendations for Gilfillan Lake will include some action items within the watershed.

The outlet of Gilfillan Lake was modified historically to raise the level of the lake. The water level was also augmented through addition of pumped groundwater. A project approved by the Minnesota Department of Natural Resources (MDNR) will once again augment lake levels using water from Pleasant Lake. Construction is complete and augmentation activities have started. Augmentation was accounted for, and included in the load allocation, in the TMDL by generating an annual load calculated from the average TP concentration in Pleasant Lake (54 µg/L) and the volume of water required to make up for the negative water balance (54.5 ac-ft./yr).

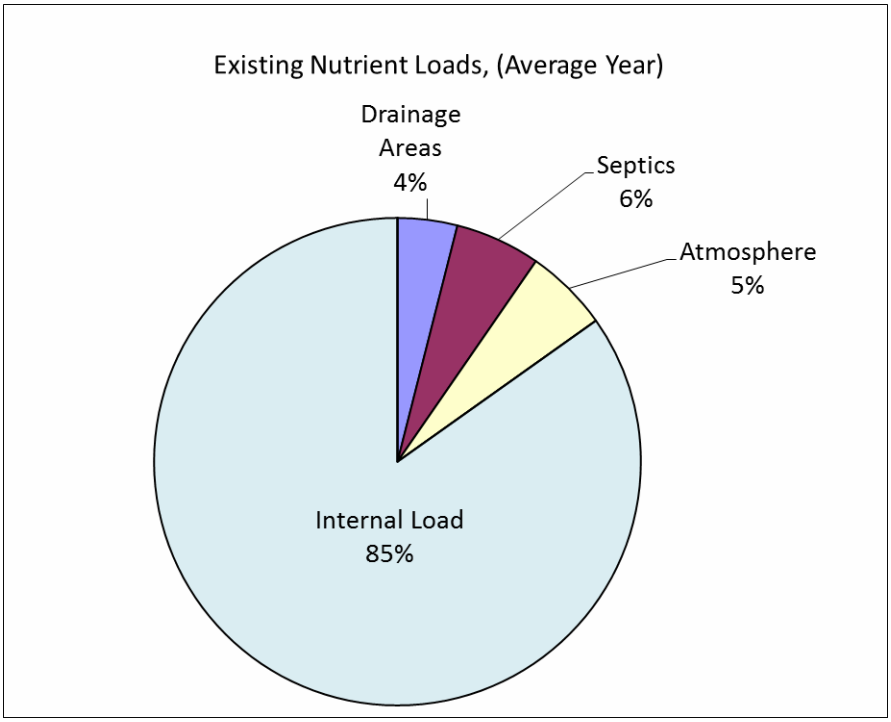


Figure 2.2. Gilfillan Lake Existing Phosphorus Load Breakdown by Source.

Table 2.6. Gilfillan Lake Existing Nutrient Load, TMDL and Required Reductions.

		Existing TP Load		TP TMDL		Load Reduction	
Allocation	Source	(lbs/year)	(lbs/day)	(lbs/year)	(lbs/day)	(lbs/year)	%
WLA	Drainage Areas	17.0	0.047	17.0	0.047	0.0	0%
LA	Septics	24.3	0.067	0.0	0.000	24.3	100%
LA	Atmosphere	23.8	0.065	23.8	0.065	0.0	0%
LA	Internal Load	364.2	0.997	107.5	0.294	264.7	73%
LA	Augmentation	0.0	0.000	8.0	0.022	0.0	NA
MOS				8.3	0.023		
	TOTAL	429.4	1.176	164.7	0.451	264.7	62%

Note: The margin of safety was deducted from the modeled allowable internal load and the total load reduction values (lbs/yr and %) account for the margin of safety. The internal load reduction also accounts for the augmentation load.

2.1.3 East Goose Lake

The dominant phosphorus loading in East Goose Lake is from internal loading, likely the result of historical loading to the sediments from the White Bear Lake Wastewater Treatment Plant (WWTP), which used to discharge to the basin (Figure 2.3). As such, the primary nutrient load reduction must come from a reduction of the internal load (Table 2.7). Significant watershed load reductions are also required. The watershed load reduction of 63% is based on what is expected to be achievable in the watershed (this reduction equates to an aerial export rate of approximately 0.14 lbs/acre). In order to meet the TP goal, an overall reduction of 91% is required.

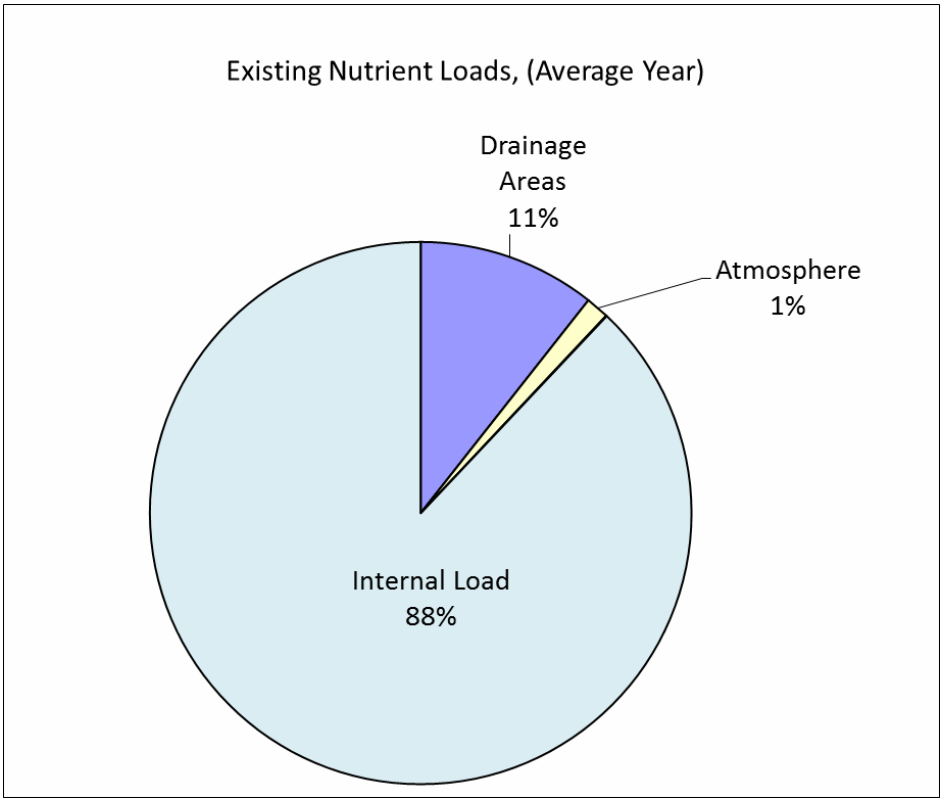


Figure 2.3. East Goose Lake Existing Phosphorus Load Breakdown by Source.

Table 2.7. East Goose Lake Existing Nutrient Load, TMDL and Required Reductions.

		Existing TP Load		TP TMDL		Load Reduction	
Allocation	Source	(lbs/year)	(lbs/day)	(lbs/year)	(lbs/day)	(lbs/year)	%
WLA	Drainage Areas	214.8	0.588	78.7	0.215	136.1	63%
LA	Atmosphere	27.9	0.076	27.9	0.076	0.0	0%
LA	Groundwater	0.8	0.002	0.8	0.002	0.0	0%
LA	Internal Load	1777.2	4.866	71.1	0.195	1706.1	96%
MOS				9.4	0.026		
	TOTAL	2020.7	5.532	187.9	0.514	1832.8	91%

Note: The margin of safety was deducted from the modeled allowable drainage area load and the total load reduction values (lbs/yr and %) account for the margin of safety.

2.1.4 West Goose Lake

Direct watershed loading to West Goose Lake represents 15% of the annual load compared with 57% from internal sources (Figure 2.4). As such, load reductions to both sources will be required to reduce the phosphorus load to the lake (Table 2.8). High phosphorus levels in the sediments are likely the result of historical loading to the sediments from the White Bear Lake Wastewater Treatment Plant (WWTP) which used to discharge to Goose Lake. The primary driver of internal loading in this lake is the re-suspension of phosphorus from lake sediments from motor boating, wind, rough fish activity, loss of native plant communities, and curly-leaf pondweed (if untreated). In order to meet the TP goal, an overall TP load reduction of 70% is required. This loading reduction also assumes that East Goose Lake (included as an upstream lake) meets its in-lake water quality goal of 60 µg/L.

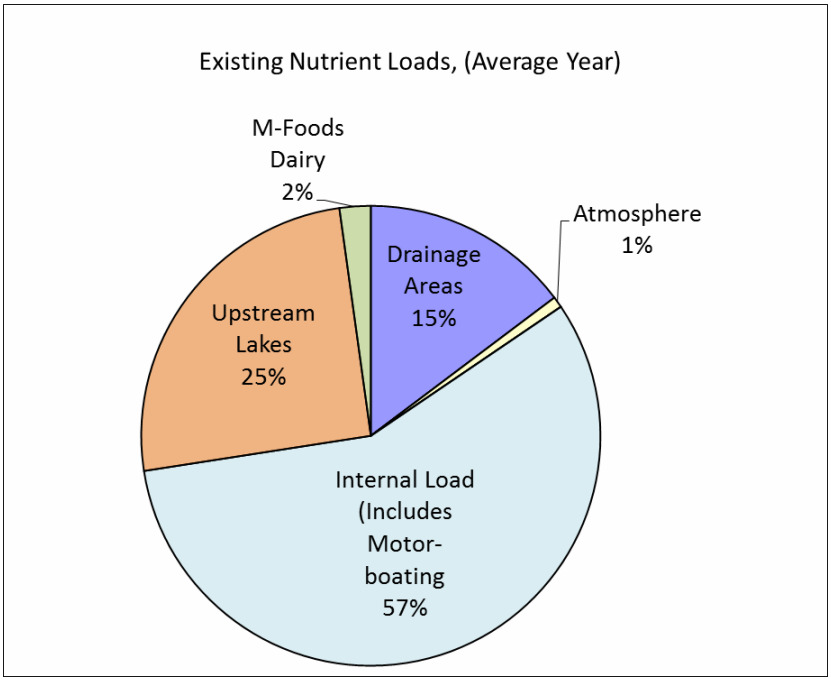


Figure 2.4. West Goose Lake Existing Phosphorus Load Breakdown by Source.

Table 2.8. West Goose Lake Existing Nutrient Load, TMDL and Required Reductions.

		Existing TP Load		TP TMDL		Load Reduction	
Allocation	Source	(lbs/year)	(lbs/day)	(lbs/year)	(lbs/day)	(lbs/year)	%
WLA	Drainage Areas	110.4	0.302	15.3	0.042	95.1	86%
LA	Atmosphere	5.8	0.016	5.8	0.016	0.0	0%
LA	Internal Load (Includes Motor-boating)	427.1	1.169	123.1	0.337	304.0	71%
LA	Upstream Lakes	189.1	0.518	44.1	0.121	145.0	77%
WLA	M-Foods Dairy*	16.5	0.045	24.7	0.068	0.0	0%
MOS				11.2	0.031		
	TOTAL	748.8	2.050	224.2	0.615	524.7	70%

* WLA may be expanded in the future. See Section 6.1.3.

Note: The margin of safety was deducted from the modeled allowable drainage area load and the total load reduction values (lbs/yr and %) account for the margin of safety.

2.1.5 Wilkinson Lake

Phosphorus loading to Wilkinson Lake is predominantly from the watershed load (Figure 2.5). Upstream lakes in the Wilkinson Lake subwatershed include Amelia and Birch Lakes. According to available data, these lakes are currently meeting State Standards with average internal phosphorus concentrations of 38.8 and 32.5 µg/L, respectively. Therefore, no load reduction from the upstream lakes is required. Internal loading comprises a small portion of the total load and with a low sediment release rate for a shallow lake such as Wilkinson (1.0 mg/m^2-day) a reduction in internal loading is not necessarily feasible. As such, nutrient load reduction must come from a reduction of direct watershed loads (Table 2.9).

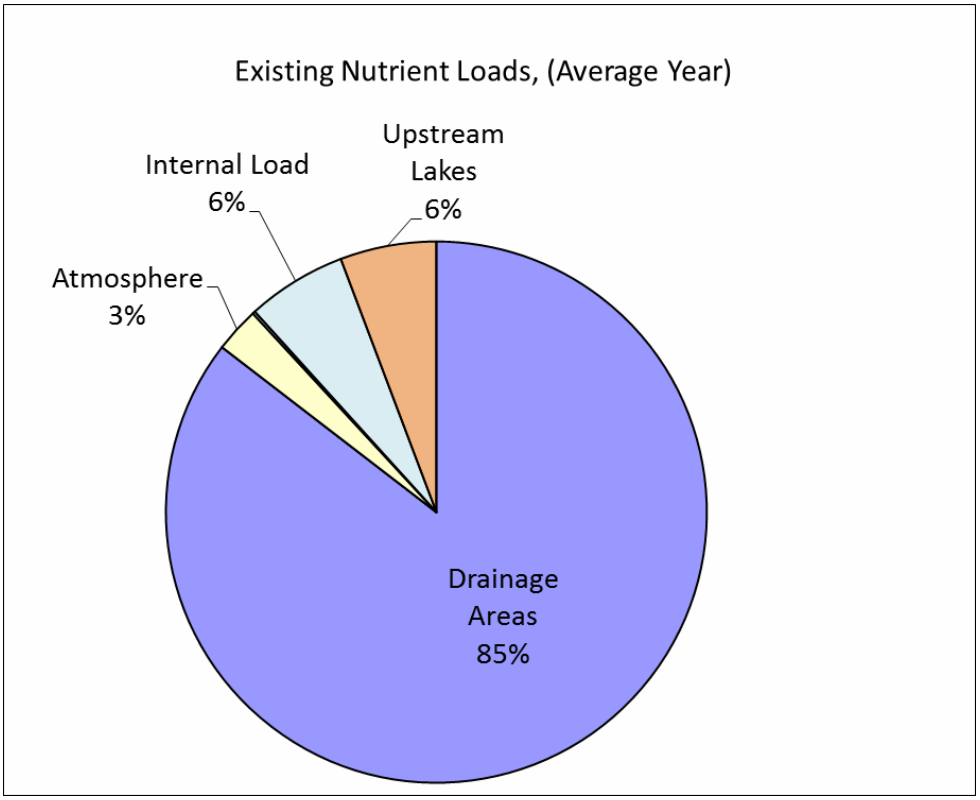


Figure 2.5. Wilkinson Lake Existing Phosphorus Load Breakdown by Source.

Table 2.9. Wilkinson Lake Existing Nutrient Load, TMDL and Required Reductions.

		Existing TP Load		TP TMDL		Load Reduction	
Allocation	Source	(lbs/year)	(lbs/day)	(lbs/year)	(lbs/day)	(lbs/year)	%
WLA	Drainage Areas	740.4	2.027	179.4	0.491	561.0	76%
LA	Atmosphere	23.3	0.064	23.3	0.064	0.0	0%
LA	Groundwater	1.4	0.004	1.4	0.004	0.0	0%
LA	Internal Load	51.8	0.142	51.8	0.142	0.0	0%
LA	Upstream Lakes	49.8	0.136	49.8	0.136	0.0	0%
MOS				16.1	0.044		
	TOTAL	866.7	2.373	321.8	0.881	544.9	63%

Note: The margin of safety was deducted from the modeled allowable drainage area load and the total load reduction values (lbs/yr and %) account for the margin of safety.

2.2 BACTERIA TMDL

2.2.1 *E. coli* Available for Runoff

The *E. coli* produced in the watershed was divided into several source areas. This process assumes that all *E. coli* produced in the watershed, remains in the watershed. The estimated amount of *E. coli* potentially available each month for runoff is shown in Table 2.10. The daily production estimates for each animal unit or individual were based on literature values for fecal coliform (MPCA 2002) which were converted to be expressed in terms of *E. coli.*

2.10. Estimated Monthly *E. coli* Bacteria Produced and Available During Runoff Events.

Category	Source	Animal Units or Individuals in Subwatershed (Presented as a range of expected values)	*E.coli* Organisms Produced Per Unit Per Month (10^9) (1)	Total *E. coli* Produced Per Month (10^9)	Total *E. coli* Produced by Category Per Month (10^9)	Total E. coli Available Per Month (10^9) (5)		Percent by Category	
						Range of Expected Values	Value used to calculate numeric TMDL	Range	Value used to calculate numeric TMDL
Wildlife	Deer	170 - 200	9.59	1,630 - 1,920	5,610 - 10,950	1,630 - 1,920	1,775	6 - 45%	19%
	Geese (4)	45 - 320	0.20	10 - 60		10 - 60	50		
	Ducks (6)	50 - 150	46.60	2,330 - 6,990		2,330 - 6,990	4,660		
	Other Wildlife	Equivalent of Deer and Geese	9.59	1,640 - 1,980		1,640 - 1,980	1,825		
Human	Failing Septic Systems (3)	-	38.35	-	-	-	-	-	-
Urban Stormwater (2)	Pet Waste	4,230 - 7,060	95.89	405,610 - 676,980	405,610 - 676,980	4,060 - 67,700	35,880	55 - 94%	81%
						Total	**44,190**		

(1) Derived from literature values in ASAE (1998), Metcalf and Eddy (1991), Horsely and Witten (1996), and Alderisio and DeLuca (1999).

(2) 0.58 dogs/household and 0.73 cats/household (Southeast Minnesota Regional TMDL (MPCA 2002)): Range based on ±25%.

(3) Based on map review, estimated four homes with septic systems adjacent to Lambert Creek. Assumed contribution of zero based on expected failure rates.

(4) Range estimated from the Canada Goose Program Report 2004 and The City of Eden Prairie Canada Goose Management Plan (2008). The "average' geese population was obtained through personal communication with Tom Keefe (President, Canada Goose Management, Inc.).

(5) Estimated that 1% to 10% of the *E. coli* produced per month attributed to pet waste is improperly managed and available for runoff.

(6) Population range estimate interpreted from statewide population information from the 2011 Waterfowl Breeding Population Survey: Minnesota by the MNDNR and USFWS and Minnesota DNR Wetland Wildlife Population Research (http://files.dnr.state.mn.us/fish_wildlife/roundtable/2010/wildlife/wf_pop-harvest.pdf)

Wildlife populations were estimated as previously discussed in the TMDL Protection Study, Section 4.2.7. Septic system failure was considered as a potential bacteria source; however, the contribution is assumed to be zero due to the lack of systems in the sub-watershed. Although most homes in Gem Lake are on septic systems, Gem Lake is an upstream boundary condition of Lambert Creek. Bacteria sourced from failing systems located around the shoreline of the lake were not considered due to dilution and other internal processes occurring in the lake prior to discharge to the creek. Based on a map review, there are only an estimated 4 homes adjacent to a tributary of Lambert Creek with septic systems. The homes are all new and soils and separation from the groundwater table in the area are ideal for proper septic system function. *E. coli* available through urban stormwater was calculated by applying a ratio of cats and dogs per household (see Table 2.10). The number of households in the Lambert Creek sub-watershed was determined using 2010 census data (5,677 households).

2.2.2 *E. coli* Delivery Potential

Delivery potential for each quantified source to reach surface waters is dependent on a variety of factors such as proximity to the creek or other conveyances and the quantity of precipitation received. The delivery potential assumptions presented in Table 2.11 are divided into wet weather conditions and dry weather conditions to differentiate between those sources that are precipitation driven versus those which are not. The dry weather sources are septic systems and wildlife with direct access to the creek. There are no known combined sewers. The septic system delivery potential is not presented as greater during wet conditions in that some septic systems are considered failing due to interaction with the water table, but may not have a direct connection to surface waters, dependent on proximity. In this particular case, the assumed septic system failure rate is zero. However, the delivery potential is included for reference. The delivery potential for geese is higher over deer and other wildlife based on the known, consistent proximity of the waterfowl to surface waters.

Table 2.11. *E. coli* Delivery Potential.

Source	Estimated Delivery Potential	
	Wet Conditions	**Dry Conditions**
Deer	Very Low	Very Low
Geese/Ducks	Moderate	Moderate
Other Wildlife	Very Low	Very Low
Urban Stormwater Runoff	Moderate	N/A

2.2.3 Bacteria TMDL

The TMDL loads for daily loads based on the 126 *E. coli*/100 mL standard are shown in Figure 2.6. The dashed lines represent the mid-point of each flow zone, from which the TMDL equation for each flow regime was derived.

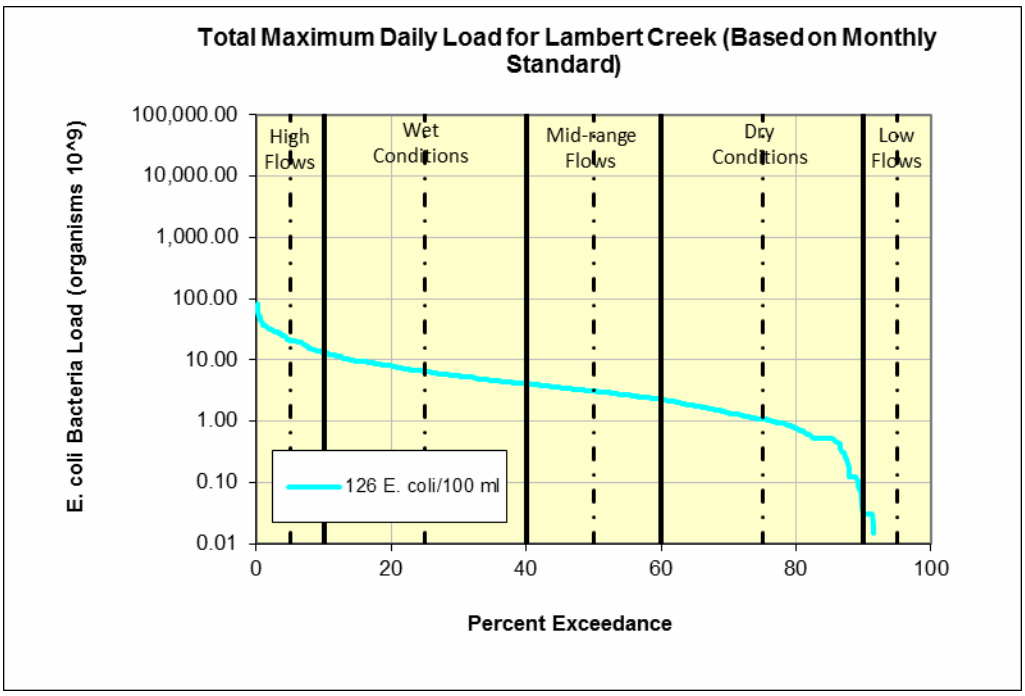


Figure 2.6. The Total Maximum Daily Load for Lambert Creek.
Values represent total daily load derived from monthly load (Standard of 126 *E. coli*/100 mL).

To develop the TMDL equation, the seasonal median discharge was calculated for each of five flow conditions. These data were then multiplied by the standard of 126 *E. coli*/100 mL to establish the TMDL (Table 2.12). The required load reduction for each flow regime is also presented on the table below. To calculate the load reduction, the geomean of all data available from each station within the impaired reach from April - October was calculated based on the five flow conditions. The resulting geomean concentration was applied to the median flow to derive the existing load; from which the required load reduction to achieve the TMDL was calculated. The above graph reflects that there are periods where Lambert Creek is dry or experiences no flow. Therefore, there is no TMDL allocation or necessary reduction for the low flow condition. It is of note that even though there are no load reductions required for the low flow condition, the BMPs recommended and applied as part of the TMDL implementation plan are effective at all flows. For example, pet waste management programs are a form of source control and not directly correlated to runoff events. The MS4 Wasteload Allocations are shown in Table 2.13. Wasteload was allocated between the MS4s for the bacteria TMDL in the same manner as for the lake nutrient TMDLs as described in Section 6.1.3 of the TMDL Protection Study.

Table 2.12. Bacteria TMDL, Expressed as Daily Loads.

Daily							
Reach	**Critical Condition**	**Current Load (Billions of org)**	**MS4 Wasteload Allocation**	**Load Allocation (Billions of**	**Margin of Safety (Billions of**	**TMDL (Billions of org)**	**Reduction Needed**
Lambert Creek	High Flow	54.35	15.38	3.56	2.10	21.04	61%
	Wet	14.26	4.78	1.11	0.65	6.54	54%
	Mid-Range	4.91	2.25	0.52	0.31	3.08	37%
	Dry	2.46	0.79	0.18	0.11	1.08	56%
	Low Flow	0.00	0.00	0.00	0.00	0.00	-

Table 2.13. MS4 Wasteload Allocation (Daily).

	MS4 Wasteload Allocation (Billions of org) (Daily)						
Critical Condition	**Gem Lake City MS4**	**MNDOT**	**Ramsey County**	**Vadnais Heights City MS4**	**White Bear Lake City MS4**	**White Bear Township MS4**	**Total Waste Load**
High Flow	0.68	1.17	0.56	8.78	3.74	0.45	15.38
Wet	0.21	0.36	0.17	2.73	1.16	0.15	4.78
Mid-Range	0.10	0.17	0.08	1.28	0.55	0.07	2.25
Dry	0.04	0.06	0.03	0.45	0.19	0.02	0.79
Low Flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.0 IMPLEMENTATION PLAN

As a part of the strategy to achieve implementation of the necessary reductions, VLAWMO sought stakeholder and public engagement and participation regarding their concerns, interests, and questions concerning the development of the Implementation Plan.

Stakeholder meetings were held on November 15, 2013 and April 1, 2014 to generate ideas from stakeholders about implementation projects that will address water quality problems in the impaired waterbodies. Representatives from the Board of Water and Soil Resources, Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, Ramsey County, Ramsey Conservation District, Wenck Engineering, White Bear Lake, White Bear Township, Vadnais Heights, North Oaks, Lino Lakes, Gem Lake, VLAWMO Board of Directors, Midwest Ski Otters, and lakeshore property owners attended the meetings. The stakeholder recommendations were used in the development, and prioritization of strategies for the Implementation Plan.

The number of Best Management Practices (BMPs) necessary to achieve the required phosphorus and bacteria load reduction is unknown and is dependent on the types of opportunities that arise. However, priority BMPs are listed in the following tables that will make progress towards meeting water quality standards. Estimated costs and prioritization of implementation activities are also indicated. Costs are dependent on the type of BMP, number implemented, location, easement requirements, and other factors. Additional BMPs not specifically listed may be applicable when opportunities arise. Some of the reduction strategies identified in the Implementation Plan may require participation of multiple entities. VLAWMO does anticipate providing leadership, or assistance in coordinating the partnership and cooperative agreements necessary to implement those BMPs.

3.1 GEM LAKE PRIORITY LOAD REDUCTION STRATEGIES

As discussed in Section 2.1.1, the dominant phosphorus loading in Gem Lake is from watershed sources (permitted MS4s). Priority management strategies will need to target the watershed nutrient loads. Septic systems are also a source of nutrient loading to Gem Lake. State law prohibits discharge from septic systems so a 100% reduction of this contribution is required. Potential phosphorus reduction strategies include:

- ***Improve street sweeping practices:*** Identify target areas for increased frequency of street sweeping. Consider replacing mechanical street sweepers with more efficient regenerative air sweepers ($250,000/truck), and/or improvements to equipment/technology to maximize sweeping effectiveness ($50,000).

- ***Infiltration practices***: Encourage the use of rain gardens and native plantings among property owners as a means to reduce direct watershed loads to the lake. Opportunities may range from providing a grant or cost share to a single property owner installing an individual rain garden ($500) to retrofitting parks and open space with native vegetation rather than mowed turf ($10,000). Maximize existing VLAWMO residential cost share programs, and community grant programs (Community Blue) to assist property owners with funding opportunities.
- ***Stormwater Management Retrofit Development and Implementation:*** Identify opportunities to retrofit existing areas to provide stormwater treatment and reduce loads to Gem Lake. The retrofit study may be found at: http://www.metrocd.org/images/stories/Programs/CWF/Assessments/GemLakeRetrofitStudy.pdf. Some implementation projects and opportunities for retrofits are identified in the study. Additionally, stakeholders may assess feasibility of larger scale regional projects that would address multiple commercial properties, and implement projects based on that assessment.
- ***Update Redevelopment Standards for Stormwater Runoff***: VLAWMO currently requires 0.5" of infiltration for projects that disturb greater than 1 acre. VLAWMO will address updating its stormwater standards in the fourth generation Water Management Plan in December 2016. Municipal Local Water Plans and standards must be updated (as needed) within two years after the VLAWMO Plan is adopted to meet or exceed the WMO's standards.
- ***Detention Pond Retrofit and Maintenance:*** As opportunities arise, retrofit stormwater treatment through a variety of BMPs. As part of NPDES permit requirements, perform maintenance (sediment removal, etc.) activities on stormwater ponds so they can achieve optimal performance for settling out pollutants as designed. Pond expansion and pre-treatment of water before it reaches ponds may be beneficial dependent on drainage area and increased volume. Cost is dependent on size and number of ponds within the watershed.
- ***Emerging technologies/yet to be identified opportunities:*** Continue to identify new education, policies, retrofit, and BMP implementation opportunities as technologies and information emerge. Technologies may include retrofit with iron-enhanced sand filters, low impact development, green streets, etc.
- ***Subsurface Sewage Treatment Systems (SSTS) inspection and maintenance***: The City of Gem Lake and White Bear Township require residents with SSTS to annually inspect and report the results of inspection. Inspections are done at homeowner expense, as well as costs required to implement necessary system repairs or replacement. This strategy eliminates loads to the lake from failing septic systems. This strategy may be a higher priority for some cities and/or townships.

Table 3.1. Gem Lake Reduction Strategies

Potential BMP	Priority	Responsible Entities	Associated Cost	Unit	Qty	Total Associated Cost
Improve street sweeping practices.	1	City of Gem Lake, City of White Bear Lake, Ramsey County,	$50,000 to $250,000	Each	2	$100,000 to $500,000
Infiltration Practices	1	City of Gem Lake, City of White Bear Lake, Ramsey County, [1]MnDOT, VLAWMO	$500 to $10,000	Each	3	$1,500 to $30,000
Stormwater management retrofit development and implementation	2	City of Gem Lake, Ramsey County, VLAWMO	$10,000 to $500,000	Each	2	$20,000 to $1,000,000
Update Redevelopment Standards for Storm Water Runoff	2	City of Gem Lake, City of White Bear Lake, VLAWMO	$30,000	As Needed	1	$30,000
Detention Pond Retrofit and Maintenance	3	City of Gem Lake	$30,000 to $250,000	Each	1	$30,000 to $250,000
Emerging technologies/yet to be identified opportunities	3	City of Gem Lake, City of White Bear Lake, Ramsey County, MnDOT, VLAWMO	$20,000 to $40,000	Each	2	$40,000 to $80,000
SSTS Inspections & Maintenance	3	City of Gem Lake, Ramsey County	$2,000	Annually	10	$20,000
TOTAL TMDL IMPLEMENTATION COST						**$241,500 to $1,910,000**

[1] Potential strategies may include Highway 61 linear transportation projects

Priority 1 = 0-2 years
Priority 2 = 2-5 years
Priority 3 = 5-10 years

3.2 EAST & WEST GOOSE LAKE PRIORITY LOAD REDUCTION STRATEGIES

The dominant phosphorus loading in East Goose Lake is from internal loading, likely the result of historical loading to the sediments from the White Bear Lake WWTP, which used to discharge to the basin. As such, the primary nutrient load reduction must come from a reduction of the internal load (Table 2.7). Significant watershed load reductions are also required to achieve the TMDL for both West and East Goose Lakes. Priority management strategies will need to target both the watershed and internal nutrient loads.
Direct watershed and internal loading both contribute to the West Goose Lake impairment (Table 2.8). As such, load reductions to both sources will be required to meet the TMDL and priority management strategies will need to target both the watershed and internal nutrient sources. Due to the magnitude of the total load reduction required, internal and external reduction strategies should be implemented concurrently. Potential reduction strategies for

East and West Goose Lake include:

- ***Internal Load Feasibility Study & Implementation*:** Conduct a feasibility study to evaluate potential methods for internal load management. This may include management of rough fish or invasive plants, drawdowns, alum application/dosing, recreational management or other technologies. The elements of this study may include additional quantification of internal load which entails analysis of lake sediment cores and collection of profile water quality data.
- ***Biological Surveys & Management Plan:*** To evaluate biological management and the impacts on internal loading, surveys and management plans are recommended.
    - Aquatic Plant Survey & Management Plan: Conduct a survey to document presence/absence of aquatic plants and document species. Concurrently, a detailed lake bottom survey can be conducted with sonar that quantifies in-lake vegetative biomass. This can be conducted at the height of curly leaf pondweed population prior to senescence and post senescence to provide an accurate picture of potential infestation and impact of this invasive species. Aquatic plants should periodically be surveyed to track changes in the plant community and monitor growth. Develop a plan to encourage a healthy native plant community to anchor sediments and reduce sediment re-suspension ($15,000-$20,000).
- ***Detention Pond Retrofit and Maintenance:*** As opportunities arise, retrofit stormwater treatment through a variety of Best Management Practices. As part of NPDES permit requirements, perform maintenance (sediment removal, etc.) activities on stormwater ponds so they can achieve optimal performance for settling out pollutants as designed. Pond expansion and pre-treatment of water before it reaches ponds may be beneficial dependent on drainage area and increased volume. Cost is dependent on size and number of ponds within the watershed.
- ***Improve street sweeping practices:*** Identify target areas for increased frequency of street sweeping. Consider replacing mechanical street sweepers with more efficient regenerative air sweepers ($250,000/truck), and/or improvements to equipment/technology to maximize sweeping effectiveness ($50,000).
- ***Shoreline Restoration:*** Implement a shoreline management program. The shoreline around both lakes includes property owners with significantly eroded shoreline, maintained turf down to the shoreline and areas of riprapped shoreline. Encourage property owners to stabilize and restore their shoreline with native plants and install buffers to reduce erosion and capture direct runoff ($30-$150/LF). Ideally, about 75 percent of the shoreline would be native vegetation. Maximize existing VLAWMO residential cost share programs, and community grant programs (Community Blue) to assist property owners with funding opportunities.
- ***Infiltration practices:*** Encourage the use of rain gardens and native plantings among property owners as a means to reduce direct watershed loads to the lakes. Opportunities may range from providing a grant or cost share to a single property owner installing an individual rain garden ($500) to retrofitting parks and open space with native vegetation rather than mowed turf ($10,000).

- ***Education and Outreach Programs targeting yard debris:*** Cities can review their local ordinances and associated enforcement and fines for residents who do not follow proper yard waste and yard debris removal techniques, and increase enforcement and education about compliance with such an ordinance.
- ***Biological Surveys & Management Plan:*** To evaluate biological management and the impacts on internal loading, surveys and management plans are recommended.
    - Fish Survey & Management Plan: A fish survey was conducted in 2012 on both East and West Goose Lakes. A healthy predator fish population was found as well as a significant bullhead population. At the recommendation of the DNR and the fish survey consultant, a bullhead harvest was started in 2013 and is currently in progress. An estimated 16,000 pounds of bullhead were removed from the lakes in 2013. The consultant and the DNR have suggested that the predator population should be able to keep the remaining bullhead population in check in the future. Further monitoring will be needed to determine the results of this bio- management ($15,000-$20,000). Maintaining a healthy fish population is important to local recreation and the ecology of the lake. Fish management will be addressed in the Goose Lake Sustainable Lake Management Plan (SLMP).
- ***Emerging technologies/yet to be identified opportunities:*** Continue to identify new education, policies, retrofit, and BMP implementation opportunities as technologies and information emerge. Technologies may include retrofit with iron-enhanced sand filters, low impact development, green streets, etc.
- ***Recreation Management Plan:*** The primary driver of internal loading (i.e. phosphorus in the lake sediment is stirred up) in West Goose Lake is motor boating. Recreation activities, such as motor boating, also impact the water quality of East Goose Lake due to the shallow lake ecology and historical loading of the lake sediments from the White Bear Lake WWTP. Implementation will require working with the Cities and lake users to develop a management plan to limit the impacts of the motor boating on lake water quality.
- ***Sustainable Lake Management Plan (SLMP):*** A SLMP is intended to strengthen local lake management efforts by providing lakeshore property owners with the tools to create a strategic vision for their lake; gather relevant information about their lake and surrounding watershed; assess existing lake management resources and programs; and establish concrete goals, priorities, and policies to achieve water quality goals. The Goose Lake SLMP (including East and West Goose Lake) will be complete in 2014 ($4,000).

Table 3.2. East & West Goose Lakes Reduction Strategies

Potential BMP	Priority	Responsible Entities	Associated Cost	Unit	Qty	Total Associated Cost
Internal Load Feasibility Study & Implementation Plan	1	VLAWMO	$25,000 to $50,000	Each	1	$25,000 to $50,000
Biological Surveys & Management Plan - Aquatic Plants	1	City of Gem Lake, City of White Bear Lake, Ramsey County, VLAWMO	$15,000 to $20,000	Each	2	$30,000 to $40,000
Detention Pond Retrofit and Maintenance	1	City of Gem Lake, City of White Bear Lake, Ramsey County, VLAWMO	$30,000 to $250,000	Each	4	$120,000 to $1,000,000
Improve street sweeping practices	1	City of Gem Lake, City of White Bear Lake, Ramsey County, VLAWMO	$50,000 to $250,000	Each	2	$100,000 to $500,000
Shoreline Restoration	2	City of White Bear Lake, Ramsey County, VLAWMO	$30 to $150	Linear Foot	3000	$90,000 to $450,000
Infiltration Practices	2	City of Gem Lake, City of White Bear Lake, Ramsey County, [1]MnDOT, VLAWMO	$500 to $10,000	Each	20	$10,000 to $200,000
Education and Outreach Programs targeting yard debris	2	City of Gem Lake, City of White Bear Lake, Ramsey County, VLAWMO	$5,000	Each	2	$10,000
Biological Surveys & Management Plan - Fish	3	City of Gem Lake, City of White Bear Lake, Ramsey County, VLAWMO	$15,000 to $20,000	Each	1	$15,000 to $20,000
Emerging technologies/yet to be identified opportunities	3	City of Gem Lake, City of White Bear Lake, Ramsey County, MnDOT, VLAWMO	$20,000 to $40,000	Each	4	$80,000 to $160,000
Recreation Management Plan	3	City of White Bear Lake, VLAWMO	$10,000 to $30,000	Each	2	$20,000 to $60,000
Sustainable Lake Management Plan (SLMP)	ongoing	City of White Bear Lake, VLAWMO	$4,000	Each	1	$4,000
TOTAL TMDL IMPLEMENTATION COST						**$504,000 to $2,494,000**

[1] Potential strategies may include Highway 61 linear transportation projects

Priority 1 = 0-2 years
Priority 2 = 2-5 years
Priority 3 = 5-10 years

3.3 GILFILLAN LAKE PRIORITY LOAD REDUCTION STRATEGIES

The dominant phosphorus loading in Gilfillan Lake is from internal loading. As such, the primary nutrient load reduction must come from a reduction of the internal load. Continuing efforts to eliminate load from septic systems will also be required. Since watershed loading is below expected background levels, and the surrounding area is fully developed with minimal impervious surface connection to the drainage system, a reduction from the watershed load is not anticipated to be achievable. Even though a load reduction from the watershed has not been explicitly called for, the recommendations below include some action items within the watershed:

- ***Biological Surveys & Management Plan:*** To evaluate biological management and the impacts on internal loading surveys and management plans are recommended.
    - Aquatic Plant Survey & Management Plan: Conduct a survey to document presence/absence of aquatic plants and document species. Concurrently, a detailed lake bottom survey can be conducted with sonar that quantifies in lake vegetative biomass. Aquatic plants should periodically be surveyed to track changes in the plant community and monitor growth. Develop a plan to encourage a healthy native plant community to anchor sediments, and reduce sediment re-suspension. ($15,000-$20,000).
    - Fish survey & Management Plan: Limited information is available on the fish community in Gilfillan Lake. A survey should be conducted and data analyzed to determine if biological management may be beneficial to managing water quality. A baseline fisheries survey can be used as the basis to develop a rough fish management program (if necessary). VLAWMO will initiate discussions with the DNR to monitor and manage the fish population to maintain a beneficial community ($15,000-$20,000).
- ***Shoreline Restoration:*** The shoreline around Gilfillan Lake includes property owners with maintained turf down to the shoreline and areas of riprapped shoreline. Encourage property owners to restore their shoreline with native plants and install buffers to reduce erosion and capture direct runoff ($30/LF). Ideally, about 75 percent of the residential shoreline would be native vegetation.
- ***Improve street sweeping practices:*** Identify target areas for increased frequency of street sweeping. Consider replacing mechanical street sweepers with more efficient regenerative air sweepers ($250,000/truck), and/or improvements to equipment/technology to maximize sweeping effectiveness ($50,000).
- ***Alum treatment assessment & application with potential internal load study & implementation*****:** Assess the feasibility of an alum application for internal load management and implement as indicated. Monitor and assess for effectiveness of this best management practice. Consider alternative internal load practices only as needed. The current augmentation of the lake will be considered.
- ***SSTS Inspection and Maintenance:*** The City of North Oaks requires residents with SSTS to pump every two years and submit a pumping report to the city. Inspections are done at the homeowners expense, as well as any costs required to implement necessary system repairs or replacement. This strategy eliminates loads to the lake from failing septic systems. This strategy may be a higher priority for some cities and/or townships.

- ***Detention Pond Retrofit and Maintenance:*** Much of the drainage area surrounding Gilfillan Lake currently flows through a series of stormwater ponds and existing stormwater management features. Inspect existing southwest detention ponds along Highway 96 as required by the NPDES program to determine quantity of sediment accumulation.
- ***Emerging technologies/yet to be identified opportunities:*** Continue to identify new education, policies, retrofit, and BMP implementation opportunities as technologies and information emerge. Technologies may include retrofit with iron- enhanced sand filters, low impact development, green streets, etc.

Table 3.3. Gilfillan Lake Reduction Strategies

Potential BMP	Priority	Responsible Entities	Associated Cost	Unit	Qty	Total Associated Cost
Biological Surveys & Management Plan	1	City of North Oaks, VLAWMO	$15,000 to $20,000	Each	2	$30,000 to $40,000
Shoreline Restoration	2	City of North Oaks, VLAWMO	$30	Linear Foot	2500	$75,000
Improve street sweeping practices	2	City of North Oaks, City of Vadnais Heights, White Bear Township, Ramsey County, VLAWMO	$50,000 to $250,000	Each	2	$100,000 to $500,000
Alum Treatment Assessment & Application	2	City of North Oaks, Ramsey County	$25,000 to $50,000	Each	1	$25,000 to $50,000
SSTS Inspection and Maintenance	3	City of North Oaks, Ramsey County	$2,000	Bi-annually	10	$20,000
Detention Pond Maintenance	3	City of North Oaks, City of Vadnais Heights, Ramsey County	$30,000 to $250,000	Each	1	$30,000 to $250,000
Emerging technologies/yet to be identified opportunities	3	City of North Oaks, City of Vadnais Heights, White Bear Township, Ramsey County	$20,000 to $40,000	Each	2	$40,000 to $80,000
TOTAL TMDL IMPLEMENTATION COST						**$320,000 to $1,015,000**

Priority 1 = 0-2 years
Priority 2 = 2-5 years
Priority 3 = 5-10 years

3.4 WILKINSON LAKE PRIORITY LOAD REDUCTION STRATEGIES

Phosphorus loading to Wilkinson Lake is predominantly from the watershed load. As such, priority management strategies will need to target the watershed nutrient loads. Potential reduction strategies include:

- ***Improve street sweeping practices:*** Identify target areas for increased frequency of street sweeping. Consider replacing mechanical street sweepers with more efficient regenerative air sweepers ($250,000/truck), and/or improvements to equipment/technology to maximize sweeping effectiveness ($50,000).
- ***Retrofit Projects for Developed Properties:*** Retrofit existing areas to provide stormwater treatment and reduce loads to Wilkinson Lake. Implement projects as opportunities arise for retrofits.
- ***Infiltration practices:*** Encourage the use of rain gardens and native plantings among property owners as a means to reduce direct watershed loads to the lakes. Opportunities may range from providing a grant or cost share to a single property owner installing an individual rain garden ($500) to retrofitting parks and open space with native vegetation rather than mowed turf ($10,000). Maximize existing VLAWMO residential cost share programs, and community grant programs (Community Blue) to assist property owners with funding opportunities.
- ***Detention Pond Retrofit and Maintenance:*** As opportunities arise, retrofit stormwater treatment through a variety of Best Management Practices. As part of NPDES permit requirements, perform maintenance (sediment removal, etc.) activities on stormwater ponds so they can achieve optimal performance for settling out pollutants as designed. Pond expansion and pre-treatment of water before it reaches ponds may be beneficial dependent on drainage area and increased volume. Cost is dependent on size and number of ponds within the watershed.
- ***Emerging technologies/yet to be identified opportunities:*** Continue to identify new education, policies, retrofit, and BMP implementation opportunities as technologies and information emerge. Technologies may include retrofit with iron-enhanced sand filters, low impact development, green streets, etc.
- ***Biological Surveys & Management Plan:*** To evaluate biological management and the impacts on internal loading surveys and management plans are recommended.
    - Aquatic Plant Survey & Management Plan: Conduct a survey to document presence/absence of aquatic plants and document species. Concurrently, a detailed lake bottom survey can be conducted with sonar that quantifies in lake vegetative biomass. Aquatic plants should periodically be surveyed to track changes in the plant community and monitor growth. Develop a plan to encourage a healthy native plant community to anchor sediments and reduce sediment re-suspension ($15,000-$20,000).
    - Fish survey & Management Plan: Limited information is available on the fish community in Wilkinson Lake. An updated survey should be conducted and data analyzed to determine if biological management may be beneficial to managing water quality. A baseline fisheries survey can be used as the basis to develop a rough fish management program (if necessary). VLAWMO will initiate discussions with the DNR to monitor and manage the fish population to maintain a beneficial community ($15,000-$20,000).

Table 3.4. Wilkinson Lake Reduction Strategies

Potential BMP	Priority	Responsible Entities	Associated Cost	Unit	Qty	Total Associated Cost
Improve street sweeping practices	1	City of Lino Lakes, City of North Oaks, City of White Bear Lake, White Bear Township, Ramsey County, Anoka County, VLAWMO	$50,000 to $250,000	Each	2	$100,000 to $500,000
Retrofit Projects for Developed Properties	1	City of Lino Lakes, City of North Oaks, City of White Bear Lake, White Bear Township, Ramsey County, Anoka County, [1]MnDOT, VLAWMO	$20,000 to $100,000	Each	2	$40,000 to $200,000
Infiltration Practices	2	City of Lino Lakes, City of North Oaks, City of White Bear Lake, White Bear Township, Ramsey County, Anoka County, [1]MnDOT, VLAWMO	$500 to $10,000	Each	10	$5,000 to $100,000
Detention Pond Retrofit and Maintenance	2	City of Lino Lakes, City of North Oaks, City of White Bear Lake, White Bear Township, Ramsey County, Anoka County	$30,000 to $250,000	Each	5	$150,000 to $1,250,000
Emerging technologies/yet to be identified opportunities	3	City of Lino Lakes, City of North Oaks, City of White Bear Lake, White Bear Township, Ramsey County, Anoka County, MnDOT, VLAWMO	$20,000 to $40,000	Each	5	$100,000 to $200,000
Biological Surveys & Management Plan	3	City of North Oaks, VLAWMO	$15,000 to $20,000	Each	2	$30,000 to $40,000
TOTAL TMDL IMPLEMENTATION COST						**$425,000 to $2,290,000**

[1] Potential strategies may include Highway 35E linear transportation projects

Priority 1 = 0-2 years
Priority 2 = 2-5 years
Priority 3 = 5-10 years

3.5 LAMBERT CREEK PRIORITY LOAD REDUCTION STRATEGIES

Bacteria loading to Lambert Creek is most likely from organic sources in urban stormwater, such as pet waste, with a smaller contribution to the load from wildlife within the watershed. Potential reduction strategies include:

- ***Inspect all outfalls along creek. Locate, inventory, assess, improvements as needed:*** Storm sewer outfalls along Lambert Creek are not currently inspected. Therefore, it is important to perform a visual inspection of outfalls within the first 2 years of implementation, looking for damage or evidence of pollutant source or illicit discharges. Targeted outfalls will be intensively monitored the first, second and third year of this monitoring effort utilizing an adaptive approach. Evaluation of storm sewers in the targeted areas will be included. Results of monitoring will be shared with interested parties.
- ***Bacterial source ID study and management plan:*** Utilize bacterial source identification monitoring to establish the most cost effective BMP implementation opportunities to achieve the WLA. Annual evaluation of the bacterial monitoring will provide direction for the following year.

- ***Infiltration Basins/Bio-retention (public/commercial/residential):*** Installation of infiltration basins and other bio-retention areas to decrease bacteria entering surface waters. Opportunities may range from a single property owner installing an individual rain garden to retrofitting parks and open space with large bio-retention areas. Maximize existing VLAWMO residential cost share programs, and community grant programs (Community Blue) to assist property owners with funding opportunities.
- ***Education & Outreach Programs targeting yard debris and pet waste:*** Cities can review their local ordinances and associated enforcement and fines for residents who do not clean up pet waste, and increase enforcement and education about compliance with such an ordinance.
- ***Biological Surveys & Management Plan:*** To evaluate biological management and the impacts on bacteria loading, surveys and management plans are recommended.
    - Waterfowl/Wildlife Survey & Management Plan: Due to the high density of ideal habitat for waterfowl, it is likely that nuisance populations of waterfowl may contribute to the bacteria impairment. Meeting the load reductions for this TMDL will require working with area wildlife managers to first assess and then potentially managing wildlife populations ($15,000-$20,000).
- ***Streambank buffers for waterfowl exclusion***: Management of waterfowl populations can be conducted by controlling access to surface waters through streambank restorations. Streambank restorations would focus on deterring waterfowl from accessing the creek and directly loading the creek as well as provide filtration of direct runoff from the riparian area.
- ***Emerging technologies/yet to be identified opportunities:*** Continue to identify new education, policies, retrofit, and BMP implementation opportunities as technologies and information emerge.

Table 3.5. Lambert Creek Reduction Strategies

Potential BMP	Priority	Responsible Entities	Associated Cost	Unit	Qty	Total Associated Cost
Inspect all outfalls along creek. Locate, inventory, assess, improvements as needed	1	City of Gem Lake, City of Vadnais Heights, City of White Bear Lake, White Bear Township, Ramsey County, VLAWMO	$2,000 to $50,000	Each	2	$4,000 to $100,000
Bacterial source ID study and management plan	1	City of Gem Lake, City of Vadnais Heights, City of White Bear Lake, White Bear Township, Ramsey County, VLAWMO	$65,000	Each	1	$65,000
Education & Outreach Programs targeting yard debris and pet waste	1	City of Gem Lake, City of Vadnais Heights, City of White Bear Lake, White Bear Township, Ramsey County, VLAWMO	$5,000	Each	3	$15,000
Infiltration Basins/Bio-retention (public/commercial/residential)	2	City of Gem Lake, City of Vadnais Heights, City of White Bear Lake, White Bear Township, Ramsey County, [1]MnDOT, VLAWMO	$3,000 to $50,000	Each	15	$45,000 to $750,000
Streambank buffers for waterfowl exclusion	2	City of Gem Lake, City of Vadnais Heights, City of White Bear Lake, White Bear Township, Ramsey County, VLAWMO	$100	Linear Foot	2000	$200,000
Biological Surveys & Management Plan	3	City of Gem Lake, City of Vadnais Heights, City of White Bear Lake, White Bear Township, Ramsey County, VLAWMO	$15,000 to $20,000	Each	2	$30,000 to $40,000
Emerging technologies/yet to be identified opportunities	3	City of Gem Lake, City of Vadnais Heights, City of White Bear Lake, White Bear Township, Ramsey County, MnDOT, VLAWMO	$20,000 to $40,000	Each	2	$40,000 to $80,000
TOTAL TMDL IMPLEMENTATION COST						**$399,000 to $1,250,000**

[1] Potential strategies may include Highway 61 and 35E linear transportation projects

Priority 1 = 0-2 years
Priority 2 = 2-5 years
Priority 3 = 5-10 years

3.6 WATERSHED WIDE REDUCTION STRATEGIES

In addition to the implementation strategies discussed in the previous sections, the load reduction strategies outlined below will be implemented throughout VLAWMO's entire jurisdiction to protect water quality. Although the VLAWMO watershed is mostly developed, small, incremental reductions are also possible through retrofit as redevelopment occurs and through the implementation of BMPs throughout the watershed. The implementation of this

Plan relies on three overall categories of activities: Regulation, Incentives, and Education. For most issues, all three means must be part of an implementation program.

Conduct education and outreach awareness programs:

VLAWMO has taken the approach that regulation is only a supplement to a strong education and incentive based program to create a healthy environment. Understanding water pollution problems through education can go a long way in preventing problems. In addition, education, in many cases, can be a simpler, less costly and a more community- friendly way of achieving goals and policies. Education efforts can provide the framework for more of a "grass roots" community plan implementation, while regulation and incentives traditionally follow a more "top-down" approach. It is recognized, however, that education by itself will not always meet intended goals, has certain limitations, and is more of a long-term approach. To this end, VLAWMO created the Education & Outreach Coordinator position in 2011. This position has principal responsibility for development and implementation of the Education, Outreach & Communication programs under guidance of the Water Plan.

The approach to implement the TMDL will mimic the education strategy of the water plan. Each source reduction strategy will need an educational component, and will be prioritized based on stakeholder input, and coordination with existing programs. Examples of education and awareness programs include educating property owners in the subwatershed about proper fertilizer use, low-impact lawn care practices, pet waste removal and other topics. These programs will increase awareness of sources of pollutant loadings to the lakes and encourage the adoption of good individual property management practices.

Incentives
Many of the existing programs on which the water management plan relies are incentive-based programs offered through VLAWMO. Reducing nutrient and bacteria sources will need to rely on a similar strategy of incorporating incentives into implementing practices in the community. VLAWMO will also apply for state and federal grant funds to assist MS4s in the application of BMPs identified in the Implementation Plan.

Intensive BMP Assessment: A common implementation action is to retrofit small BMPs as opportunities arise. Cities may complete these as stand-alone projects as funds are available; incorporated into street or park reconstruction projects; or as development and redevelopment provides opportunities. Intensive BMP analysis is a way to identify where small practices such as rain gardens or pond retrofits would be most effective at reducing pollutant loading. It uses a structured assessment to evaluate conditions in a concentrated area to see where there are opportunities to do small things that when they are done in many locations can add up to significant reductions. The Metro Conservation District has developed a Stormwater Retrofit Protocol, and the national Center for Watershed Protection has developed an Urban Stormwater Retrofit Practices manual that can be used as guides. They suggest systematically working through the drainage areas in the watershed to identify cost-effective BMPs on a

neighborhood or site scale, and possibly following it up with small grants to implement these small projects.

Construction Stormwater: To meet the WLA for construction stormwater, construction stormwater activities are required to meet the conditions of the Construction General Permit under the NPDES program and properly select, install and maintain all BMPs required under the permit, including any applicable additional BMPs required in Appendix A of the Construction General Permit for discharges to impaired waters, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit.

Industrial Stormwater: To meet the WLA for industrial stormwater, industrial stormwater activities are required to meet the conditions of the industrial stormwater general permit or General Sand and Gravel general permit (MNG49) under the NPDES program and properly select, install and maintain all BMPs required under the permit.

3.7 INTERIM MILESTONES

It can take many years for a water body to respond to pollutant load reduction activities in the watershed and within the water body. Interim measures will need to be implemented to assess the progress toward achieving the water quality standards. Most of the reduction strategies are identical for all water bodies, and therefore interim milestones will also be similar:

- Education and outreach programs targeting yard debris and pet waste along with documentation of new or modified educational materials and activities that address nutrient and bacteria management will be completed within the first five years (depending on funding)
- Documentation of expanded street sweeping efforts that target areas that currently receive little or no treatment before discharging to the lake, including the expanded extent, frequency, or improvements in technology will be implemented within the first five years (depending on funding)
- Since completion of the TMDL the new MS4 permit was published with new development rules for MS4s. As an interim step, MS4s will comply with the new permit at the next relevant permit cycle (5 year maximum) then track progress and evaluate the need to provide more stringent rules and standards as needed in order to be in compliance with the new MS4 permit, and/or VLAWMO standards.
- Most biological surveys and management plans will be completed within the first ten years (depending on funding)
- Retrofit and feasibility studies will be completed within the first ten years (depending on funding)
- SSTS inspection and maintenance may be completed within the first ten years (depending on funding)

- Detention pond maintenance and inspection may be completed within the first ten years (depending on funding)
- The interim milestones for infiltration/bio-retention practices, and shoreline restoration projects activities could include:
    - Tracking of new BMPs retrofit into the watershed, including the number, types, and estimated load reduction for each and publishing in VLAWMO's Annual Report
    - Tracking of redevelopment projects within the watershed that could incorporate new or oversized BMPs, including the types and estimated load reductions for each
    - Tracking of the participation of private property owners in existing programs to implement rainwater gardens, native shoreline buffers, etc. including their location and type of project implemented

These milestones will provide information that documents the progress being made to achieve the TMDLs established for Gem, East Goose, West Goose, Gilfillan, and Wilkinson Lakes, and Lambert Creek even when water quality improvement is not yet observed. Documentation and tracking milestones may follow the requirements and reporting details described in the entities MS4 permits. The water quality monitoring program for the TMDL *Implementation Plan* is discussed in Section 3.9.

3.8 ADAPTIVE MANAGEMENT

The load allocations in the TMDL represent aggressive goals for nutrient and bacteria reductions. Consequently, implementation will be conducted using adaptive management principles (Figure 3.1). Adaptive management is appropriate because it is difficult to predict both the lake response that will occur from implementing strategies with the limited information available to demonstrate expected nutrient reductions, and stream response from implementing strategies to reduce bacteria concentrations. Future technological advances may alter the course of actions detailed here. Continued monitoring and "course corrections" responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL. Management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the impaired lakes and stream reaches.

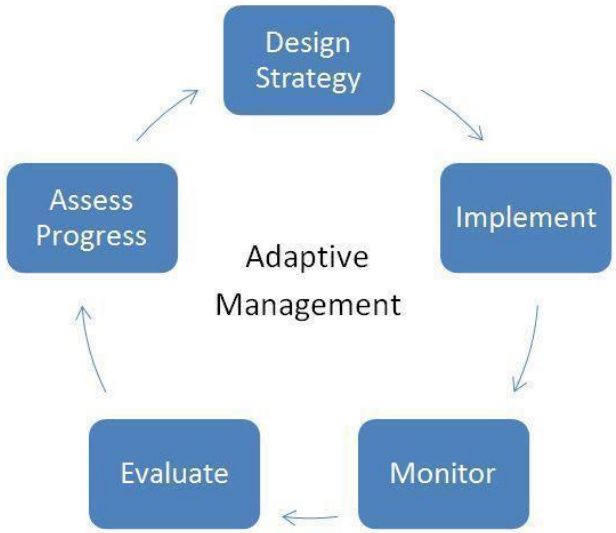


Figure 3.1. Adaptive management.

3.9 MONITORING PLAN

3.9.1 Lakes Monitoring

VLAWMO will continue bi-weekly (May – October) in-lake monitoring of Gem, East Goose, West Goose, Wilkinson, and Gilfillan Lakes in order to adequately assess water quality trends in each lake. In-lake monitoring includes collection of temperature, dissolved oxygen, and Secchi depth data from each lake. Discrete water samples are also collected from the surface and analyzed for total phosphorus, total nitrogen, and chlorophyll-*a*.

Assessment of the stormwater discharge may be monitored to better grasp the nutrient loads caused by runoff from surrounding land. This monitoring may assist in evaluating the success of projects and identify changes needed in management strategies. Revision of management and monitoring strategies will occur as needed.

3.9.2 Creek Monitoring

VLAWMO will lead monitoring and tracking of the effectiveness of activities implemented to manage runoff volume and improve *E. coli* concentrations in Lambert Creek. This monitoring will continue to be detailed in VLAWMO's Annual Water Quality Monitoring Report. Water samples are collected by VLAWMO staff at six sites along Lambert Creek on a bi-weekly basis May through September as well as after significant storm events (at least 0.5 inches). The samples are analyzed for total phosphorus, soluble reactive phosphorus, total

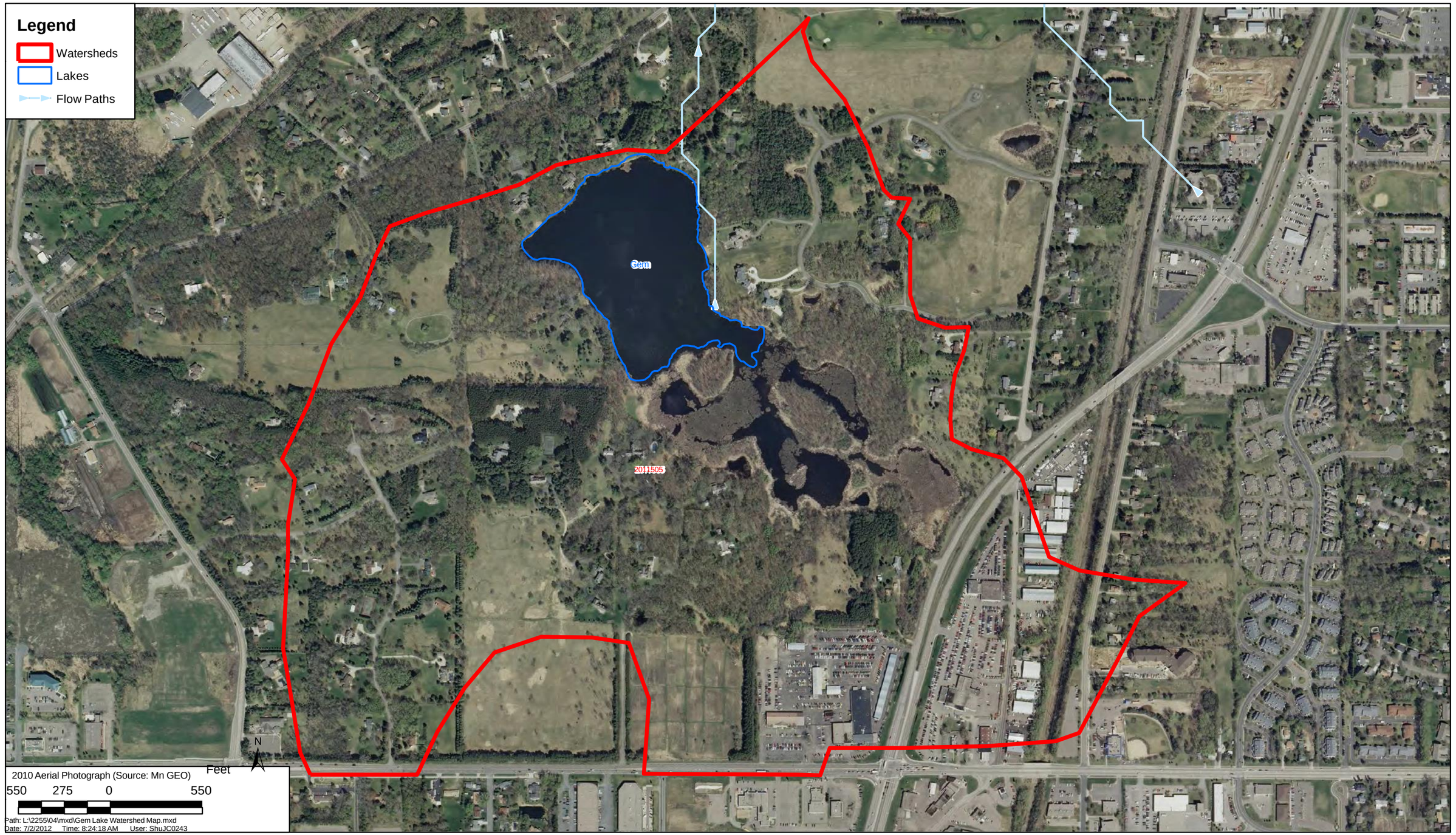
kjehldahl nitrogen, ammonia, nitrate, total suspended solids, and turbidity. Dissolved oxygen, temperature, pH, conductivity, and flow are also collected in-situ at three flume locations on Lambert Creek. VLAWMO has collected samples from 2008-2012 at five of the six sites to test for *E. coli*. VLAWMO discontinued routine *E. coli* monitoring in 2013 and will begin targeted monitoring in 2014 to try to determine the source of *E. coli* contamination in Lambert Creek. Standard flow and nutrient monitoring will continue along the whole reach of the creek.

4.0 LITERATURE CITED

Minnesota Pollution Control Agency (MPCA). 2002. Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota. Minnesota Pollution Control Agency, St. Paul, Minnesota.

Wenck Associates, Inc. 2014. Vadnais Lake Area WMO Total Maximum Daily Load (TMDL) and Protection Study 2255-08.

5.0 APPENDIX



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Gem Lake Watershed

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JAN 2012

Figure 1

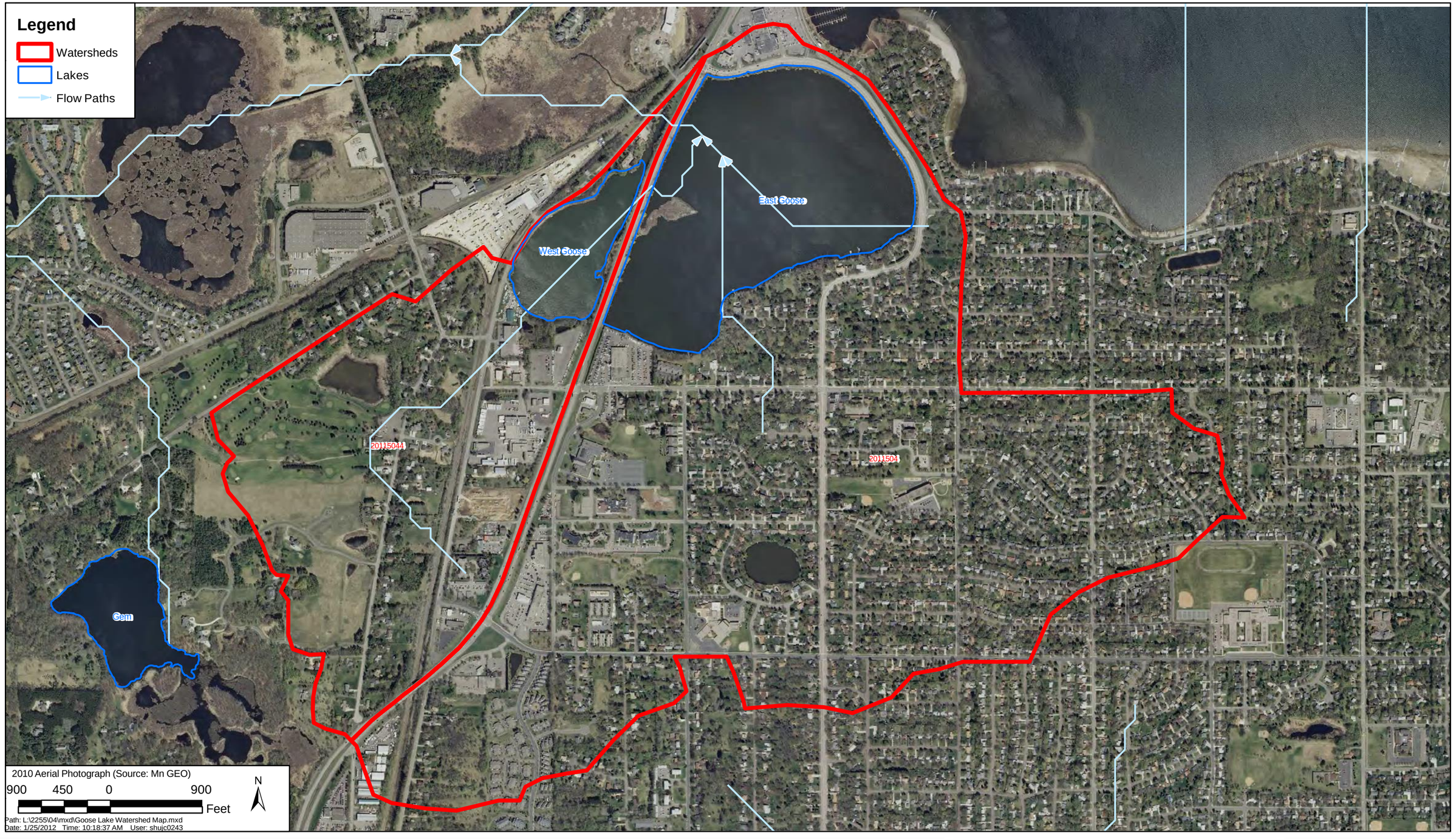

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Figure 1

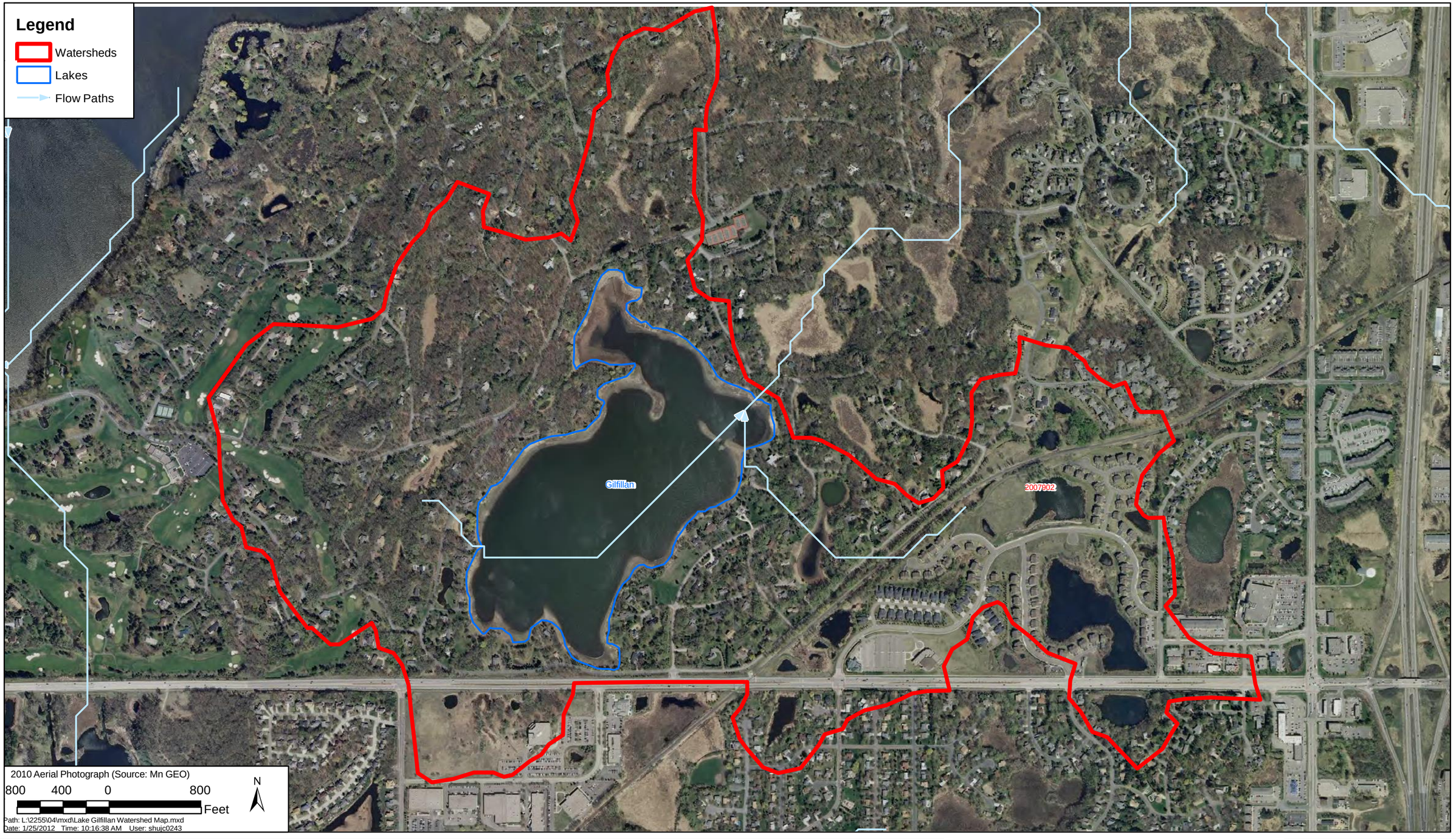

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Figure 1

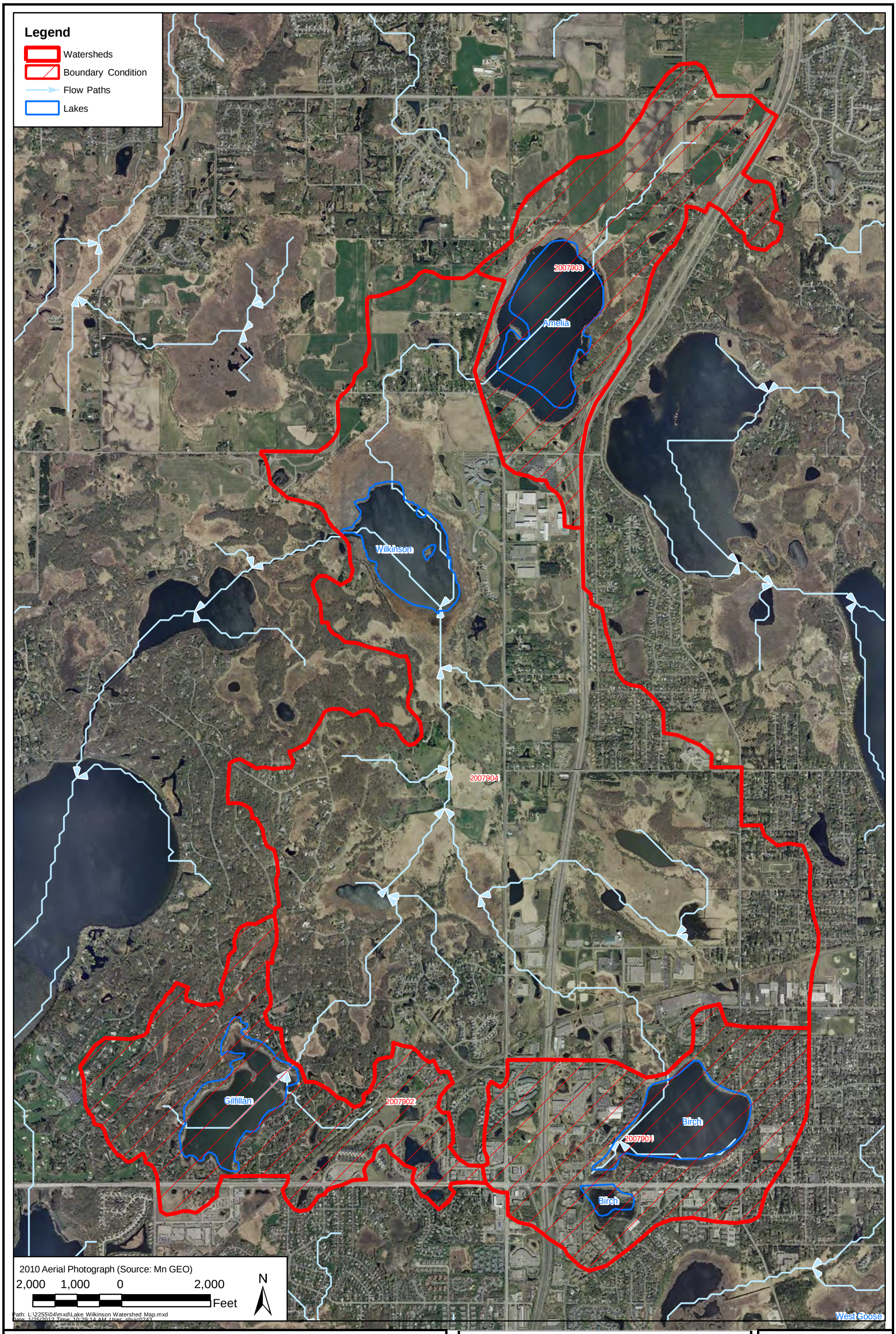

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Figure 1

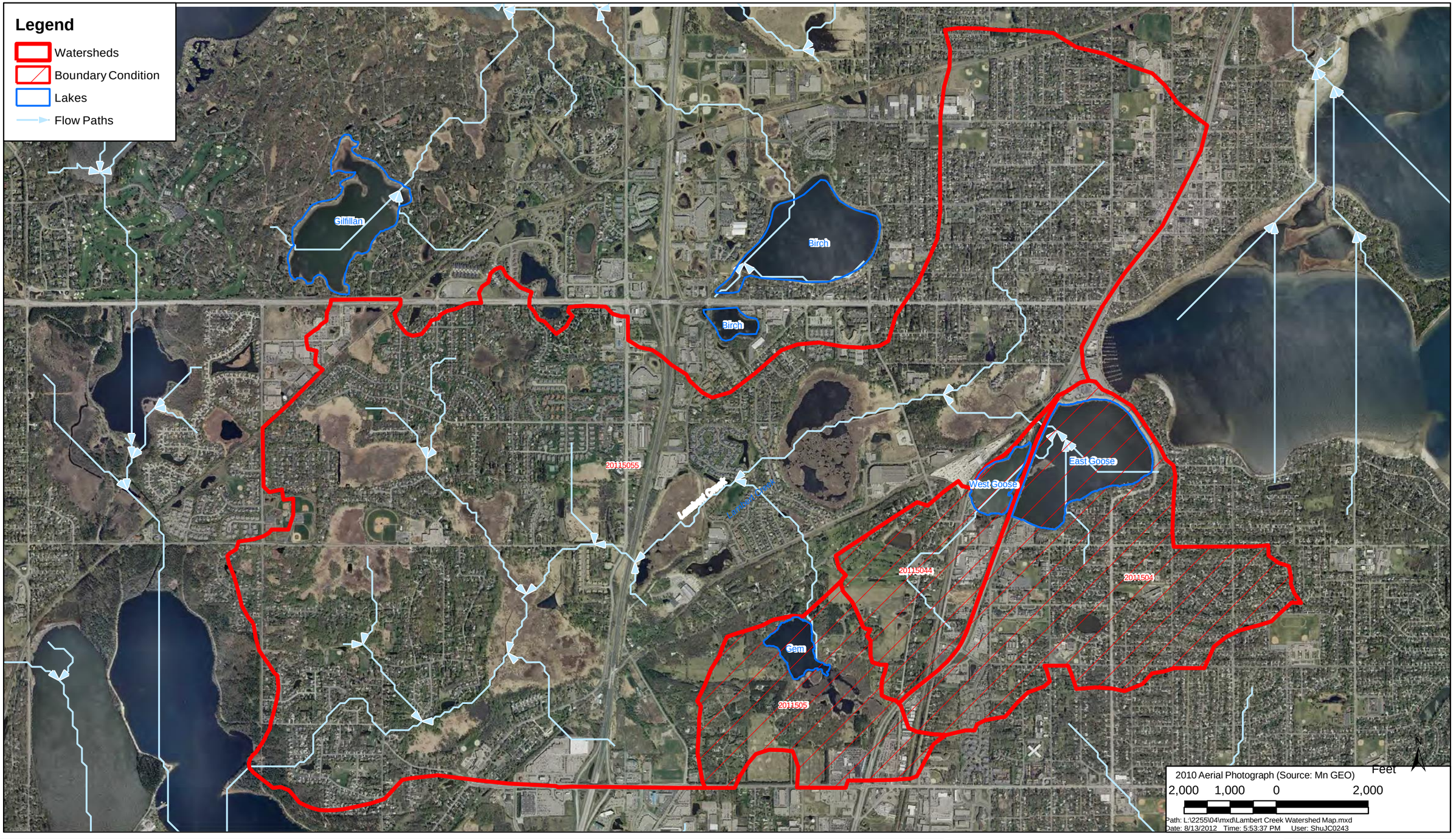

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Figure 1