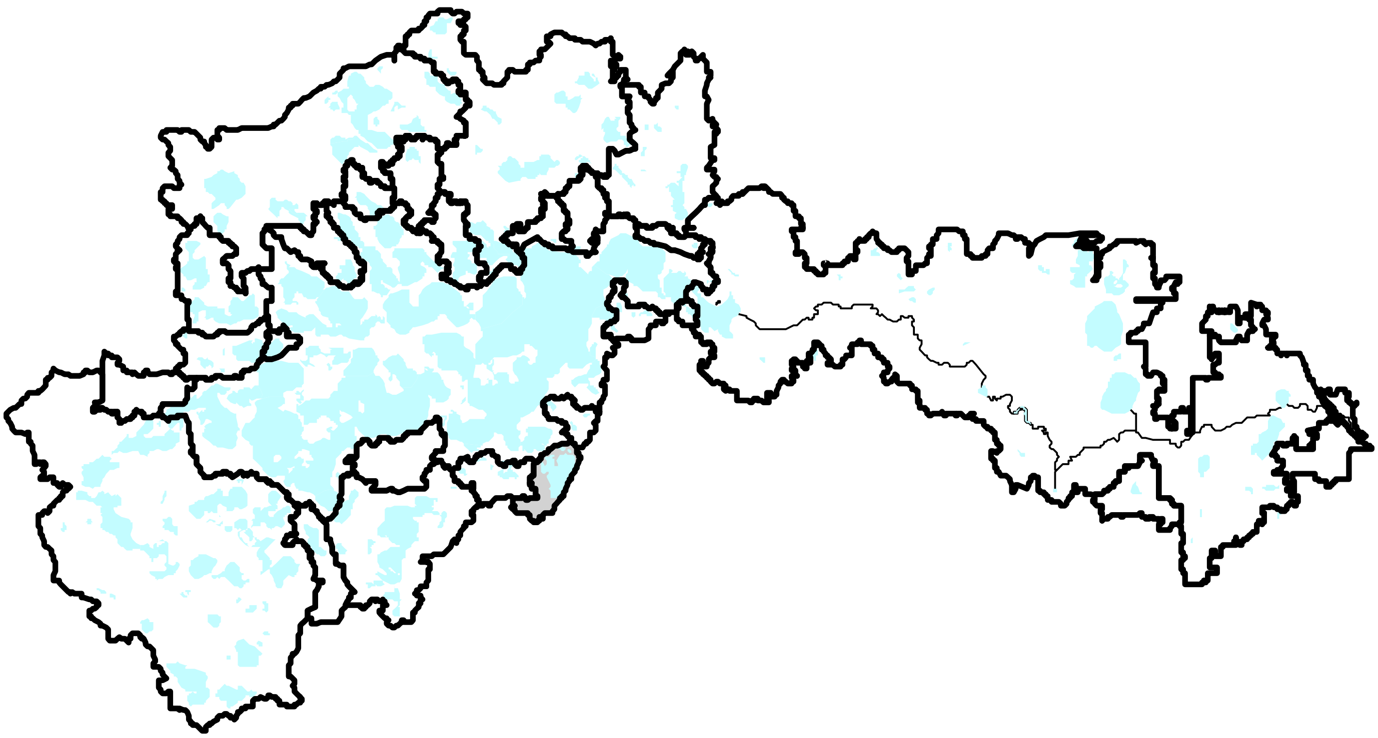


CHRISTMAS LAKE

Christmas Lake

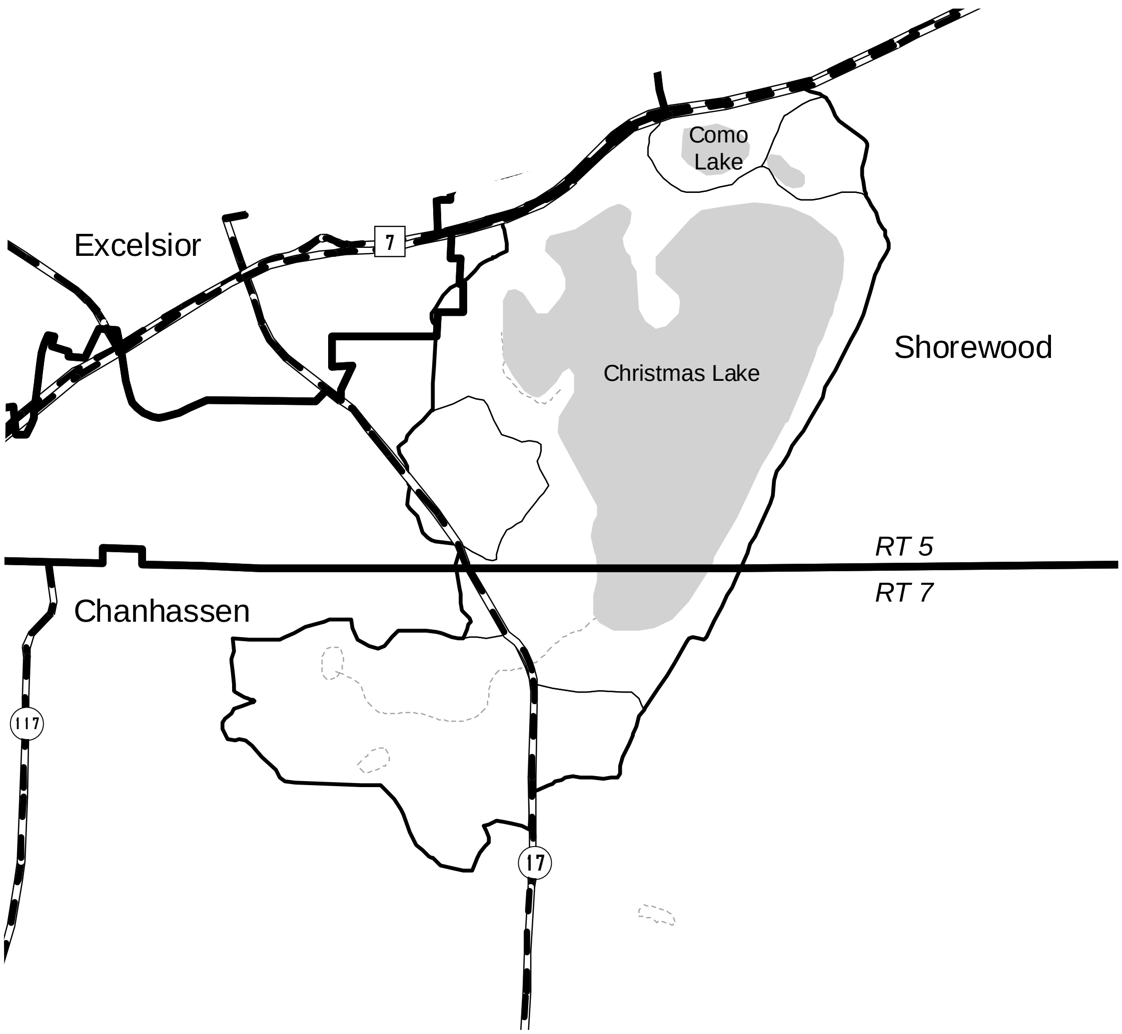
Table of Contents

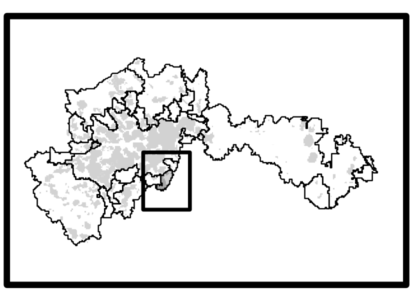
I. Christmas Lake

I.1. General Description

The Christmas Lake watershed is located along the southern boundary of the MCWD and within the cities of Chanhassen and Shorewood (Figure IV.I.1-1). The watershed is approximately 742 acres in size (about 1.2 sq. miles), and includes five subwatershed units (designated CL-1 through CL-5). Figure IV.E.1-2 shows the subwatersheds and their drainage configuration.

Minnehaha Creek Watershed District





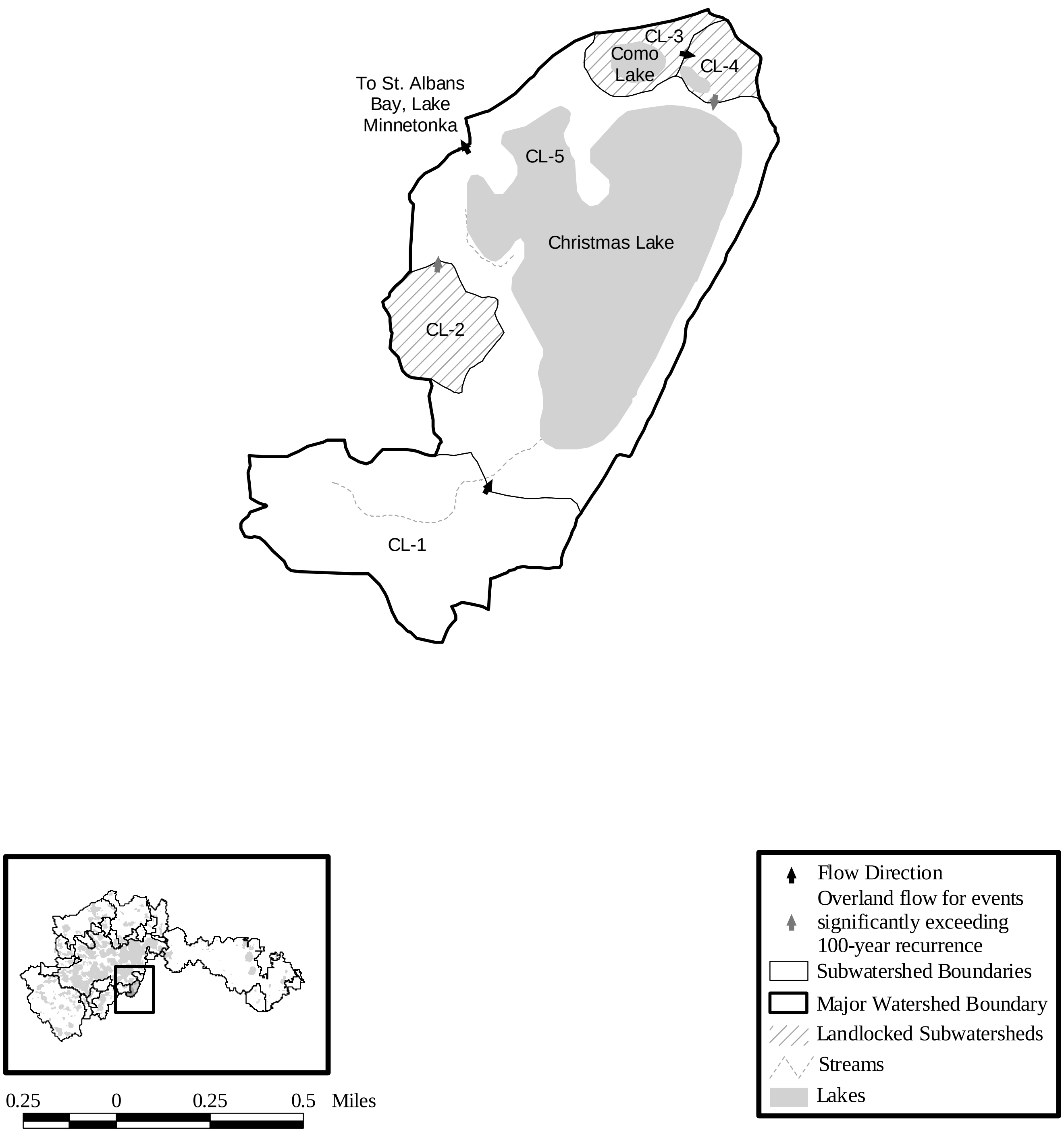
0.25 0 0.25 0.5 Miles

- Subwatershed Boundaries
- Major Watershed Boundary
- Major Roads
- City Boundaries
- Streams
- Lakes

N

H&H Report/Basins/Projects/flow_030226_kl

Figure IV.I.1-1
Christmas Lake Watershed
Political Boundaries



EMMONS & OLIVIER RESOURCES

N

H&H Report/Basins/Projects/flow_030417_kl

Figure IV.I.1-2
Christmas Lake Watershed
Flow Direction

I.2. Physical Features

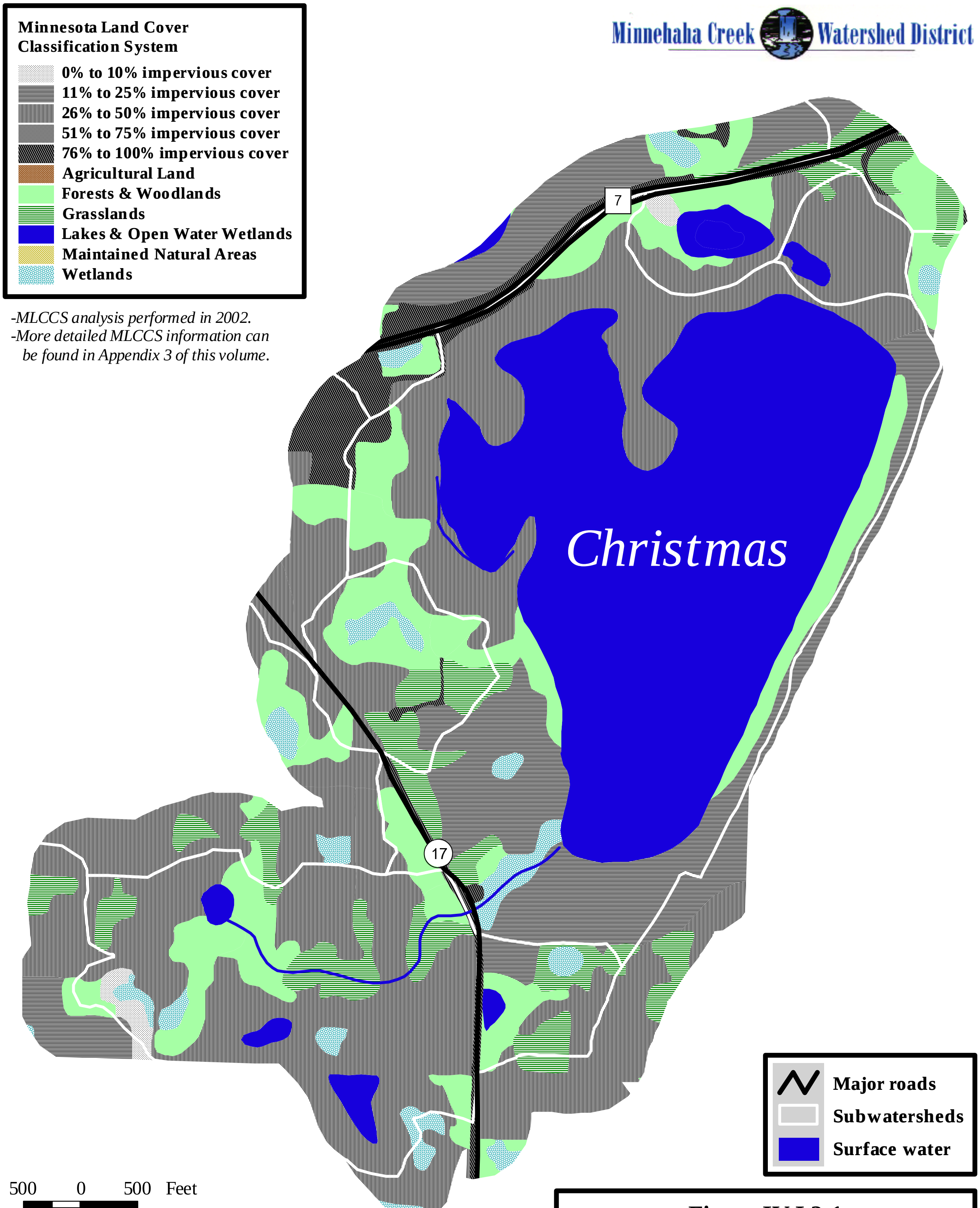
The following sections detail the MLCCS, geology, soils, and groundwater of the Christmas Lake watershed.

I.2.a. Land Cover/Land Use

For comparison purposes, the various MLCCS land cover classifications have been combined into five impervious surface area categories and six vegetative cover type categories (Figures IV.I.2-1 and IV.I.2-2). Although not shown here, each of the impervious surface area categories was further broken down with respect to type of land use and vegetative cover found on non-impervious surface areas. A more detailed map showing MLCCS cover types to Level 3 for the entire MCWD is included in Appendix 3 (Figure IV.Appendix.3-1). A description of all MLCCS cover types is also included in Appendix 3 and is incorporated into the District's interactive GIS tool.

Following lakes and open water, single family residential land use dominates the Christmas Lake watershed. Within this residential setting, isolated undeveloped pockets of woodland, forest and other natural areas exist. Land use immediately adjacent to Christmas Lake is primarily single family residential.

Currently in the Christmas Lake watershed, the lakes and open water wetlands category of land use dominates, making up 37% of the watershed (Figure IV.I.2-2), followed by the "26% to 50% impervious cover category," making up 30% of the watershed. Under 2020 land use conditions, these same two categories remain dominant. The biggest percent increase (Table IV.I.2-1) was in the "0% to 10% impervious cover" category. The biggest percent decrease was found in the forests and woodlands category.



EMMONS & OLIVIER RESOURCES

N

H&H Report/Basins/minnewashta_virginia.apr___030226aps

Figure IV.I.2-1
Christmas Lake Watershed
Minnesota Land Cover
Classification System

Figure IV.I.2-2
Christmas Lake Watershed Land Cover

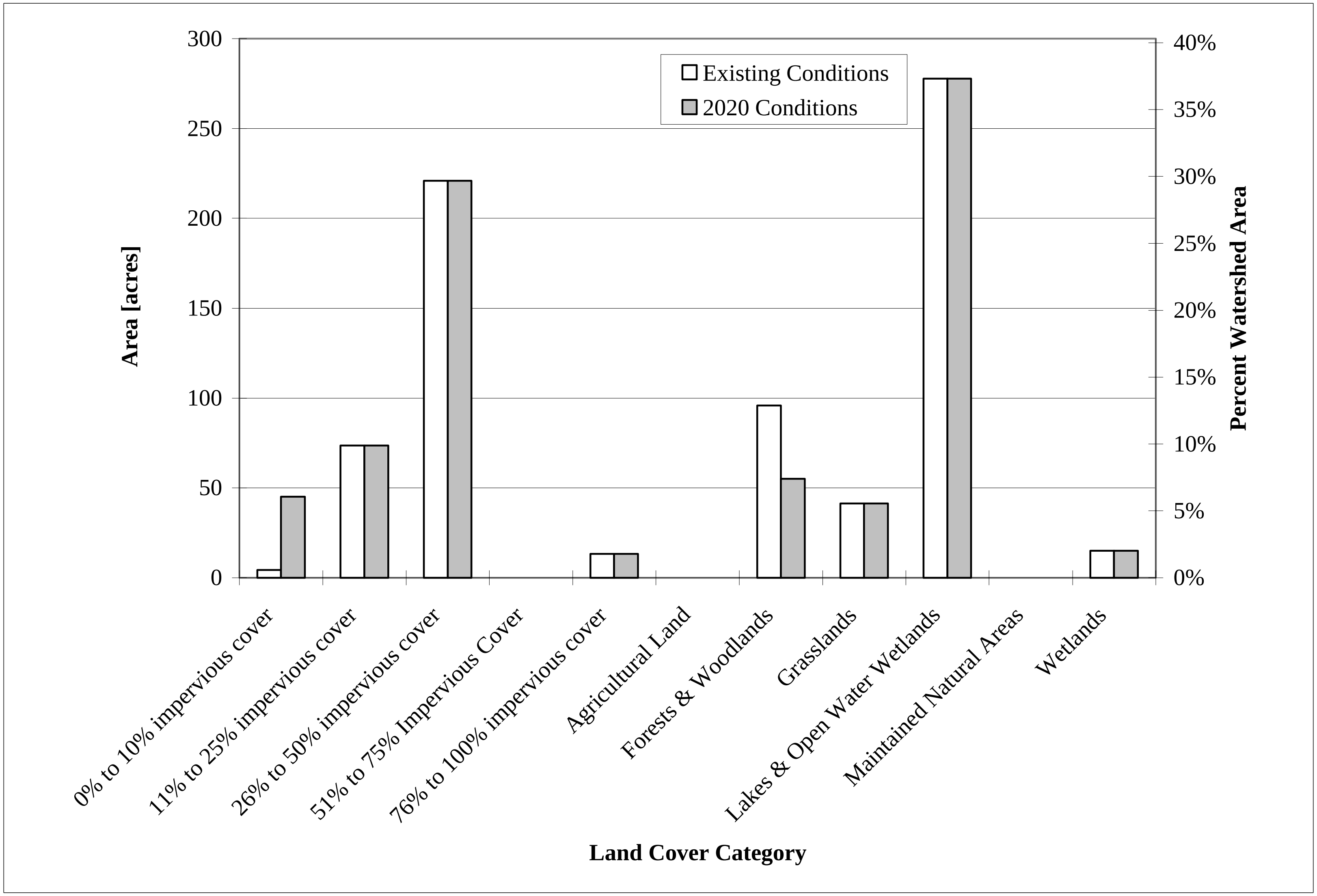


Table IV.I.2-1
Christmas Lake Watershed Land Cover Percent Change

Land Cover Category	Percent Change (from existing to 2020 conditions)
0% to 10% impervious cover	942%
11% to 25% impervious cover	0%
26% to 50% impervious cover	0%
51% to 75% impervious cover	0%
76% to 100% impervious cover	0%
Agricultural Land	0%
Forests & Woodlands	-43%
Grasslands	0%
Lakes & Open Water Wetlands	0%
Maintained Natural Areas	0%
Wetlands	0%

I.2.b. Geology

The Prairie du Chien Limestone is the uppermost bedrock layer in the southern portion of Christmas Lake watershed. Overlying the limestone in the north is the St. Peter Sandstone.

The Quaternary deposits are associated with the Des Moines Lobe glaciation. They are composed primarily of loamy till in hummocky and irregular topography. Other deposits of sandy till are located on the north side of Christmas Lake. Sandy till deposits are generally loam- to sandy loam-textured unsorted sediment. A large esker has been mapped along the eastern edge of Christmas Lake. This unusual feature affects both surface water and groundwater flow.

(See *Volume II: Framework and Methodology, D. Groundwater* for a description of methodology for sections I.2.b through I.2.d.)

I.2.c. Soils

Soil Hydrologic Groups are shown on Figure IV.I.2-3. The predominant hydrologic groups are B (moderate infiltration rate when wet) and D (very slow infiltration rate). The group D soils are found in low-lying areas that have a seasonably high water table or in areas with clayey soils. Group B soils have moderately fine to moderately coarse texture. Some group C (slow infiltration rate) soils are present and are composed of fine-grained material. The soil figure should be used as a guide for further soil examination at the site of inquiry.

I.2.d. Groundwater

Water table elevation contours are shown on Figure IV.I.2-4. Shallow groundwater flow is generally from the south and west towards Christmas Lake, and from there north towards Lake Minnetonka. There may also be shallow groundwater flow to the southeast out of Christmas Lake and Minnehaha Creek Watershed District. That is, the surface watershed and the "groundwatershed" do not coincide. Surface water and groundwater flow patterns are influenced by the large esker along the eastern side of Christmas Lake. Further investigation of groundwater conditions is warranted before working in this area.

Figure IV.I.2-5 shows depth to the water table. The water table is deep throughout much of the south of Christmas Lake watershed due to the large amount of hilly topography that does not have surface water features. Areas in the north and west are flatter and wet, corresponding to a high water table.

Infiltration potential for the watershed is represented on Figure IV.I.2-6 and is generally medium to low. Much of this is due to the presence of group B soils in these areas. Due to the variable composition of soils that have been classified as "Organic", areas that contain these soils have variable infiltration potential as well.

Further geology and groundwater discussion can be found in *Volume V: Watershed Issues Integration*.

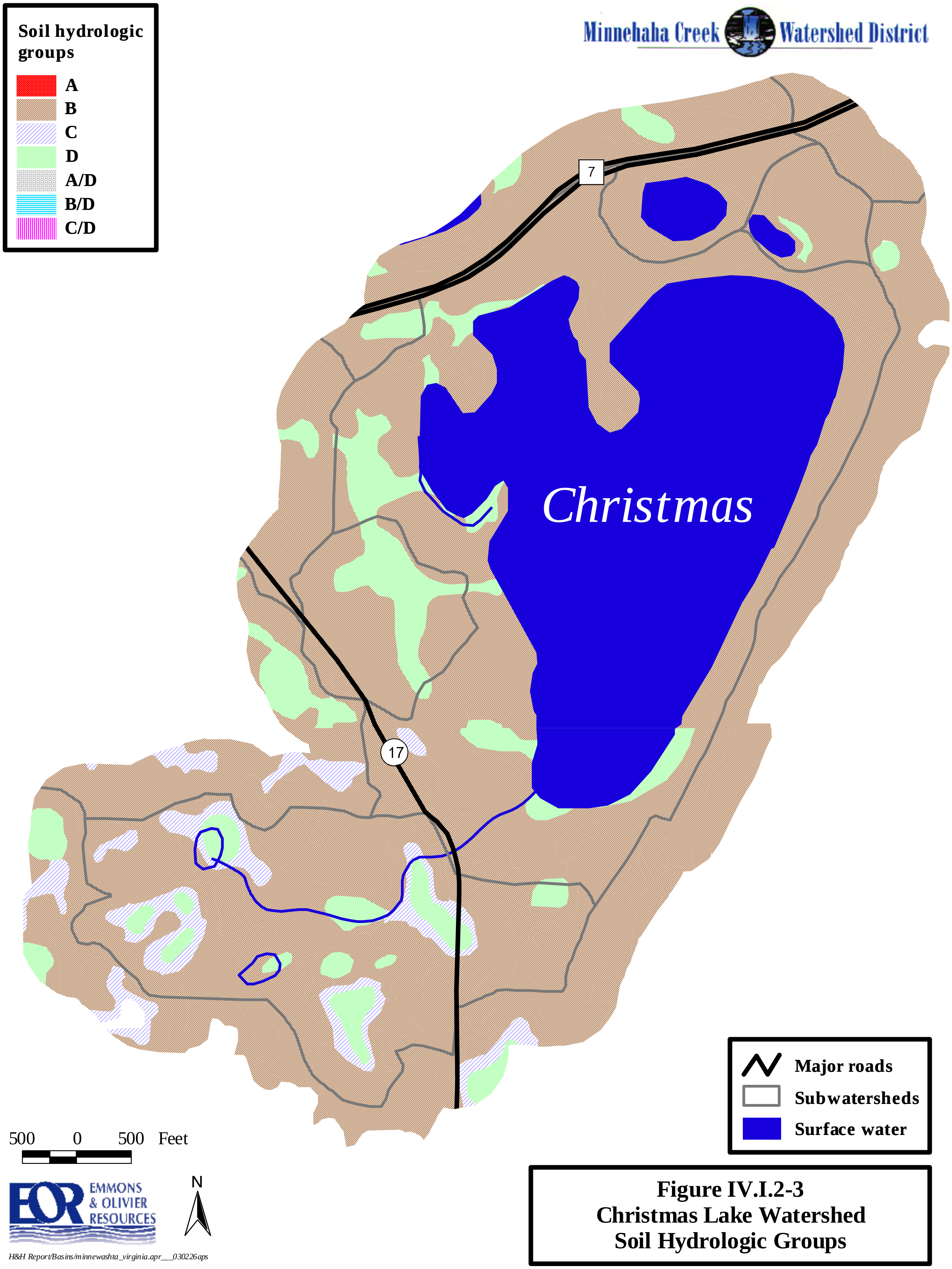


Figure IV.I.2-3
Christmas Lake Watershed
Soil Hydrologic Groups

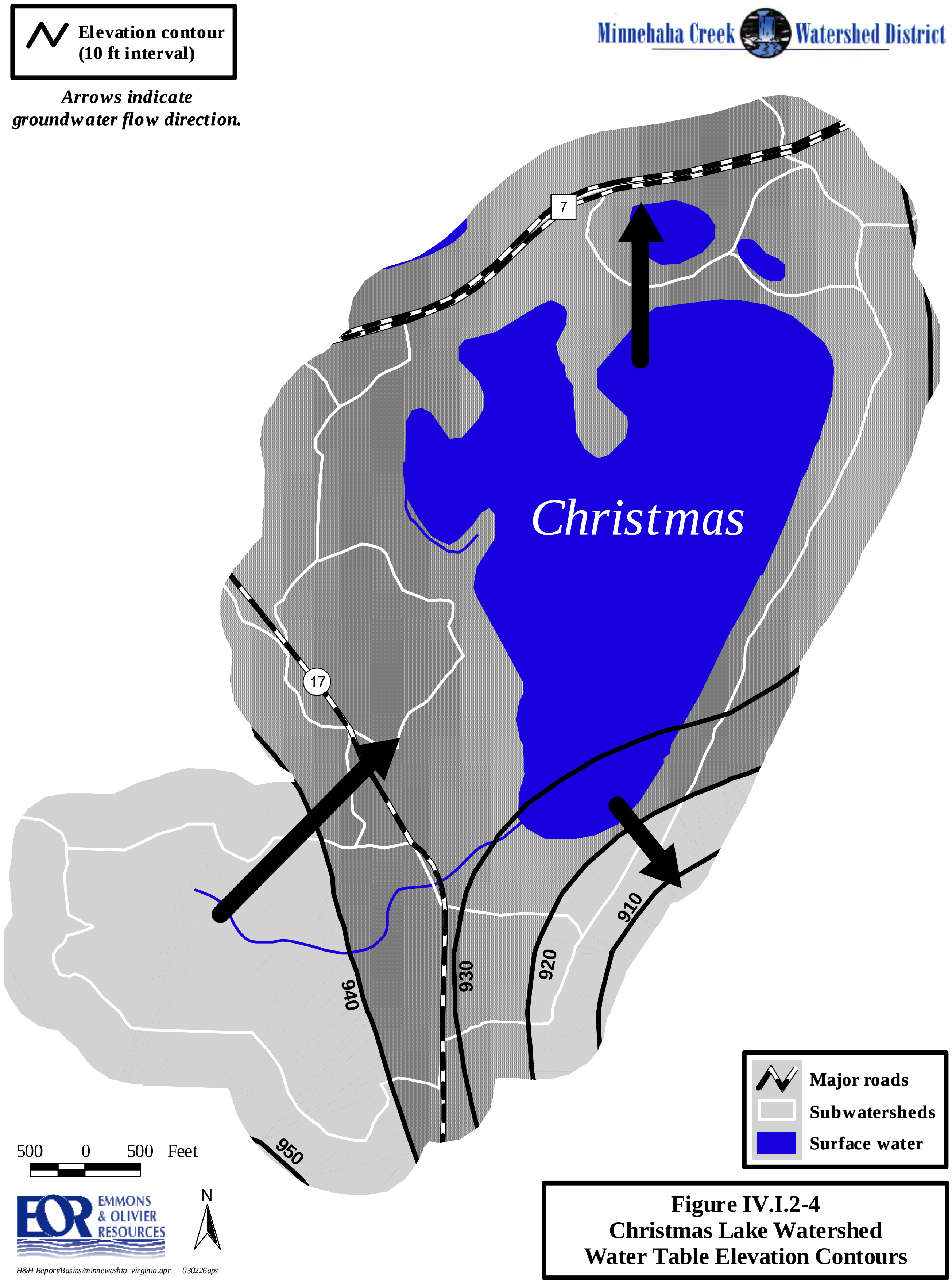


Figure IV.I.2-4
Christmas Lake Watershed
Water Table Elevation Contours

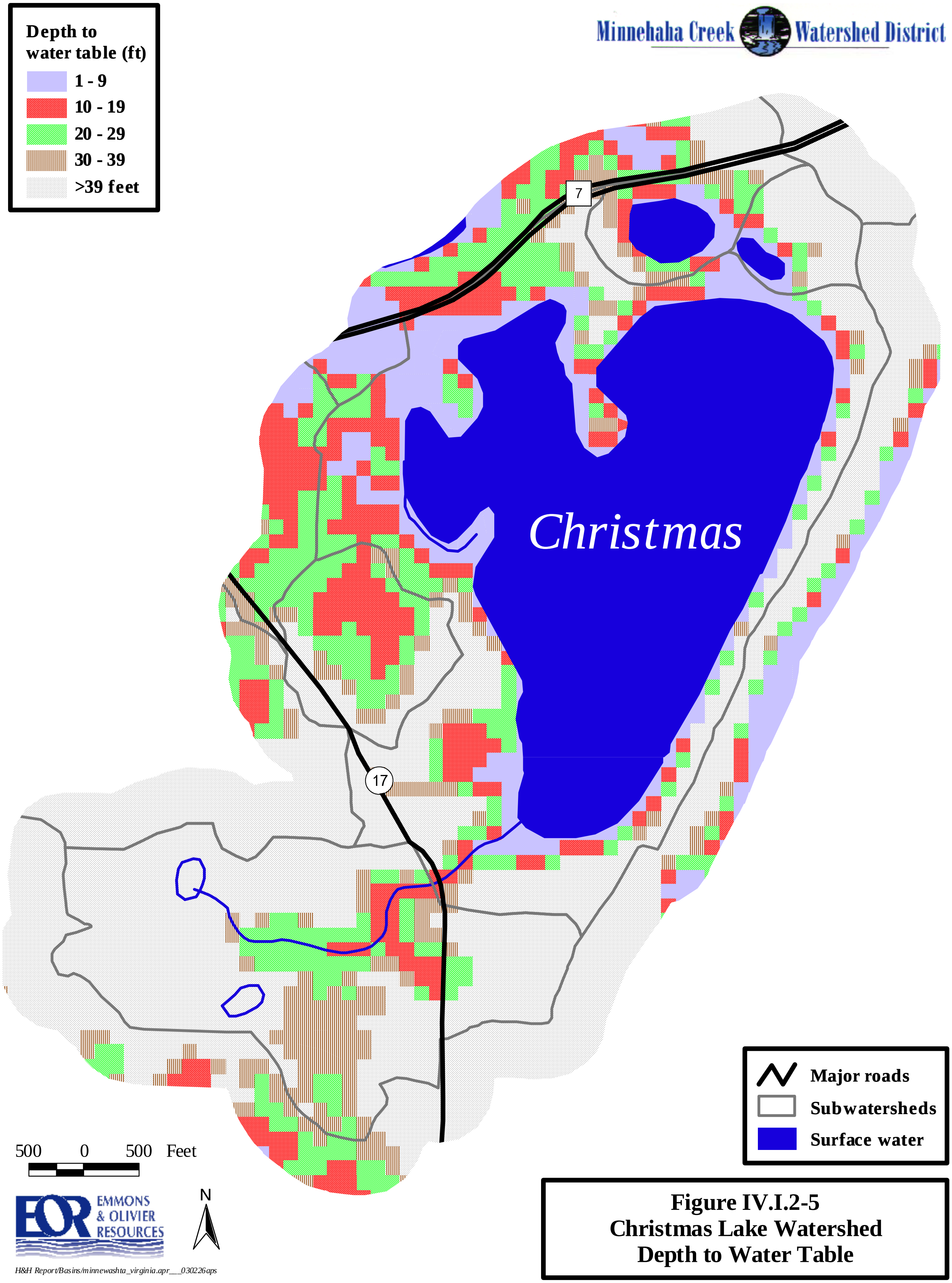


Figure IV.I.2-5
Christmas Lake Watershed
Depth to Water Table

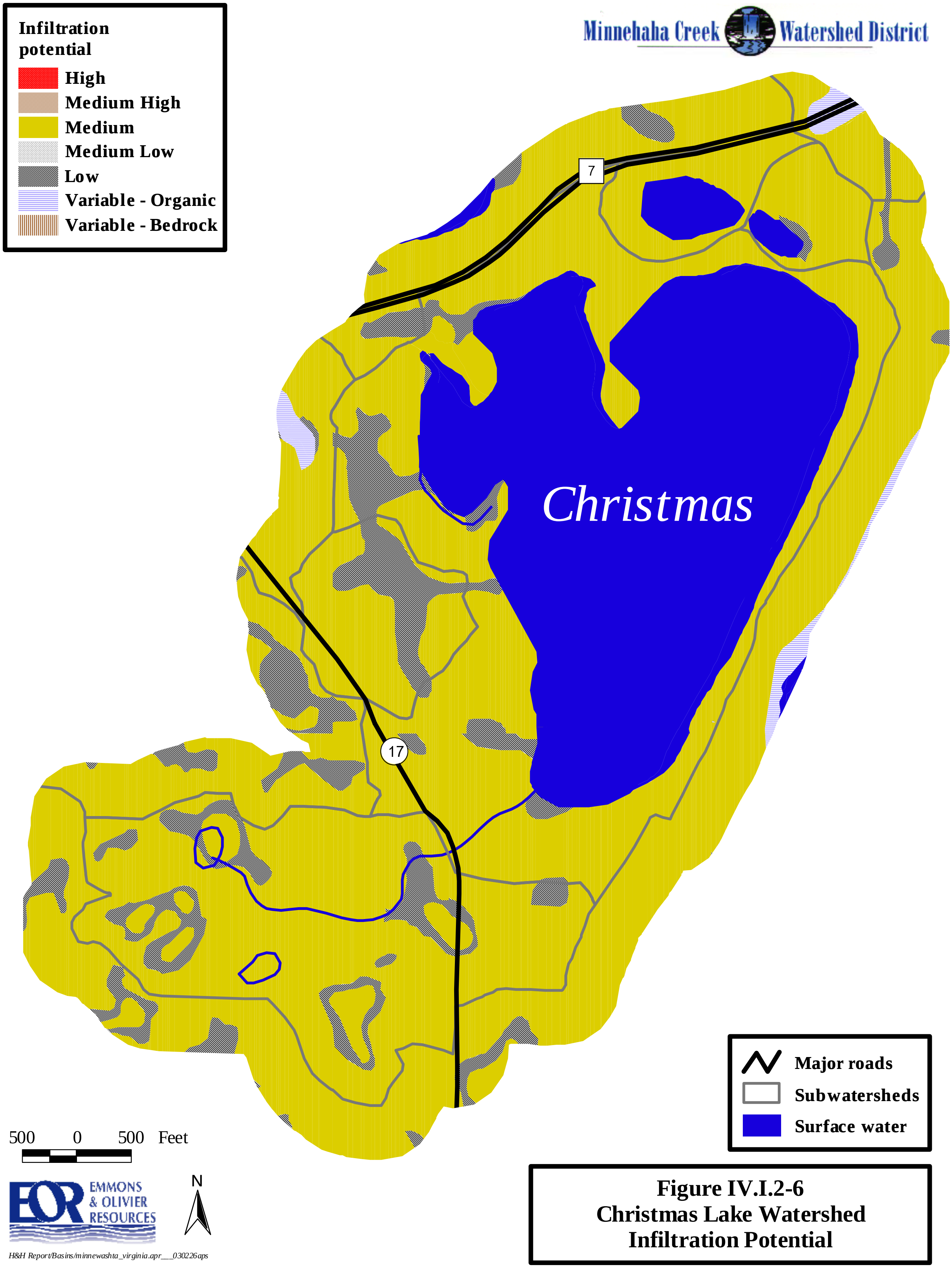


Figure IV.I.2-6
Christmas Lake Watershed
Infiltration Potential

I.3. Water Quantity

I.3.a. Watershed Hydrology

A description of the watershed morphology, drainage, land use, land cover, and soils exists under the Christmas Lake watershed section I.1. and I.2. For labeling of modeled features and XP-SWMM diagram, refer to Christmas Lake Watershed Figure IV.Appendix.1-I1 in the Appendix.

Input Parameters:

The hydrology of the Christmas Lake watershed is influenced by a mixture of urban residential development, lake, and wetland areas. The most concentrated development of the watershed is along the Hwy 7 corridor which runs between Christmas Lake and St. Albans Bay of Lake Minnetonka (Figure IV.I.1-1). Hydrologic input parameters include: area, slope, width, percent impervious, depression storage, hydraulic conductivity, capillary suction, and initial soil moisture deficit. The methodology used to generate these parameters is described under the model methodology section (II.F.1). The input parameter values for the Christmas Lake watershed are shown on Table IV.Appendix.1-I1.

Subwatershed Boundaries:

The Christmas Lake watershed was subdivided into a total of 5 subwatersheds. The average subwatershed size in the Christmas Lake watershed is about 150 acres.

The largest subwatershed, with a total area of about 472 acres, contains Christmas Lake (CL-5) of which approximately 54% of the total area is composed of lake surface. The total area draining to Christmas Lake is about 746 acres.

The subwatershed boundaries drawn were aided by the use of:

- new MCWD topography (10 foot resolution, generated with 5 foot interpolated intervals),
- City of Shorewood existing watershed boundaries
- USGS 10 foot topography

Where applicable and reasonable, subwatershed boundaries were matched with those already in use by others (i.e. city subwatershed boundaries). In general, boundary definitions were straight forward.

Boundary considerations:

- None.

Subwatershed growth:

The subwatershed area and percent impervious for all Christmas Lake (CL) subwatersheds for existing and 2020 conditions are listed in Table IV.I.3-1.

Highlighted by the last column of Table IV.I.3-1, the greatest increases of impervious surfaces are predicted in subwatersheds CL-1 and LC-2. The overall predicted increase of percent impervious by the year 2020 for the entire Christmas Lake watershed is 2.6 percent.

As these areas develop or re-develop, care should be taken to ensure development does not negatively impact the watershed resources. Specific recommendations concerning development in the Christmas Lake watershed are located in section *I.6: Recommendation*s.

Table IV.I.3-1
Christmas Lake Growth by Subwatershed

Subwatershed I.D.	Area (acres)	Percent Impervious* (%)	2020 Percent Impervious* (%)	Change in Percent Impervious (%)
CL-1	177	31	36	4
CL-2	46	33	36	3
CL-3	30	50	51	1
CL-4	22	43	43	0
CL-5	472	68	70	2
Average **	**149**	**55.5**	**58.1**	**2.6**
Total Area	**746**			

* Includes open water and saturated wetlands.

** Percent impervious average is weighted on area.

I.3.b. Watershed Hydraulics

Input Parameters:

Table IV.Appendix.1-I2 in the Appendix shows a summary of the hydraulic input parameters for all the modeled links. More specific input information such as cross section slopes, friction coefficients, or entrance/exit conduit losses (minor losses) can be found under the hydraulic mode of the XP-SWMM model.

Stage/area information for all the storage nodes modeled (lakes, wetlands, ponds, road crossings, etc.) are also available in the model.

Drainage Routing:

Surface flows in the Christmas Lake watershed are routed primarily though a system of culverts connecting small depressions. Flows are received by small pocket wetlands (some landlocked) and then Christmas Lake before ultimately discharging into St. Albans Bay.

Several landlocked and semi-landlocked areas within the watershed do not typically contribute to Christmas Lake. The main landlocked areas in the Christmas Lake watershed include:

- Unnamed wetland DNR ID 27-892W (CL-2)
- Como Lake DNR ID 27-145P (CL-3 & CL-4)

The landlocked basins are shaded in Figure IV.I.1-2. The west basin of Como Lake, CL-3, is marked as landlocked because it does not contribute to Christmas Lake, however, it does outlet to the east basin of Como Lake modeled in subwatershed CL-4.

A portion of subwatershed CL-1 also contains several small pocked wetlands and depressions that are landlocked and do not typically contribute to Christmas Lake.

I.3.c. Water Quantity Findings and Discussion

A summary of subwatershed findings and notes resulting from the modeling effort are compiled in Table IV.I.3-2. Additional modeling specific comments pertaining to the individual subwatershed basins are in Table IV.Appendix.1-I5.

Results Summary:

The normal water level (NWL), high water level (HWL), peak discharge, and peak velocities predicted for the 100-year events are listed in Table IV.Appendix.1-I3 and Table IV.Appendix.1-I4 of this volume. Hydrographs and time dependent stages and velocities for continuous simulations and other event runs can be found in the provided XP-SWMM models. Figure IV.Appendix.1-I1 in the Appendix shows the XP-SWMM model diagram depicting the names of the links and nodes representing the hydraulics (water routing) of the watershed.

Subwatershed Critical Event:

The modeled 100-year event that produced the “critical” or greater HWLs in the watershed basins varied. Table IV.I.3-2 and Table IV.Appendix.1-I3 should be referenced for each subwatershed’s “critical” event and HWL.

The 100-year 10-day snowmelt event resulted in the greater HWL in Christmas Lake (CL-5).

Table IV.I.3-2
Summary of Water Quantity Findings for Christmas Lake Watershed

Subwatershed I.D.	100-year Critical Event	Significant 2020 Impacts	Infrastructure notes	Flooding Issues	Landlocked Issues	Boundary Issues	Backwater conditions	Flow Velocities/Erosion Issues	Named water body	DNR jurisdiction	Water Quantity Improvement Priority	Additional H/H Modeling Notes (see Table IV. Appendix.1-I5)
CL-1	Rainfall	✓			✓			✓			high	✓
CL-2	Snowmelt			✓	✓					27-892W	high	✓
CL-3	Snowmelt				✓				Como Lake	27-145P	high	✓
CL-4	Snowmelt				✓			✓	Como Lake (east basin)	27-145P	high	✓
CL-5	Snowmelt						✓		Christmas Lake	27-137P	low	✓

2020 Impacts:

High water levels are not predicted to be significantly impacted as a result of 2020 landuse changes. The greatest HWL increase predicted is an increase of 0.4 feet in subwatershed CL-1.

Although 2020 conditions do not predict significant increases in either HWLs or peak discharge, development flows and especially volumes should continue to be regulated to ensure continued health of the watershed resources. For further discussion of impacts related to water quality, refer to section I.5.

Special Subwatershed Issues:

Landlocked basins in the subwatershed (noted above) are particularly sensitive to stormwater volumes. For this reason, strong volume control standards are recommended in all areas draining to landlocked areas.

In addition to the major landlocked basins, pockets of smaller unconnected wetlands (not explicitly modeled) exist throughout the watershed. Proposed culverts (new and/or upgrades to existing) shown in the City of Chanhassen Surface Water Management Plan (February 1994) and the City of Shorewood Comprehensive Water Resource Management Plan (Draft, August 1999) indicate that many of these smaller wetlands and pocket areas are proposed to be connected and/or drained. By "improving" drainage, water that was once retained and stored within these depressions will be transferred downstream. The additional volume of stormwater discharged from these previously noncontributing areas can have significant negative impacts to downstream water quality and flooding. It is recommended that low impact development techniques be employed as the area develops and that the function of the pocket wetland areas be retained. Particular attention to volume control and green space planning will greatly ease that burden.

The following areas are proposed to remain unconnected and volume control standards should be enforced:

- CL-1: Several small unconnected pocket wetlands exist in this subwatershed. Volume control practices are strongly recommended.
- CL-2 (Unnamed wetland DNR ID 27-892W): This wetland is landlocked but, is shown to just overtop during the 100-year snowmelt event modeled. The basin is controlled by a natural swale. High water elevations are strongly dependent upon the initial water elevation in the basin, therefore, volume control practices are very strongly recommended to limit any additional stormwater.
- CL-3 & 4 (Como Lake): Como Lake is landlocked. Flood flows would be received directly by Christmas Lake. Freeboard is less than 2 feet from the road low point separating the east and west basins. Strong volume control standards should be implemented and it is strongly recommended that this area be managed as landlocked.

Although Christmas Lake (CL-5) is not landlocked, its water elevations are frequently below the crest of the outlet control structure meaning it does not always discharge to Lake Minnetonka. Water elevations of Christmas Lake indicate that the lake is significantly influenced by evaporation and that there is likely a strong groundwater interaction.

All subwatersheds draining to Christmas Lake (CL-1 through CL-4) are currently landlocked or have landlocked pockets. Both the City of Chanhassen and Shorewood have proposed connections which will allow additional stormwater drainage to Christmas Lake. Additional volumes to Christmas Lake will increase the lake discharge frequency and may negatively impact water quality. For further discussion of Christmas Lake water quality, refer to section I.5.

Flow Velocities/Erosion Issues:

The modeled storm events did not result in any pipe velocities greater than 10 ft/s, which is used throughout the rest of the report as the criteria for significant conduit velocities. All Christmas Lake peak conduit velocity and discharge are available in Table IV.Appendix.1-I4.

The following Table IV.I.3-3 shows the results for the more significant conduit velocities predicted in the Christmas Lake watershed.

Table IV.I.3-3
Significant Conduit Velocities in Christmas Lake Watershed

Description	Link or Multi Link Name	Peak Velocity (ft/s)			
		Existing		2020	Snow-melt Event
		1.5-year, 24-hour	100-year, 24-hour	100-year, 24-hour	100-year, 10-day
Culvert under Powers Boulevard	CL1-PB	5.2	8.6	9.0	5.7

Where:

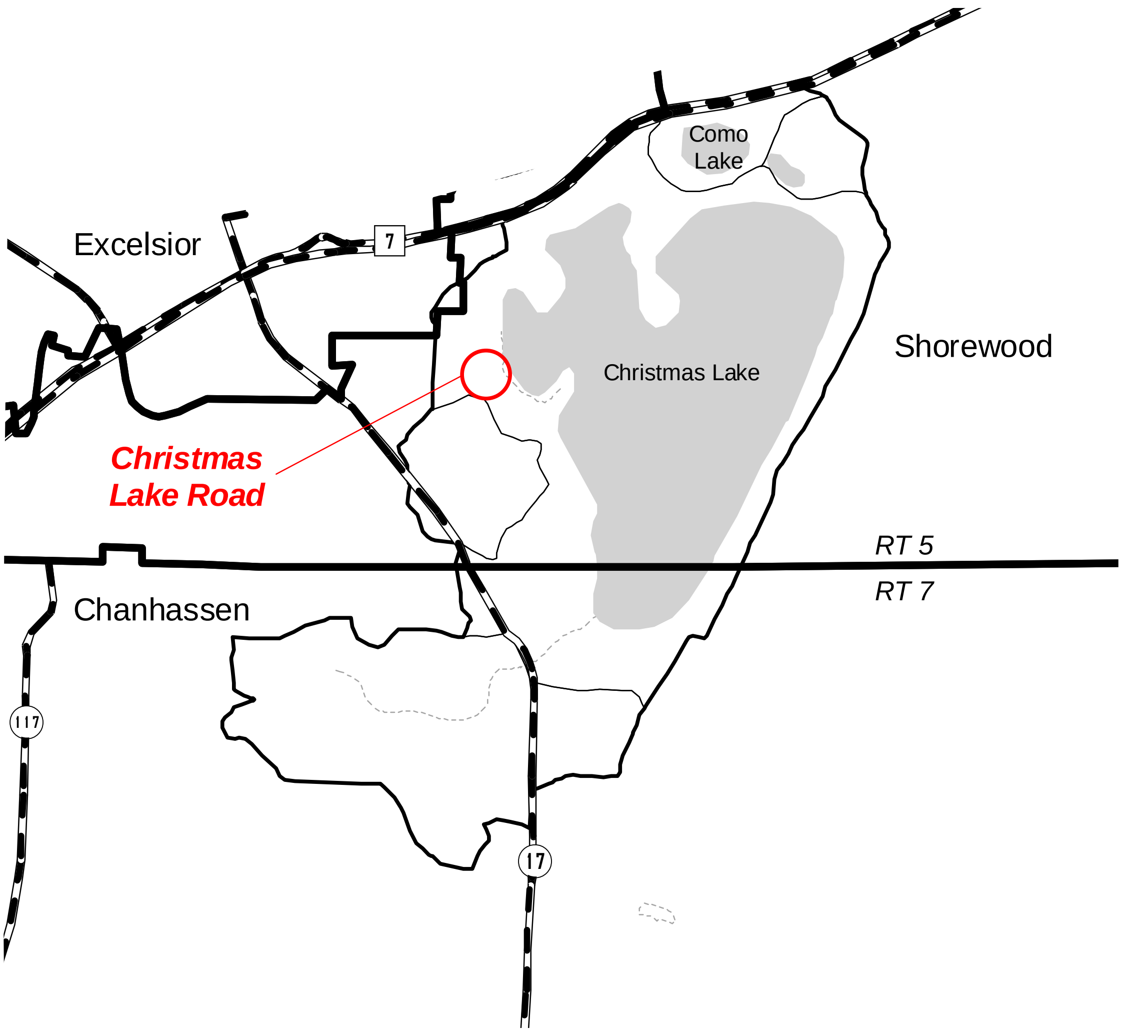
Velocity Range	
	10 to 11.9
	12 to 14.9
	15+

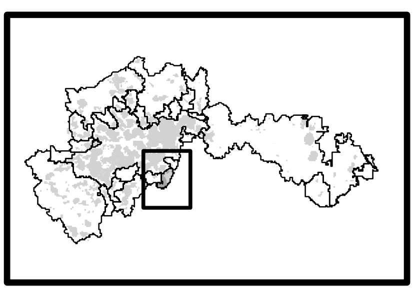
Flooding Issues:

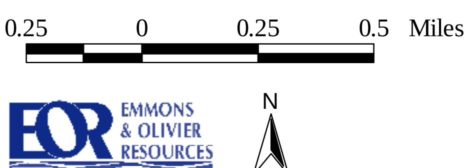
Modeling of the Christmas Lake watershed predicted that one location will overtop. Areas predicted to flood under 100-year events are shown in Figure IV.I.3-1.

The natural swale outletting the unnamed wetland, DNR ID 27-892W, in subwatershed CL-2 is predicted to just overtop during the 100-year snowmelt event. Flood flows must cross over Christmas Lake Road to the northeast of the wetland before entering Christmas Lake.

There are also roads modeled under existing and proposed conditions that show 100-year water levels close to overtopping the roads and within the freeboard (2 feet) required by the District. This information can be obtained using Table IV.Appendix.1-I3 and the road overtopping elevation.







Flooding Area
Subwatershed Boundaries
Major Watershed Boundary
Major Roads
City Boundaries
Streams
Lakes

H&H Report/Basins/Projects/flow_030612_kl

Figure IV.I.3-1
Christmas Lake Watershed
Flooding

I.3.d. Watershed Recommendations

Recommendations specific to water quantity issues can be found in *I.6: Recommendations*, along with recommendations relevant to other aspects of Christmas Lake water resources.

I.3.e. Watershed References

Pertinent information available to aid model construction and to compare and contrast XP-SWMM model results included:

- MCWD hydrodata
- MCWD Water Resource Plan
  - TR-20 Model results
- MNDNR historical water elevations:
  - Christmas Lake DNR ID 27-137P (CL-5)
- Surface Water Management Plans:
  - City of Chanhassen: Surface Water Management Plan (February, 1994)
  - City of Shorewood: Comprehensive Water Resource Management Plan (Draft, March 20, 2000)
- Mn/DOT / Hennepin County Road Plans
  - T.H. 7: State Project No. 2706-164 (1/1997)
- USGS Quadrangle Maps

This information was used to aid model construction and also model validation where applicable. Engineering and modeling judgment was used to assess and resolve conflicting information. Additional field information was gathered when necessary to fill in gaps, update and/or resolve conflicting information.

The XP-SWMM model results were calibrated against measured data and compared to other models for general results validation.

I.4. Scour and Erosion-Prone Areas

I.4.a. Streams

The Christmas Lake watershed does not contain one of the six main creeks selected for a more detailed erosion analysis. Therefore, no scour analysis has been performed in the watershed.

Two erosive locations were identified by Regional Team 7. Sediment enters Christmas Lake from the tributary flowing into the lake from the south at Powers Boulevard, and there is an erosive area along Holly Lane entering Christmas Lake, near the Shorewood border. See *Volume III. Public Involvement, G. Regional Team 7* (Figure III.G-1) for more details.

I.4.b. Lakeshore

The identification of lakeshore erosion areas was conducted primarily at the Regional Team meetings, when participants were asked to locate any known erosion areas on a map of the area represented. The RT 7 meetings did not identify any locations. This, however, does not necessarily mean that none exist; rather, it indicates that the members have not seen specific problems. The District should remain vigilant in locating lakeshore erosion because of the direct threat that these problems present through sediment delivery into lakes.

I.5. Water Quality

I.5.a. Watershed Pollutant Load Analysis

The pollutant loads (lbs/ac-yr) for the Christmas Lake watershed are illustrated in Figures IV.I.5-1 through -3. The remaining model results, including runoff volume and pollutant loads (lbs/yr), are listed in Appendix 2 of this volume.

The Christmas Lake watershed is already fully developed; therefore, pollutant loads are expected to increase only minimally (Table IV.I.5-1).

Table IV.I.5-1
Christmas Lake Watershed Pollutant Load Summary

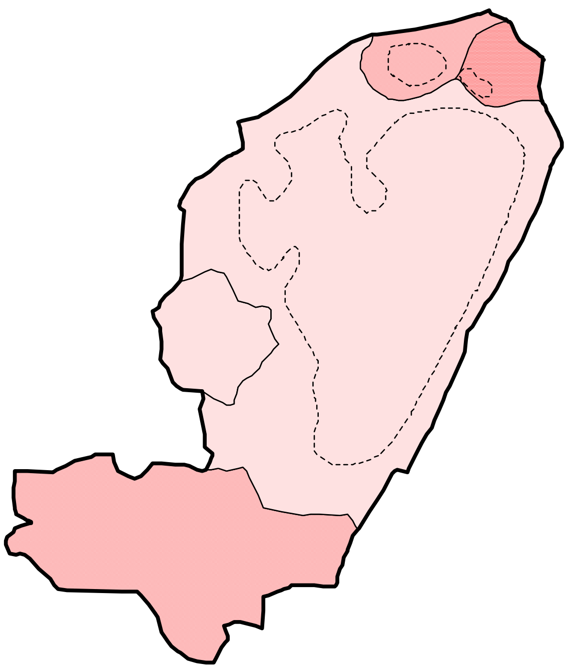
TP load (lbs/yr)				TN load (lbs/yr)				TSS load (lbs/yr)			
Existing	2020	Increase	% Increase	Existing	2020	Increase	% Increase	Existing	2020	Increase	% Increase
95	96	0	0%	904	941	37	4%	23164	24605	1441	6%

Under current conditions, TP loads (per unit area) in the Christmas Lake watershed are relatively low, with a small area of higher loads in the northeast subwatershed (CL-4; Figure IV.I.5-1). This subwatershed has a higher proportion of single family residential land uses than the other subwatersheds. TP loads are predicted to remain relatively constant.

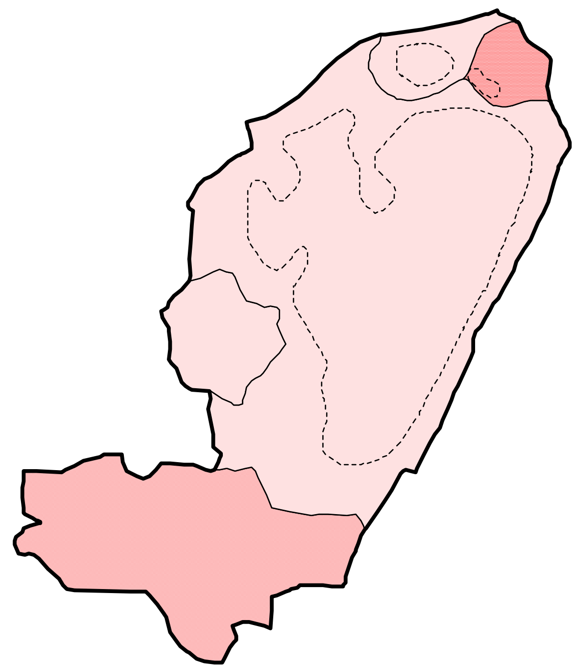
The TN and TSS loads follow a similar pattern (Figures IV.I.5-2 and IV.I.5-3), with higher loads in the northeast subwatershed. Management implications for these modeling results are discussed in *Section I.6: Recommendations*.

Minnehaha Creek Watershed District

Existing Conditions



2020 Conditions



Watershed Boundary

Lakes

Watershed TP Loads (lbs/ac-yr):

- 0.0 - 0.13
- 0.13 - 0.2
- 0.2 - 0.28
- 0.28 - 0.35
- 0.35- 1.0

0.5 0 0.5 Miles

N

EMMONS & OLIVIER RESOURCES

H&H Report/Basins/Projects/pload_030225_kl

Figure IV.I.5-1
Christmas Lake Watershed
Total Phosphorus Loads

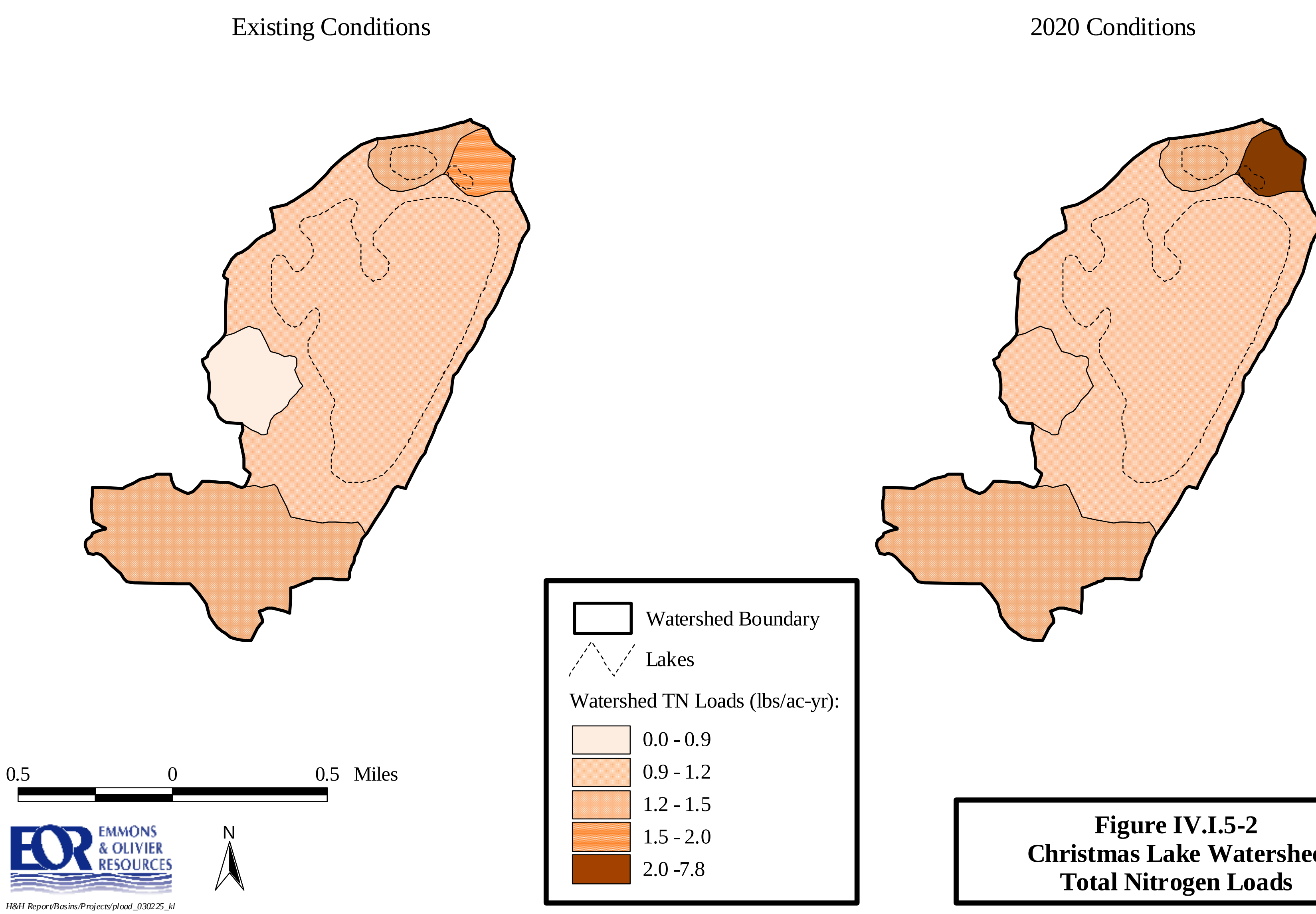


Figure IV.I.5-2
Christmas Lake Watershed
Total Nitrogen Loads

Minnehaha Creek Watershed District

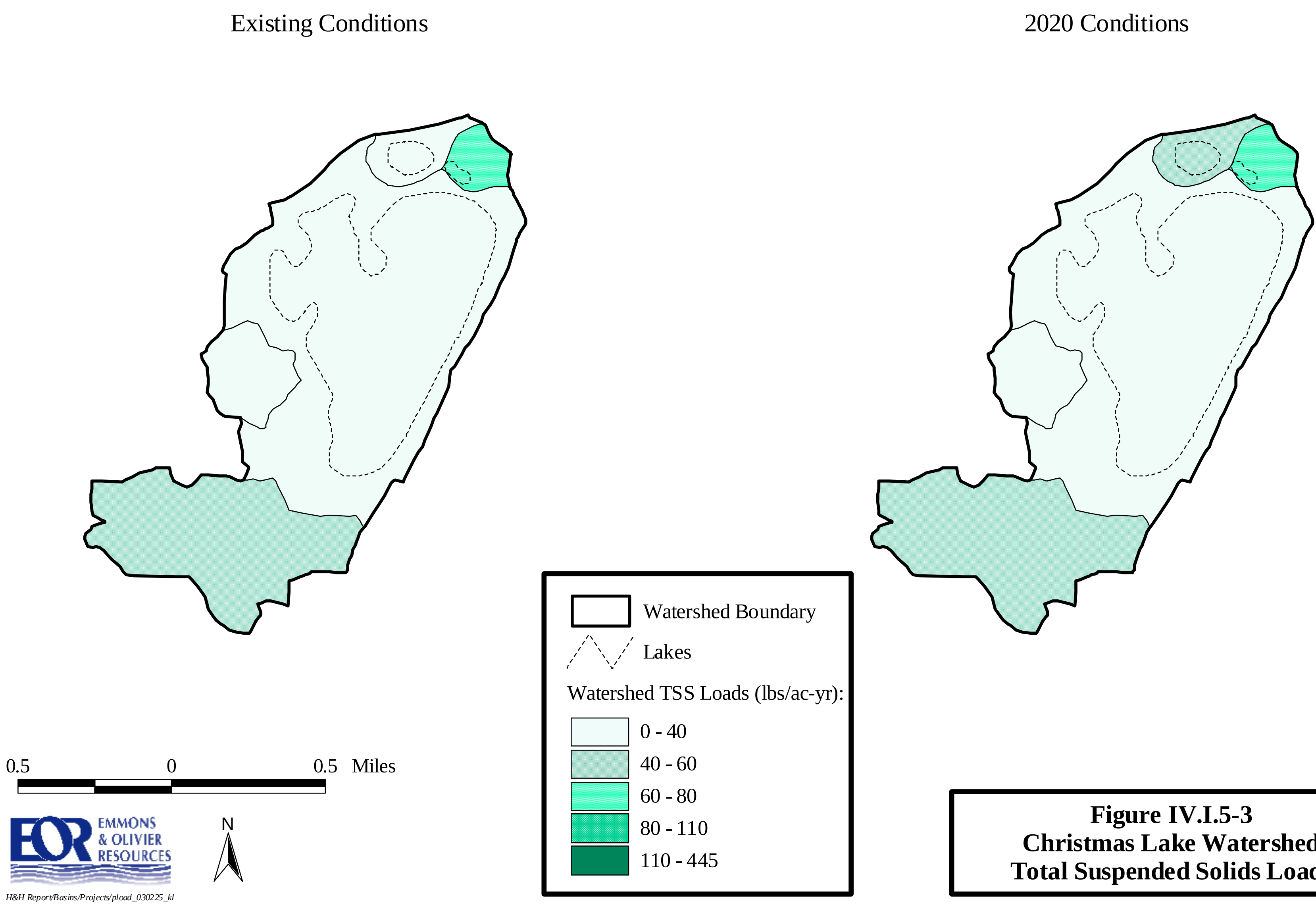


Figure IV.I.5-3
Christmas Lake Watershed
Total Suspended Solids Loads

I.5.b. Lake Modeling and Associated Goals

This section summarizes the lake modeling results for Christmas Lake. WiLMS input parameters (see *Volume II: Framework and Methodology*) are presented in Table IV.I.5-2, and the lake modeling results are presented in Table IV.I.5-3.

The watershed pollutant load estimate over-predicted the current in-lake concentration. Therefore, the load to the lake is derived from the observed in-lake concentration, along with lake and watershed characteristics (see *Volume II. Framework and Methodology, Section F* for a complete explanation). The mean annual runoff used for the lake modeling was 4.3 inches for both existing and 2020 conditions, the same values used in the watershed pollutant loading model. The runoff volume did not increase due to low levels of predicted future development in the watershed.

Table IV.I.5-2
WiLMS Input Parameters

Lake	Lake Area (acres)	Volume (ac-ft)	Mean Depth (ft)	Drainage Area (ac)	Watershed TP Load to Lake (lbs./year)	
					Existing	2020
Christmas	257	9252	36	387	35	36

Table IV.I.5-3
Lake Modeling Results

Lake	Observed (µg/L)		Predicted 2020 TP (µg/L)	
	Observed TP (June-Sept mean)	Years averaged	Based on modeled watershed loadings	"Adjusted 2020" estimate*
Christmas	15	1997 - 2000	--	17

*See methodology, Volume II, section F.2: Modeling, water quality.

For Christmas Lake, the lake model predicts that in-lake TP concentrations will increase slightly to 17 µg/L from existing to 2020 conditions. Current TP loads to the lake are relatively low, and future development in the watershed is also predicted to be low, leading to predicted stable in-lake TP concentrations.

Table IV.I.5-4 reviews the lake goals recommended by Regional Team 5 and identifies the load to Christmas Lake that corresponds to the RT recommendations. (More information regarding the RT5 goal recommendations can be found in *Volume III: Public Involvement, E. Regional Team 5*.) Additionally, the percent load reduction necessary to achieve the desired goal is presented.

Table IV.I.5-4
Christmas Lake Watershed Goal and Target Load

Lake	TP Goal (µg/L)		TP Load to Lake (lbs/yr)		Required % Reduction in Load (current vs. goal)
	MCWD 1997 Goal	**Proposed Regional Team 5 TP Goal**	**Current Load** (calculated from either PLOAD estimate or observed in-lake concentration)	**Load Goal** (calculated from RT goal)	
Christmas	18	15	35	35	0

With a mean depth of 36 feet and a relatively small watershed (watershed:lake area ratio of 2:1), Christmas Lake is noteworthy in that it has the best water quality of any lake in the MCWD. Monitoring data from 1997 - 2000 suggest that the TP concentration (15 µg/L) in the lake is lower than the MCWD goal of 18 µg/L. Due to both the high quality of the lake and the prediction that loading to the lake will not worsen by 2020, RT5 proposes to set the in-lake TP goal at 15 µg/L, in order to maintain current water quality. The lake fully meets the MPCA criteria of 40 µg/L for swimming use and is classified as having full swimming support.

I.5.c. MPCA Impaired Waters and Point Source Permits

Christmas Lake is on the MPCA's 303(d) list of impaired waters. The lake is listed under a region-wide mercury fish consumption advisory affecting aquatic life. The MPCA is working with the U.S. EPA in pursuing large-scale geographic remediation of these region-wide listings, so specific local actions are not expected.

Today, very few point source discharges of any treated material occur in the Minnehaha Creek Watershed. Of the six discharges that currently exist, none are located in the Christmas Lake watershed.

I.6. Recommendations

Christmas Lake has the highest water quality of any lake in the MCWD. This condition is due to a combination of factors including lake morphometry, small watershed to lake ratio, low levels of impervious surfaces, substantial areas of native vegetation, and probable strong groundwater-surface water interaction. The general approach, therefore, is to maintain and protect the existing conditions that, taken together, sustain the high quality of Christmas Lake. Since much of the lake is well buffered by natural vegetation and receives minimal runoff, the recommendations contained herein are focused on managing the shoreline buffer, minimizing stormwater runoff and addressing several areas of known erosion.

To address the load reduction needs identified in Table IV.I.5-4 and to incorporate the management alternatives in Table III.H-3 (*Volume III. Public Involvement, E. Regional Team 5*), the management scheme outlined in Table IV.I.6-1 is proposed for the Christmas Lake watershed. Details of the recommendations follow the table. Recommendations applicable to the entire MCWD are discussed in *Volume V: Watershed Issues Integration*.

Table IV.I.6-1
Christmas Lake Watershed Recommended Actions

Recommended Action	Receiving Water Body	Priority	Category					Responsible Party*
			Capital Improvement	Maintenance	Information /Education	Permitting/Enforcement	Monitoring/Investigation	
1) Christmas Lake tributary stabilization	Christmas Lake	High	X	X		X	X	A, B, E
2) Bluffline erosion protection	Christmas Lake	High			X	X		A, B, E
3) Stormwater volume control	Christmas Lake	High			X	X		A, B
4) Shoreline buffer protection	Christmas Lake	High			X	X		A, B, E
5) Maintain all landlocked basins (CL-1, 2, 3, &4)	Christmas Lake	High				X		A, B

*Responsible party: A – MCWD, B – City, C – Three Rivers Park District, D – Mn/DOT, E – Private Landowners

1) Christmas Lake Tributary Stabilization

The tributary enters Christmas Lake from the south and drains the single largest subwatershed of Christmas Lake (CL-1). As the gradient increases north of Powers Boulevard, a gully has been formed, resulting in the discharge of sediment to Christmas Lake. The following corrective actions are recommended:

- Rate control at the outlet of the small pond in CL-1 (serving as the tributary's source) should be evaluated.
- Additional storage opportunities should be evaluated in areas draining to this tributary to determine if rain gardens, infiltration swales and other BMPs are appropriate.
- Where active erosion is occurring, evaluate species composition and canopy structure of existing vegetation to determine if selective thinning (to increase groundcover sunlight) and/or establishment of shrubs, grasses and forbs would be appropriate.

- Maintain existing landlocked pockets on western side of subwatershed CL-1

2) Bluffline erosion protection

Significant portions of Christmas Lake shoreline areas contain steep slopes with a high potential for erosion. The area along Holly Lane, near the Shorewood/Chanhassen border, has active erosion problems. Stormwater runoff flow paths along bluffline should be evaluated to determine if/where concentrated flows are occurring. Where flows occur over the bluffline, impervious areas including roof tops, driveways and sidewalks should be sloped away from the bluff line. Alternatively, diversions, grading and other techniques should be applied to direct runoff away from the bluffline.

3) Stormwater volume control.

Many landlocked basins and pockets exist in the Christmas Lake watershed. Landlocked areas are particularly sensitive to additional volumes. The addition of stormwater volumes to landlocked basins should be limited to the extent possible with strict stormwater volume control.

The Christmas Lake watershed generally has a moderate infiltration potential. Where possible, stormwater infiltration should be used to lower the rate and volume of stormwater runoff from existing and new development.

4) Shoreland buffer protection

A large portion of the Christmas Lake shoreland area is comprised of forested areas, particularly along the steep slopes. Protecting this buffer of native shoreline vegetation is critical to preventing shoreline erosion and maintaining the lake's exceptional water quality. An evaluation should be performed of the quality and condition of these areas and a management plan should be developed. The management plan should include:

- Description of plant communities including tree, shrub and groundcover species composition of natural and semi-natural areas around the lake
- Description of near-shore littoral emergent/submergent plant communities
- Identification of invasive/exotic species infestation location and abundance

- Location of any areas of special concern (e.g., erosion sites)

5) Maintain all landlocked basins (CL-1, 2, 3, & 4)

Landlocked basins and smaller landlocked pockets (CL-1) should be maintained to limit additional stormwater discharge to Christmas Lake and to protect its existing exceptional water quality.

These recommendations emerged out of discussions as part of the Regional Team 5 public involvement process. Additional issues and management recommendations were identified as part of this process. A complete presentation of the recommendations can be found in *Volume III: Public Involvement, Regional Team 5*, which includes information regarding the priority of each issue, who would be responsible for undertaking each suggested management approach, and a recommendation of when the approach should be undertaken.