Stormwater Drainage Plan
Storm Sewer Drainage Districts

Detroit Lakes, Minnesota

FINAL VERSION

June, 2001

LARSON-PETERSON & ASSOCIATES, INC.
Consulting Municipal Engineers
Detroit Lakes, Minnesota

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

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Gary L. Nansen, P.E.

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Detroit Lakes, Minnesota

August, 2000

1. Introduction

The City of Detroit Lakes, Minnesota has the objective to properly collect and treat stormwater discharge from the existing and future expansion of the municipal storm sewer system in a manner that is not detrimental to the receiving waters. The water quality of surface waters including Big and Little Detroit Lakes is important to the local economy and contributes to the quality of life in this region.

This Stormwater Drainage Plan has been prepared at the request of the City of Detroit Lakes to provide information regarding the drainage characteristics, existing storm sewer capabilities and sediment and nutrient characteristics relating to the drainage districts within the City limits. The Pelican River Watershed Rules require each municipality having a population of more than 2,000 inhabitants to prepare a drainage plan for description of the existing system and management of future storm sewer as a result of urban development.

This drainage plan discusses the characteristics of the existing municipal system including collection facilities, detention devices and discharge points. The plan estimates flow, sediment and phosphorus discharge quantities from the system and future improvements to the existing system that will require water quality considerations.

2. Historical Review of the Drainage System

The initial storm sewer system for the City of Detroit Lakes in the early 1900's included a combined sanitary sewer and storm sewer system. The system often collected the sanitary and storm runoff in a common pipe, or involved separate pipes utilizing the same manholes and common discharge points. The primary receiving waters for the City of Detroit Lakes during this period were the Pelican River and Detroit Lake.

As the City expanded and advanced treatment of the sanitary sewer discharge became necessary, the sanitary sewer and storm sewer systems were separated. The conversion began in the 1930's and 1940's and cross connections between the systems are almost non-existent today. The storm sewer system was expanded as a result of community growth and improvements in the transportation system.

Initial planning began in the early 1960's to develop a project for diversion of stormwater from discharging into Detroit Lake. The project consisted of placement of a large storm sewer adjacent to the shoreline to intercept storm sewers and direct discharge to the lake and pipe the flow to the fairgrounds. A large stormwater pumping station was constructed to pump the water into a non-recreational watercourse that flows through wetlands to County Ditch No. 14. This project began a review of the stormwater discharge impacts on recreational waters which has resulted in the elimination of untreated stormwater outlets at several locations in the City.

Stormwater treatment and diversion improvements have continued to protect the river and Detroit Lake. The City has installed detention basins at several discharge locations and the Pelican River Watershed District has recently constructed wet detention basins in the Industrial Park. The Minnesota Department of Transportation installed an underground Vortek unit for separation and removal of solids at the intersection of T.H. No. 10 and at the Pelican River.

Funding for storm sewer and stormwater treatment facilities has been provided through various methods. The City of Detroit Lakes financed storm sewer improvements by special assessments for a period of time. More recently, the funding for these facilities has been obtained through user fees. Other sources of funding which are project specific include the Minnesota Department of Transportation, the Economic Development Administration (EDA) and other federal and state agencies. The Pelican River Watershed District funds improvements by a special levy.

3. Drainage System Review Agencies

Improvements and expansion of the municipal drainage system are subject to possible review by several agencies. Federal agencies may include the U.S. Army Corps of Engineers, the U. S. Fish and Wildlife Service and the Environmental Protection Agency (EPA). State and local review agencies include the Department of Natural Resources, the Minnesota Department of Transportation, the Minnesota Pollution Control Agency and the Pelican River Watershed District. The City of Detroit Lakes also includes ordinances that govern development and drainage. The scope of the project determines the involvement of agencies in the review process.

The U.S. Army Corps of Engineers has authority over navigable waters, the U.S. Fish and Wildlife Service can become involved in wetlands issues and the EPA has become active in legislation of non-point sources of pollution.

The Minnesota Department of Transportation is involved in the planning and funding of State, Federal and Municipal State Aid (MSA) streets within the corporate limits. MnDOT reviews storm sewer system installations and replacements to determine that the sizing is adequate to meet minimum design criteria. The department also funds water quality improvements such as detention facilities provided justification can be determined for their use.

The MPCA is involved in non-point source review and provides information for erosion control during construction projects, including the General Stormwater Permit.

The Minnesota Department of Natural Resources administers programs that affect natural streams and wetland areas in the state. Development of property in the Shoreland Zone is often reviewed by DNR for conformance with development regulations.

The Pelican River Watershed District is active in the review of stormwater runoff and drainage systems, but is not a permitting agency. The watershed monitors construction projects and site improvements to assure that applicable regulations are met. The watershed has recently become responsible for the Becker County ditch system adjacent to the City of Detroit Lakes and is therefore further involved in drainage issues.

4. City Ordinances

The City of Detroit Lakes ordinances include comprehensive zoning and subdivision requirements, including the following information:

> Section 16. Floodplain District: This section details the limitations and usage of property located within flood plain areas. Special consideration is give to erosion control and shoreland management in this section.
>
> Section 17. Wetland Systems District: This section defines suitable land uses and regulates activities within wetland districts.
>
> Section 18. Shoreland District: This section regulates land use within 300 feet of rivers and 1,000 feet of lakes.

Appendix C. Subdivision: The subdivision ordinance considers several issues related to runoff, erosion and drainage issues. This ordinance discusses inadequate drainage, pollution of water sources and damage from erosion. The ordinance requires erosion and sediment control including use of sedimentation basins. The requirement for a grading plan includes limitations for slope development to reduce erosion. The City can require dedication of up to six percent of the land to be subdivided as stormwater holding areas or ponds.

City Code 507: This code regulates the application of lawn fertilizer.

5. Study Area

The City of Detroit Lakes is located in northwestern Minnesota and is the County Seat for Becker County. The City is a juncture for State Highway No. 34, U.S. Highway No. 10 and 59, Soo Line Railroad and Burlington Northern Santa Fe Railroad.

The City is located within the Pelican River Watershed. The advancement of glaciers from the northwest are primarily responsible for the topography of the Pelican River Watershed, resulting in a thick layer of glacial drift. Watershed soils range from well-drained, medium textured sandy soils developed from calcareous, glacial till on the east to dark colored, coarse to medium textured material formed from outwash near the center, to well drained dark soils produced from calcareous glacial till on the west.

The mean annual temperature for the area is 39.2°F although yearly temperature extremes from -20° to 90°F are common. The mean annual precipitation according to the U.S. Weather Bureau is 23.5 inches per year, which is below the mean annual precipitation for Minnesota of 25 inches per year. Precipitation received in the form of rain between April and September normally constitutes 75-80% of the annual total. Evapotranspiration ranges from 20 to 30 inches per year.

The economy of the City is centered around tourism and agricultural activities with commercial establishments to support the tourism and agricultural industries by supplying the necessary goods and services.

The City has a municipal water supply including treatment and distribution. The City also owns a wastewater treatment facility which serves the municipal collection system. The electrical utilities are owned by the City.

The population of the City of Detroit Lakes and Becker County are given from information received from the State Demographer's office:

Table 1: Population Data

	Becker County		Detroit Lakes	
Year	Population	Percent Change	Population	Percent Change
1950	24,836	-	5,787	-
1960	23,959	-3.53	5,633	-2.66
1970	24,372	1.72	5,797	2.91
1980	29,336	20.37	7,106	22.58
1990	27,881	-4.96	6,635	-6.63
2000	30,000	7.6	7,348	10.75

Detroit Lakes has shown a moderate increase in population in recent years, according to census data although a significant amount of that increase is due to annexation of adjacent property. Becker County has experienced a moderate increase in population which appears to be leveling off. Due to the County population statistics and the strong reliance on an agricultural economy, it is anticipated that the population will remain at or near the current level.

The study area considered in this Report consists of the property identified in the attached location map.

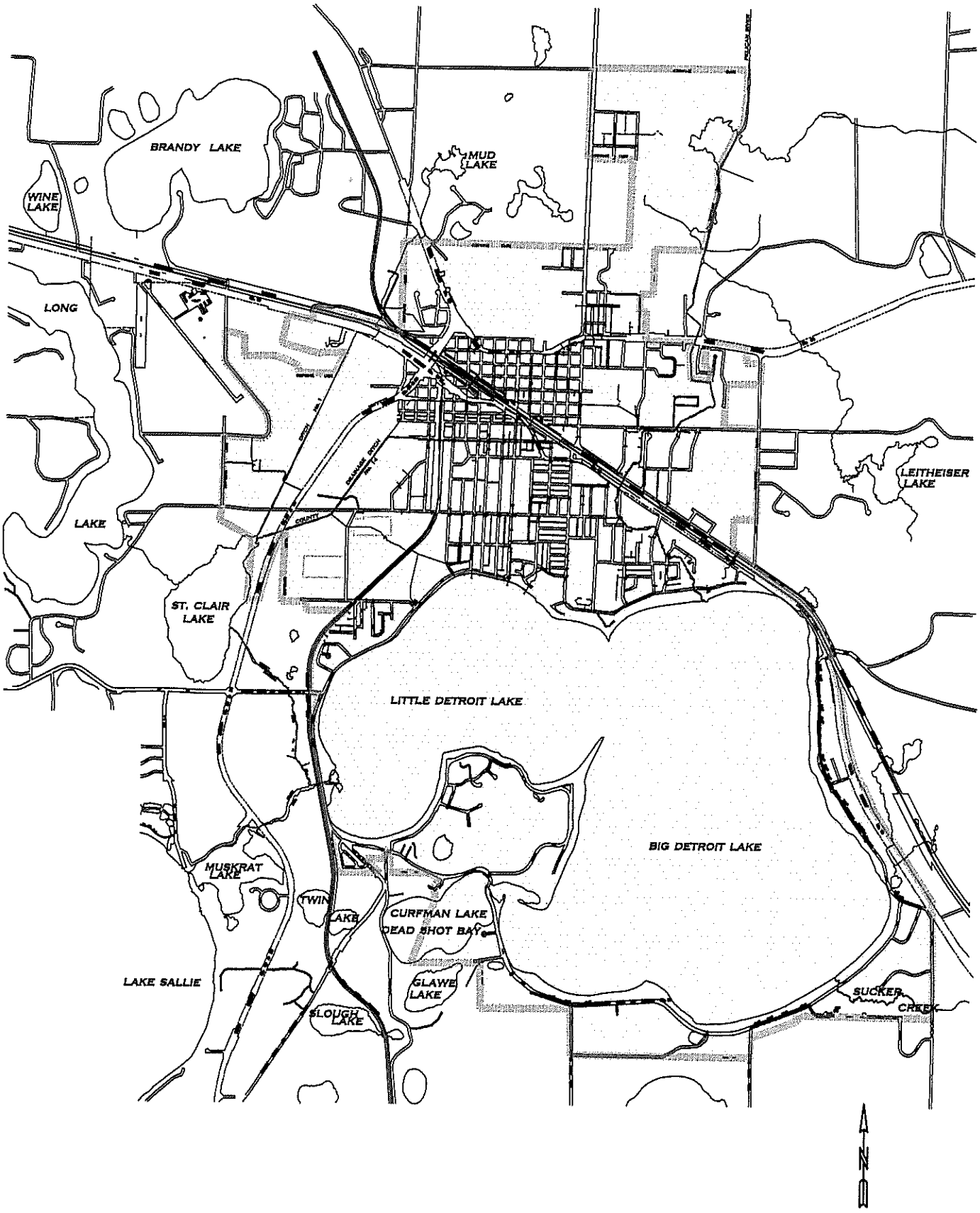

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FIGURE NUMBER 1 – COMPREHENSIVE STUDY AREA
STORMWATER DRAINAGE PLAN
DETROIT LAKES , MINNESOTA

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APPROVED BY: S.L.M.
DATE: JUNE, 2001
FILE NO.: 98-078-08
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6. Existing Stormwater Drainage Facilities

Storm sewer facilities are designed based upon the sizing necessary to convey stormwater during a defined storm event. Critical factors determining the quantity of runoff include soil types, land usage, topography and size of the watershed. However, the intensity and duration of a rainfall are the most significant variables in defining the ability of the storm sewer to handle a rainfall.

The Minnesota Department of Transportation (MnDOT) standards recommend storm sewer pipe capacities for storm sewer installations to achieve a design frequency of three to five years. The greater the design frequency the less likely a given storm will exceed the system capacity. A three year design frequency for a community the size of the City of Detroit Lakes is common based upon the traffic volumes of the residential streets. Many existing storm sewer systems do not meet the three to five year criteria for a number of reasons. For example, properties may be developed as impervious surface to a degree beyond the original expectations, or drainage areas may be expanded beyond the original boundaries. It is not uncommon for a system to meet the criteria for a two year or less storm event.

If a storm event exceeds the design frequency of the system, the result is ponding at the inlet locations. Initially, the ponding occurs in the street at the low points and may extend above the curb into the boulevard areas. The greater the rainfall intensity and the longer the duration of the storm, the more volume of stormwater results in the ponding sites.

Storm sewers are not sized to accommodate larger storm events primarily due to the associated costs for the larger system. The critical criteria in evaluating storm sewer performance are the characteristics of the ponding areas. Of particular concern is that the water spread zone does not flood structures. Generally, the stormwater dissipates quickly after a storm and the ponding is just a temporary inconvenience.

However, if a structure is built below the street elevation or low enough to be affected by the ponding, there can be significant property damage.

Figure No. 2A and 2B presents a map of the existing storm sewer in the City and the sizes of the major trunk and collector mains.

7. Existing Drainage District Descriptions

The drainage districts have been delineated on the basis of the boundaries that are served by each storm sewer collection system and on the existing topography. The drainage districts are further broken down into drainage sub-districts, which consist of individual basins that have their own runoff characteristics. Runoff in these sub-districts collects in low areas and is directed either through storm sewers, natural ditches or man-made channels to other districts or sub-districts downstream. The information provided below has been assembled from existing information and visual inspection of the drainage districts. No additional field surveys or contour mapping have been completed for the preparation of this plan.

The City of Detroit Lakes lies almost entirely within the boundary of the Pelican River Watershed District. The majority of the City is located along the north shores of Big and Little Detroit Lakes and consists mainly of urban section streets with storm sewer trunks and laterals and some undeveloped areas. The rest of the City is spread out along the remaining shoreline of Big and Little Detroit Lakes and consists primarily of rural section streets drained by ditches and culverts. The focus of this report will be on the urbanized portion of the City.

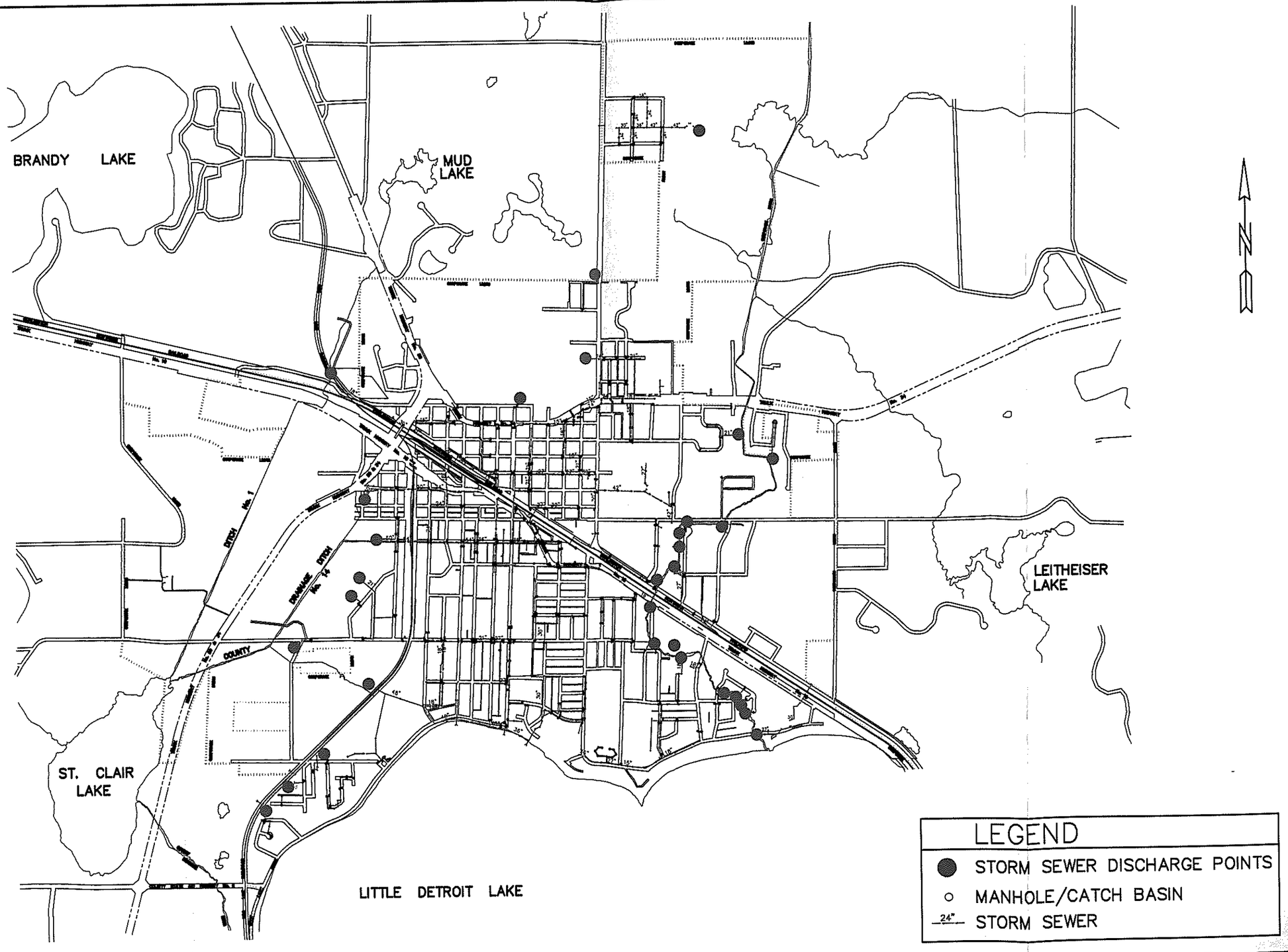

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FIGURE NO. 2A
STORM DRAINAGE FACILITIES (NORTH)
DETROIT LAKES, MINNESOTA

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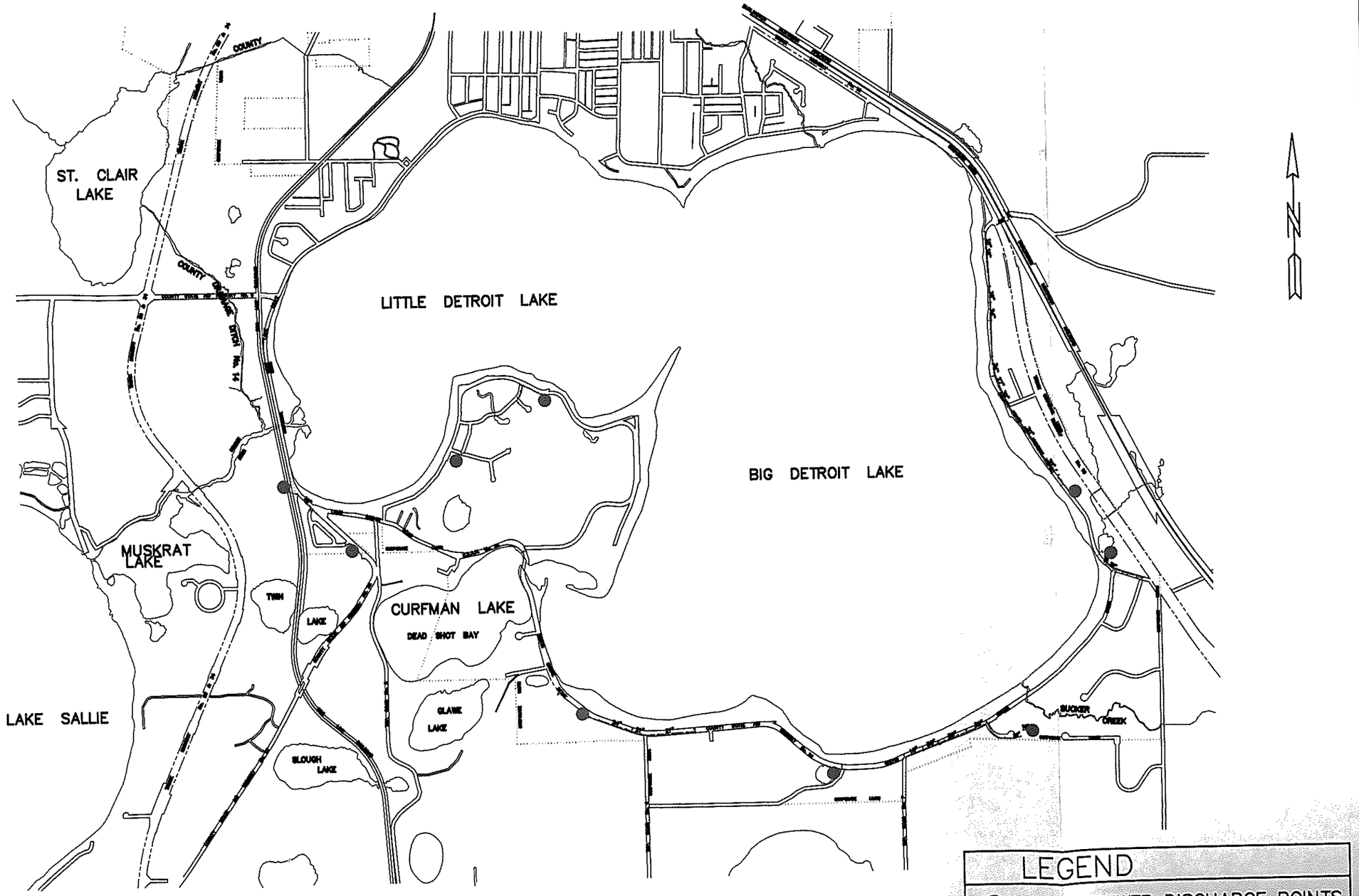

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- ● STORM SEWER DISCHARGE POINTS
- ○ MANHOLE/CATCH BASIN
- —24"— STORM SEWER

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FIGURE NO. 2B
STORM DRAINAGE FACILITIES (SOUTH)
DETROIT LAKES, MINNESOTA

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SHEET 2 OF 2

The majority of the area within the City limits falls into two drainage districts. The major portion of the east half of the City of Detroit Lakes drains directly into the Pelican River upstream of Big Detroit Lake, which is also called County Ditch 13 within the City limits. The west half of the City drains to County Ditch 14 and Branch Ditch No. 1 which are tributaries of the Pelican River downstream of Little Detroit Lake. The rest of the City lies along the east, south and west shores of Big and Little Detroit Lakes, and consists of several smaller drainage districts. Some of these districts drain to the lakes, some are isolated and some drain away from the Pelican River Watershed.

These districts in turn are divided into sub-districts for areas that are associated with specific storm sewer outlets and detention areas and also for significant storm sewer trunks and laterals. These sub-districts include 13 storm sewer outlets to wetland areas drained by the County Ditch No. 1 and No. 14 system, 20 storm sewer outlets to the Pelican River and 7 outlets to wetlands that are part of the Detroit Lake basin. These outlets range in size from 12" to 60" in diameter. There are also several non-point sources of storm runoff and several small storm sewer outlets to a wetland area north of the City.

The 48" storm sewer that runs along the City beach from Rossman Avenue to Washington Avenue and discharges to the wetlands north of Snappy Park includes 3 overflows to Little Detroit Lake. During normal rain events, these overflows carry little or no stormwater, but they may function during heavy rain events.

Twelve of the storm sewer outlets discharging directly to the Pelican River have had detention basins constructed at the outlets in order to improve water quality in downstream lakes. Also MnDOT has installed a Vor-Tek structure at another outlet that to date is estimated to have removed up to 70% of phosphorous and total suspended solids. Two of the basins that discharge to the County Ditch 14 system have a detention pond at the outlet and a third is scheduled to be constructed in 2001 at the Holmes Street outlet (sub-district D-1). Three other detention ponds are located at

storm sewer outlets to wetlands around Big Detroit Lake. There are more ponds along the Pelican River because the City has made a commitment to improving the water quality of Big and Little Detroit Lakes. However, it may not be feasible to construct ponds at the remaining untreated outlets on the Pelican River due to a shortage of space. Along County Ditch 14 there is abundant space, but much of it is wetlands and might require mitigation.

Six of the storm sewer outlets to the Pelican River are routed through 'wet' detention ponds, which are overexcavated to provide a permanent pool of water below the outlet elevation. These ponds are typically the most efficient at removing pollutants from runoff. As part of the 2001 North Shore Drive improvements, an existing dry pond will be converted to a wet pond. The proposed Holmes Street pond, the Legion Park pond and the three ponds around Big Detroit Lake are also wet ponds. All of the other detention basins in the City are considered to function as 'dry' basins. These are designed to control peak runoff by temporarily impounding runoff during rainfall events. Between rainfall events, the detention basins may dry up completely. Although not designed for water quality control, these basins also remove some pollutants by allowing them time to settle out.

Figure 3A and 3B presents the stormwater drainage districts and sub-districts in the City.

8. Stormwater Runoff Considerations

Storm sewer facilities are designed based upon the sizing necessary to convey stormwater during a defined storm event. For this report, the Rational Method as used by MnDOT will be used. Critical factors determining the quantity of runoff include soil types, land usage, topography and size of the watershed. However, the intensity and duration of a rainfall are the most significant variables in defining the ability of the storm sewer to handle a rainfall.

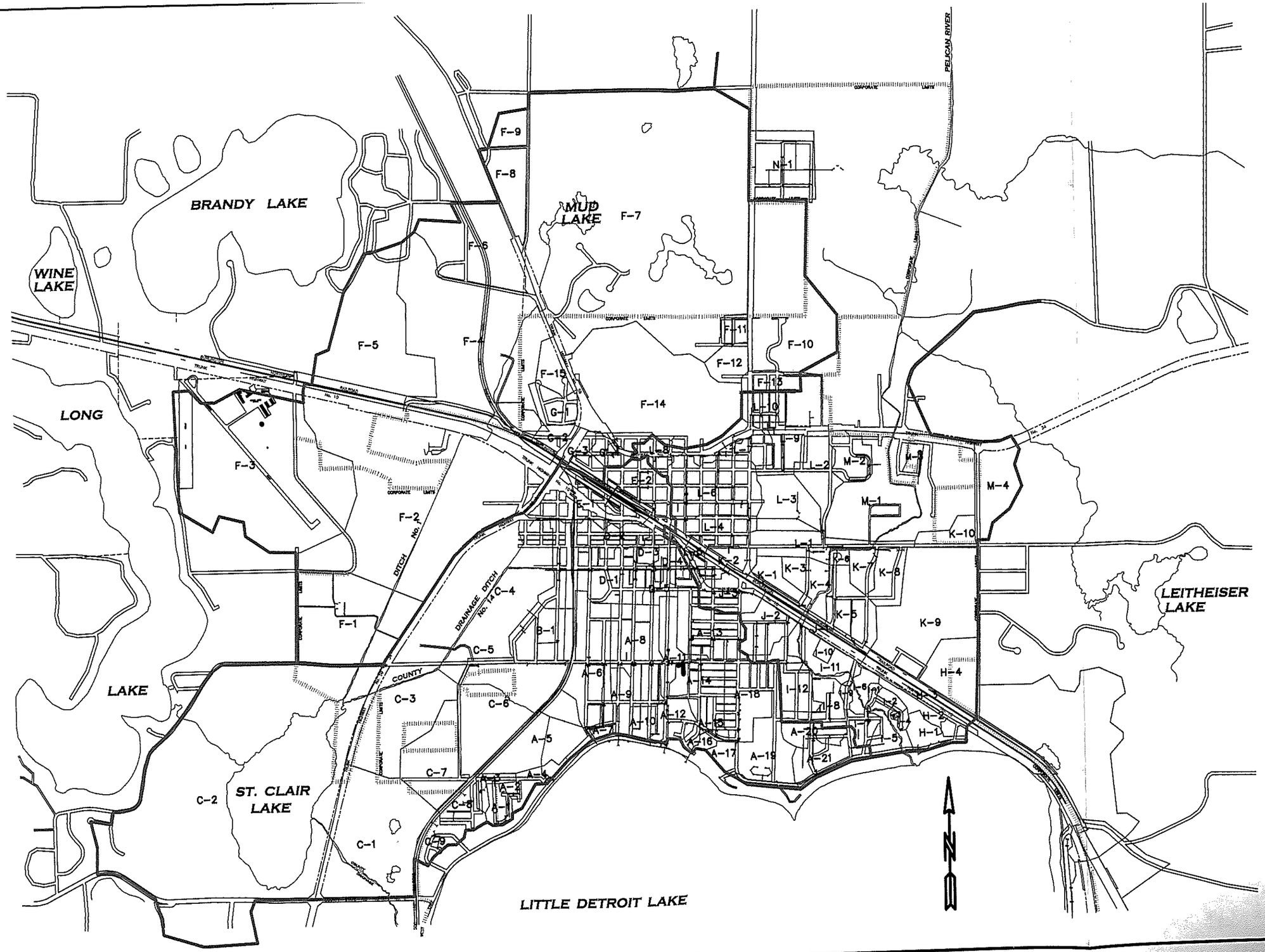

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FIGURE NO. 3A
DRAINAGE AREA MAP – NORTH AREA
DETROIT LAKES, MINNESOTA

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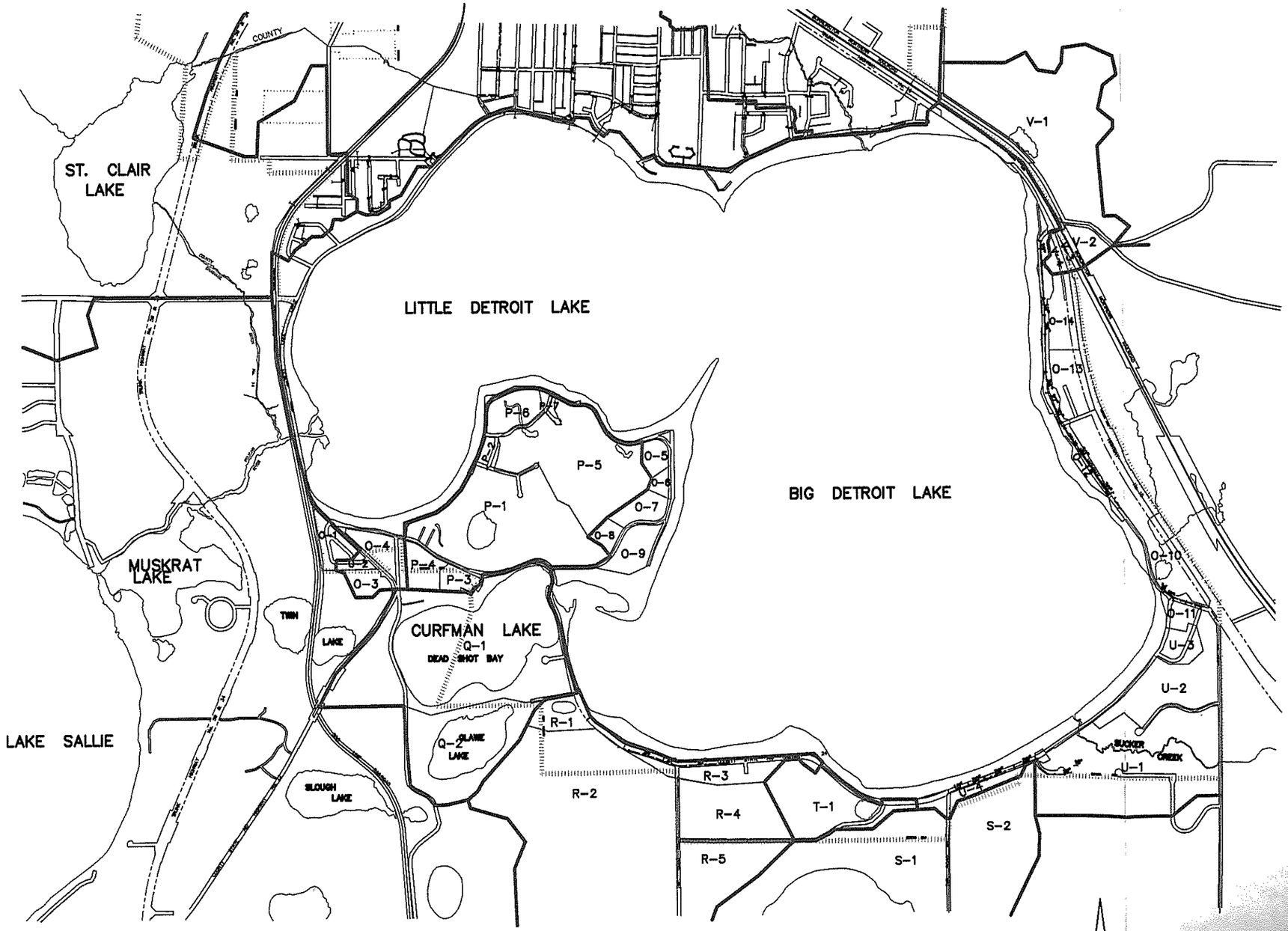

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FIGURE NO. 3B
DRAINAGE AREA MAP – SOUTH AREA
DETROIT LAKES, MINNESOTA

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NO SCALE

A. Zoning Data

The drainage districts within City limits are substantially developed, consisting primarily of residential property, commercial property adjacent to T.H. No. 10 and 59, institutional usage and open space in the north region of the district.

Table 2: Zoning

Zoning	Description	Runoff Coefficient
R-1	Residential, Single Family	0.20 - 0.35
R-2	Residential, Multiple Family	0.25 - 0.45
R-3	Residential, Apartments	0.45 - 0.65
R-A	Residential, Agricultural	0.10 - 0.30
R-MH	Residential, Mobile Homes	0.30 - 0.50
R-LB	Residential, Lakeshore Business	0.30 - 0.50
B-1	Business	0.70 - 0.85
B-2	Business	0.60 - 0.75
B-3	Business, Automotive	0.65 - 0.80
I-1	Industrial, Light	0.50 - 0.65
I-2	Industrial, Heavy	0.55 - 0.70

B. Soils Data

The soils are generally characterized as well drained granular soils including sands and coarse gravels. However, silt and clay soils exist within some areas of the drainage sub-districts and impact the volume of runoff for a given storm event. The land slopes vary, but on average are rolling, with street grades typically ranging from 2 to 5 percent.

The soils information for the City has been obtained from the "Becker County Soils Survey" and is included with this plan. The four basic soil categories and their associated characteristics are:

Table 3: Hydrologic Soil Groups

A.	Deep, well drained sands or gravelly sands that have a high infiltration rate when thoroughly wet.
B.	Moderately deep, moderately well drained moderately fine to moderately coarse soils that have a moderate infiltration rate when thoroughly wet.
C.	Soils that have a slow infiltration rate when thoroughly wet due to the presence of an impeding layer or of fine-textured soils.
D.	Clay soils or soils with a permanent high water table that have a very slow infiltration rate when thoroughly wet.

C. Design Storm Event

The storm event for runoff calculations is a three year storm. The Rational Method assumes a constant intensity, or rate of rainfall, over a given period of time called the Time of Concentration. For the City of Detroit Lakes, the Time of Concentration ranges from 9 minutes to 45 minutes for individual sub-districts and up to 80 minutes for cumulative areas. The corresponding three year storm intensities vary from 1.14 inches per hour for the longer duration storms to 4.05 inches per hour for the shortest

Time of Concentration. MnDOT Figure B 5-294.222 was used to determine the intensities and is included in the Appendix.

D. Drainage Subdistricts

The districts have been subdivided into smaller areas to assist in defining the Time of Concentration and the peak discharge rate for each outlet as a result of the storm event. The Time of Concentration is a function of the basin's shape, size, topography and land use, and is necessary to determine the peak discharge rate. Peak flows are also affected by

detention ponds which temporarily store runoff and release it over a longer time period thereby reducing the peak rates. Calculations for each drainage district are shown in Appendix A.

E. Summary of Stormwater Discharge

A summary of the estimated stormwater discharge volumes is presented in Appendix B. The total volume of discharge is the product of the area times the runoff coefficient times the depth of rainfall. For Detroit Lakes, the average annual precipitation is approximately 23.5 inches. Stormwater detention ponds have little or no effect on the total volume of discharge.

F. Storm Sewer Detention Facilities

The Pelican River Watershed District has constructed several stormwater ponds within city limits to reduce both the peak stormwater runoff and the concentration of pollutants in the runoff. The City of Detroit Lakes with the assistance of grants provided by the Pelican River Watershed District has also been constructing ponds at storm sewer outlets to the Pelican River. The purpose of constructing these ponds is to improve the water quality in Big and Little Detroit Lakes as well as other downstream lakes. The basins reduce peak runoff by restricting the outflow rate and providing an area for temporary storage. This also tends to improve runoff water quality by allowing the pollutants time to settle out. Where space is available, two-cell pond systems with permanent pools of water are the most efficient and economical methods of removing pollutants, although single-cell dry ponds are also helpful in removing pollutants. The City's storm sewer detention facilities are shown along with the storm sewer in Figure No. 4A and 4B.

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FIGURE NO. 4A
STORMWATER DETENTION BASINS
DETROIT LAKES, MINNESOTA

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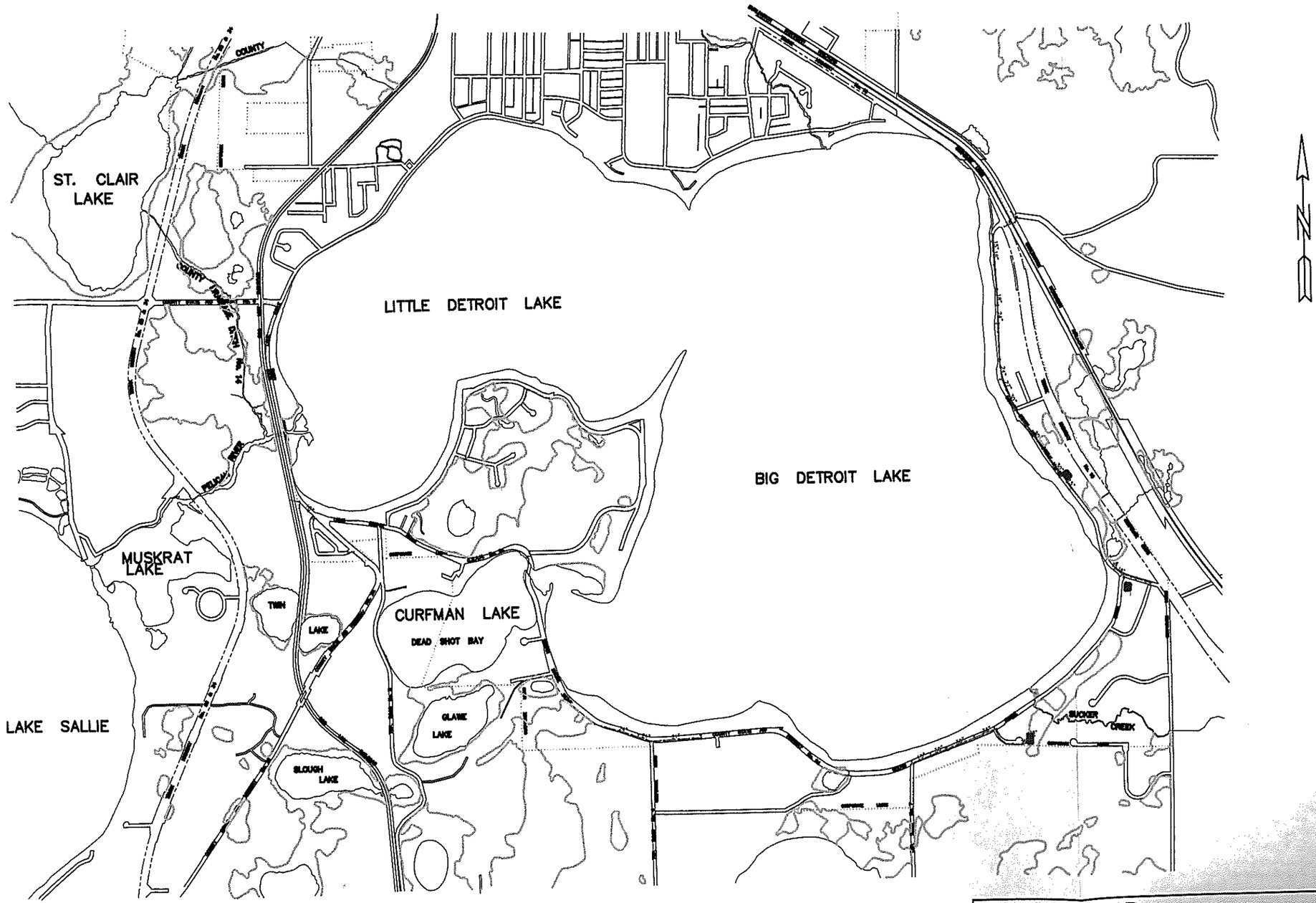

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- WET DETENTION PONDS
- DRY DETENTION PONDS
- MANHOLE/CATCH BASIN
- 24" STORM SEWER

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FIGURE NO. 4B
STORMWATER DETENTION BASINS
DETROIT LAKES, MINNESOTA

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9. Summary of Sediment and Nutrient Loadings

Sediment and nutrient loadings were determined using the Simple Method as described in the Federal Highway Administration (FHWA) Urban Drainage Design Manual. The formula for the Simple Method is included in the appendix. The critical variables in the equation are the assumed pollutant concentrations in the stormwater runoff and the presence of detention ponds. The principal pollutants that the City and the Watershed District are trying to reduce are phosphorous and total suspended solids. For this report, it was assumed that the typical stormwater runoff has a phosphorous concentration of 0.650 mg/l and a total suspended solids concentration of approximately 500 mg/l. Wet detention ponds typically are effective at removing up to 90% of suspended solids and 50% of phosphorous. Dry detention ponds, though not as effective as wet ponds also have water quality value. They typically remove up to 70% of suspended solids and 25% of phosphorous. The sediment and nutrient loading calculations are included in Appendix C.

This drainage report analyzes the storm sewer collection and treatment facilities for that part of the City of Detroit Lakes located approximately north of Becker C.S.A.H. No. 6 and North Shore Drive. The total area studied is approximately 4,318 acres. Of that total, approximately 1,420 acres are directly connected to storm sewer, with 840 acres directed to the County Ditch 14 system and 580 acres to the Pelican River. The

estimated runoff volumes and sediment and phosphorous loadings for the sewered areas are summarized in the Table below:

Table 4: Drainage Area Characteristics

	Area	Runoff Volume	Sediment Loading (Tons/yr)		Phosphorus Loading (lbs/yr)	
Sub Watershed	(Ac)	(Ac-Ft)	In	Out	In	Out
Pelican River (County Ditch #13)	1,401	985	669	353	1,740	1,178
County Ditch #14	2,048	1,522	850	806	2,211	2,147
Big & Little Detroit Lakes	460	268	182	165	473	439
Other	409	238	158	158	411	411

Approximately 75% of the sewered portion that is drained to the Pelican River is routed through detention basins, while less than 10% of the County Ditch #14 sewered area is treated. The detention basins are estimated to reduce sediment and phosphorous loading from City storm sewer into the Pelican River by 60% and 40%, respectively. The reduction in loading to County Ditch #14 is negligible because of the relative lack of detention ponds. The estimated phosphorous loadings are shown in Figure 5A and Figure 5B.

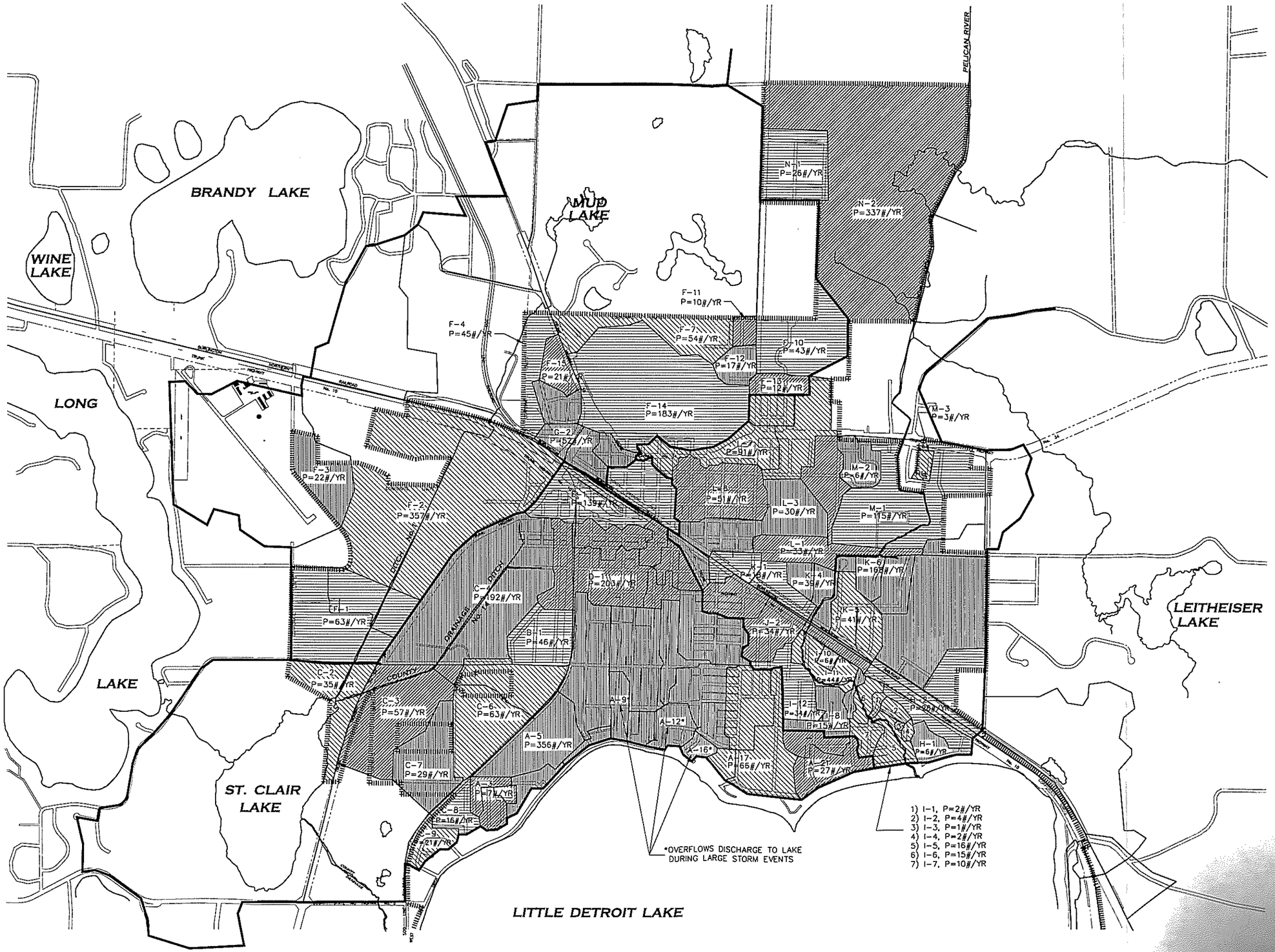

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FIGURE NO. 5A
ESTIMATED PHOSPHOROUS LOADING
DETROIT LAKES, MINNESOTA

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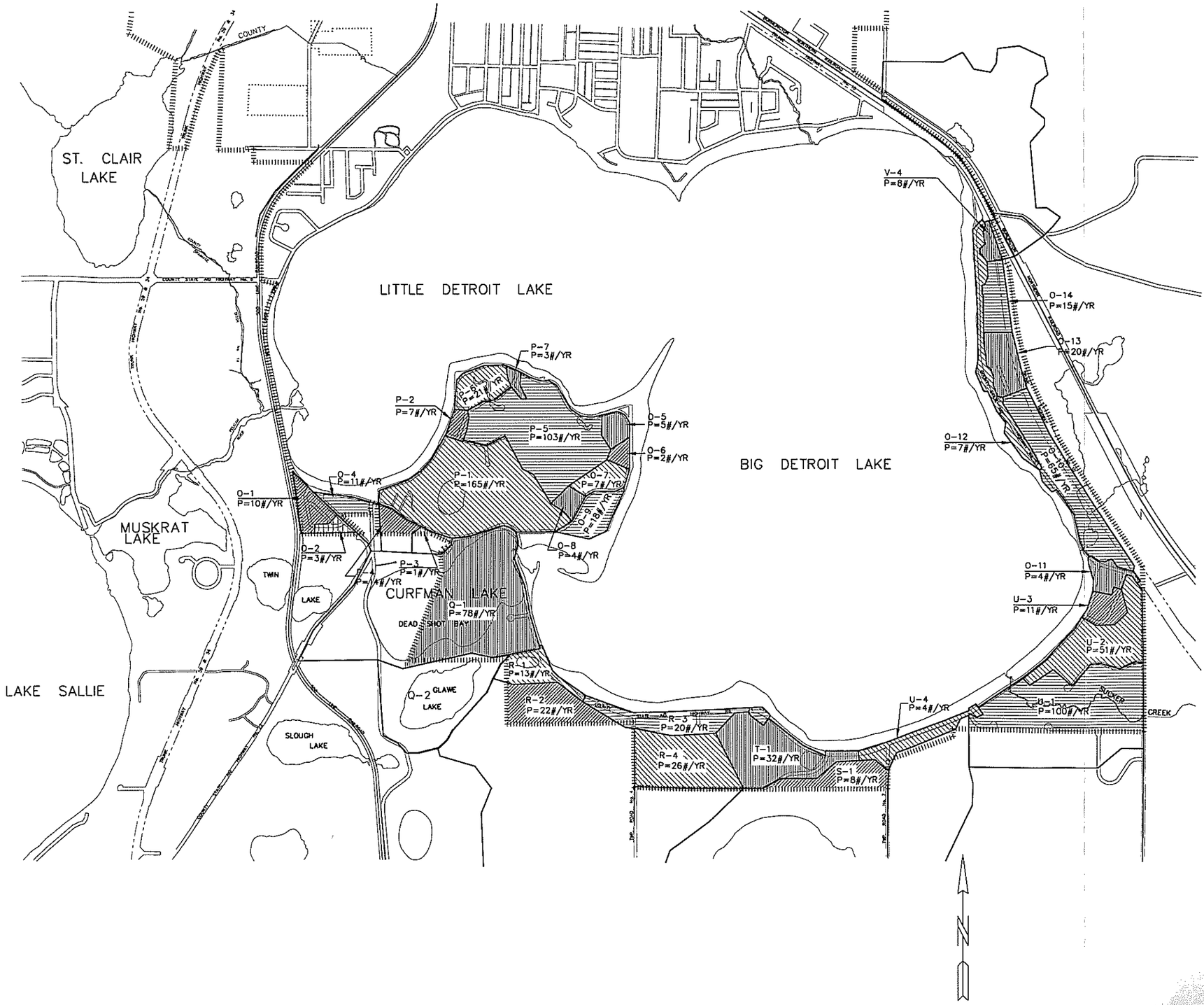

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FIGURE NO. 5B
ESTIMATED PHOSPHOROUS LOADING
DETROIT LAKES, MINNESOTA

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SHEET 2 OF 2

10. Urban Drainage Management Plan Goals and Policies

The goal of the City of Detroit Lakes Stormwater Management Plan should be to provide adequate facilities to collect and discharge municipal stormwater runoff in accordance with accepted flow design standards and incorporate water quality management practices in the system while minimizing capital expenditures. Capital expenditures can best be minimized by development policies that emphasize green space and on-site storage, thereby reducing runoff volumes, rates and pollutant concentrations. The control of discharges to lakes, wetlands, streams and ditches will also serve to reduce pollution.

There are several policies either in place or recommended that will assist the City of Detroit Lakes in achieving the previously described goals. These policies are categorized as Maintenance, Public Education, Regulations and Capital Improvements, and are summarized below.

Maintenance

- The City should continue its street sweeping program to minimize the amount of sediments entering the storm sewer system.
- The City should continue its practice of storing removed snow in areas where the materials applied to the roadway during the winter will not enter the storm sewer system.
- The City should continue identifying and eliminating sources of infiltration and inflow (I/I) from its sanitary sewer system.
- The City should continue to regularly inspect its stormwater detention facilities and remove accumulated sediments as necessary.

- The Watershed District should continue the aquatic harvesting of underwater plants from area lakes.
- The City may wish to consider chemical application to Saint Clair Lake for the purpose of removing phosphorous.

Public Education

- The City should continue to educate its citizens regarding the proper use of lawn fertilizer.
- The City should continue educating the public about proper methods of composting.
- The City should continue educating the public about the problems and solutions to I/I.
- Property owners in shoreland districts should be informed of proper methods for maintaining and improving their property.

Regulations

- The City should continue to encourage the use of Best Management Practices during construction. These include:
  - maintain a minimum of at least 4 inches of topsoil;
  - minimize extent and duration of disturbed areas;
  - prompt turf establishment including mulch and disc anchoring; and
  - erosion control devices.
- Continue licensing fertilizer applicators, limiting the phosphorous content and regulating the timing of fertilization in accordance with City Code 507.
- The City and developers should consider stormwater needs during subdivision of land. This includes:
  - preservation of natural features including trees, drainage ways, wetlands and slopes
  - maximize green space

- flood plain protection
- preserve environmentally sensitive areas
- developments should consider on-site retention and sediment control

Capital Improvements

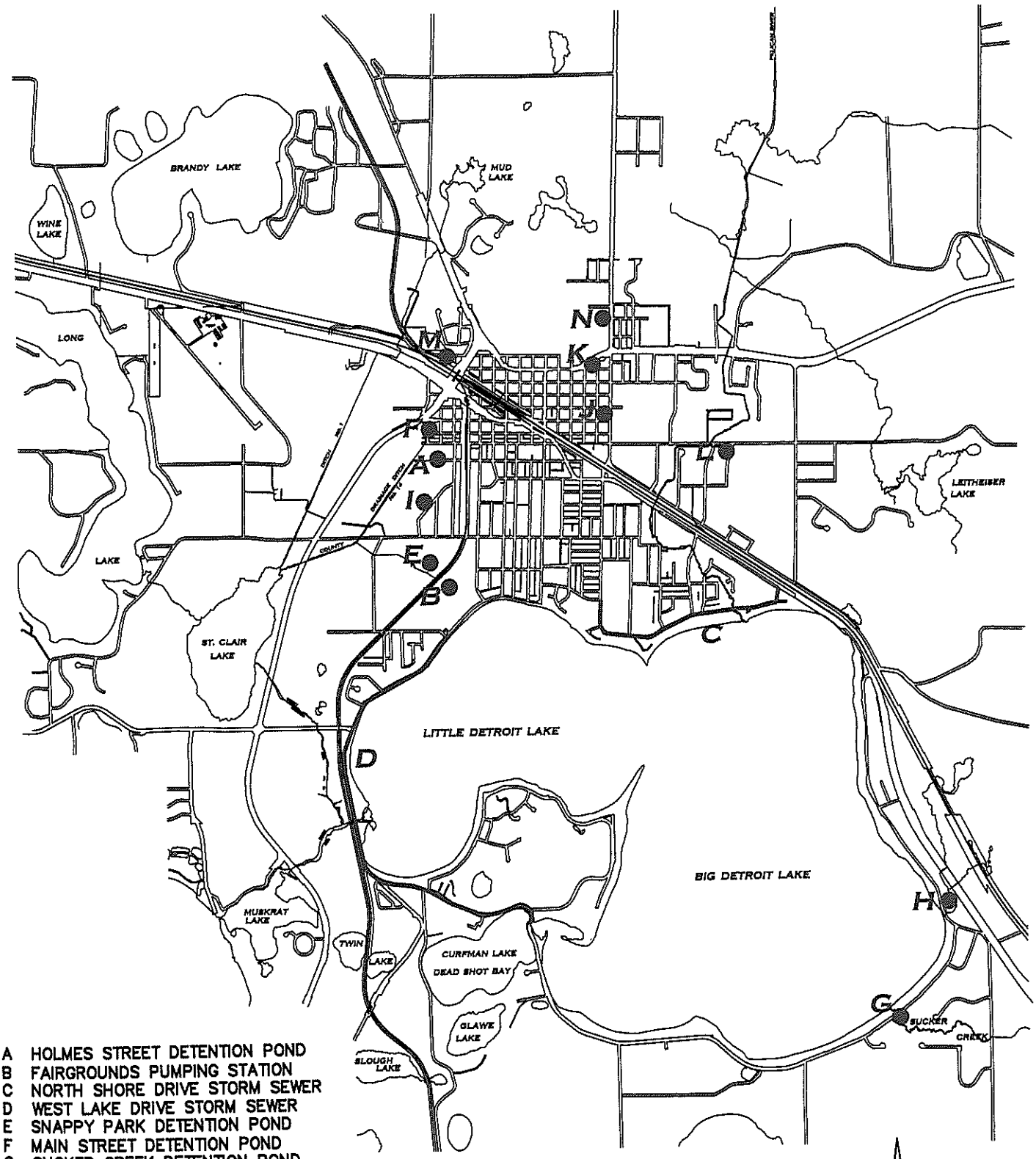
- Construct storm sewer improvements to eliminate discharges to the Pelican River and Detroit Lakes, where feasible.
- Construct detention facilities/water quality ponds at storm sewer outlets where space is available – especially those leading to the Pelican River and Detroit Lakes. They should be designed to adequately treat the drainage runoff from the service area.

11. High Priority Stormwater Drainage Improvements

Several storm sewer and water quality projects have been identified as high priority projects based on discharges to environmentally sensitive areas and/or large volumes of stormwater runoff and pollutant loading. These should be considered for construction within the next 20 years. These are shown in Figure 6 and are described below.

A. Holmes Street Storm Sewer Outlet

The Holmes Street storm sewer outlet discharges into a drainage ditch that flows into County Ditch No. 14. Treatment of the stormwater at the pipe outlet from Holmes Street could reduce sediment and phosphorous loadings by up to 70 tons/year and 140 pounds/year, respectively. This project is scheduled to be constructed in the summer of 2001 by the City of Detroit Lakes.



A HOLMES STREET DETENTION POND
B FAIRGROUNDS PUMPING STATION
C NORTH SHORE DRIVE STORM SEWER
D WEST LAKE DRIVE STORM SEWER
E SNAPPY PARK DETENTION POND
F MAIN STREET DETENTION POND
G SUCKER CREEK DETENTION POND
H EAST SHORE DRIVE DETENTION POND
I CAMPBELL AVENUE DETENTION POND
J GRANT / ROOSEVELT DETENTION POND
K TH 34 / BOWLING DETENTION POND
L 15TH AVENUE S.E. DETENTION POND
M TH 10 / ELM STREET DETENTION POND
N NORTHLAND STREET DETENTION POND

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FIGURE NUMBER 6
POTENTIAL STORM SEWER IMPROVEMENTS
DETROIT LAKES , MINNESOTA

DRAWN BY TET
CHECKED BY G.L.N.
APPROVED BY G.L.N.
DATE JUNE, 2001
FILE NO. 99-DTL-06
REVISED BY
REVISED BY

B. Fairgrounds Stormwater Pumping Station

The stormwater pumping station at the fairgrounds discharges the flow from the West Lake Drive Interceptor. Improvements are needed to this facility including an upgrade to the pumps, controls and structure. The reliability and pumping capacity of this station will have a direct impact on the overflow of stormwater into Detroit Lake during significant rainfall events. This project is scheduled to be constructed during the summer of 2001.

C. North Shore Drive Street Improvements

North Shore Drive is a Municipal State Aid Street that is scheduled for improvement in 2001. The rural section street will be replaced with an urban curb and gutter street section. The street width is planned as a minimum urban section width to maintain a minimum amount of additional runoff resulting from the improvement. The existing storm sewer collection system will be revised to maintain drainage and the detention ponds will be expanded to handle the increased runoff and maintain water quality.

D. West Lake Drive and CSAH No. 24 Street Improvements

West Lake Drive and CSAH No. 24 from Legion Road to Long Bridge are scheduled to be improved upon receipt of federal funding approval. The project is planned as a joint City/County effort, and may be funded for construction by 2005. The work will include roadway improvements to an urban section and stormwater facilities. The existing storm sewer consists of a few catch basins and culverts. The stormwater improvements will intercept and treat surface runoff currently being discharged directly into

Detroit Lakes. The discharge location will be a detention or wetland site, or a combination thereof to eliminate stormwater runoff from the street directly into the lake. If wetlands are used for this purpose, treatment will be required prior to the discharge.

E. Snappy Park Water Quality Pond

The City's main trunk sewer (48" diameter) runs along the City beach and through the County Fairgrounds before outletting to a wetland area located between Willow Street, Cheryl Avenue and the Soo Line Railroad. This wetland is drained by a ditch tributary to the Pelican River downstream from Little Detroit Lake. A pond at the outlet could reduce sediment loading by up to 120 tons/yr and phosphorous loading by up to 250 lbs/yr. However, it may not be feasible to construct detention facilities at this location due to wetland mitigation requirements and the large amount of space required to handle the stormwater flows.

F. Main Street/Thomas Avenue Water Quality Pond

There is a 30-inch trunk storm sewer along Main Street that outlets to a wetland at Thomas Avenue. The wetland is drained by County Ditch 14. A pond at this location could reduce sediment and phosphorous loadings by up to 45 tons/yr and 100 lbs/yr, respectively. Wetland mitigation requirements could be significant for this improvement.

G. Sucker Creek Water Quality Pond

There is a portion of South Shore Drive east of Sucker Creek that has a rural section draining to the creek. A pond near Sucker Creek could reduce sediment and phosphorous loading by up to 20 tons/yr and 40 lbs/yr, respectively. The lack of storm sewer in this area could limit the

effectiveness of a detention pond. Also, plans for a park along Sucker Creek could affect plans for improvements in this area.

H. East Shore Drive Water Quality Pond

The north half of the East Shore Drive storm sewer is routed through a detention pond. However, the south half of the storm sewer discharges directly to a wetland that flows into Big Detroit Lake. A water quality pond in this area could reduce sediment and phosphorous loadings by up to 20 tons/yr and 40 lbs/yr, respectively. Wetland mitigation could be a significant issue in this area.

I. Campbell Avenue Water Quality Pond

The Campbell Avenue storm sewer outlets to a wetland area drained by County Ditch 14. A pond at the outlet could reduce sediment and phosphorous loadings by up to 15 tons/yr and 30 lbs/yr, respectively.

J. Grant Street/Roosevelt Avenue Water Quality Pond

There is an existing detention basin located near the intersection of Grant Street and Roosevelt Avenue. Converting it to a water quality pond could reduce sediment and phosphorous loading by up to 10 tons/yr and 30 lbs/yr, respectively. Since this is located in an existing residential area, there may be insufficient space for the improvements. The City would also need to determine if the improvements would be compatible with the existing housing developments.

K. Trunk Highway 34/Bowling Avenue Water Quality Pond

There is an existing water quality pond located near the intersection of Trunk Highway 34 and Bowling Avenue. Converting it to a water quality pond could reduce sediment and phosphorous loading by up to 15 tons/yr and 50 lbs/yr, respectively.

L. 15th Avenue Southeast Water Quality Pond

The construction of a water quality pond at the outlet to the 15th Avenue S.E. storm sewer could reduce sediment and phosphorous loading by up to 10 tons/yr and 20 lbs/yr, respectively.

M. Trunk Highway 10/Elm Street Water Quality Pond

There is an existing detention basin located between Trunk Highway 10 and Elm Street in the northwest area of the City. The basin is drained by a storm sewer to County Ditch No. 1. Converting the basin to a water quality pond could reduce sediment and phosphorous loading by up to 10 tons/yr and 30 lbs/yr, respectively.

N. Northland Street Water Quality Pond

There is a 24-inch storm sewer along Northland Street that discharges to an open area west of Richwood Road. This area is tributary to County Ditch No. 1. Constructing a water quality pond at the outlet could reduce sediment and phosphorous loading by up to 4 tons/yr and 8 lbs/yr, respectively.

The City should review the list above to determine the relative merits and feasibility of the potential improvements. Then the City should establish a long-term Capital Improvements Program (CIP) that incorporates specific capital improvement projects and a pond maintenance schedule in keeping with its Stormwater Management Plan.

Respectfully submitted,

LARSON-PETERSON & ASSOCIATES, INC.
Consulting Municipal Engineers
Detroit Lakes, Minnesota

Appendices

A. Basin Runoff Coefficients

B. Estimate of Stormwater Drainage – Basin Peak Runoff

C. Estimated Phosphorous/Sediment Loadings

D. MnDOT Figure B 5-294.222

E. Simple Method Formula and Typical Pollutant Concentrations

F. Excerpts from City Code and Zoning Ordinance

G. Excerpts from the Rules of the Pelican River Watershed District

APPENDIX A
BASIN RUNOFF COEFFICIENTS
DETROIT LAKES, MINNESOTA

BASIN I.D.	AREA (acres)	ZONING DESIGNATIONS WITHIN BASIN (%)											SOIL TYPES WITHIN BASIN (%)				RUNOFF COEFFICIENT c
		R-1	R-2	R-3	R-A	R-MH	R-LB	B-1	B-2	B-3	I-1	I-2	A	B	C	D	
		0.20	0.25	0.45	0.10	0.30	0.30	0.70	0.60	0.65	0.50	0.55					
		0.25	0.30	0.50	0.15	0.35	0.35	0.75	0.65	0.70	0.55	0.60					
		0.30	0.40	0.60	0.25	0.45	0.45	0.80	0.70	0.75	0.60	0.65					
		0.35	0.45	0.65	0.30	0.50	0.50	0.85	0.75	0.80	0.65	0.70					
A-1	10.5		100%										0%	80%	20%	0%	0.32
A-2	3.6		100%										0%	100%	0%	0%	0.30
A-3	8.3		100%										0%	70%	0%	30%	0.35
A-4	12.0		70%				30%						60%	40%	0%	0%	0.29
A-5	53.9		85%				15%						50%	45%	0%	5%	0.29
A-6	59.6		90%				10%						40%	25%	15%	20%	0.33
A-7	5.5						100%						90%	10%	0%	0%	0.31
A-8	52.5		80%	5%			5%						0%	95%	0%	5%	0.29
A-9	14.1		80%				20%						0%	50%	40%	10%	0.37
A-10	9.8		60%				40%						40%	60%	0%	0%	0.30
A-11	22.7			25%						75%			0%	70%	0%	30%	0.68
A-12	18.6						100%						25%	60%	15%	0%	0.35
A-13	43.8		85%	15%									0%	100%	0%	0%	0.33
A-14	26.7		85%				10%						0%	100%	0%	0%	0.29
A-15	12.8		85%				15%						0%	95%	0%	5%	0.32
A-16	7.0			5%			95%						40%	60%	0%	0%	0.34
A-17	7.3		5%				95%						10%	65%	0%	25%	0.38
A-18	39.1		95%				5%						40%	40%	0%	20%	0.31
A-19	41.4		70%	30%									70%	30%	0%	0%	0.33
A-20	14.6		70%	30%									10%	75%	5%	10%	0.38
A-21	20.3		90%	10%									75%	5%	20%	0%	0.30
B-1	37.0		85%								15%		0%	50%	15%	35%	0.40
C-2	46.0				100%								25%	5%	0%	70%	0.24
C-3	70.8				100%								20%	0%	5%	75%	0.26
C-4	162.7		45%		45%					10%			10%	10%	10%	70%	0.38
C-5	3.3		80%		20%								0%	100%	0%	0%	0.27
C-6	78.1		10%		80%						10%		0%	70%	0%	30%	0.25
C-7	33.9				70%						30%		70%	0%	10%	20%	0.27
C-8	18.2		100%										80%	0%	0%	20%	0.29
C-9	16.8		100%										5%	0%	95%	0%	0.39

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		R-1	R-2	R-3	R-A	R-MH	R-LB	B-1	B-2	B-3	I-1	I-2	A	B	C	D	
		0.20	0.25	0.45	0.10	0.30	0.30	0.70	0.60	0.65	0.50	0.55					
		0.25	0.30	0.50	0.15	0.35	0.35	0.75	0.65	0.70	0.55	0.60					
		0.30	0.40	0.60	0.25	0.45	0.45	0.80	0.70	0.75	0.60	0.65					
		0.35	0.45	0.65	0.30	0.50	0.50	0.85	0.75	0.80	0.65	0.70					
D-1	67.9		60%	10%				10%	5%		15%		15%	70%	15%	0%	0.43
D-2	23.3		40%	20%				20%	20%				0%	90%	10%	0%	0.51
D-3	9.8							100%					0%	70%	30%	0%	0.77
D-4	15.0							100%					0%	100%	0%	0%	0.75
D-5	9.4		25%					50%		25%			10%	90%	0%	0%	0.62
E-1	50.8		30%						10%		60%		10%	75%	10%	5%	0.49
E-2	34.7		30%					30%	30%		10%		0%	100%	0%	0%	0.57
F-1	112.4				100%								50%	10%	10%	30%	0.18
F-2	282.5				50%				20%	5%	25%		35%	20%	20%	25%	0.41
F-3	35.3				100%								25%	25%	25%	25%	0.20
F-4	28.6		10%								90%		80%	0%	0%	20%	0.51
F-7	56.3		40%		60%								0%	30%	10%	60%	0.31
F-10	63.2	30%	10%		60%								25%	50%	0%	25%	0.22
F-11	7.9		100%										0%	15%	15%	70%	0.42
F-12	16.2		100%										15%	60%	0%	25%	0.33
F-13	14.3		100%										50%	50%	0%	0%	0.28
F-14	182.1		40%	5%	50%						5%		15%	25%	10%	50%	0.32
F-15	17.1		40%								60%		100%	0%	0%	0%	0.40
G-1	17.7		100%										0%	100%	0%	0%	0.30
G-2	12.4		60%								40%		0%	100%	0%	0%	0.40
G-3	16.1		25%						25%		50%		20%	60%	0%	20%	0.53
G-4	10.6		100%										10%	60%	20%	10%	0.33
H-1	12.1		30%							70%			80%	20%	0%	0%	0.54
H-2	12.7									100%			20%	80%	0%	0%	0.69
H-3	22.6									40%	60%		90%	0%	0%	10%	0.58
H-4	22.3				35%						65%		70%	20%	0%	10%	0.39
I-1	2.6		100%										40%	50%	0%	10%	0.30
I-2	5.2		100%										0%	100%	0%	0%	0.30
I-3	0.8		100%										0%	100%	0%	0%	0.30
I-4	2.3		100%										0%	100%	0%	0%	0.30

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		R-1	R-2	R-3	R-A	R-MH	R-LB	B-1	B-2	B-3	I-1	I-2	A	B	C	D	
		0.20	0.25	0.45	0.10	0.30	0.30	0.70	0.60	0.65	0.50	0.55					
		0.25	0.30	0.50	0.15	0.35	0.35	0.75	0.65	0.70	0.55	0.60					
		0.30	0.40	0.60	0.25	0.45	0.45	0.80	0.70	0.75	0.60	0.65					
		0.35	0.45	0.65	0.30	0.50	0.50	0.85	0.75	0.80	0.65	0.70					
I-5	17.3		100%										80%	0%	0%	20%	0.29
I-6	9.7		50%							50%			80%	0%	0%	20%	0.49
I-7	10.3		100%										0%	100%	0%	0%	0.30
I-8	19.8		90%	10%									5%	95%	0%	0%	0.32
I-9	4.8		70%							30%			30%	60%	0%	10%	0.42
I-10	3.8									100%			100%	0%	0%	0%	0.65
I-11	22.2		10%							90%			80%	0%	0%	20%	0.64
I-12	35.0		50%	30%						20%			50%	50%	0%	0%	0.42
J-1	10.6									100%			100%	0%	0%	0%	0.65
J-2	29.1		60%							30%	10%		0%	100%	0%	0%	0.45
J-3	25.7		5%	10%						75%	10%		0%	100%	0%	0%	0.65
K-1	18.1										100%		20%	80%	0%	0%	0.54
K-2	16.7										100%		25%	75%	0%	0%	0.54
K-3	9.5										100%		90%	10%	0%	0%	0.51
K-4	15.4										100%		90%	10%	0%	0%	0.51
K-5	33.6										50%	50%	95%	5%	0%	0%	0.53
K-6	3.8											100%	100%	0%	0%	0%	0.55
K-7	12.2											100%	95%	5%	0%	0%	0.55
K-8	20.7				10%							90%	50%	40%	0%	10%	0.54
K-9	115.2				40%						40%	20%	30%	20%	0%	50%	0.45
K-10	5.7				100%								0%	100%	0%	0%	0.15
L-1	33.2										100%		90%	10%	0%	0%	0.51
L-2	51.4		60%	30%						10%			90%	10%	0%	0%	0.36
L-3	36.4		60%									40%	80%	20%	0%	0%	0.38
L-4	26.5		45%								45%	10%	5%	95%	0%	0%	0.44
L-5	11.5		20%	20%				40%			20%		0%	100%	0%	0%	0.57
L-6	61.2		80%	5%				5%	5%			5%	15%	85%	0%	0%	0.36
L-7	30.5		80%						10%	10%			15%	50%	0%	35%	0.42
L-8	12.6		40%						60%				0%	100%	0%	0%	0.51
L-9	42.9		60%	30%						10%			70%	30%	0%	0%	0.37

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		R-1	R-2	R-3	R-A	R-MH	R-LB	B-1	B-2	B-3	I-1	I-2	A	B	C	D	
		0.20	0.25	0.45	0.10	0.30	0.30	0.70	0.60	0.65	0.50	0.55					
		0.25	0.30	0.50	0.15	0.35	0.35	0.75	0.65	0.70	0.55	0.60					
		0.30	0.40	0.60	0.25	0.45	0.45	0.80	0.70	0.75	0.60	0.65					
		0.35	0.45	0.65	0.30	0.50	0.50	0.85	0.75	0.80	0.65	0.70					
L-10	16.4		100%										90%	10%	0%	0%	0.26
M-1	112.5		40%		20%	30%				5%		5%	50%	25%	5%	20%	0.33
M-2	20.9		75%	15%						10%			100%	0%	0%	0%	0.32
M-3	5.1		100%										50%	50%	0%	0%	0.28
N-1	55.0				10%						55%	35%	70%	15%	15%	0%	0.50
N-2	365.0				75%						10%	15%	40%	15%	5%	40%	0.30
O-1	12.7		100%										100%	0%	0%	0%	0.25
O-2	4.1		100%										100%	0%	0%	0%	0.25
O-4	7.5			100%									80%	20%	0%	0%	0.46
O-5	8.1		50%		50%								50%	50%	0%	0%	0.20
O-6	4.4				100%								0%	100%	0%	0%	0.15
O-7	12.5		10%		90%								0%	80%	15%	5%	0.19
O-8	6.1		50%		50%								0%	100%	0%	0%	0.23
O-9	17.7		100%										0%	80%	0%	20%	0.33
O-10	53.2		70%		20%					10%			0%	40%	10%	50%	0.39
O-11	10.5		90%							10%			0%	60%	10%	30%	0.39
O-12	24.5		95%							5%			10%	90%	0%	0%	0.32
O-13	18.9		100%										0%	70%	0%	30%	0.35
O-14	16.3		100%										0%	100%	0%	0%	0.30
P-1	118.3		60%	20%	5%	10%				5%			15%	15%	10%	60%	0.45
P-2	5.1			100%									80%	20%	0%	0%	0.46
P-3	0.9		100%										0%	80%	10%	10%	0.33
P-4	8.3		40%							60%			10%	70%	15%	5%	0.55
P-5	95.5		50%	10%	40%								10%	30%	0%	60%	0.35
P-6	17.9		100%										20%	20%	0%	60%	0.38
P-7	3.1		100%										0%	100%	0%	0%	0.30
Q-1	55.0		30%	70%									60%	0%	25%	15%	0.46
R-1	18.3		10%	10%	80%								60%	0%	0%	40%	0.23
R-2	32.2				100%								15%	30%	5%	50%	0.22
R-3	30.2		40%		60%								0%	100%	0%	0%	0.21

APPENDIX A
BASIN RUNOFF COEFFICIENTS
DETROIT LAKES, MINNESOTA

BASIN I.D.	AREA (acres)	ZONING DESIGNATIONS WITHIN BASIN (%)											SOIL TYPES WITHIN BASIN (%)				RUNOFF COEFFICIENT c
		R-1	R-2	R-3	R-A	R-MH	R-LB	B-1	B-2	B-3	I-1	I-2	A	B	C	D	
		0.20	0.25	0.45	0.10	0.30	0.30	0.70	0.60	0.65	0.50	0.55					
		0.25	0.30	0.50	0.15	0.35	0.35	0.75	0.65	0.70	0.55	0.60					
		0.30	0.40	0.60	0.25	0.45	0.45	0.80	0.70	0.75	0.60	0.65					
		0.35	0.45	0.65	0.30	0.50	0.50	0.85	0.75	0.80	0.65	0.70					
R-4	51.4		10%		90%								0%	100%	0%	0%	0.17
S-1	23.0				100%								95%	0%	0%	5%	0.11
T-1	54.8		5%		95%								10%	65%	0%	25%	0.19
U-1	88.3		100%										20%	30%	0%	50%	0.37
U-2	50.0		100%										10%	70%	0%	20%	0.33
U-3	11.7		100%										10%	80%	10%	0%	0.31
U-4	16.8		80%										25%	75%	0%	0%	0.23
V-4	4.9		50%							50%			0%	100%	0%	0%	0.50

APPENDIX B
ESTIMATE OF STORMWATER DRAINAGE
DETROIT LAKES, MINNESOTA

BASIN I.D.	AREA (acres)	RUNOFF COEFFICIENT c	c x A	BASIN PEAK RUNOFF		
				TIME OF CONC. tc (min)	RAINFALL INTENSITY i (in/hr)*	Q BASIN (cfs)
A-1	10.5	0.32	3.4	21	2.81	9.4
A-2	3.6	0.30	1.1	21	2.81	3.0
A-3	8.3	0.35	2.9	20	2.88	8.2
A-4	12.0	0.29	3.4	30	2.26	7.7
A-5	53.9	0.29	15.6	40	1.86	29.1
A-6	59.6	0.33	19.7	35	2.03	39.9
A-7	5.5	0.31	1.7	20	2.88	4.8
A-8	52.5	0.29	15.2	29	2.31	35.1
A-9	14.1	0.37	5.1	21	2.81	14.5
A-10	9.8	0.30	2.9	20	2.88	8.5
A-11	22.7	0.68	15.5	26	2.50	38.8
A-12	18.6	0.35	6.6	29	2.31	15.1
A-13	43.8	0.33	14.5	23	2.66	38.4
A-14	26.7	0.29	7.7	29	2.31	17.9
A-15	12.8	0.32	4.0	25	2.56	10.3
A-16	7.0	0.34	2.4	16	3.21	7.6
A-17	7.3	0.38	2.8	22	2.74	7.6
A-18	39.1	0.31	12.2	18	3.03	37.0
A-19	41.4	0.33	13.5	32	2.16	29.1
A-20	14.6	0.38	5.5	21	2.81	15.4
A-21	20.3	0.30	6.1	18	3.03	18.6
B-1	37.0	0.40	14.8	31	2.21	32.8
C-2	46.0	0.24	11.2	47	1.70	19.0
C-3	70.8	0.26	18.2	53	1.58	28.8
C-4	162.7	0.38	61.6	62	1.38	85.0
C-5	3.3	0.27	0.9	21	2.81	2.5
C-6	78.1	0.25	19.4	49	1.66	32.2
C-7	33.9	0.27	9.2	27	2.44	22.4
C-8	18.2	0.29	5.3	18	3.03	16.0
C-9	16.8	0.39	6.6	20	2.88	19.0
D-1	67.9	0.43	28.9	30	2.26	65.3
D-2	23.3	0.51	11.8	25	2.56	30.3
D-3	9.8	0.77	7.5	9	4.05	30.4
D-4	15.0	0.75	11.3	12	3.64	41.0
D-5	9.4	0.62	5.8	21	2.81	16.4
E-1	50.8	0.49	25.0	36	1.99	49.8
E-2	34.7	0.57	19.6	28	2.37	46.5
F-1	112.4	0.18	20.2	41	1.84	37.2
F-2	282.5	0.41	114.8	59	1.45	166.4
F-3	35.3	0.20	7.1	48	1.68	11.9
F-4	28.6	0.51	14.5	44	1.76	25.5
F-7	56.3	0.31	17.5	68	1.31	22.9
F-10	63.2	0.22	13.7	52	1.60	21.9
F-11	7.9	0.42	3.3	21	2.81	9.3
F-12	16.2	0.33	5.3	21	2.81	15.0
F-13	14.3	0.28	3.9	23	2.66	10.5
F-14	182.1	0.32	58.9	50	1.64	96.6
F-15	17.1	0.40	6.8	21	2.81	19.2

*Intensity and peak runoff are for the 3-year event

APPENDIX B
ESTIMATE OF STORMWATER DRAINAGE
DETROIT LAKES, MINNESOTA

BASIN I.D.	AREA (acres)	RUNOFF COEFFICIENT c	c x A	BASIN PEAK RUNOFF		
				TIME OF CONC. tc (min)	RAINFALL INTENSITY i (in/hr)*	Q BASIN (cfs)
G-1	17.7	0.30	5.3	22	2.74	14.5
G-2	12.4	0.40	5.0	19	2.95	14.6
G-3	16.1	0.53	8.5	18	2.74	23.2
G-4	10.6	0.33	3.5	20	2.31	8.1
H-1	12.1	0.54	6.5	18	3.03	19.8
H-2	12.7	0.69	8.8	18	3.03	26.6
H-3	22.6	0.58	13.0	39	1.90	24.7
H-4	22.3	0.39	8.6	33	2.12	18.3
I-1	2.6	0.30	0.8	17	3.12	2.4
I-2	5.2	0.30	1.6	20	2.88	4.5
I-3	0.8	0.30	0.2	13	3.53	0.8
I-4	2.3	0.30	0.7	15	3.31	2.3
I-5	17.3	0.29	5.0	26	2.50	12.5
I-6	9.7	0.49	4.7	18	3.03	14.3
I-7	10.3	0.30	3.1	22	2.74	8.5
I-8	19.8	0.32	6.3	23	2.66	16.7
I-9	4.8	0.42	2.0	18	3.03	6.1
I-10	3.8	0.65	2.5	7	4.41	10.9
I-11	22.2	0.64	14.2	20	2.88	41.0
I-12	35.0	0.42	14.5	23	2.66	38.6
J-1	10.6	0.65	6.9	13	3.55	24.5
J-2	29.1	0.45	12.9	23	2.66	34.4
J-3	25.7	0.65	16.6	31	2.21	36.6
K-1	18.1	0.54	9.8	22	2.74	26.8
K-2	16.7	0.54	9.0	20	2.88	25.9
K-3	9.5	0.51	4.8	22	2.74	13.1
K-4	15.4	0.51	7.8	24	2.61	20.3
K-5	33.6	0.53	17.7	26	2.50	44.3
K-6	3.8	0.55	2.1	8	4.23	8.8
K-7	12.2	0.55	6.7	19	2.95	19.9
K-8	20.7	0.54	11.2	17	3.12	34.9
K-9	115.2	0.45	51.3	33	2.12	108.7
K-10	5.7	0.15	0.9	33	2.12	1.8
L-1	33.2	0.51	16.8	19	2.95	49.5
L-2	51.4	0.36	18.2	25	2.56	46.7
L-3	36.4	0.38	13.8	18	3.03	41.9
L-4	26.5	0.44	11.7	28	2.37	27.6
L-5	11.5	0.57	6.6	15	3.31	21.7
L-6	61.2	0.36	21.9	27	2.44	53.4
L-7	30.5	0.42	12.7	25	2.56	32.5
L-8	12.6	0.51	6.4	19	2.95	19.0
L-9	42.9	0.37	15.7	23	2.66	41.7
L-10	16.4	0.26	4.2	23	2.66	11.1
M-1	112.5	0.33	37.0	40	1.86	68.8
M-2	20.9	0.32	6.7	26	2.50	16.7
M-3	5.1	0.28	1.4	20	2.88	4.0
N-1	55.0	0.50	27.5	20	2.88	79.3
N-2	365.0	0.30	108.4	45	1.74	188.5

*Intensity and peak runoff are for the 3-year event

APPENDIX B
ESTIMATE OF STORMWATER DRAINAGE
DETROIT LAKES, MINNESOTA

BASIN I.D.	AREA (acres)	RUNOFF COEFFICIENT c	c x A	BASIN PEAK RUNOFF		
				TIME OF CONC. tc (min)	RAINFALL INTENSITY i (in/hr)*	Q BASIN (cfs)
O-1	12.7	0.25	3.2	16	3.21	10.2
O-2	4.1	0.25	1.0	12	3.64	3.7
O-4	7.5	0.46	3.5	30	2.26	7.8
O-5	8.1	0.20	1.6	20	2.88	4.7
O-6	4.4	0.15	0.7	17	3.12	2.1
O-7	12.5	0.19	2.3	26	2.50	5.9
O-8	6.1	0.23	1.4	18	3.03	4.2
O-9	17.7	0.33	5.8	19	2.95	17.2
O-10	53.2	0.39	20.9	40	1.86	38.8
O-11	10.5	0.39	4.1	22	2.74	11.3
O-12	24.5	0.32	7.7	46	1.71	13.2
O-13	18.9	0.35	6.5	33	2.12	13.8
O-14	16.3	0.30	4.9	15	3.31	16.2
P-1	118.3	0.45	53.0	31	2.21	117.2
P-2	5.1	0.46	2.3	16	3.21	7.5
P-3	0.9	0.33	0.3	18	3.03	0.9
P-4	8.3	0.55	4.6	19	2.95	13.5
P-5	95.5	0.35	32.9	31	2.21	72.8
P-6	17.9	0.38	6.8	22	2.74	18.6
P-7	3.1	0.30	0.9	11	3.77	3.5
Q-1	55.0	0.46	25.2	24	2.61	65.7
R-1	18.3	0.23	4.2	20	2.88	12.1
R-2	32.2	0.22	7.2	40	1.86	13.3
R-3	30.2	0.21	6.3	22	2.74	17.4
R-4	51.4	0.17	8.5	35	2.03	17.2
S-1	23.0	0.11	2.5	27	2.44	6.2
T-1	54.8	0.19	10.4	39	1.89	19.7
U-1	88.3	0.37	32.2	31	2.21	71.2
U-2	50.0	0.33	16.3	31	2.21	35.9
U-3	11.7	0.31	3.6	18	3.03	10.8
U-4	16.8	0.23	3.9	34	2.08	8.0
V-4	4.9	0.50	2.4	12	3.64	8.9

*Intensity and peak runoff are for the 3-year event

APPENDIX C
ESTIMATE OF SEDIMENT NUTRIENT LOADING
DETROIT LAKES, MN

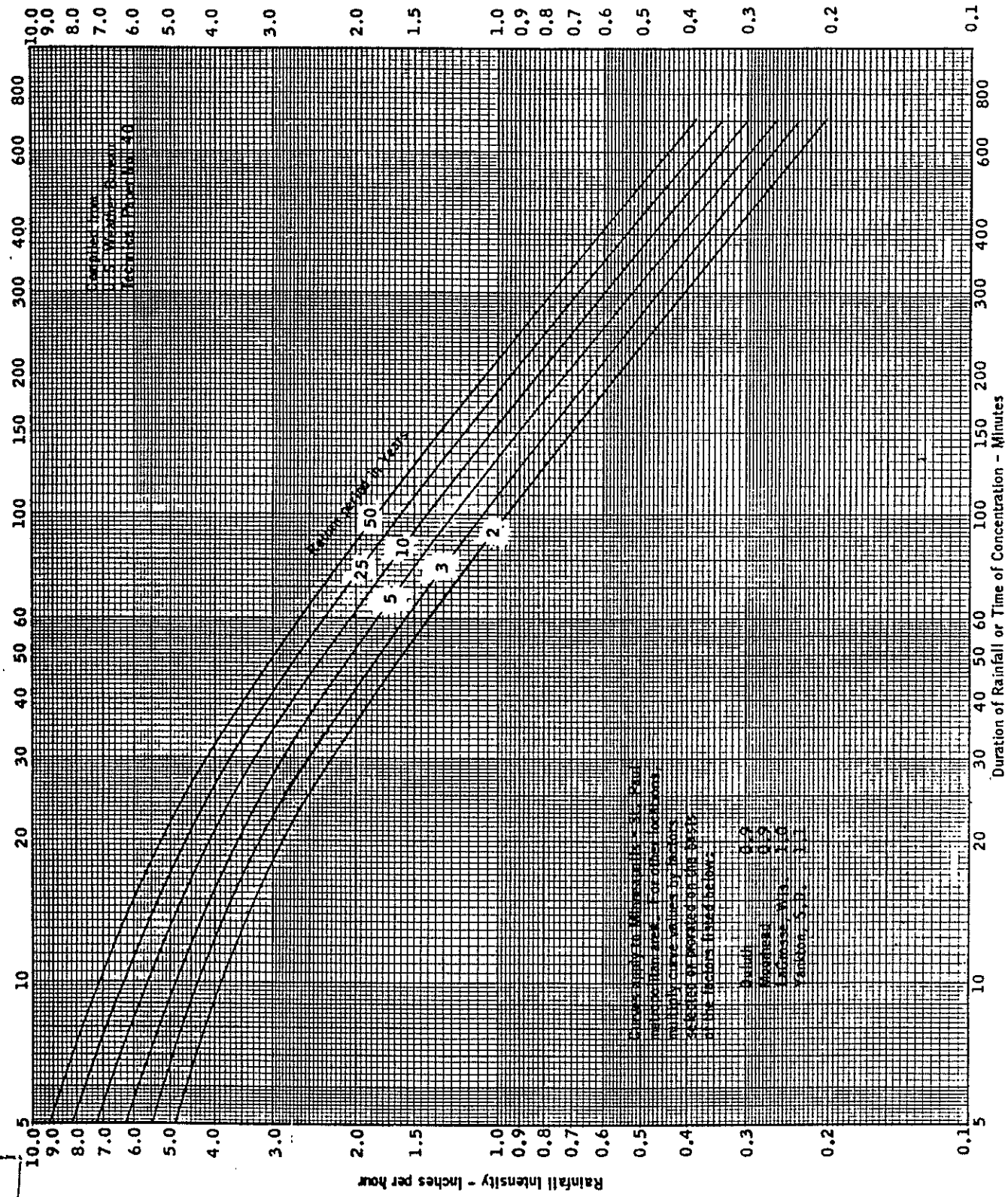
DRAINAGE BASIN	POINT OF DISCHARGE	BASIN AREA (Ac)	RUNOFF COEFFICIENT	ANNUAL RUNOFF (Ac-Ft)	EST. ANNUAL SEDIMENT LOADING INTO PONDS (T/yr)	EST. ANNUAL NUTRIENT LOADING INTO PONDS (lbs-P/yr)	WET PONDS	DRY PONDS	EST. ANNUAL SEDIMENT LOADING (Tons/yr)	EST. ANNUAL NUTRIENT LOADING (lbs-P/yr)
A-21	A-17	34.9	0.33	20.5	13.91	36.2	0	1	6.95	27.1
A-17	A-12	87.8	0.32	50.1	34.06	88.6	0	1	17.03	66.4
A-16	A-12*	90.3	0.32	50.4	N/A	N/A	N/A	N/A	N/A	N/A
A-12	A-9*	131.6	0.39	89.3	N/A	N/A	N/A	N/A	N/A	N/A
A-9	A-5*	208.0	0.36	130.3	N/A	N/A	N/A	N/A	N/A	N/A
A-3	A-5	22.4	0.33	12.9	8.74	22.7	1	0	0.87	6.8
A-5	Ditch #14	339.0	0.34	201.5	136.90	355.9	0	0	136.90	355.9
B-1	Ditch #14	37.0	0.40	26.2	17.78	46.2	0	0	17.78	46.2
C-4	Ditch #14	162.7	0.38	108.5	73.73	191.7	0	0	73.73	191.7
C-5	C-3	3.3	0.27	1.6	1.07	2.8	0	0	1.07	2.8
C-6	C-3	78.1	0.25	34.2	23.24	60.4	0	0	23.24	60.4
C-3	Ditch #14	70.8	0.26	32.1	21.83	56.8	0	0	21.83	56.8
C-2	Ditch #14	46.0	0.24	19.7	13.36	34.7	0	0	13.36	34.7
C-8	C-7	18.2	0.29	9.3	6.32	16.4	0	0	6.32	16.4
C-7	C-1	33.9	0.27	16.2	10.98	28.5	0	0	10.98	28.5
C-9	C-1	16.8	0.39	11.6	7.90	20.5	0	0	7.90	20.5
D-1	Ditch #14	125.4	0.52	115.1	78.17	203.2	0	0	78.17	203.2
E-1	Ditch #14	85.5	0.52	78.6	53.41	138.9	0	0	53.41	138.9
F-15	F-14	17.1	0.4	12.1	8.19	21.3	0	0	8.19	21.3
F-13	F-14	14.3	0.275	6.9	4.71	12.2	0	0	4.71	12.2
F-14	F-7	182.1	0.3235	103.8	70.53	183.4	0	0	70.53	183.4
F-10	F-7	63.2	0.21625	24.1	16.36	42.5	0	0	16.36	42.5
F-11	F-7	7.9	0.42	5.8	3.97	10.3	0	0	3.97	10.3
F-12	F-7	16.2	0.33	9.4	6.40	16.6	0	0	6.40	16.6
F-7	F-4	56.3	0.31	30.8	20.90	54.3	0	0	20.90	54.3
F-4	Ditch #1	28.6	0.506	25.5	17.33	45.0	0	0	17.33	45.0
F-3	F-2	35.3	0.2	12.4	8.45	22.0	0	0	8.45	22.0
F-2	Ditch #1	282.5	0.40625	202.3	137.41	357.3	0	0	137.41	357.3
F-1	Ditch #1	112.4	0.18	35.7	24.22	63.0	0	0	24.22	63.0
G-2	Ditch #1	56.8	0.39	39.2	26.60	69.2	0	1	13.30	51.9

APPENDIX C
ESTIMATE OF SEDIMENT NUTRIENT LOADING
DETROIT LAKES, MN

DRAINAGE BASIN	POINT OF DISCHARGE	BASIN AREA (Ac)	RUNOFF COEFFICIENT	ANNUAL RUNOFF (Ac-Ft)	EST. ANNUAL SEDIMENT LOADING INTO PONDS (T/yr)	EST. ANNUAL NUTRIENT LOADING INTO PONDS (lbs-P/yr)	WET PONDS	DRY PONDS	EST. ANNUAL SEDIMENT LOADING (Tons/yr)	EST. ANNUAL NUTRIENT LOADING (lbs-P/yr)
H-2	H-1	57.6	0.53	53.5	36.38	94.6	1	0	3.64	28.4
H-1	Pel. River	12.1	0.54	11.5	7.82	20.3	1	0	0.78	6.1
I-1	Pel. River	2.6	0.30	1.4	0.92	2.4	0	1	0.46	1.8
I-2	Pel. River	5.2	0.30	2.7	1.87	4.9	0	1	0.93	3.6
I-3	Pel. River	0.8	0.30	0.4	0.29	0.7	0	1	0.14	0.6
I-4	Pel. River	2.3	0.30	1.2	0.83	2.1	0	1	0.41	1.6
I-5	Pel. River	17.3	0.29	8.8	6.01	15.6	0	0	6.01	15.6
I-6	Pel. River	9.7	0.49	8.3	5.63	14.6	0	0	5.63	14.6
I-7	Pel. River	10.3	0.30	5.4	3.70	9.6	0	0	3.70	9.6
I-9	I-8	4.8	0.42	3.5	2.41	6.3	0	1	1.20	4.7
I-8	Pel. River	19.8	0.32	11.1	7.53	19.6	0	1	3.76	14.7
I-10	Pel. River	3.8	0.65	4.4	2.96	7.7	0	1	1.48	5.8
I-11	Pel. River	22.2	0.64	25.1	17.04	44.3	0	0	17.04	44.3
I-12	Pel. River	35.0	0.42	25.6	17.39	45.2	0	1	8.70	33.9
J-2	Pel. River	65.4	0.56	64.2	43.60	113.4	1	0	4.36	34.0
K-1	Pel. River	34.8	0.54	33.0	22.45	58.4	1	0	2.24	17.5
K-4	Pel. River	24.9	0.51	22.2	15.06	39.1	0	0	15.06	39.1
K-5	Pel. River	33.6	0.53	31.2	21.22	55.2	0	1	10.61	41.4
K-6	Pel. River	157.6	0.46	127.1	86.37	224.6	0	1	43.19	168.4
L-7	L-6	102.4	0.38	68.7	46.66	121.3	0	1	23.33	91.0
L-6	L-3	61.2	0.36	38.6	26.20	68.1	0	1	13.10	51.1
L-3	L-1	74.4	0.43	56.5	38.37	99.8	1	0	3.84	29.9
L-1	Pel. River	84.6	0.41	61.7	41.92	109.0	1	0	4.19	32.7
M-1	Pel. River	112.5	0.33	65.2	44.28	115.1	0	0	44.28	115.1
M-2	Pel. River	20.9	0.32	11.8	8.01	20.8	1	0	0.80	6.2
M-3	Pel. River	5.1	0.28	2.5	1.68	4.4	0	1	0.84	3.3
N-1	Pel. River	55.0	0.50	48.5	32.98	85.7	1	0	3.30	25.7
N-2	Pel. River	365.0	0.30	191.0	129.74	337.3	0	0	129.74	337.3
O-1	Pel. River**	12.7	0.25	5.6	3.80	9.9	0	0	3.80	9.9
O-2	Det. Lake	4.1	0.25	1.8	1.23	3.2	0	0	1.23	3.2

APPENDIX C
ESTIMATE OF SEDIMENT NUTRIENT LOADING
DETROIT LAKES, MN

DRAINAGE BASIN	POINT OF DISCHARGE	BASIN AREA (Ac)	RUNOFF COEFFICIENT	ANNUAL RUNOFF (Ac-Ft)	EST. ANNUAL SEDIMENT LOADING INTO PONDS (T/yr)	EST. ANNUAL NUTRIENT LOADING INTO PONDS (lbs-P/yr)	WET PONDS	DRY PONDS	EST. ANNUAL SEDIMENT LOADING (Tons/yr)	EST. ANNUAL NUTRIENT LOADING (lbs-P/yr)
O-4	Det. Lake	7.5	0.46	6.1	4.13	10.7	0	0	4.13	10.7
O-5	Det. Lake	8.1	0.20	2.9	1.94	5.0	0	0	1.94	5.0
O-6	Det. Lake	4.4	0.15	1.2	0.79	2.1	0	0	0.79	2.1
O-7	Det. Lake	12.5	0.19	4.1	2.81	7.3	0	0	2.81	7.3
O-8	Det. Lake	6.1	0.23	2.4	1.64	4.3	0	0	1.64	4.3
O-9	Det. Lake	17.7	0.33	10.3	6.99	18.2	0	0	6.99	18.2
O-11	O-10	10.5	0.39	7.3	4.94	12.8	1	0	0.49	3.9
O-12	O-10	24.5	0.32	13.6	9.24	24.0	1	0	0.92	7.2
O-14	O-13	16.3	0.30	8.6	5.85	15.2	0	0	5.85	15.2
O-13	O-10	18.9	0.35	11.5	7.81	20.3	0	0	7.81	20.3
O-10	Det. Lake	53.2	0.39	36.8	24.97	64.9	0	0	24.97	64.9
P-1	Unknown	118.3	0.45	93.5	63.49	165.1	0	0	63.49	165.1
P-2	Unknown	5.1	0.46	4.1	2.81	7.3	0	0	2.81	7.3
P-3	Unknown	0.9	0.33	0.5	0.35	0.9	0	0	0.35	0.9
P-4	Unknown	8.3	0.55	8.1	5.48	14.2	0	0	5.48	14.2
P-5	Unknown	95.5	0.35	58.1	39.45	102.6	0	0	39.45	102.6
P-6	Unknown	17.9	0.38	12.0	8.14	21.2	0	0	8.14	21.2
P-7	Unknown	3.1	0.30	1.6	1.11	2.9	0	0	1.11	2.9
Q-1	Det. Lake	55.0	0.46	44.3	30.13	78.3	0	0	30.13	78.3
R-1	Unknown	18.3	0.23	7.4	5.04	13.1	0	0	5.04	13.1
R-3	R-2	30.2	0.21	11.2	7.59	19.7	0	0	7.59	19.7
R-2	Unknown	32.2	0.22	12.6	8.58	22.3	0	0	8.58	22.3
R-4	Unknown	51.4	0.17	14.9	10.15	26.4	0	0	10.15	26.4
S-1	Abbey Lake	23.0	0.11	4.5	3.03	7.9	0	0	3.03	7.9
T-1	Det. Lake	54.8	0.19	18.4	12.47	32.4	0	0	12.47	32.4
U-3	U-2	11.7	0.31	6.3	4.27	11.1	0	0	4.27	11.1
U-2	U-1	50.0	0.33	28.6	19.46	50.6	0	0	19.46	50.6
U-4	U-1	16.8	0.23	6.8	4.63	12.0	1	0	0.46	3.6
U-1	Det. Lake	88.3	0.37	56.8	38.59	100.3	0	0	38.59	100.3
V-4	Unknown	4.9	0.50	4.3	2.92	7.6	0	0	2.92	7.6



RAINFALL INTENSITY - DURATION - FREQUENCY CURVES
For use with rational formula

10.2 ESTIMATING POLLUTANT LOADS

To predict the impact of highway development activities in a watershed, pollutant loadings can be estimated for both pre- and post-development scenarios. The following methods and models are currently available which employ algorithms for pollutant loading estimation.

10.2.1 Simple Method

The Simple method is an aptly named empirical method which is intended for use on sites of less than 2.5 km^2 (1 mi^2). [58] It assumes an average pollutant concentration is multiplied by the average runoff to yield an average loading estimate. The pollutant export, or loading from a given area can be estimated from the following equation:

$$L = \frac{[P\ R_v\ P_j]\ [C]\ [A]}{98.6} \qquad (10\text{-}1)$$

where:
- L = pollutant load, kg
- P = rainfall depth over the desired time interval, mm
- R_v = runoff coefficient
- P_j = correction factor for storms that produce no flow
- C = flow-weighted mean concentration of the pollutant in urban runoff, mg/L
- A = area of the development site, ha
- 98.6 = unit conversion factor

The rainfall depth value, P, is selected based on the time interval over which loading estimates are desired. Rainfall records for a specific region of the country can be obtained from the National Weather Service (NWS).

The value of P_j is used to account for the percentage of annual rainfall that does not produce measurable runoff. This value adjusts the loading estimation equation to eliminate the portion of annual rainfall that does not produce any direct runoff. Rainfall from minor storm events are stored in surface depressions and do not generate runoff. Based on an analysis of National Urban Runoff Program (NURP) rainfall gage data in the Washington, DC area, it was determined that 10 percent of annual rainfall is so slight that no appreciable runoff is produced. [57] Therefore, P_j should be set to 0.9 for annual and seasonal calculation. P_j is not used (i.e., it is set equal to 1.0) in the analysis of a single storm.

The runoff coefficient, R_v, for a site is dependent on the degree of watershed imperviousness, and can be estimated with the following equation:

$$R_v = 0.05 + 0.009\ (I) \qquad (10\text{-}2)$$

where:
- R_v = runoff coefficient
- I = degree of site imperviousness (percent) (This can be readily obtained from site plans.)

Average flow weighted pollutant concentration values (C) are presented in table 10-4 for selected pollutants. The values are derived from a statistical analysis of runoff events in the NURP database. The following example uses the Simple method to estimate pollutant loads.

Table 10-4. Urban 'C' values for use with the Simple method (mg/L). [58]

Pollutant	National Urban Highway Runoff	New Suburban NURP Sites (Wash., DC)	Older Urban Areas (Baltimore)	Central Business District (Wash., DC)	National NURP Study Average	Hardwood Forest (Northern Virginia)
Phosphorus						
Total	-	0.26	1.08	-	0.46	0.15
Ortho	-	0.12	0.26	1.01	-	0.02
Soluble	0.59	0.16	-	-	0.16	0.04
Organic	-	0.10	0.82	-	0.13	0.11
Nitrogen						
Total	-	2.00	13.6	2.17	3.31	0.78
Nitrate	-	0.48	8.9	0.84	0.96	0.17
Ammonia	-	0.26	1.1	-	-	0.07
Organic	-	1.25	-	-	-	0.54
TKN	2.72	1.51	7.2	1.49	2.35	0.61
COD	124.0	35.6	163	-	90.8	>40.0
BOD (5-day)	-	5.1	-	36	11.9	-
Metals						
Zinc	0.380	0.037	0.397	0.250	0.176	-
Lead	0.550	0.018	0.389	0.370	0.180	-
Copper	-	-	0.105	-	0.047	-

TKN = total Kjeldahl nitrogen; COD = chemical oxygen demand; BOD = biochemical oxygen demand.

Example 10-1

Given: ***Pre- and post-development parameters are given for a 20 ha (50 ac) development site:***

Parameter	*Pre-development (forest)*	*Post-development (suburban)*
P	*890 mm (35 in)*	*890 mm (35 in)*
P_j	*0.9*	*0.9*
% Imp	*2% (forest)*	*45%*
R_v	*0.05 + .009(2) = 0.07*	*0.05 + .009(45) = 0.46*
C (total N)	*0.78 mg/L*	*2.00 mg/L*
C (total P)	*0.15 mg/L*	*0.26 mg/L*
C (lead)		*0.018 mg/L*

EXCERPTS FROM DL ZONING ORDINANCE (Shoreland Amendments of Nov. 1992)

ction 18. "S" Shoreland District (areas within 1000 feet of lake, and 300 feet of stream).

Subd. 5 Zoning and Water Supply/Sanitary Provisions

B. Placement, Design, and Height of Structures

2. Design Criteria for Structures

e. Steep Slopes. The Building Official must evaluate possible soil erosion impacts and development visibility from public waters before issuing a permit for construction of sewage treatment systems, roads, driveways, structures, or other improvements on steep slopes. When determined necessary, conditions must be attached to issued permits to prevent erosion and to preserve existing vegetation screening of structures, vehicles, and other facilities as viewed from the surface of public waters, assuming summer, leaf-on vegetation.

C. Shoreland Alterations. Alterations of vegetation and topography will be regulated to prevent erosion into public waters, fix nutrients, preserve shoreland aesthetics, preserve historic values, prevent bank slump, and protect fish and wildlife habitat.

1. Vegetation Alterations.

b.1 Intensive vegetation clearing within the shore and bluff impact zones and on steep slopes is not allowed. Intensive vegetation clearing for forest land conversation to another use outside of these areas is allowable as a conditional use if an erosion control and sedimentation plan is developed and approved by the soil and water conservation district in which the property is located.

2. Topographic Alterations/Grading and Filling.

c. ... A grading and filling permit will be required for:

1. The movement of more than ten (10) cubic yards of material on steep slopes or within shore or bluff impact zones; and

2. The movement of more than 50 cubic yards of material outside of steep slopes and shore and bluff impact zones.

d. The following considerations and conditions must be adhered to during the issuance of construction permits, grading and filling permits, conditional use permits, variances, and subdivision approvals:

1. Grading or filling in any type 2, 3, 4, 5, 6, 7, or 8 wetland must be evaluated to determine how extensively the proposed activity would affect the following functional qualities of the wetland:

a. sediment and pollutant trapping and retention;

b. storage of surface runoff to prevent or reduce flood damage.

2. Alterations must be designed and conducted in a manner that ensures only the smallest amount of bare ground is exposed for the shortest period of time possible;

3. Mulches or similar materials must be used, where necessary, for temporary bare soil coverage, and a permanent vegetation cover must be established as soon as possible:

5. Altered areas must be stabilized to acceptable erosion control standards consistent with the field office technical guides of the local soil and water conservation districts and the United States Soil Conservation Service;

6. Fill or excavated material must not be placed in a manner that creates an unstable slope;

7. Plans to place fill or excavated material on steep slopes must be reviewed by qualified professionals for continued slope stability and must not create finished slopes of 30 percent or greater.

8. Fill or excavated material must not be placed in bluff impact zones:

D. Placement and Design of Roads, Driveways, and Parking Areas.

1. Public and private roads and parking areas must be designed to take advantage of natural vegetation and topography to achieve maximum screening from view from public waters. Documentation must be provided by a qualified and individual that all roads and parking areas are designed and constructed to minimize and control erosion to public waters consistent with the field office technical guides of the local soil and water conservation district, or other applicable technical materials.

E. Stormwater Management.
The following general and specific standards shall apply:

1. General Standards:

a. When possible, existing natural drainageways, wetlands, and vegetated soil surfaces must be used to convey, store, filter, and retain stormwater runoff before discharge to public waters.

b. Development must be planned and conducted in a manner that will minimize the extent of disturbed areas, runoff velocities, erosion potential, and reduce and delay runoff volumes. Disturbed areas must be stabilized and protected as soon as possible and facilities or methods used to retain sediment on the site.

c. When development density, topographic features, and soil and vegetation conditions are not sufficient to adequately handle stormwater runoff using natural features and vegetation, various types of constructed facilities such as diversions, settling basins, skimming devices, dikes, waterways, and ponds may be used. Preference must be given to designs using surface drainage, vegetation, and infiltration rather than buried pipes and manmade materials and facilities.

2. Specific Standards:

a. Impervious surface coverage of lots must not exceed 25 percent of the lot area.

b. When constructed facilities are used for stormwater management, documentation must be provided by a qualified individual that they are designed and installed consistent with the field office technical guide of the local soil and water conservation districts.

c. New constructed stormwater outfalls to public waters must provide for filtering or settling of suspended solids and skimming of surface debris before

STORMWATER MANAGEMENT IN CITY OF DETROIT LAKES

CERPTS FROM DL SUBDIVISION REGULATIONS (Ordinance 510.00)

n 6. Premature Subdivision

reliminary plat of proposed subdivision deemed premature for development shall be l by the City Council of the City of Detroit Lakes.

bdivision 1. Condition Establishing Premature Subdivisions.

subdivision may be deemed premature should any of the conditions set forth in e provisions which follow exist:

(A) Lack of Adequate Drainage. A condition of inadequate drainage shall be deemed to exist if:

(1) Surface or subsurface water retention and runoff is such that it constitutes a danger to the structural security of the proposed structure.

(2) The proposed subdivision will cause pollution of water sources or damage from erosion and siltation on downhill or downstream land.

(3) The proposed site grading and development will cause harmful and irreparable damage from erosion and siltation on downhill or downstream land.

(4) Factors to be considered in making these determinations may include: average rainfall for the area; the relation of the land to floodplains; the nature of soils and subsoils and their ability to adequately support surface water runoff and waste disposal systems; the slope of the land and its effect on effluents; and the presence of stream as related to effluent disposal.

ion 7. Plat and Data Requirements

Subdivision 1. Preliminary Plat

The subdivider shall prepare and submit a preliminary plat, together with any necessary supplementary information.

(D) Supplementary Information.

(1) Any or all of the supplementary information requirements set forth in this subdivision shall be submitted when deemed necessary by the Planning Commission.

(3) An accurate soil survey of the subdivision prepared by a qualified person.

(6) Provision for surface water disposal, ponding, drainage, and flood control.

(9) A plan for soil erosion and sediment control both during construction and after development has been completed. The plan shall include gradients of waterways, design of velocity and erosion control measures, design of sediment control measures, and landscaping of the erosion and sediment control system.

(10) All vegetation preservation and protection plan that shows those trees proposed to be removed, those to remain, the types and locations of trees and other vegetation that are to be planted.

Section 8. Design Standards

Subdivision 5. Erosion and Sediment Control.

(A) The development shall conform to the natural limitations presented by topography and soil so as to create the least potential for soil erosion.

(B) Erosion and siltation control measures shall be coordinated with the different stages of construction. Appropriate control measures shall be installed prior to development when necessary to control erosion.

(C) Land shall be developed in increments of workable size such that adequate erosion and siltation controls can be provided as construction progresses. The smallest practical area of land shall be exposed at any one period of time.

(D) When soil is exposed, the exposure shall be for the shortest feasible period of time, as specified by the City Engineer.

(E) Where the topsoil is removed, sufficient arable soil shall be set aside for respreading over the developed area. Top soil shall be restored or provided to a depth of four (4) inches and shall be of a quality at least equal to the soil quality prior to development.

(F) Natural vegetation shall be protected wherever practical.

(G) Runoff water shall be diverted to a sedimentation basin before being allowed to enter the natural drainage system.

Subdivision 6. Storm Drainage.

All subdivision design shall incorporate adequate provisions for storm water runoff subject to review and approval of the City Engineer.

Subdivision 7. Protected Areas.

Where land proposed for subdivision is deemed environmentally sensitive by the City, due to the existence of wetlands, drainage ways, water courses, floodable areas of steep slopes, the design of said subdivisions shall clearly reflect all necessary measures of protection to insure against adverse environmental impact.

Subdivision 8. Shoreland Areas.

A. Land Suitability. Each lot created through subdivision, including planned unit developments authorized under Section 18 of the Zoning Ordinance, must be suitable in its natural state for the proposed use with minimal alteration. Suitability analysis by the local unit of government shall consider susceptibility to flooding, existence of wetlands, soil and rock formations with severe limitations for development, severe erosion potential, steep topography, inadequate water supply or sewage treatment capabilities, near-shore aquatic conditions unsuitable for waterbased recreation, important fish and wildlife habitat, presence of significant historic sites, or any other feature of the natural land likely to be harmful to the health, safety, or welfare of future residents of the proposed subdivision of the community.

(D) Dedications. When a land or easement dedication is a condition of subdivision approval, the approval must provide easements over natural drainage or ponding areas for management of storm water and significant wetlands.

ion 9. Required Basic Improvements

ubdivision 2. Improvements.

he following improvements shall be constructed as provided for in this section. rogramming of improvements shall be approved by the City Engineer.

A) City Obligation.

(1) Storm Sewer. Storm sewer mains will be constructed by the City as funds are available. Connection shall be made at the boundary of the subdivision, if available, or to some other approved discharge outlet. The developer shall secure or provide the necessary easements or discharge permits. This requirements shall not prevent the City from acquiring necessary easements by eminent domain. Any costs for such easements shall be borne by the developer.

C) Parks and Open Space Criteria.

(2) Dedication of Storm Water Holding Areas or Ponds. Upon recommendation of the City Engineer and Planning Commission and approval by the City Council, the subdivider may be required to dedicate to the public up to six (6) percent of the land proposed to the subdivided for storm water holding areas or ponds. The six (6) percent dedication shall not be considered in addition to the six (6) percent dedicated for parks and recreation purposes as it relates to residential subdivisions. (Ordinance No. 80, Adopted 7-7-92)