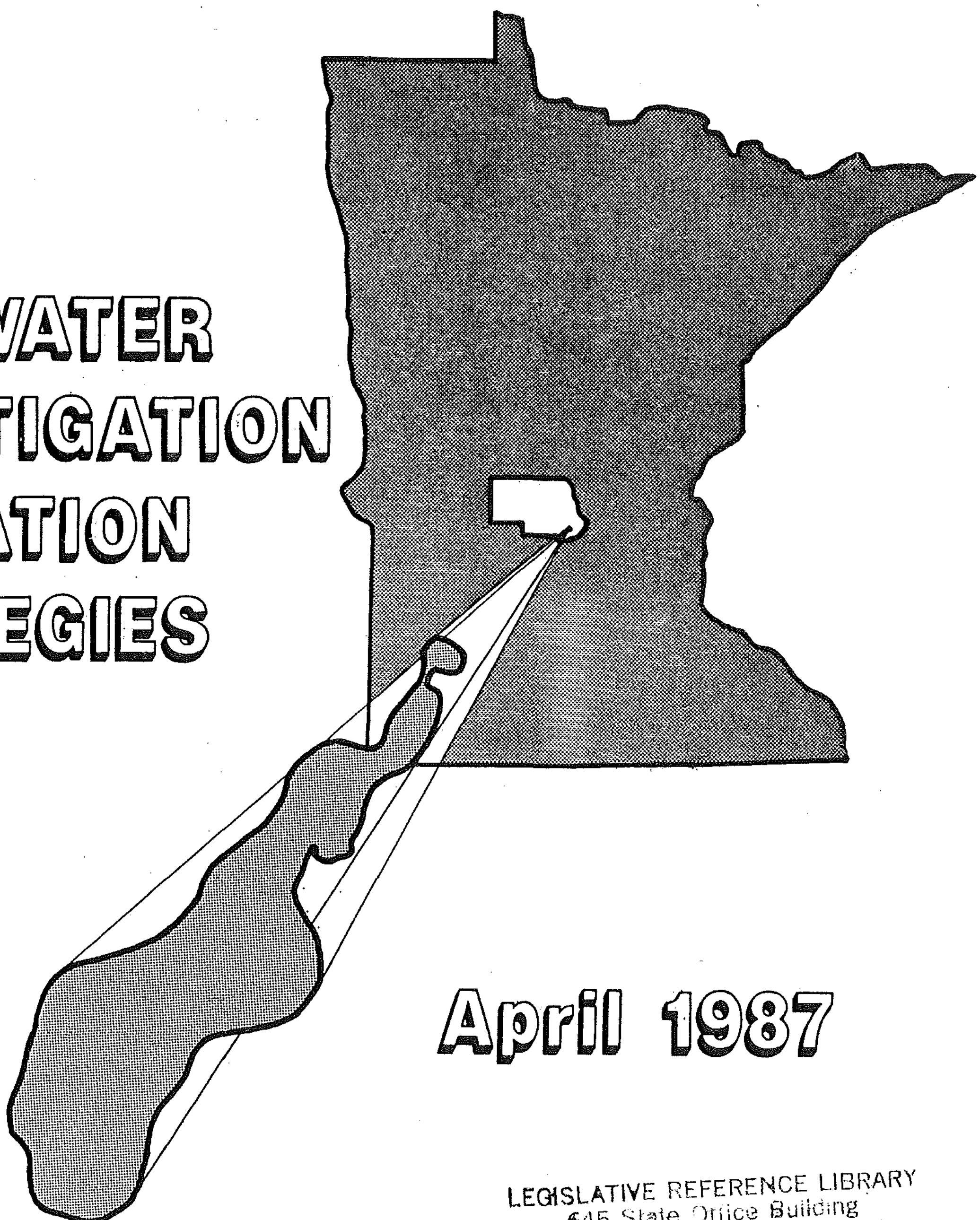
# CARNELIAN LAKE

## (Stearns County, 73-38)

# HIGH WATER INVESTIGATION MITIGATION STRATEGIES



**April 1987**



Minnesota Department of Natural Resources
Division of Waters

# HIGH WATER INVESTIGATION

# AND

# MITIGATION STRATEGIES

# FOR

# CARNELIAN LAKE

# BASIN #73-38

# STEARNS COUNTY

Minnesota Department of Natural Resources

Division of Waters

April 1987

## ACKNOWLEDGEMENT

This report was prepared under a Hazard Mitigation Assistance Grant from the Federal Emergency Management Agency with matching funds from the Department of Natural Resources, Division of Waters. This report would not have been possible without the special assistance of Gary Grossinger and Don Rambler of the Stearns County Assessors Office.

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# INTRODUCTION

Lake Carnelian is located in southeastern Stearns County, Minnesota, approximately 60 miles northwest of the Twin Cities metropolitan area. The lake is 3 miles north northeast of the City of Kimball, and most of its area is within Section 24 of Township 122 North, Range 29 West (Plate 1).

Lake Carnelian is one of over 50 landlocked lakes within glaciated terrain in Minnesota that are currently experiencing highwater level problems. These lakes have no active natural outlets for surface water outflow and are susceptible to large natural water level fluctuations. The duration of these fluctuations is usually on the order of years and is dependent on long-term climatic trends. These lakes typically have small watershed-to-lake area ratios, usually less than 5 to 1.

Lake Carnelian is situated in outwash sands and gravels within the St. Croix moraine complex. In the summer of 1983 the lake level began to rise after heavy rainstorms, and by the summer of 1984, the lake was 3.4 ft. above the Ordinary High Water Level (OHW elevation 1129.3', NGVD, 1929)[1]. By the end of 1986 the water level was 4.2 feet above the OHW, which resulted in the flooding of several structures.

This report is intended as a resource document to assist landowners and the local unit of government in terms of long range planning, developing flood loss reduction or mitigation strategies and in obtaining assistance in dealing with a high water level problem lake. In addition, this report will include background data on the watershed setting, geology, soils, climatology, fish and wildlife, water quality, historic water levels, and land use and existing development.

The report which follows is divided into 4 parts: Summary and Conclusions, Part 1, Part 2 and Appendices. Part 1, through the presentation and analysis of watershed, geologic, precipitation, water level and other data, will identify the source of the problem, project future conditions and identify the potential impact of continued rising water levels. Part 2 will identify mitigation options and implementation strategies. The Appendices will provide additional background data to be used by landowners and local, state and federal officials.

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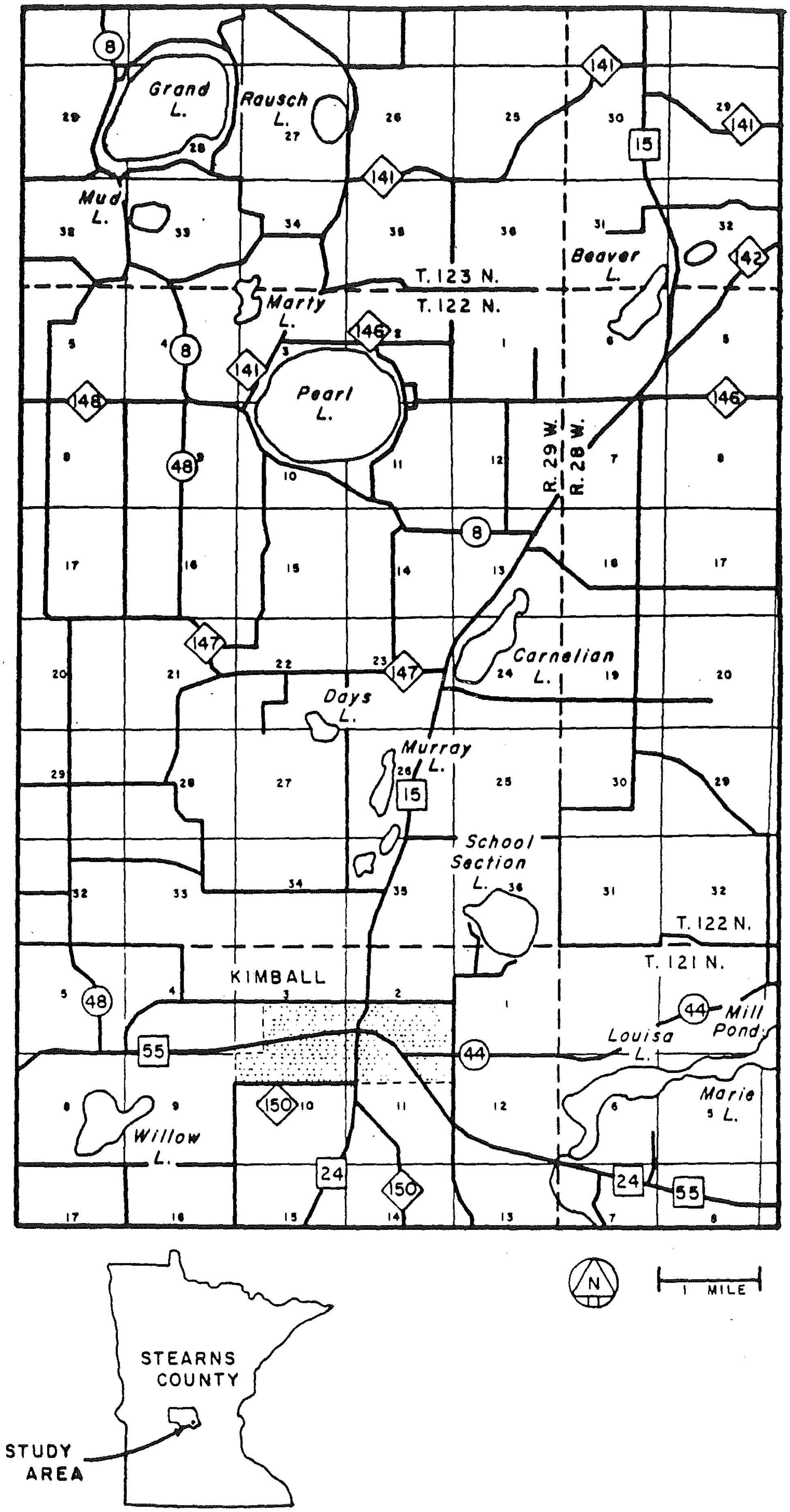
[1] National Geodedic Vertical Datum of 1929 is used for all elevations included in this report.

## PLATE 1


Grand L.
Rausch L.
Mud L.
Marty L.
Pearl L.
Beaver L.
Carnelian L.
Days L.
Murray L.
School Section L.
Louisa L.
Mill Pond
Marie L.
Willow L.
T. 123 N.
T. 122 N.
T. 121 N.
R. 29 W.
R. 28 W.
KIMBALL
N
1 MILE
STEARNS COUNTY
STUDY AREA

## SUMMARY AND CONCLUSIONS/RECOMMENDATIONS

### Water Level Data (See Part 1)

-In December of 1986 Lake Carnelian was at elevation 1133.5', an elevation of 4.2' above the lake's ordinary high water elevation of 1129.3'. Lake Carnelian's water level reacts to both surface (above ground) runoff and ground water inflow.

-There is a correlation between the area's annual precipitation and Lake Carnelian's water level. During the last 5-year period, there has been an excess of 30.38" of precipitation above normal annual precipitation. This has resulted in significant surface and ground water inflow and caused the current high water problem.

-This area in the past has experienced alternating wet and dry periods of varied duration. The current period may continue for several more years resulting in still higher water levels.

-If the lake were to rise to elevation 1138.14', 15 structures would be flooded with 1986 assessed market values totalling $223,849. At this elevation, it is estimated a minimum $168,475 of damage would occur. If the lake were to rise to elevation 1145.14', a minimum of $223,849 damages would occur.

-Methodologies do not exist which can predict what Carnelian's maximum elevation will be in the future. The major factor on limiting potential increases in lake levels would be if the lake should reach its natural runout elevation (not determined, but likely between elevations 1140-1150').

-Methodologies do exist which can calculate the probabilities of future water levels (i.e., both increases and decreases in water levels). There is a one-percent probability that Lake Carnelian will: 1) rise to elevation 1135.4' by December 1, 1987; or 2) rise to elevation 1137.8' by December 1, 1991. Conversely, there is a one-percent probability the lake will: 1) fall below elevation 1131.8' by December 1, 1987; or 2) fall below elevation 1129.2' by December 31, 1991. There is a 50% probability chance over the next 5-year period that the lake will approximate its December 1986 level of 1133.5'.

### MITIGATION STRATEGIES (SEE PART II)

-The flood protection standards for new development in Stearns County's current flood plain ordinance do not apply to the Lake Carnelian shoreline because a flood delineation is not currently shown for the lake on the County's current flood plain zoning map. The County must properly regulate new development adjacent to the lake's shoreline. The County can properly regulate new development with its existing state-approved shoreland regulations with two recommended revisions, as follows:

1) New development within the lake's shoreland district must be elevated, at a minimum, to elevation 1136.5' (3' above the highest known water level). It is recommended that the County adopt a flood protection elevation of 1140.8' (3' of safety factor above elevation 1137.8'). This will provide an additional safety factor should Lake Carnelian exceed elevation 1136.5' in the future; and

2) A provision should be added which requires elevated road access to new construction to the minimum flood protection elevation established by the County (presently 1136.5').

-The County should develop a strategy to address the inundation of sewage treatment systems and wells, as well as the abandonment of flooded structures. The DNR will work with the County in formulating and implementing joint actions where appropriate.

-Flood insurance is available to all landowners and renters in the unincorporated area of Stearns County. A structure and/or its contents can be insured. Landowners or renters adjacent to Carnelian Lake should explore purchasing flood insurance, especially those located within 3.5' of the lake's current water surface elevation.

-Landowners can take emergency measures to protect existing development. The safest method is either relocating a structure to natural ground above elevation 1140.8 or elevating a structure at its existing site on fill to the recommended flood protection elevation of 1140.8'. Emergency protection measures, such as filling, sandbagging, diking, etc., will require a permit from the County. A design professional should be contacted in advance to insure the flood protection measure will function properly.

-State and federal cost-sharing programs may be available to assist landowners and/or local governmental bodies in dealing with a high water problem. These programs include Corp of Engineers' flood control authorities, Small Cities Development Block Grant Program, Section 1362 of the Federal Flood Disaster Protection Act of 1973 and proposed State Flood Loss Reduction Legislation. Local interests should explore these programs and the requirements for an acceptable local sponsor to submit the application.

-At the request of Maine Prairie Township, the Corps of Engineers is investigating the possibility of a federally cost-shared flood control project on Lake Carnelian. The information in this report will be made available to the Corps of Engineers to assist in their study effort. Local interests should participate in this study effort to the degree possible. Should a federally cost-shared project be feasible, local interests must designate a "local project sponsor" acceptable to the Corps of Engineers.

-Comprehensive basinwide solutions to high water problems are best implemented when a local entity or interest group takes the lead role. The legislature has established special taxing procedures and quasi-governmental authorities (e.g., lake improvement districts/watershed districts) which can be used to deal with high water type problems. Landowners and local governmental bodies should: 1) define their respective roles in dealing with the existing high water problem; and 2) if necessary, use the special taxing procedures and/or quasi-governmental authorities to implement feasible basinwide solutions.

The report which follows goes into greater detail on the issues of water level data and mitigation measures (including additional recommendations). Part II also presents in detail state permitting requirements for future actions which would affect the lake basin proper. The reader is encouraged to read the remainder of this report. The Department of Natural Resources will assist local interests in the degree possible in implementing future flood loss reduction measures.

## PART 1

### GEOLOGIC SETTING

Carnelian Lake is situated in medium to coarse outwash sands and gravels within the St. Croix moraine complex, several miles north of the boundary with Des Moines Lobe drift (Plate 2). The outwash is around 100 feet thick at the lake, and thins to less than 20 feet toward the areas of exposed till. The outwash rests on older gray till associated with the Wadena Lobe, Wisconsin Ice Stage.

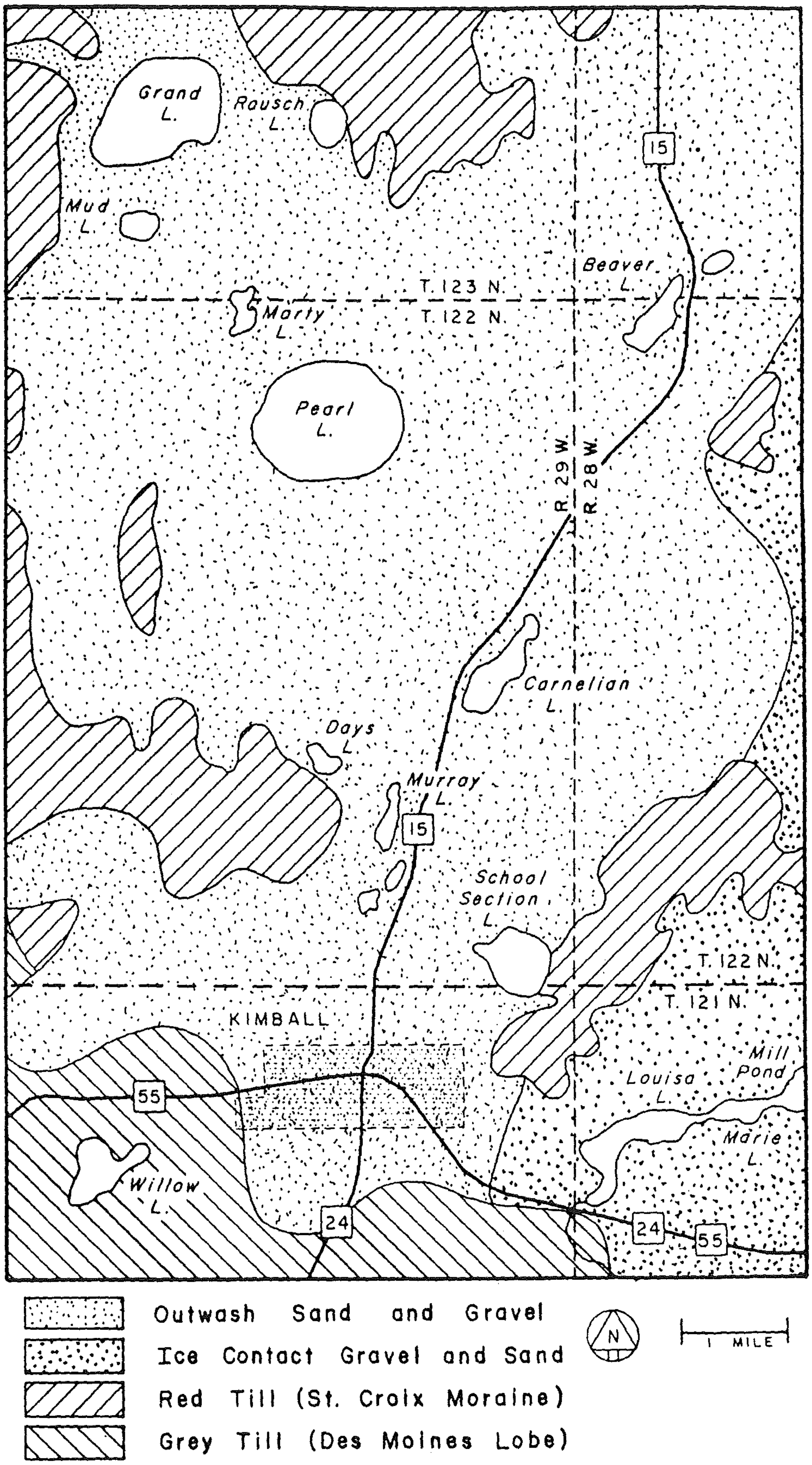
### SOILS

Soils in the area of the lake are developed over the sand and gravel parent material, and contain varying amounts of silt and clay. The soils typically contain loam, sandy loam, silt loam, or clay loam in the upper 1-2 feet, underlain by gravelly coarse sand. The lake shore and lake bottom sediments are primarily sand and gravel, with a small percentage of muck (±10%). A more detailed explanation of the soil types and characteristics is included in Appendix A.

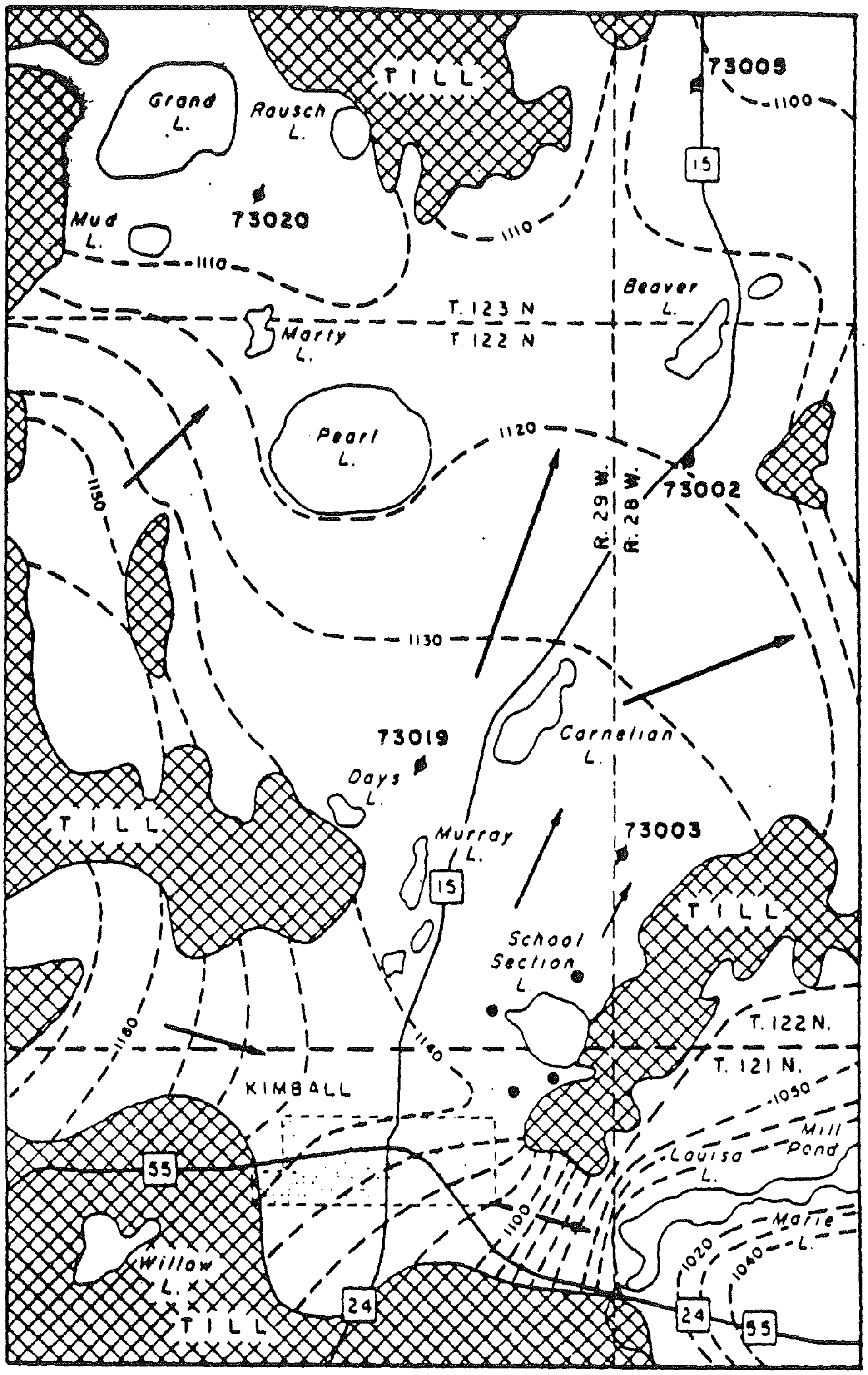
### HYDROGEOLOGIC SETTING

The local direction of ground water flow in the outwash is to the northeast towards the Mississippi River (Plate 3). The lake is hydrologically connected to the outwash aquifer, and is part of the ground water flow system. Fine grained lake sediments will slow down the lake-ground water interaction somewhat, but the lake is still basically a reflection of the water table within the outwash aquifer. The water table gradient in the vicinity of the lake is approximately 0.002, based on observation well and lake level readings. The lake is a ground water "flow-through" lake, with seepage to the lake on its southwest side, and seepage out of the lake from its northeast side. A rough calculation of the amount of ground water flowing through the lake (under Fall 1986 conditions) using the above gradient, permeability derived from transmissivity maps by Lindholm (1980), and assuming a 20 ft. depth of flow yielded 25,000 cubic feet of water per day (187,000 gallons) or 0.3 cubic feet of water per second (cfs).

## PLATE 2


Grand L.
Rousch L.
Mud L.
Marty L.
Beaver L.
T. 123 N.
T. 122 N.
Pearl L.
R. 29 W.
R. 28 W.
15
Carnelian L.
Days L.
Murray L.
School Section L.
T. 122 N.
T. 121 N.
KIMBALL
Louisa L.
Mill Pond
Marie L.
Willow L.
55
24
Outwash Sand and Gravel
Ice Contact Gravel and Sand
Red Till (St. Croix Moraine)
Grey Till (Des Moines Lobe)
N
1 MILE

# PLATE 3




--1130-- Water Table Elevation Contour, Summer 1984

N

1 MILE

73003 ⌀ Observation Well (DNR Network)

● Observation Well Nest (School Section Lake Study)

⟶ General Ground Water Flow Direction

## WATERSHED

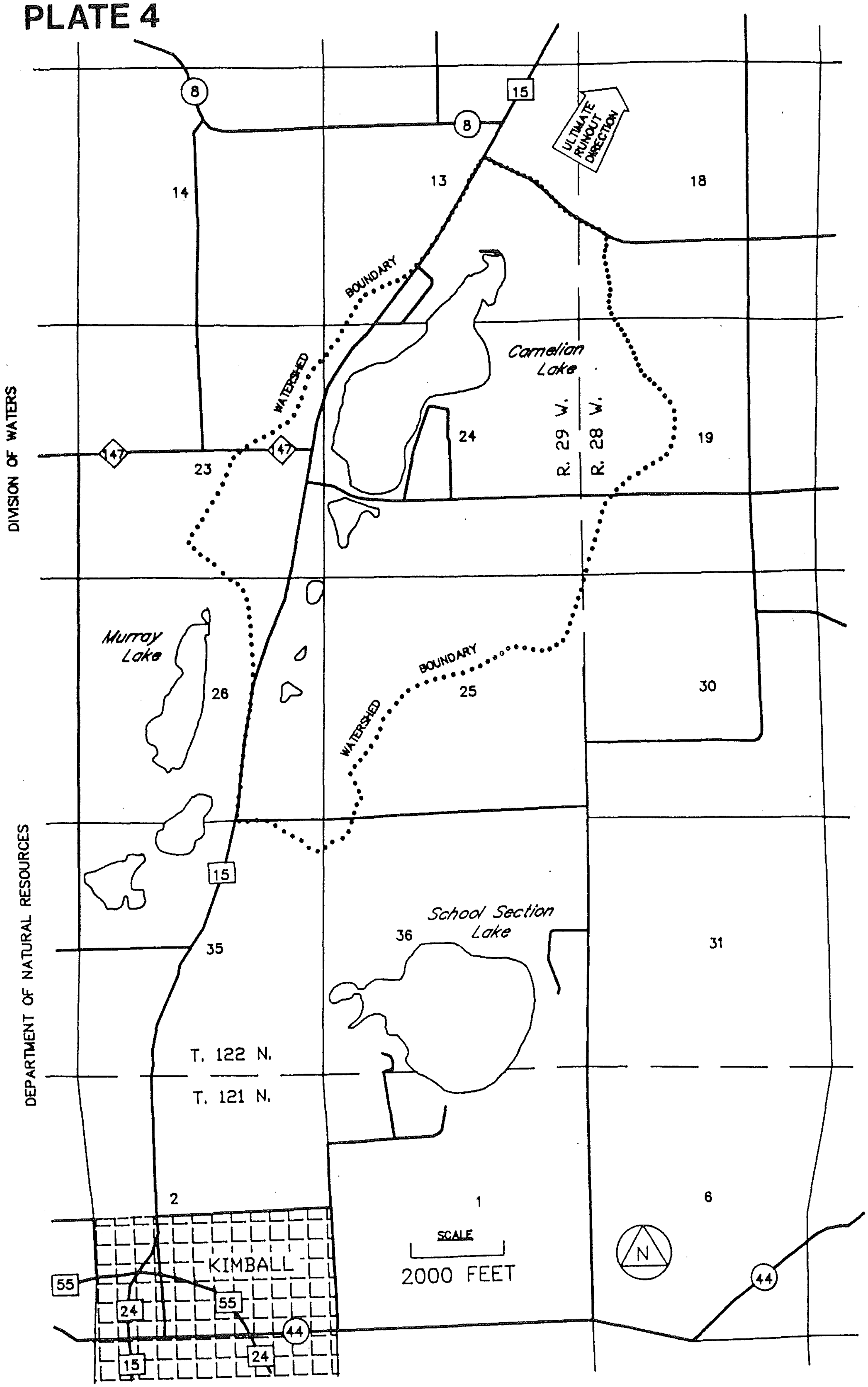
The total watershed area for Lake Carnelian is approximately 1,760 acres (Plate 4). The watershed of 1,760 acres minus the lake water surface area of about 172 acres equals 1,588 acres or a total watershed area to lake area ratio of 9:1. However, a closer examintion of the total watershed area reveals that there are about 700 acres of smaller depressed areas or subwatersheds which also store runoff water and recharge the groundwater. These subwatersheds reduce the amount of the total watershed to about 888 acres and, therefore the effective watershed to lake area ratio is about 5 to 1.

This effective watershed to lake area ratio of about 5 to 1 is generally considered adequate to maintain lake levels during periods of normal precipitation. During periods of below normal precipitation the lake level would probably drop in elevation and during periods of above normal precipitation it would be expected to see a rise in elevation. Since the area has been experiencing periods of above normal precipitation it is not surprising to see a rise in the lake water level.

From the available data, it would appear that a closed basin (no outlet) such as Lake Carnelian is experiencing above normal lake water levels due primarily to above normal precipitation which results in increased surface water runoff together with increased net groundwater flow into the lake.

A further examination of the U.S. Geological Survey 7½' quadrangle map indicates that the lake would ultimately outlet to the northeast if the surface water reached an elevation between 1140.0'-1150.0' (See Plate 4). The exact run-out elevation has not been determined but it is likely between 6.5' and 16.5' higher than the lake's elevation of 1133.5' in December 1986.

PLATE 4



8
15
ULTIMATE RUNOUT DIRECTION
14
13
18
BOUNDARY
WATERSHED
Camelion Lake
24
19
R. 29 W.
R. 28 W.
147
47
23
DIVISION OF WATERS
Murray Lake
26
BOUNDARY
WATERSHED
25
30
15
School Section Lake
36
35
31
T. 122 N.
T. 121 N.
DEPARTMENT OF NATURAL RESOURCES
2
1
6
SCALE
2000 FEET
N
KIMBALL
55
55
24
44
24
15
44

## WATER QUALITY

Available water test data for Carnelian Lake taken from the Minnesota Pollution Control Agency's Lake File and the Minnesota Department of Natural Resources' Fisheries Lake Survey Report (both 1981 data) indicate the lake to be in a slightly better than average condition as compared to other lakes in the area.

The lake can be described as a pleasant, relatively clean, mesotrophic, hardwater lake containing a normal distribution of aquatic vegetation. The water temperatures together with available nitrogen and phosphorous content contribute to the lake experiencing light algal blooms during the late summer months. Generally, the total nitrogen and total phosphorous levels would have to exceed 1.0 Mg/L and 0.1 Mg/L respectively, to produce nuisance algal blooms. The total nitrogen and total phosphorous readings recorded are low and would more than likely be low to moderate if the nitrogen and phosphorus contained in the light algal bloom were released.

## FISH AND WILDLIFE

The Minnesota Department of Natural Resources' Fisheries Lake Survey Report classifies Carnelian Lake in ecological and management terms as Centrarchid (Bass/Panfish). The fish population of the lake includes largemouth bass, sunfish, crappies, yellow perch, some walleyes, northern pike, and a variety of rough fish. Recent Department surveys indicate that northern pike reproduction from an adjoining marsh is such that there is an overabundance of this species. The Department's Fisheries Section recommends that the lake should be managed for largemouth bass, panfish and northern pike. This would require the reduction of the rough fish population, posting the bass spawning area, and reducing the northern pike population by the periodic blocking of the south marsh spawning area. The panfish population of Lake Carnelain is characterized by being slow growing, overabundant, and of a small average size.

The Department of Natural Resources' files do not contain wildlife information pertaining to Lake Carnelian. However, observations by the area wildlife manager reports the following information:

1. Some muskrats are present.
2. Great Blue Heron and other rookeries are in the area and use the lake for feeding purposes.
3. Waterfowl use the lake as a spring staging and resting area. Waterfowl pair off for mating prior to their northern migration.
4. Some waterfowl are present and use the lake during the summer months.
5. Waterfowl use the lake as a fall staging and resting area. The lake attracts migrating waterfowl from which larger flocks disperse continuing their southern migration.
6. The Federal Conservation Reserve Program (CRP) and the State Reinvest in Minnesota (RIM) programs are currently responsible for several projects in the area which will provide additional feeding, cover, loafing and nesting areas for a variety of wildlife species.

Appendix B contains a more detailed presentation of water quality, fish and wildlife management, development history, and other information.

## PRECIPITATION

The State Climatology Office reports that the average number of annual rain days for the St. Cloud area is 111. It actually rained 110 days in the St. Cloud area during 1986, which is normal. However, the area experienced more rain days in the higher 3 precipitation categories listed below which accounted for above normal total precipitation in 1986.

| MEAN RAIN DAYS | MEAN PRECIPITATION CATEGORIES IN INCHES* | 1986 ACTUAL RAIN DAYS |
|---|---|---|
| 50 | 0.1 - 0.49 | 68 |
| 15 | 0.5 - 0.99 | 20 |
| 5 | 1.0 and above | 7 |

*Trace amounts of precipitation less than .1" are not included.

### St. Cloud Area

Long Range Normal Annual Precipitation Average (1893-1986) = 26.84"

Normal Annual Precipitation (current trends) 1951-1980 = 27.72" (Plates 5 and 6)

Actual Annual Precipitation:

**1982-1986**

1982 = 30.46"
1983 = 36.18"
1984 = 33.20"
1985 = 34.41"
1986 = 34.73"

5-year period, yearly average precipitation = 33.79"/year

Excess above normal precipitation for 5 year period = 30.38"

**1977-1986**

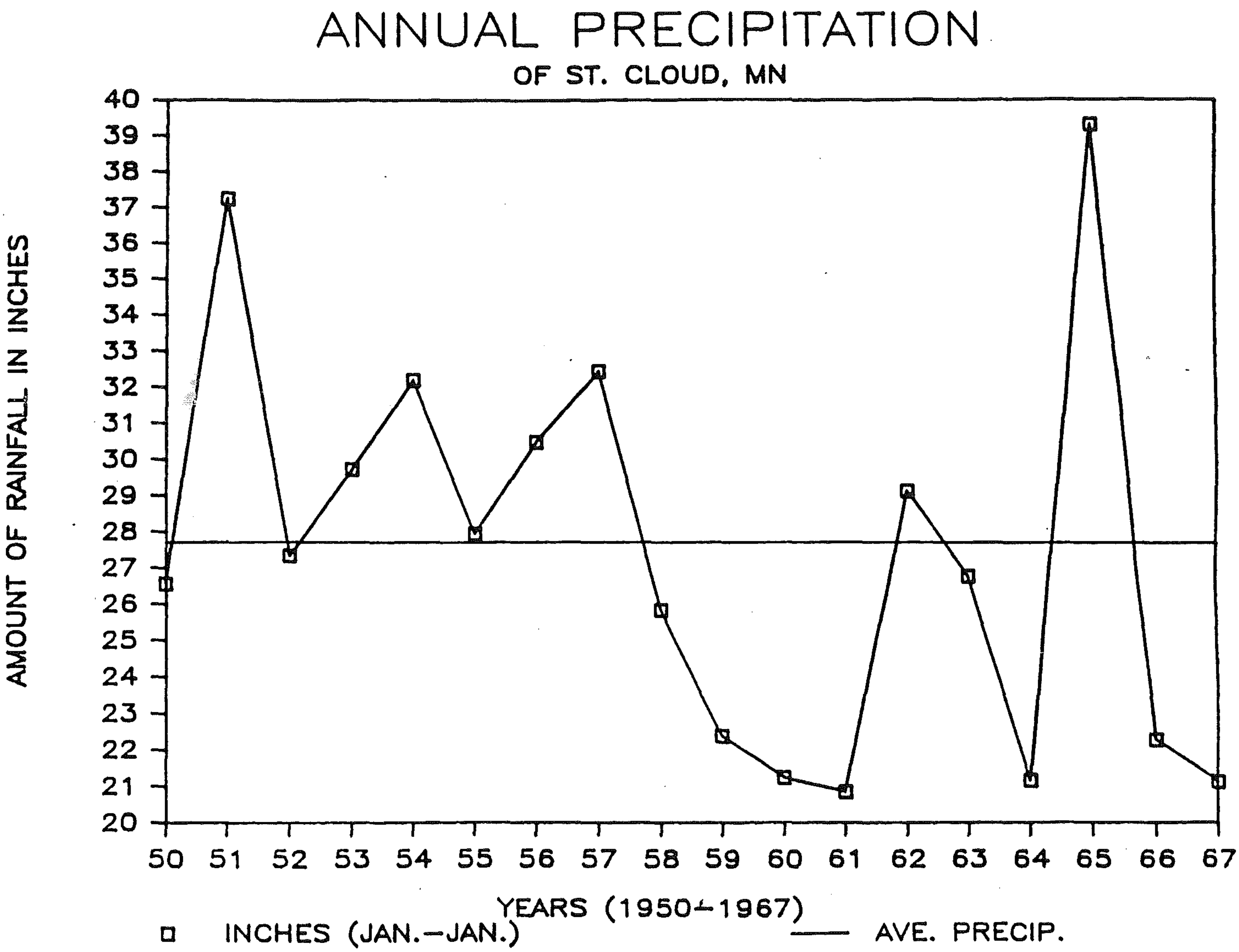
1977 = 35.59"
1978 = 27.91"
1979 = 31.18"
1980 = 26.34"
1981 = 23.00"
1982 = 30.46"
1983 = 36.18"
1984 = 33.20"
1985 = 34.41"
1986 = 34.73"

10-year period, yearly average precipitation = 31.30"/year

Excess above normal precipitation for 10-year period = 35.80"

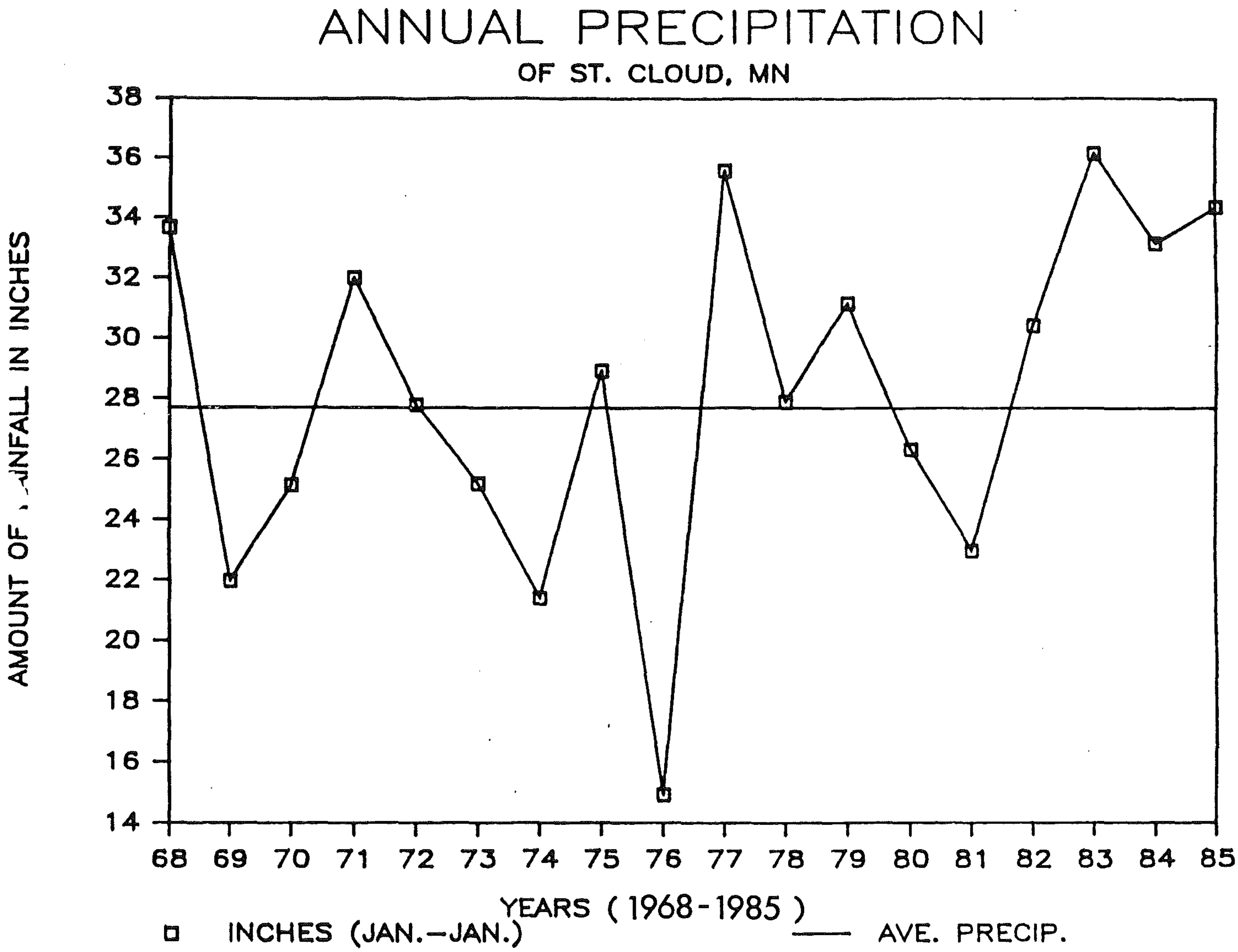
A more in-depth discussion of climatological data is contained in Appendix C.

**PLATE 5**



ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67
YEARS (1950–1967)
INCHES (JAN.–JAN.)
AVE. PRECIP.

## PLATE 6


ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
38
36
34
32
30
28
26
24
22
20
18
16
14
68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85
YEARS ( 1968-1985 )
INCHES (JAN.—JAN.)
AVE. PRECIP.

## WATER LEVEL HISTORY

The Department of Natural Resources' Carnelian Lake file contains nineteen fairly reliable surface water elevations dating from June 6, 1957 through December 3, 1986 (see Chart 1 and Table 1 below). The available precipitation and lake level data indicate a correlation between the area's annual precipitation and the lake's water level. From 1982 through 1986 (last 5 years), the area has received an additional 30.38 inches of precipitation over the normal annual precipitation of 27.72 inches. The water level of the lake (1133.5') in December, 1986 is about 4.2' above the lake's Natural Ordinary High Water mark (1129.3') and is presumably due to several years of above normal precipitation.

It should also be noted that the precipitation patterns in this area are characterized by alternating wet and dry periods of varied duration (Plates 7 and 8). These long-term precipitation variations could continue into the future and Lake Carnelian's water surface elevation will respond accordingly. Because above normal periods of precipitation of longer duration than the current period have occurred in the past, the current period may continue for several more years resulting in continued increasing lake levels.

Chart 1

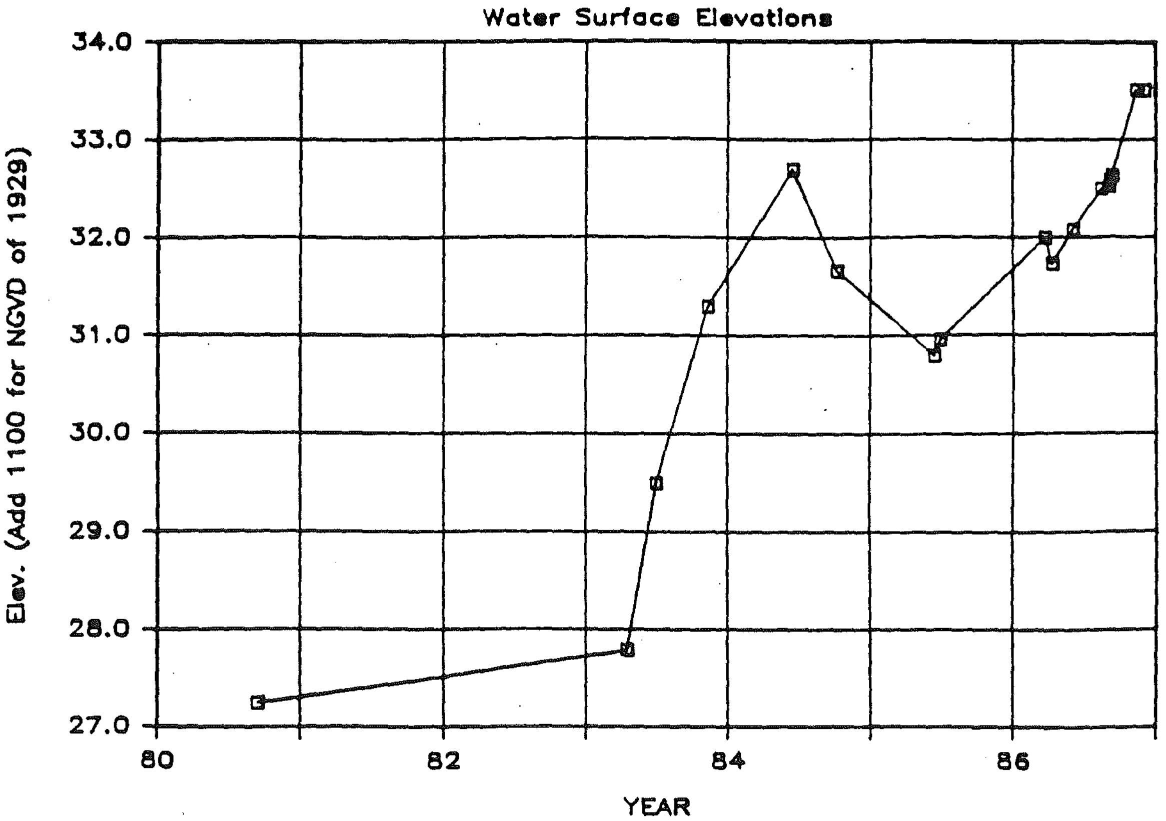
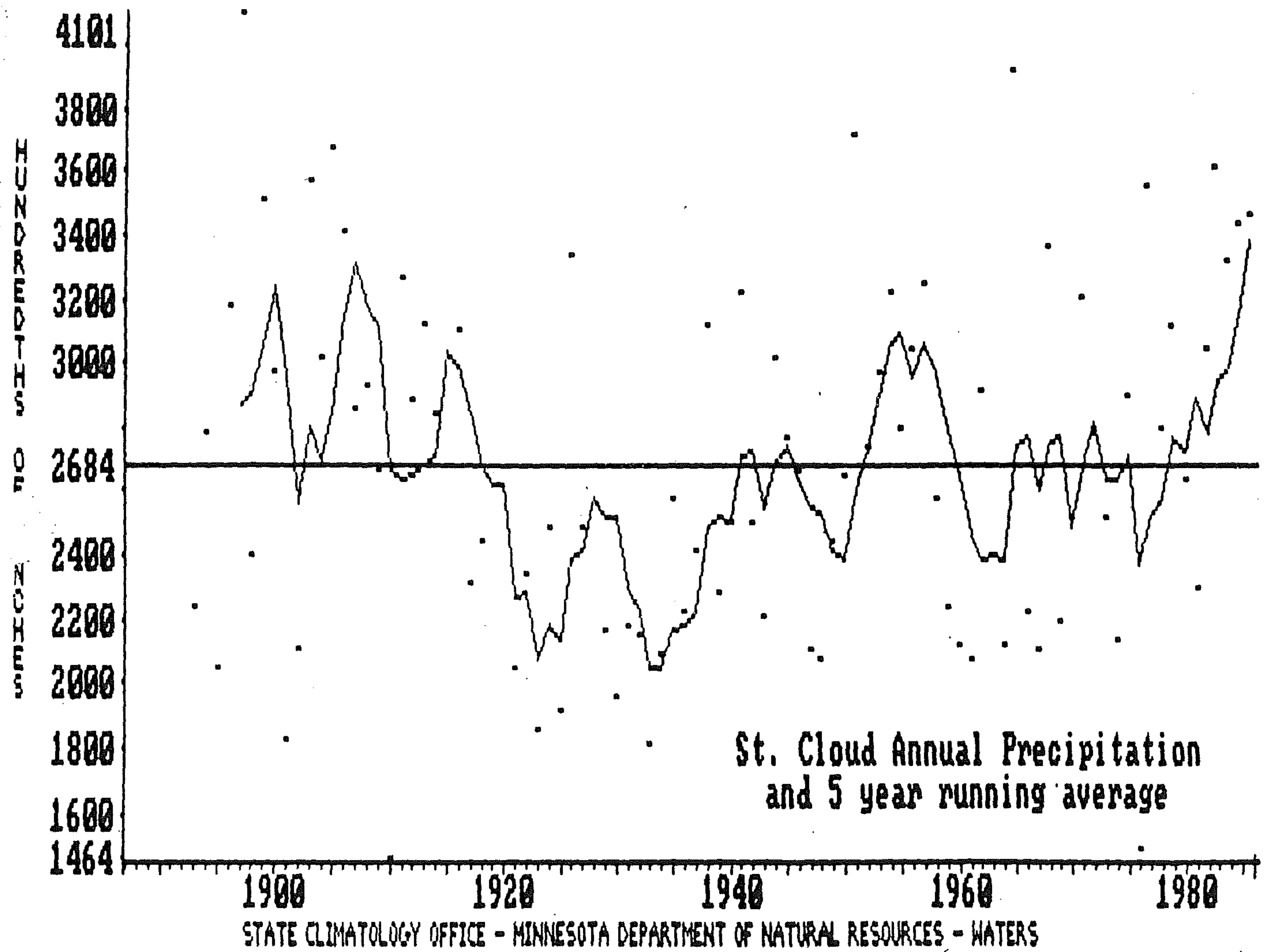


Table 1

WATER LEVEL HISTORY

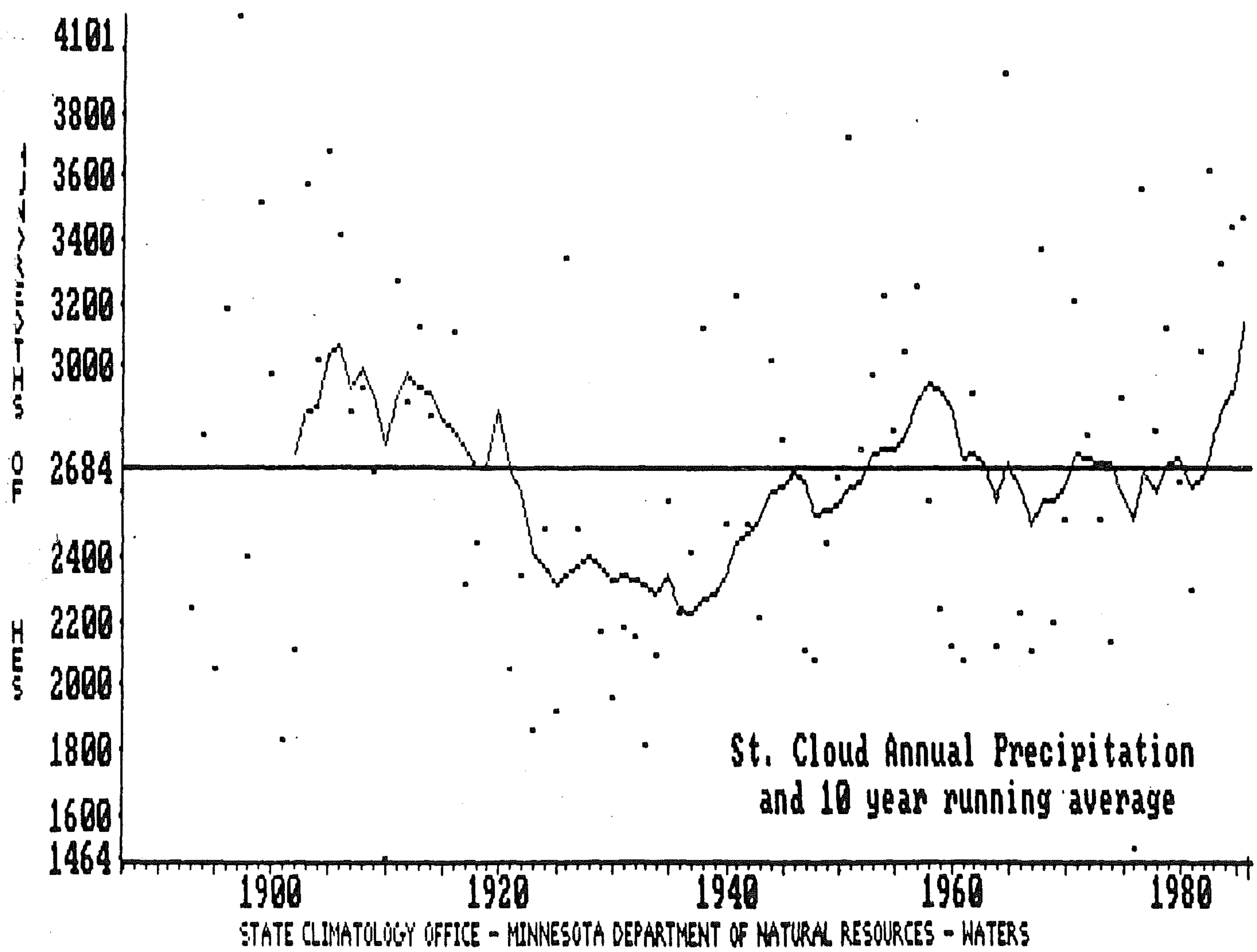
| Date | Water Level | Source |
|---|---|---|
| 6/6/57 | 1124.20 | Sounding Map |
| 1967 | 1125.00 | USGS Quadrangle Map |
| 9/15/80 | 1127.25 | DOW Field Survey |
| 4/15/83 | 1127.80 | Measurement |
| 6/29/83 | 1129.50 | Measurement |
| 11/10/83 | 1131.30 | Measurement |
| 6/14/84 | 1132.70 | Estimate |
| 10/8/84 | 1131.66 | DOW Field Survey |
| 6/11/85 | 1130.80 | Gauge |
| 6/27/85 | 1130.96 | Gauge |
| 3/22/86 | 1132.00 | Gauge |
| 4/9/86 | 1131.73 | Gauge |
| 6/3/86 | 1132.08 | Gauge |
| 8/13/86 | 1132.50 | Gauge |
| 9/3/86 | 1132.53 | Gauge |
| 9/4/86 | 1132.59 | Gauge |
| 9/11/86 | 1132.64 | Gauge |
| 11/12/86 | 1133.51 | Gauge |
| 12/3/86 | 1133.51 | Gauge |

## PLATE 7



4101
3800
3600
3400
3200
3000
2684
2400
2200
2000
1800
1600
1464
HUNDREDTHS OF INCHES
St. Cloud Annual Precipitation
and 5 year running average
1900
1920
1940
1960
1980
STATE CLIMATOLOGY OFFICE - MINNESOTA DEPARTMENT OF NATURAL RESOURCES - WATERS

# PLATE 8



4101
3800
3600
3400
3200
3000
2684
2400
2200
2000
1800
1600
1464
1900
1920
1940
1960
1980
St. Cloud Annual Precipitation
and 10 year running average
STATE CLIMATOLOGY OFFICE - MINNESOTA DEPARTMENT OF NATURAL RESOURCES - WATERS

## ORDINARY HIGH WATER LEVEL (OHW)

The Ordinary High Water level (OHW)[(2)] for Carnelian Lake has been determined by the Department of Natural Resources, Division of Waters in accordance with Minnesota Statute § 105.37, Subdivision 16. OHW data was obtained from field surveys completed on September 26, 1980 and December 3, 1986, and the subsequent analysis indicated the OHW to be at elevation 1129.3'.

### OHW General

Resource management and riparian rights pertaining to an inland lake are dependent upon identification and establishment of that lake's Ordinary High Water (OHW) elevation. The OHW is coordinated with the upper limit of the lake basin and defines the elevation (contour) on the lakeshore which delineates the boundary of public waters. Identification of the OHW comes from an examination of the bed and banks of a lake to ascertain the highest water level where the presence and action of water has been maintained for a sufficient length of time to leave recoverable evidence. The primary evidence used to identify the OHW of a lake consists of vegetational and physical features found on the banks of the lake.

Because trees are the most predominant and permanent expression of upland vegetation they are used as OHW indicators wherever suitable species and sites can be located. Particular attention must be given to the species of upland growth selected for consideration. In general, willow, cottonwood and most ash are very water tolerant; maples and elms tolerant; and most birch intermediately tolerant and oak intolerant. The less tolerant trees make the best indicators but factors in addition to species also have to be considered such as age, the slope of ground, the effect of water and ice action on the shoreline and the physical condition and growing characteristics of the trees. Water dependent vegetation such as cattails will follow lake levels as they rise and fall and therefore provide little evidence as to the lakes OHW, except in cases where more permanent vegetation does not exist.

Physical features searched for include soil characteristics, beachlines, beach ridges, scarp or escarpment (more prominent scarp can often be found in the form of the undercutting of banks and slopes), ice ridges, natural levees, berms, erosion, deposition, debris, washed exposed shoreline boulders, high water marks, movement of deposits as a result of wave action, top and toe of bank elevations as well as water levels. Caution is taken to be aware that many of

[2] According to Minnesota Statutes Section 105.37, Subdivision 16, "ordinary high water level" means the boundary of public waters and wetlands, and shall be an elevation delineating the highest water level which has been maintained for a sufficient period of time to leave evidence upon the landscape, commonly that point where the natural vegetation changes from predominantly aquatic to predominantly terrestrial. For watercourses, the ordinary high water level shall be the elevation of the top of the bank of the channel. For reservoirs and flowages the ordinary high water level shall be the operating elevation of the normal summer pool.

the listed geomorphological features may take a long time to develop and also that several sets of these features may be found. That is, a lake likely will have more than one stage where the action of water has left recoverable evidence however only the stage coordinated with the upper limit of a basin are used to assist in identifying the OHW level. As an extreme example, water level stages resulting from the drought years of the 1930's certainly were the result of natural conditions extending over a number of years, but the resulting recoverable evidence is of no use in OHW determinations.

## ANTICIPATED FUTURE LAKE LEVELS - PROBABILITIES

The problem facing landowners and governmental bodies for land-locked lakes is to respond to high water problems when there is no specific formula which tells us exactly whether (and when) the lake will go up or go down or will it remain steady. What we have seen so far is that Lake Carnelian responds directly to precipitation. Precipitation patterns historically have been cyclical in this area and currently the area is on a cyclical upswing in yearly precipitation. No one can predict with certainty whether this will continue into next year, for five-years, etc.

The probability of different scenarios of future water level conditions can be estimated from historical precipitation data and groundwater and lake level data. The DNR, Division of Waters has used a water budget computer model with a long-term series of monthly precipitation to determine probabilities of anticipated lake levels for the end of one and five year periods. Each end of period anticipated level was computed using the specific period or slice of historic precipitation (1 year or 5 years) and the known December 1, 1986 lake level. By using all of the specific periods within the precipitation record, a series of anticipated lake levels is developed and then statistically analyzed to assign probabilities to the range of computed levels.

The in-house water budget computer model "WATBUD" computes net monthly inflow and outflow volumes and storage routes them through the lake using the previous months lake level for initial conditions. The inflows consist of precipitation and runoff computed from precipitation using a constant coefficient. Outflows consist of evaporation and any discharge from an outlet. A constant monthly groundwater seepage rate may be an inflow or outflow and together with the rainfall-runoff coefficient are used as calibration parameters to provide a balanced water budget.

At Carnelian Lake the WATBUD model was calibrated for the period April through December, 1986 using monthly precipitation from the St. Cloud and pan evaporation data from Becker. The initial lake level of 1133.5' recorded December 3, 1986 was used with monthly time series precipitation data from St. Cloud precipitation record (1983 to 1986) to compute the specific one and five year period anticipated lake level series.

The modeling results indicate that there is a one-percent probability the lake level would rise above elevation 1135.4' by December 1, 1987 and a one-percent probability the lake will exceed elevation 1137.8' by December 31, 1991. These elevations are still many feet below the run-out. Conversely, probabilities exist which state the liklihood the lake elevation may fall. There is a one-percent probability the lake may fall below elevation 1131.8 by December 1, 1987 and a one-percent probability the lake may fall below elevation 1129.2' by December 31, 1991. The modeling results also suggest a 50-percent probability (a 50/50 chance) that the lake will be at elevation 1133.4 on December 1, 1987 and 1133.2' in approximately 5-years.

The above-noted modeling concerned itself with longer periods of total precipitation and did not attempt to determine the impacts of major storm events which occur relatively quickly and are not cyclical. A management plan for an area must consider the impact of these storm events because of their severe nature and there is little or no time to react to them. The probability of lake level increases was also computed for the 24 hour and 10 day, 100-year duration storm events. Assuming the same initial condition lake elevation of 1133.5, the 100-year, 24 hour duration event of 5.7 inches of precipitation would result in a lake level increase of 1.5 feet to elevation 1135.0' and the 100-year, 10 day runoff of 7.2 inches would result in a lake level increase of 3.2 feet to elevation 1136.2'.

## POTENTIAL STRUCTURAL DAMAGES

To determine the impact of potential continued increases in water levels, descriptive base data were collected for certain structures along the shoreline of Lake Carnelian. These base data were collected on September 9, 1986, when the lake was at elevation 1131.59'. While the potential maximum elevation of Carnelian Lake is unknown, it was felt surveying structures within an approximate 7' vertical elevation above elevation 1131.59' would identify those structures most immediately subject to flood damage.

The example below shows a generic fact sheet that was completed for each structure surveyed. The elevations provided are in Mean Sea Level Datum, 1929 Adjustment, and were determined from instrument surveys. Plate 9 on the following page shows the location of each structure surveyed. Appendix D contains the actual fact sheet for each structure surveyed with a numerical index to match the location map.

### EXAMPLE

Structure number : Doe, John
Name : R.R. 1
Address : City, MN 55312

Legal Description: Lake Subdivision
N 1/2, Sec. 24., Twp. 122, R. 29
Lot 2

Floor Elevation : 1135.41
Ground Elevation : 1130.12

Basement : Yes
Walkout : Yes

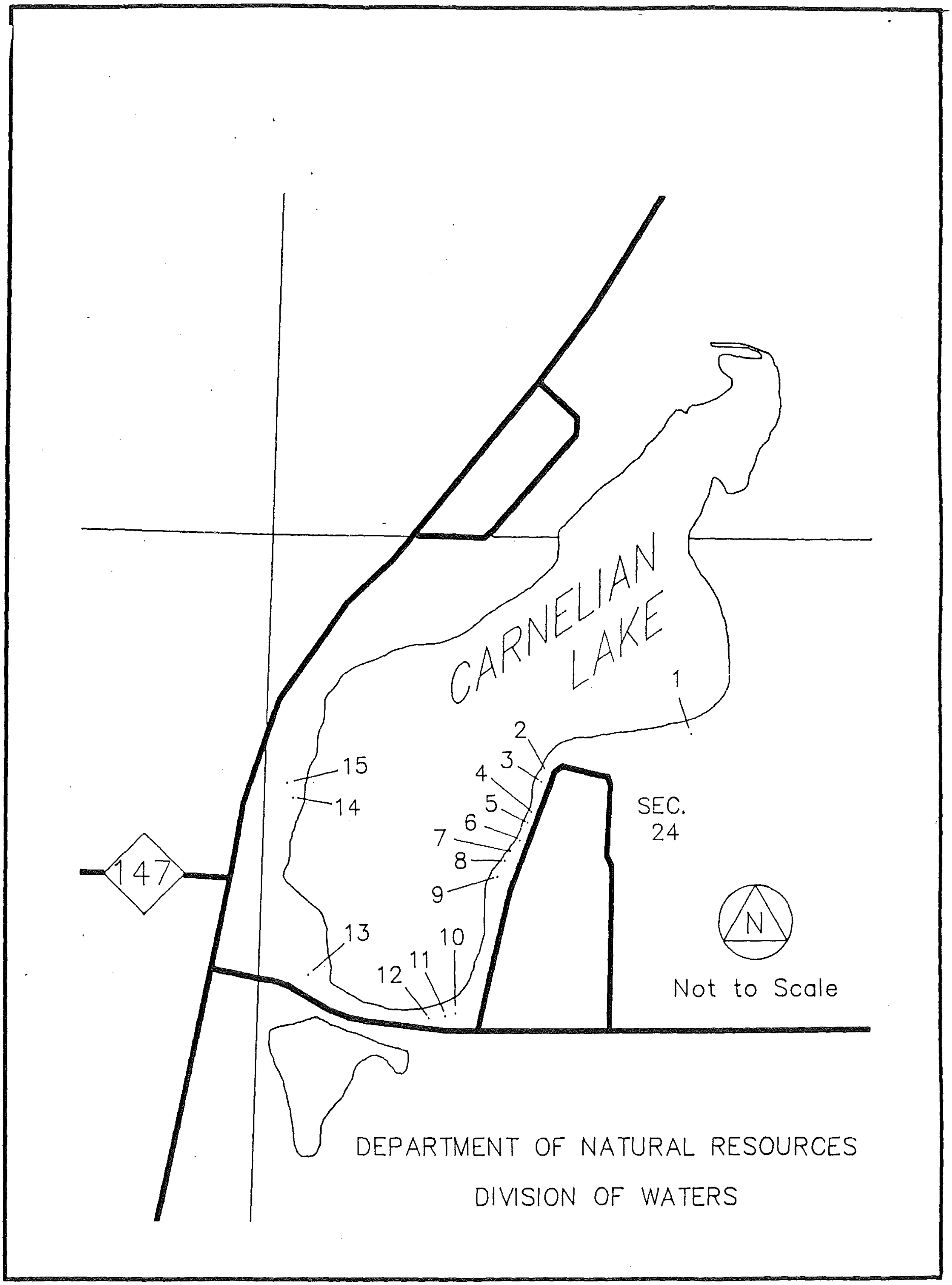
Assessed Market Value
Building Value : $25,300.00
Land : $15,200.00

Total Value : $40,500.00

Flood Insurance : Yes: Structure = $25,300.00
Contents = $10,000.00

STRUCTURE PHOTO PROVIDED

PLATE 9


CARNELIAN LAKE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
147
SEC. 24
N
Not to Scale
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS

Potential structural losses for Lake Carnelian can be viewed from two different viewpoints:

First - Once water enters a structure (e.g., in the walkout level) for an extended period of time (e.g., over a winter season), the structure has minimal or no monetary value. The rationale being the structure's habitability to the owner is seriously in question and, on the competitive real estate market, the structure would be most likely unsellable. In effect, the structure's useful and economic life has ended. The loss to the landowner would be the structure's fair market value prior to the water entering the structure. Table 2 tabulates the total assessed market values per incremental increase in water levels. The total loss for all newly damaged structures between elevations 1131.59'-1138.14' would be $223,849.

Second - The actual loss to the landowner could be viewed as the physical damage to the structure caused by the water. This assumption is premised upon the water receding at some future date and the landowner could fix the damage and re-occupy the structure. Table 2 tabulates the estimated actual damage to each structure by incremental 1' increase in lake levels. At elevation 1138.14', an estimated $168,475 of structural damage would occur. The reader is cautioned that the damage figures are taken from generalized assumptions and are applicable for basinwide planning purposes only.

The decision making process to take corrective measures can include the analysis of the degree of risk exposure, the anticipated benefits (losses prevented) and the cost of corrective measures. The data presented thus far should aid landowners and local officials in assessing the degree (probability) of risk exposure. Special reference should be given to the discussion on anticipated future lake levels on pages 18 and 19 and the site specific surveyed elevations found in Appendix D. Basinwide solutions to a given problem (e.g., a lake outlet) often-times are based upon the total dollars worth of anticipated benefits (losses prevented). Table 2 was provided to show the estimated losses which could occur should the lake continue to rise.

Again, potential loss figures provided here were from generalized assumptions and the intent was to not provide exact projected damages for individual structures. Potential damages per individual structure would have to be determined after a site-specific investigation. Pages 31-34 in Part II do provide suggested site specific protection measures and general construction guidelines which could be followed.

Note: Should Lake Carnelian continue to rise, the access road on the south end of the lake would be inundated. Appendix E provides a survey of the road's elevation.

Table 2

Potential Increases in Flood Losses
By
Incremental Increases in Water Levels

| | Structure Number as shown on Location Map | Market Value of Building[7] | First Floor Level | Walkout Level | Potential Damages/ Row Totals[4] | | Potential Damages/ Cumulative Row Totals[6] | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Market Value[7] | Actual Damages[5] | Market Value[7] | Actual Damage |
| Structures below elevation 1131.59[1] presently flooded[1] | 5 | $12,400 | 1136.50 | 1127.50 | | | | |
| | 12 | 300 | 1130.49 | N/A | | | | |
| | 11 | 300 | 1130.80 | N/A | | | | |
| Newly damaged structures between elevations 1133.60 and 1134.59[2] | 2 | 17,236 | 1140.10 | 1133.90 | | | | |
| | 14 | 25,800 | 1141.15[3] | 1134.15 | $ 60,274 | $ 12,054 | $ 60,274 | $ 12,054 |
| | 6 | 17,238 | 1141.32[3] | 1134.32 | | | | |
| Newly damaged structures between elevations 1134.60 and 1135.59 | 1 | 7,695 | 1142.41[3] | 1135.41 | | | | |
| | 9 | 32,800 | 1142.53[3] | 1135.53 | $ 40,495 | $ 42,249 | $100,769 | $ 53,303 |
| Newly damaged structures between elevations 1135.60 and 1136.59 | 4 | 19,200 | 1142.93[3] | 1135.93 | | | | |
| | 7 | 17,600 | 1143.50[3] | 1136.50 | | | | |
| | 10 | 55,000 | 1142.89[3] | 1135.89 | $ 91,800 | $ 43,732 | $192,569 | $ 97,035 |
| | 8 | | | | | | | |
| Newly damaged structures between elevations 1136.60 and 1137.59 | 3 | 5,880 | 1144.07[3] | 1137.07 | | | | |
| | 13 | 20,800 | 1144.13[3] | 1137.13 | $ 26,680 | $ 55,846 | $219,249 | $152,881 |
| Newly damaged structures between elevations 1137.60 and 1138.14 | 15 | 4,600 | 1145.14[3] | 1138.14 | $ 4,600 | $ 15,594 | $223,849 | $168,475[5] |

[1] Lake Carnelian's water surface elevation was 1131.59' on September 9, 1986, which is the date the structure elevation data were collected.

[2] No newly damaged structures between elevations 1131.60' and 1133.60'.

[3] Estimated main floor elevation by adding 7' to elevation of walkout floor elevation.

[4] Estimated damage for walkouts followed the recommendations of the National Flood Insurance Program's Loss Adjustment staff by: 1) Assuming 20-percent damages when flood water was up to 1' in depth in a structure; 2) by assuming an additional 55% damage when the flood water was greater than 1' in depth but less than the floor level of the main habitable floor; and 3) assume total damage, or an additional 25% damage, when water reaches the main habitable floor. The reader should be cautioned these figures do not include any allowance for contents damage because of the uncertainty whether contents would be removed prior to damage to the structure. If an adjustment is to be made for contents damage, the author recommends a 20% adjustment to each figure provided.

[5] This figure does not include damages should water enter the second level of a structure where the second level is above 1138.14'. When the water enters the second level above the walkout, 25% additional damages would occur. The first structure where this would occur is structure #2, at elevation 1140.2 - see column "First Floor Level".

[6] The figures provided do not include the additional costs for removal and disposal of flooded/abandoned structures, providing replacement water supply and waste treatment systems or abandonment of flooded wells according to health department standards.

[7] 1986 assessed market value supplied by County Assessor.

# PART II

## FLOOD HAZARD MITIGATION - INTRODUCTION

A broad definition of flood hazard mitigation is those actions taken by individuals and governmental bodies to prevent future flood losses. Prevention of future losses can pertain to existing structures already at risk as well as future development which, if built improperly, will be subject to flood damage. Individual strategies by the landowner should also consider properly insuring oneself against financial, catastropic loss.

Part II will emphasize those structural and nonstructural hazard mitigation actions which will prevent future losses. These actions will generally include flood insurance, local government land use regulations, lake level control structures (especially state permit requirements) and site-specific flood protection techniques (i.e., flood proofing). There will also be a discussion of: 1) potential non local cost-sharing programs to assist in constructing hazard mitigation measures; and 2) institutional frameworks for implementing these measures.

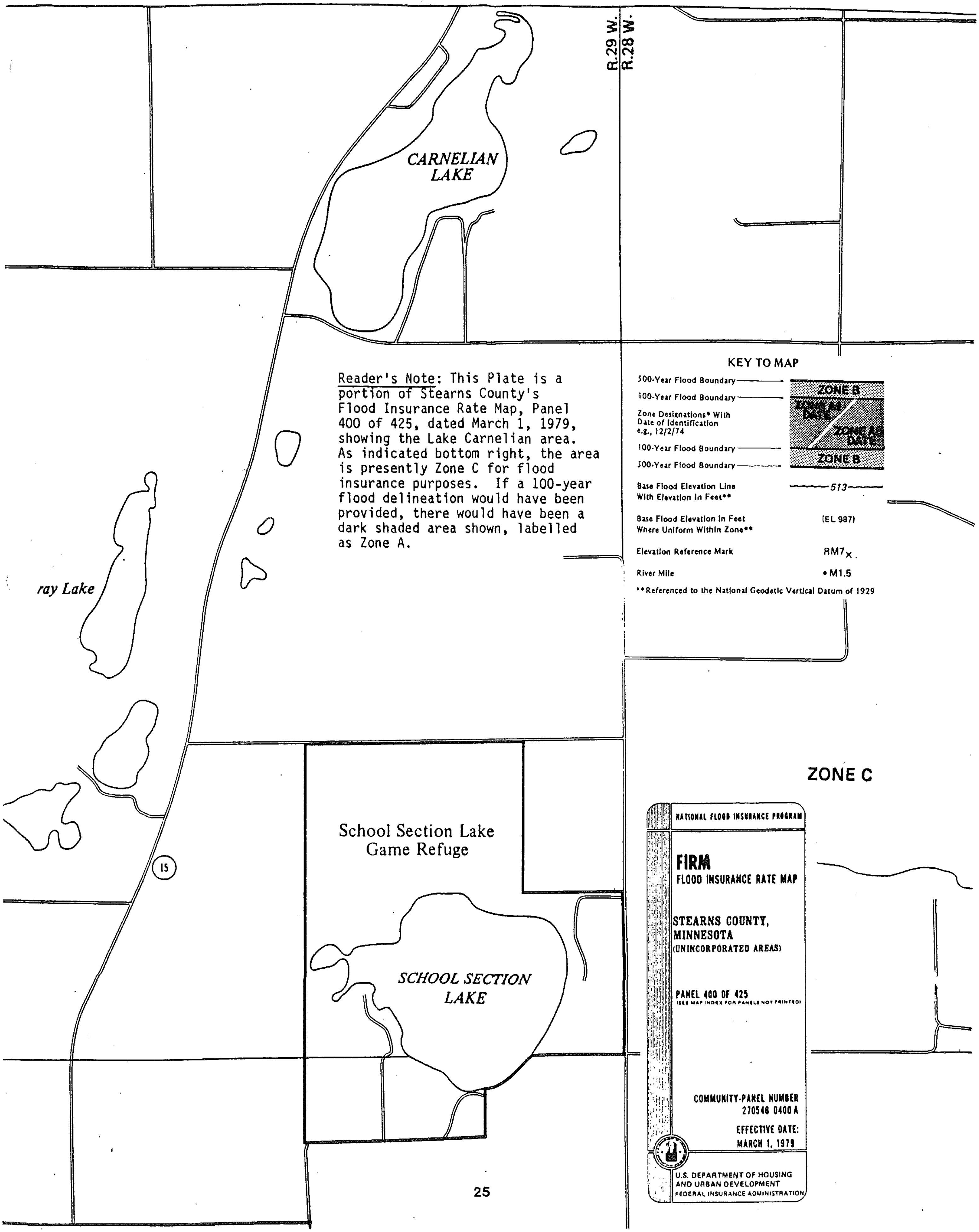
## FLOOD INSURANCE

Landowners adjacent to Carnelian Lake can purchase flood insurance through Stearns County's eligibility in the National Flood Insurance Program (NFIP). Actually, <u>all</u> property owners and renters in the unincorporated areas of in Stearns County can purchase flood insurance <u>regardless of whether or not the property is located in an identified flood hazard area</u>. This latter point must be stressed because a review of Stearns County's Flood Insurance Rate Map (Plate 10) shows a flood hazard delineation has <u>not</u> been provided for Carnelian Lake. The significance of a lack of a flood hazard delineation will be discussed in greater detail on Pages 29-31 for the discussion on local government land use regulations.

Obviously, the decision to purchase flood insurance will be based primarily on the probability that a structure and/or its contents will be flooded. The decision making process must also take into consideration the provisions of the standard flood insurance policy which identifies amongst other things:

- When losses are covered (i.e., a general condition of flooding exists);
- Items covered and not covered;
- Removal of a flood damaged structure from a site;
- a "loss in progress" (5-day waiting period); and
- special loss adjustment for continuous lake flooding.

# PLATE 10




Reader's Note: This Plate is a portion of Stearns County's Flood Insurance Rate Map, Panel 400 of 425, dated March 1, 1979, showing the Lake Carnelian area. As indicated bottom right, the area is presently Zone C for flood insurance purposes. If a 100-year flood delineation would have been provided, there would have been a dark shaded area shown, labelled as Zone A.

Table 3 identifies the amount of flood insurance coverage available via the NFIP. Stearns County has been in the Regular Program since March 1, 1979 so, for residential structures, $185,000 of coverage is available for a structure and 60,000 for contents. Questions pertaining to flood insurance premiums (i.e., costs) should be referred to the NFIP toll-free at 1-800-638-6620. It should be noted that all areas not now mapped as having a flood delination on the Flood Insurance Rate Map are considered "Zone C" for flood insurance rating purposes. Zone C has the cheapest flood insurance premium costs. The reader is also cautioned that if contents coverage is desired it must be specifically requested.

Table 3

| | Emergency Program | Regular Program | |
|---|---|---|---|
| | Total Amount Available Basic Coverage | Additional Limits | Total Coverage Available |
| Residential Buildings - Single Family | $35,000 | $150,000 | $185,000 |
| Residential Contents | 10,000 | 50,000 | 60,000 |
| Other Residential Buildings | 100,000 | 150,000 | 250,000 |
| Small Business - Buildings | 100,000 | 150,000 | 250,000 |
| Small Business - Contents | 100,000 | 200,000 | 300,000 |
| Other Nonresidential Buildings | 100,000 | 100,000 | 200,000 |
| Other Nonresidential Contents | 100,000 | 100,000 | 200,000 |

The most important factors in determining whether flood insurance will cover a loss are:

1) Is the water body experiencing a "general condition of flooding"? A general condition of flooding is defined in the standard flood insurance policy as:

-"A general and temporary condition of partial or complete inundation of normally dry land areas from:

a. The overflow of inland or tidal waters;
b. The unusual and rapid accumulation or runoff of surface waters from any source;
c. Mudslides (i.e., mudflows) which are proximately caused by flood, as defined above and are akin to a river of liquid and flowing mud on the surface or normally dry land areas, as when earth carried by a current of water and deposited along the path of the current.

-The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding the cyclical levels which result in flood, as defined above.

-Sewer (drain) backup, which is covered only if it is caused by flood, as defined above."

2) Was an insured structure and/or its contents damaged by direct surface water contact during a general condition of flooding?

Land-locked lakes with no outlets do not react to high water like streams/rivers and waterbodies with outlets. The latter, generally go up and down fairly quickly (days or weeks) and there is little question that a general and temporary condition of flooding has occurred. Lakes such as Carnelian can increase and decrease in elevation very slowly over a period of years. While the NFIP will judge each land-locked lake with a high water problem individually, a general condition of flooding has been determined to exist on Lake Carnelian.

It must be pointed out that a flood insurance policy only covers a structure and its contents. Department of Natural Resource's experience with the NFIP claims adjustment process indicates that surface water must come into direct physical contact with an insured structure during a general condition of flooding before the loss will be eligible for reimbursement. Seepage losses due to water table fluctuations during a general condition of flooding will not be reimbursed. The following is a general description of items covered and not covered (specific questions on coverage should be referred to the above-noted NFIP toll-free number):

> A building and its contents may be insured. Almost every type of walled and roofed building that is principally above ground can be insured. In most cases, this includes mobile homes, but not travel trailers or converted buses. Gas and liquid storage tanks, wharves, piers, bulkhead, crops, shrubbery, land, livestock , roads, machinery or equipment in the open and motor vehicles are among the types of property which are not insurable.

There is a 5-day waiting period for a flood insurance policy to take effect. A loss which occurs during the 5-day waiting period after a policy has been taken out is considered a "loss in progress" and will not be covered by the NFIP. This is a critical factor. The reader may wish to refer back to the Part 1, pages 18 and 19 for the discussion on anticipated water surface elevations.

The discussion on anticipated water surface elevations stresses two important facts. First, no one can predict a maximum water surface elevation for Lake Carnelian. If the lake should continue to rise, a dampening effect would occur as the lake reaches its runout elevation (at an elevation between elevation 1140-1150'). If the cause is the lake reacting only to long-term, above normal precipitation, then the assumption would be as the lake rises slowly (e.g., 1-2' per year) a landowner would have sufficient advance warning to purchase flood insurance and meet the 5-day waiting period before a loss occurs.

The second important factor to consider is that Carnelian Lake can react quickly to high intensity rainfall events (i.e., the 100-year 24 hour and 100-year, 10-day rainfall events). These high intensity rainfall events do occur randomly over time with little or no advance warning to the landowner. If these rainfall events were to occur, there would likely be insufficient time for a landowner to purchase a flood insurance policy and meet the 5-day waiting period.

The previous section on anticipated lake levels indicates that at a starting lake elevation of 1133.5' Lake Carnelian would bounce 1.5' upward during a 100-year, 24 hour rainfall event and 3.2' upward for a 100-year, 10-day rainfall event. Landowners should refer to Appendix D which provides actual lowest floor elevations for adjacent shoreland development. It is the author's recommendation that, at a minimum, any landowner with a structure within 3.5' of the lake's current water surface elevation should strongly consider purchasing flood insurance.

The NFIP has recently adopted special provisions to deal with continuous lake flooding situations. These provisions are provided below for the reader's information.

> W. Continuous Lake Flooding: Where the insured building has been flooded continuously for 90 days or more by rising lake waters and it appears that a continuation of this flooding will result in damage reimbursable under this policy to the insured building of the building policy limits plus the deductible, the Insurer will pay the Insured the building policy limits without waiting for the further damage to occur if the Insured signs a release agreeing (i) to make no further claim under this policy, (ii) not to seek renewal of this policy, and (iii) not to apply for any flood insurance under the National Flood Insurance Act of 1968, as amended, for property at the property location of the insured building. If the policy term ends before the insured building has been flooded continuously for 90 days, the provisions of this paragraph W still apply so long as the first building damage reimbursable under this policy from the continuous flooding occurred before the end of the policy term.

It should also be noted that the DNR has had discussions with the NFIP about whether a flood insurance policy will reimburse a landowner for the cost of removing a damaged structure from a site. Under most situations the answer is yes. A determining factor is that the cost of removal, in combination with the reimbursement for all covered losses, does not exceed the limits of structural coverage. If a landowner is considering purchasing flood insurance, the issue of maintaining additional coverage for removal of a damaged structure should be kept in mind.

A discussion on basement coverage will be provided here because of the number of structures with "walkout" basements adjacent to Lake Carnelian. In the early 1980's, the NFIP reduced coverage to basement areas to cover primarily damage only to the structural components (e.g., foundation walls, floors, etc.) and limited contents. There would no longer be coverage for finishing materials on walls and floors and most contents. A basement was defined, though, as a space subgrade <u>on all four sides</u>. Therefore, a walkout basement is not subgrade on all four sides and does not meet the definition of a "basement". The coverage reductions do not apply to structures with walkout lower levels.

This section was intended to provide background information on the NFIP and information relevant to lake flooding situations. Specific questions should be referred to the NFIP. Flood insurance can be purchased through any licensed insurance agent or broker who can write property insurance in Minnesota. Landowners contemplating purchasing flood insurance should locate an insurance agent familiar with the NFIP.

## LOCAL GOVERNMENT
## LAND USE REGULATIONS

Proper enforcement of land use regulations for new development is the cornerstone of a hazard mitigation program. New development includes not only new construction but also modifications, additions to and repair of existing construction. Stearns County, by virtue of its eligibility in the NFIP, must properly regulate new development in flood prone areas to insure continued eligibility in the NFIP for all citizens in the unincorporated area of the County.

As noted earlier, the current Flood Insurance Rate Map for Stearns County does not show a flood delineation (i.e., Zone A) for Lake Carnelian. This means that: 1) technically, Stearns County does not now have to apply the provisions of its flood plain ordinance to new development bordering Lake Carnelian; and 2) the NFIP, while making flood insurance available to property owners, places no minimum development standards to be met by the County when regulating new development on Lake Carnelian.

The obvious question is what prudent course of action should Stearns County take when regulating new development adjacent to Carnelian Lake? Stearns County must continue to properly enforce its state-approved shoreland management regulations adopted pursuant to Minnesota Statute, Chapter 105. The basic regulatory components of the County's shoreland regulations relevant to flooding potential on a land-locked basin include:

- The County can specify a flood protection elevation. In the absence of a 100-year flood level, all new structures and additions/modifications/ substantial repairs of existing construction must be elevated with the lowest floor (including basement) to 3' above the highest known water level. On Lake Carnelian, this is elevation 1133.5' + 3' or 1136.5', NGVD-1929;

- On-site water supply and sewage treatment systems must be designed so as not to be impaired/contaminated during times of flooding. These systems, at a minimum, must be designed to elevation 1136.5'; and

- New subdivisions, prior to approval by the County, must be reviewed to insure the area is suitable for the proposed use including a consideration of the potential for flooding. Each newly created lot must have a building site and a location for on-site utilities above elevation 1136.5'.

The basic issues as to whether a flood delineation should be added to the County's Flood Insurance Rate Map (FIRM) are essentially three-fold:

1) A flood delineation would provide a notification to potential purchasers of existing property that the area is flood prone (and the potential magnitude of the flooding) and that the purchase of flood insurance may be advisable;

2) Flood insurance in a mapped Zone A (approximate 100-year flood plain) would be mandatory for all federally insured, financed or regulated mortgages, grants, etc., thus protecting the investment of the public at large. Otherwise, a landowner may default on a mortgage if a non insured loss were to occur; and

3) Would the delineation of an approximate Zone A on the FIRM better facilitate the future regulation of new development adjacent to Lake Carnelian?

The latter of the above-noted three issues will be discussed first. It is the Department of Natural Resources' opinion that the County's current shoreland zoning and subdivision regulations will adequately regulate new development on Lake Carnelian with the adoption of two additional provisions: 1) an elevated road access requirement; and 2) a flood protection elevation above 1136.5' which provides additional freeboard or safety factor. These issues will be discussed below.

The rationale for using 1136.5' is that in the absence of any studies of projected high water levels, 3' above the highest known water level is reasonable for most basins (but not necessarily land-locked basins). Aside from the flood plain mapping/ordinance issue, the County must assess whether using elevation 1136.5' under its current shoreland regulations is a proper long-term strategy for regulating new development.

The County must look to the long-term because the economic life of new residential construction can be on the order of 60-80 years. With the documented cyclical nature of water levels and precipitation in this area, what might the maximum water level be in the next 60-80 year period? The answer to this question is unknown. What is known is that if new development is built to elevation 1136.5', and this level is exceeded during the life of the development, the ramifications will be severe. Considering the above, a proper course of action for the County would be to provide additional freeboard (or safety factor) above elevation 1136.5'.

It is the Department's recommendation that the County use a minimum elevation of 1140.8' for regulating new development adjacent to Carnelian Lake. The previous section on anticipated water levels indicates that there is a one-percent probability that Lake Carnelian could be at elevation 1137.8' on December 31, 1991. Elevation 1137.8' exceeds both the 24 hour and 10-day, 100-year rainfall events based on a starting water surface elevation of 1133.50'. Elevation 1137.8', plus 3' of safety factor or freeboard, would give a flood protection elevation of 1140.80'. While it is conceivable that Lake Carnelian could exceed elevation 1140.80', this elevation does provide 4.3' of justifiable safety factor above elevation 1136.5'.

Adding a flood delineation on the County's FIRM would primarily act as a consumer awareness device for potential purchases of property and would also better protect the investment of federal dollars in mortgages, subsidized flood insurance, etc. The County has the authority to properly regulate new development with its current shoreland regulations, in the absence of a flood delineation and the jurisdiction of its flood plain ordinance. Adding a flood delineation on the FIRM would have to be premised on the selection of a flood elevation which best serves the public's interest. The decision will be left to the Federal Emergency Management Agency, with local input.

The author makes the following recommendations:

1) At a minimum, the County must use elevation 1136.5' as a flood protection elevation when regulating new developments/subdivisions within the shoreland district of Lake Carnelian. The County should add a provision to its shoreland ordinance requiring elevated road access to all new development/subdivisions at an elevation no lower than elevation 1136.5';

2) The County should strongly consider adopting a flood protection elevation of a minimum of 1140.8' into its shoreland regulations (instead of 1136.5') for regulating new development/subdivisions in the shoreland district of Carnelian Lake; and

3) The County should determine the actual runout elevation of Carnelian Lake. Adjustments to the above-noted level of protection should be considered if the runout exceeds elevation 1140.8'.

## PROTECTING NEW/EXISTING STRUCTURES

As mentioned in the previous section on local land use regulations, new construction and additions, modifications to and repair of existing structures must be protected against potential flood damage. The minimum protection level pursuant to local shoreland regulations is 1136.5'. The Department of Natural Resources strongly encourages a local flood protection level for Lake Carnelian of 1140.8' or 1141 (rounded).

The most prudent method of protecting new and existing development in a potentially long duration flooding event is to elevate the building site on properly compacted fill. The lowest floor (including crawl spaces, basements, and other enclosed areas), must not extend below the identified flood protection level, even if continuous fill is placed around the structure to the identified flood protection level. Standard flood proofing techniques for enclosed spaces below the flood protection level generally are not recommended in flood plains for land-locked basins. This is due to the long duration of flooding and associated saturated soil conditions. Although flood proofing of spaces is generally not recommended when flooding is long-duration, more detailed information is available in the report "Flood Proofing Regulations" which has been adopted into the State Building Code.

Taking emergency action to protect existing development presents a particular problem to the landowner and the community. Because these activities require structural modifications to structures, grading/filling, alteration to shoreline vegetation, etc., a development permit will be required from the local unit of government. The County would review the proposal so as to insure neighboring properties are not affected and the lake resource protection standards are met (e.g., setbacks, flood protection, vegetation removal, etc.)

Plates 11 and 12 provide a number of potential emergency protection measures. The decision to employ any given measure will depend on the site-specific flooding situation. These emergency protection measures are presented here so as to inform the reader of the general design factors which must be considered. The reader is cautioned that an engineer or architect and the local building code official should be consulted prior to the design of emergency flood protection measures.

Except for the following two situations, a landowner may choose the protection level for <u>emergency protection measures</u>.

1) A structure has been damaged to 50-percent of its market value at the time of loss and the landowner wishes to repair the damage; or

2) The emergency protection measures would equal or exceed 50-percent of the structures market value.

For the two above situations, the structure, at a minimum, must be protected to elevation 1136.5 (or to a higher elevation if the County wishes to adopt one).

The reader is requested to pay special attention to the discussion of levees and filling around structures on Plates 11 and 12 on the following pages. Levees are temporary measures and should not be considered as a permanent solution. In no case should a structure protected by a levee be used for human occupancy. This is especially true when the top of the levee is higher than 1-2' above the lowest floor level. A sudden collapse of the levee or overtopping can cause structural failure to the supporting walls, inundating the building with little warning and causing serious damage. All damageable items should be removed from potentially damaged areas and provisions should be made to allow water to enter the building (to equalize water pressure inside and out) should the levee fail.

Secondly, fill could be placed around an existing building to keep surface water away. It is likely that the fill material adjacent to the building will become saturated because of the potentially long duration of the high water and the porosity of the soil. Water pressure will likely build on the outside walls at an elevation equal to the lake level. Any attempt to keep the area inside the building dry by pumping will create differential pressures inside and outside of the building's walls. This could lead to wall and floor collapse and, in no case, should the building be used for human occupancy. A design professional should be consulted prior to pumping the inside of a structure to determine if the structure can tolerate differential pressures against its walls and floors. A safer alternative may be to fill the inside area of the building with granular material (a permanent loss of a lower level) or to allow water to enter into and equalize inside the lower level.

# TE 11

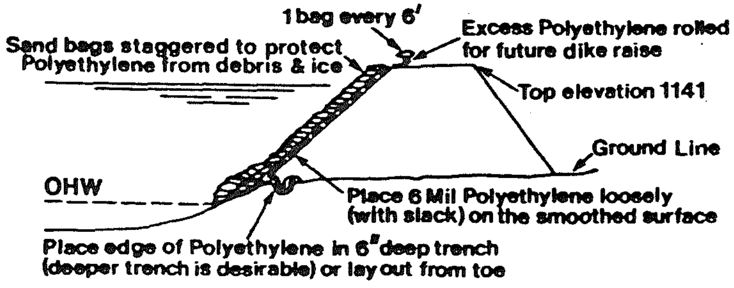
# FLOOD PROTECTION MEASURES

The following information is being presented to stress the importance of following prudent design and permit review procedures prior to installing emergency or permanent protection measures. Design guidelines assisted by a qualified professional are not only cost effective (e.g., the measure will work as designed and will not be over or under-designed), but protect the investment of the landowner. Community permit review will insure consistency with local land use controls which were designed to avoid haphazard, unregulated shoreline encroachment that will have adverse impacts on adjoining landowners, long term property values and the lake resource.

## TYPE OF PROTECTION

## GENERAL DESIGN CONSIDERATIONS

### EARTHEN LEVEE



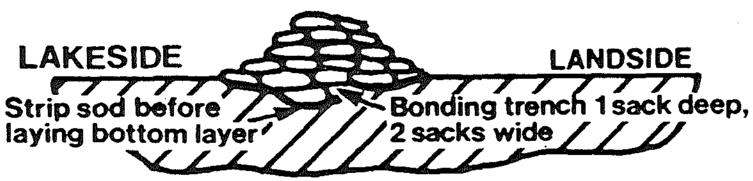

SECTION

These criteria are guidelines for construction of temporary levees. The criteria are not for permanent protection and not intended for long term exposure to high water.

- Site Preparation: Remove topsoil and vegetation on the foundation of the levee. This material can be stockpiled and used for cover of the levee.
- Construction Materials and Placement: The preferred material is clay as it is relatively impervious if compacted properly. The material should be placed in layers not exceeding 9 inches and compacted with four to six passes of a roller. Impervious material such as sand or sandy-clay can be used. This material requires a flatter side slope than clay. Place material in layers not more than 12 inches, and compact with not less than two passes of a roller.
- Side Slope (minimum):
  Clay - 1 vertical on 2½ horizontal
  Sand - 1 vertical on 3 horizontal (lakeward)
  1 vertical on 5 horizontal (landward)
- Top Width: Clay - 8 feet
  Sand - 10 feet
- Interior Drainage: Pumping will always be required for removal of seepage and rainfall behind the levee. The amount of pumping depends on the foundation soils, the levee material and the drainage area behind the levee.
- Slope Protection: Protection is needed on the lakeward side of the levee to prevent erosion from wave action. The preferred protection is a layer of rock riprap 12 inches in diameter with a filter underneath (filter cloth, poly sheeting). Protection of the toe of the levee and foundation is critical for areas of high wave action. A second method of protection is reinforced polyethylene sheeting weighted with sandbags.
- Placement in Water: Construction of earthen levees in water is not recommended. A temporary sandbag levee can be constructed and the area behind pumped. Then the earthen levee can be constructed behind the sandbag levee.

*Each project should be analyzed and designed by an engineer competent in earthen structure construction.

### SANDBAGGING

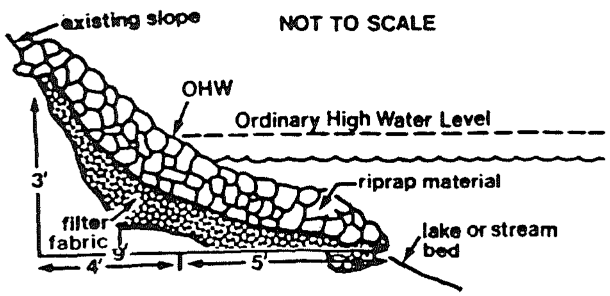



SECTION

A sandbag levee provides temporary protection from short term rises in lake elevations.

- Site Preparation: Remove topsoil and vegetation. Dig a bonding trench to key in the levee to the foundation.
- Construction Materials and Placement: Sand or predominantly sandy or gravelly material should be used. Woven plastic sandbags are preferred if the levee is long term, as burlap bags will deteriorate over time. Bags should be filled ½ full, lapped when placed, and tamped tightly in place. The bags should be staggered when placing to prevent gaps through the levee.
- Cross Section: The base width should be 3 times the height, as a minimum. The top width should be sufficient to add additional bags to raise the levee if needed. A maximum height of 3 feet is recommended.
- Seepage Barrier: Polyethelyne sheeting may be incorporated into the lakeward face of the levee to reduce seepage. Placement is similar to placement on an earthen levee.
- Interior Drainage: Pumping will be required for removal of seepage and rainfall behind the levee. Sandbag levees will seep more than earthen levees, as the material is pervious and the cross section is not as wide.
- Placement in Water: If the levee is placed in the water, it is important to monitor the levee for settlement, erosion under the levee and excessive seepage.

### RIPRAP: NATURAL SHORELINE OR FILL EMBANKMENT PROTECTION



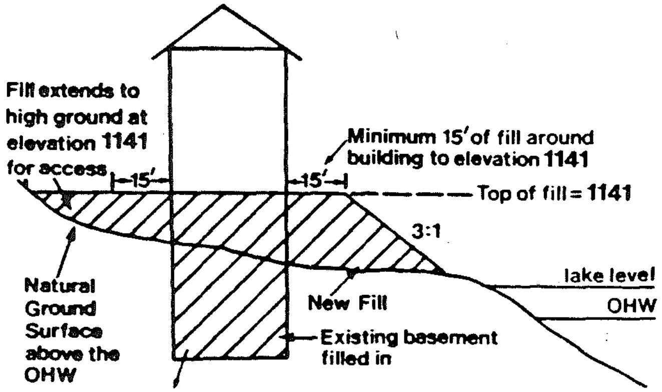

- Natural rock riprap 12" in diameter or larger
- Finished side slope no steeper than 3:1 (3' horizontal to 1' vertical)
- A transitional layer of filter fabric is required to be placed between the slope or embankment material and the riprap.

# PLATE 12

# FLOOD PROTECTION MEASURES

## TYPE OF PROTECTION

### ELEVATED STRUCTURE (PERMANENT)

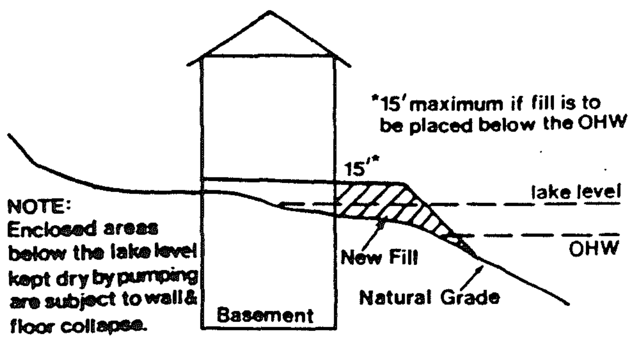



NOTE: Enclosed areas below the lake level intentionally kept dry by pumping are subject to wall and floor collapse.

## GENERAL DESIGN CONSIDERATIONS

- Stabilized fill elevation underneath and 15' around the structure is at elevation **1141** at a minimum.
- Fill selection and placement shall recognize the effects of saturation from flood waters on slope stability, uniform and differential settlement and scour/wave action.
- Fill material would be preferably granular and free-graining, placed in compacted layers.
- The minimum distance from any point of the building perimeter to the top of the edge of the fill slope shall be 15'.
- Side slope sections of fill areas should be anticipated to experience wave action and must be properly riprapped or otherwise protected.
- The area to be filled shall be properly cleared of trees, brush, debris or other growth which the building officials considers unstable as a foundation material.

### PERMANENT FILLING AROUND STRUCTURE




- The top of fill elevation should be elevation **1141**
- The side slope of the fill area shall be properly protected by a method of protection as outlined above.
- Pumping lower level enclosed areas may result in hydrostatic pressure levels being higher on the outside of the walls as compared to the inside of the walls. This pressure differential can cause walls to collapse or floors to buckle.

## RESOURCE MANAGEMENT - THE DIRECT ROLE OF THE STATE

The preceeding sections in Part II indicate that the federal government plays the primary role in providing flood insurance and local government is actively involved in regulating development adjacent to Lake Carnelian. The State, pursuant to Minnesota Statutes Chapter 105, regulates directly those actions affecting the course, current or cross section (i.e., the bed) of public waters and protected wetlands, as defined in Minnesota Statutes Section 105.37, Subd. 14. Lake Carnelian has been identified as a public water (Basin 38P) in the Protected Waters Inventory for Stearns County and, thus, falls under the jurisdiction of Minnesota Statutes Section 105.42.

A common response to rising lake levels is to: 1) artificially control the lake's level by constructing an outlet or pumping; 2) protecting existing structures by constructing temporary levees, placing fill around structures or elevating structures on-site with fill; and 3) constructing shoreline erosion protection measures. Pursuant to Minnesota Statutes Section 105.42, a state permit is required for the following specific activities below elevation 1129.3', the Ordinary High Water Elevation (OHW) for Carnelian Lake (this is not an all inclusive list of state permit requirements):

- Any action which would attempt to control the lake to prevent it from returning to its OHW;
- Any fill or obstruction placed below the OHW to protect a structure; or
- Placement of any shoreline protection measure which does not meet the following criteria:

  Riprap shall be natural rock 12" in diameter or larger;

  The finished side slope shall be no steeper than 3:1 (3' horizontal to 1' vertical);

  A transitional zone or layer of gravel, small stone or fabric is placed between the slope or embankment material and the riprap; and

  The shore protection measure does not extend more than 5' horizontally lakeward of the OHW.

Lake Carnelian was 4.2' above its OHW elevation in December of 1986. Therefore, it is unlikely that short-term protection measures will require a state permit (i.e., a DNR permit). A DNR permit would be required: 1) to lower the lake below 1129.3'; or 2) to control the lake at an elevation above 1129.3', when:

1) Water is pumped in excess of 10,000 gallons a day or 1,000,000 gallons a year; or
2) The OHW of another public water or protected wetland is affected.

State Rules for managing public waters and protected wetlands do allow for controlling a land-locked waterbody up to 1.5' below its OHW when its in the public's interest to do so. State Rules balance the public's interest in protecting a public resource in a natural condition versus a landowner's (or group of landowners) right to alter a statewide resource to protect existing development. This balancing of interests is paramount for <u>any activity</u> which changes the course, current or cross section of protected wetlands and public waters.

The following statements are excerpts from DNR Rules which address the above-noted "balancing of interests" concept:

<u>Goals, Objectives and Standards</u>

-Maintain natural flow and natural water level conditions to the maximum extent feasible;

-Encourage the construction of small upstream retarding structures for the conservation of waters in natural waterbasins and watercourses consistent with any overall plans for the affected water;

-Limit the artificial manipulation of water levels except where the balance of affected public interest clearly warrants the establishment of appropriate controls and it is not proposed solely to satisfy private interests;

-The project will involve a minimum of encroachment, change or damage to the environment including but not limited to fish and wildlife habitat, navigation, water supply, storm water retention and agricultural uses;

-Adverse effects on the physical and biological character of the waters shall be subject to feasible and practical measures to mitigate the effects;

-Where no natural or artificial outlet exists and the lake for all practical purposes "landlocked", the control elevation shall not be more than 1½ feet below the ordinary high water mark; and

-Justification has been made of the need in terms of public and private interests and the available alternatives, including the impact on receiving waters and public uses thereof, through a detailed hydrologic study.

Those considering any action which would alter the course, current or cross-section of Lake Carnelian should contact the DNR area hydrologist in St. Cloud at: DNR-Division of Waters, 3725 12th Street North, P.O. Box 370, St. Cloud, MN 56302, Phone: (612) 255-4278.

## IMPLEMENTING MITIGATION MEASURES/INTRODUCTION

This report up until now has attempted to provide landowners and local government officials with the resource management information necessary to judge which mitigation strategies would be most successful on Lake Carnelian. The Department's experience in similar flooding situations indicates that implementation of mitigation strategies is most successful when a local unit of government (i.e., below the level of state and federal government) takes the lead role. The remainder of this report will emphasize: 1) those non-local funding programs which may be available to assist local interests; and 2) institutional arrangements (both governmental and quasi-governmental) which are available to secure funding or direct mitigation strategies.

## COST-SHARING ASSISTANCE

This section will give an overview of the non local funding sources that the Department of Natural Resources is aware have been used to alleviate flooding problems in Minnesota. Some of these funding sources have been used more successfully than others, while potential funding sources (i.e. programs) are still under consideration at the state and federal level.

### U.S. Army Corps of Engineers/Flood Control Assistance

The U.S. Army Corps of Engineers has two primary authorities for providing technical and financial assistance for constructing local flood control measures. Flood control measures can consist of "structural" measures, such as levees, dams, lake outlet structures, pumping stations, etc., and "non-structural" measures, such as flood proofing structures, acquisition/relocation of structures, etc. The two primary federal funding authorities are:

1) Small Projects - Continuing Authorities Program. This is an ongoing program established by Congress to provide a more timely response to local flood control, erosion and navigational problems. Funding decisions are made directly by the Corps of Engineers through established review procedures without direct congressional approval on a project-by-project basis. By virtue of the small projects connotation, federal financial assistance is limited to $5,000,000 or less for each project; and

2) Congressionally Authorized Projects. The federal government, via the Corps of Engineers, can participate in "large" flood control projects where the federal cost would exceed $5,000,000. The study and funding mechanism is time consuming and requires direct congressional approval at each stage of each project.

The Small Projects, Continuing Authorities Program has been successful in assisting many Minnesota communities. Two recent successful projects are the Lake Pulaski outlet and the City of Halstad ring levees. At the request of Maine Prairie Township, the Corps of Engineers has conducted a small projects initial appraisal investigation for flood control on Carnelian Lake. This cursory analysis of the flood problem found that potential damages warrant further analysis by the federal government. In March of 1987 the Corps of Engineers received funding to perform a more in-depth evaluation of the flooding problem, potential solutions and the cost and benefits of alternate approaches to reduce potential damages. The Corps of Engineers has estimated this further evaluation will be completed in late 1987 or early 1988.

It must also be noted that this federal assistance will be premised upon an acceptable local sponsor and non-federal cost-sharing. Generally, the local sponsor must provide the lands, easements and rights-of-way necessary to construct the project or approximately 35% of total project, whichever is greater. A political entity must sponsor the project and eventually enter into contractual agreements to insure all guarantees and cost-sharing commitments are met (the reader should refer to the next section on institutional arrangements).

If local interests should desire Corps of Engineers' flood control assistance, a written request should be submitted to: Flood Plain Management and Small Projects, Planning Division, St. Paul District Corps of Engineers, St. Paul, Minnesota 55101-1479. The Corps of Engineers will conduct an initial appraisal and assess federal interest and potential economic feasibility.

## SMALL CITIES DEVELOPMENT PROGRAM

The Small Cities Development Program (SCDP) is the state-administered portion of the U.S. Department of Housing and Urban Development Community Block Grant Program. The SCDP is a competitive program for smaller general purpose local units of government to provide a suitable living environment and expanding economic opportunities, primarily for persons of low to moderate income. It must be stressed that the program is competitive and that application requests have traditionally exceeded the grant monies available.

This program is designed to address a broad range of community development needs, including: 1) housing grants to rehabilitate local housing stock; 2) public facilities grants; and 3) comprehensive grants, comprising a combination of housing and public facilities grants or other economic development components. Smaller general purpose local units of government, defined as cities and towns with populations under 50,000 and counties with populations under 200,000 can apply for SCDP grant funds.

The SCDP has been used successfully by a number of Minnesota communities to alleviate flooding problems. Examples include:

- St. Vincent Township, Kittson County: purchase of the right-of-way to construct permanent flood control levees, designed and cost-shared by the Corps of Engineers;

- City of Argyle: acquisition and relocation/demolition of flood prone structures, as part of an overall Corp of Engineers' permanent levee project. Approximately one-dozen structures will be acquired and relocated from the flood plain, as they could not be included within a levee system which will protect the City; and

- City of Austin: acquisition and relocation/demolition of approximately 75 frequently flooded structures.

It should be noted that use of the SCDP appears most probable (i.e., the application becomes more competitive) as the amount of non SCDP matching funds increases. Therefore, it is in the local sponsor's best interest to attempt to package a number of assistance programs if possible. This not only reduces the cost to the sponsoring local government/individual landowners but oftentimes one grant program can be used as offsetting matching funds for another grant program.

The SCDP is administered by the state's Department of Energy and Economic Development. An annual application cycle has been established. Currently, applications are due by the end of January. Potential applicants should contact the Department of Energy and Economic Development immediately so they can be notified of the deadline for submitting future applications. To qualify for funding, an applicant must meet one of the three following federal objectives:

-Benefit low and moderate income people;

-Eliminate slum or blight; or

-Eliminate threats to public health and safety.

Inquiries should be addressed to:

Department of Energy and Economic Development
Division of Community Development
9th Floor, American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101
Phone: (612) 296-5005

State Assistance Programs

Presently, there are no ongoing state financial assistance programs designed to alleviate flooding problems. The state has acted with emergency funds in the past when cost-sharing projects to respond to high water problems. A recent example is the $250,000 made available in 1986 by the Governor through the Legislative Advisory Committee. These funds were made available on a competitive basis to respond to ongoing high water problems. As expected, the requests for assistance outweighed the funds available (on the order of 2:1, for projects totalling $2.3 million).

The Department of Natural Resources is sponsoring a cost-share flood loss reduction program. As proposed, the state could cost-share up to a 50/50 match with a local government sponsor to implement mitigation measures. The primary benefit is that increased state funding levels would be available for advance mitigation measures on a priority basis. The present draft of this proposed legislation places a high priority on alleviating lake flooding problems. If approved, the DNR will provide the County and lake association with information regarding eligibility. Technical assistance will be available to assist in formulating and evaluating damage reduction strategies.

The Standard Flood Insurance Policy

The State of Minnesota has encouraged the National Flood Insurance Program, primarily through the standard flood insurance policy, to fund advance hazard mitigation measures. The thought being that the NFIP will pay for insured losses as structures adjacent to land-locked basins are flooded (many of which sustain severe damage or near total loss). It is reasoned that, with the generally gradual rise of flood waters on land-locked basins and the likelihood the water will continue to rise, it would be prudent and cost-effective to either relocate a potentially damaged structure from the site or elevate it in place. As the NFIP would be a primary beneficiary of these actions (i.e., reduced insurance payments), the state suggested the NFIP should consider bearing part of the cost for advance mitigation measures.

Unfortunately, the federal legislation for the National Flood Insurance Program prevents federal participation in these advance mitigation measures. This may be short-sighted, but the NFIP by legislation is presently put in a reactionary mode of only being able to pay for eligible, insured losses as they occur. The only ongoing hazard mitigation program currently administered by the Federal Emergency Management Agency is Section 1362 of the Flood Disaster Protection Act of 1973.

The Section 1362 Program, which is strictly a voluntary program, is reactionary in nature because damages must have already occurred prior to the submittal of an application to FEMA. This competitive, nationwide program is designed to acquire and relocate/demolish frequently flooded or severely damaged structures and to return the flood plain to an "open space" nature.

The program is of limited application to lake flooding situations and is to complex to discuss in any great detail in this report. It must be stressed though that only those structures covered with a flood insurance policy at the time of loss are eligible for the program. As mentioned, the program is competitive nationwide where application requests have far outweighed the funds appropriated by Congress. Similar to the Small Cities Development Program discussed earlier, applications become more competitive as a package of non Section 1362 Program, matching funds are proposed in the application.

Further information on the FEMA's Section 1362 Program can be secured from:

Federal Emergency Management Agency
300 South Wacker Drive, 24th Floor
Chicago, Illinois 60606
ATTN: Flood Hazard Mitigation Officer

## IMPLEMENTATION AUTHORITIES

The immediately preceeding section dealt with non local funding sources for cost-sharing hazard mitigation measures. A focal point of this discussion was that a local sponsoring authority is necessary to enter into formal (contractual) arrangements with potential funding agencies. Generally, aside from the actions of individual landowners, basinwide mitigation strategies require at least one political entity to take the lead role if for no other reason than to secure the necessary funding.

The authorities and obligations for implementing comprehensive or basinwide mitigation strategies (and the securing of local or matching funds) does not lie solely with municipalities or counties, as the case may be for incorporated and unincorporated areas, respectively. State legislation has provided for establishing special purpose quasi-governmental districts or special taxing authorities which may be used for implementing mitigation strategies.

Experience has shown that city and county governments have been willing to take varying degrees of active participation in solving local high water problems. Therefore, the remainder of this section will discuss how existing local authorities, special districts and special taxing authorities can be used for implementing hazard mitigation measures.

### Local Government Capabilities

Municipal and county government can: 1) appropriate general funds for hazard mitigation measures; and 2) act as a local sponsoring agency. It is totally at the discretion of the respective governmental body to determine their degree of participation. This is a local matter. The Department's experience has shown that some governmental bodies have been hesitant to appropriate community-wide funds to benefit a select group of landowners (e.g., landowners in flood prone areas).

To bypass the issues of uniform local tax rates and providing community-wide funds for a select category of landowners, most counties, including Stearns County, can establish "subordinate service districts" pursuant to Minnesota Statutes Chapter 375. Subordinate service districts, once established, allow a county to provide additional governmental services only within that service district. Importantly, the revenues to fund these additional government services come only from within the subordinate service district.

Subordinate service districts are initiated either by a resolution of the county board or by petition to the county board signed by ten percent of the qualified voters within the portion of the county proposed for the subordinate service district. The reader should refer to Minnesota Statute, Chapter 375 for a more detailed explanation of subordinate service districts.

### Lake Improvement Districts

Pursuant to Minnesota Statutes Chapter 378, a lake improvement district (LID) is a local unit of government established by resolution of the county board. A LID provides the opportunity for greater landowner involvement in lake management activities by actions initiated at the local level of government.

As with the following discussion on the establishment of watershed districts, there is no upper or lower size limit for the area which may be included in a LID. Establishing a LID versus a watershed district is a matter of weighing the pro's and con's of each approach. Each lake improvement district may be delegated different levels of authority by the county board depending upon existing problems and proposed activities. It does allow those [landowners] closest to the situation to directly seek solutions to their problem. A county board may grant powers to LID to, amongst other things:

- -Acquire, construct and operate a dam or other lake control structure;
- -Undertake research projects;
- -Conduct programs of water improvement and conservation;
- -Construct and maintain water and sewer systems;
- -Serve as local sponsors for state and federal projects or grants; and
- -Provide and finance governmental services.

To finance LID projects, services and general administration, a county may:

- -Assess costs to benefitted properties;
- -Impose service charges;
- -Issue general obligation bonds;
- -Levy an ad valorem tax solely on property within the LID boundaries; or
- -Any combination of the above.

The minimum guidelines and requirements for the formation of a LID are contained in (Minnesota Rules Part 6115.0920 - 6115.0980). These rules provide specific guidance on the content and issues to be addressed by the petition or county board resolution.

Specific questions pertaining to lake improvement districts can be directed to:

Minnesota Department of Natural Resources
Division of Waters
500 Lafayette Road, Box 32
St. Paul, MN 55155-4032
Phone: (612) 296-4800

Watershed Districts

Watershed districts are independent units of government established pursuant to Minnesota Statutes Chapter 112. Watershed districts are initiated following a formal petition to the state's Water Resources Board. Once established, watershed districts can have broad powers including (but not limited to):

- -Control or alleviation of damage by flood waters;

- -Imposition of preventative or remedial measures for the control or alleviation of land and soil erosion and siltation of watercourses of bodies of water affected thereby; and

- -Regulating improvements by riparian landowners of the beds, banks and shores of lakes, streams, and marshes by permit or otherwise in order to preserve the same for beneficial use.

Watershed districts are suited to resolving multiple water resource issues over a large area. As noted earlier, there is no upper or lower limit on the geographic area which may be included in a watershed district. Establishment of a watershed district requires development of an overall plan, adoption of formalized rules for operation of business and preparation of yearly reports.

Questions concerning watershed districts should be directed to the DNR-Division of Waters at the above-noted address and telephone number for questions on lake improvement districts.

# APPENDIX A

# SOIL TYPES AND CHARACTERISTICS

Carnelian Lake
water
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## SOIL SURVEY OF STEARNS COUNTY - CARNELIAN LAKE

| # on Map | Soil Classification | % Slope | Series |
|---|---|---|---|
| 392 | Biscay Loam | | Biscay |
| 129 | Cylinder Loam | | Cylinder |
| 5B | Dakota Loam | 2-6 | Dakota |
| 327B | Dickman Sandy Loam | 2-6 | Dickman |
| 260 | Duelm Loamy Sand | | Duelm |
| 41A | Estherville Sandy Loam | 0-2 | Estherville |
| 41B | Estherville Sandy Loam | 2-6 | Estherville |
| 41C | Estherville Sandy Loam | 6-12 | Estherville |
| 875B | Estherville Hawick Complex | 2-6 | Estherville Hawick |
| 156A | Fairhaven Loam | 0-2 | Fairhaven |
| 156B | Fairhaven Loam | 2-6 | Fairhaven |
| 611C | Hawick Loamy Sand | 6-12 | Hawick |
| 611D | Hawick Loamy Sand | 12-40 | Hawick |
| 1055 | Histosols and Haplaquolls, Ponded | | Histosols and Hapalaquolls, Ponded |
| 7B | Hubbard Loamy Sand | 2-6 | Hubbard |
| 7C | Hubbard Loamy Sand | 6-12 | Hubbard |
| 261 | Isan Loamy Sand | | Isan |
| 318 | Mayer Loam Depressional | | Mayer |

## Biscay Series

The Biscay series consists of deep, poorly drained soils on outwash plains and stream terraces. Permeability is moderate in the upper part and rapid in the lower part. The soils formed in loamy material overlying calcareous sandy outwash. Slopes range from 0 to 2 percent.

Biscay soils are similar to Mayer and Regal soils and are adjacent on the landscape to Estherville, Mayer, and Osakis soils. Mayer soils have free carbonates in the upper part and are in positions on the landscape similar to those of Biscay soils. Regal soils have an upper loamy mantle that is less than 20 inches thick. Osakis and Estherville soils are in higher positions on the landscape.

## Cylinder Series

The Cylinder series consists of deep, somewhat poorly drained soils. Permeability is moderate in the upper part and very rapid in the underlying material. The soils are on outwash plains and on stream terraces. They formed in glacial outwash consisting of a loamy mantle underlain by sandy material. Slopes range from 0 to 2 percent.

Cylinder soils commonly are adjacent to Biscay, Dakota, Estherville, and Fairhaven soils. Biscay soils are lower on the landscape than Cylinder soils, and Dakota, Fairhaven, Estherville soils are higher.

## Dakota Series

The Dakota series consists of deep, well drained soils. Permeability is moderate in the upper part and rapid in the lower part. The soils are on outwash plains, stream terraces, and valley trains. They formed in glacial outwash consisting of a loamy mantle over sandy material. Slopes range from 0 to 6 percent.

Dakota soils are similar to Ridgeport soils and commonly are adjacent on the landscape to Biscay, Cylinder, Estherville, and Fairhaven soils. Ridgeport soils formed in sandier material and do not have an argillic horizon. Biscay and Cylinder soils are in lower positions on the landscape. Estherville and Fairhaven soils are in positions similar to those of Dakota soils.

## Dickman Series

The Dickman series consists of deep, well drained soils. The soils have moderately rapid permeability in the upper part and rapid permeability in the underlying material. They are on outwash plains and stream terraces. They formed in loamy material 12 to 20 inches thick and in the underlying sandy outwash. Slopes range from 0 to 6 percent.

Dickman soils are similar to Estherville soils and commonly are adjacent on the landscape to Dickinson, Duelm, and Hubbard soils. Dickinson soils have a loamy mantle more than 20 inches thick. They and Dickman soils are in similar positions. Estherville soils have free carbonates at a depth of 15 to 24 inches. Hubbard soils have coarser textures below a depth of 10 inches than Dickman soils, and they are in similar positions. Duelm soils are downslopes.

Typical pedon of Dickman sandy loam, 0 to 2 percent slopes, 2,260 feet south and 2,100 feet west of the northeast corner of sec. 32, T 127 N, R 34 W.

## Duelm Series

The Duelm series consists of somewhat poorly drained and moderately well drained, rapidly permeable soils on outwash plains. The soils formed in sandy outwash. Slopes range from 0 to 2 percent.

Duelm soils are similar to Osakis soils and commonly are adjacent on the landscape to Hubbard and Isan soils. Unlike Duelm soils, Osakis soils have free carbonates in the C horizon. Hubbard soils are upslope, and Isan soils are downslope from Duelm soils.

Typical pedon of Duelm loamy sand, 220 feet north and 1,610 feet east of the southwest corner of sec. 16, T 124 N, R 28 W.

## Estherville Series

The Estherville series consists of deep, somewhat excessively drained soils. Permeability is moderately rapid in the upper part and rapid in the lower part. The soils are on outwash plains and stream terraces. They formed in loamy material and in the underlying calcareous, sandy outwash. The slopes range from 0 to 25 percent.

Estherville soils are similar to Dickman and Osakis soils and commonly are adjacent on the landscape to Hawick, Osakis, and Regal soils. Unlike Estherville soils, Dickman soils do not have free carbonates to a depth of 60 inches or more. Osakis soils have mottles in the lower part of the B horizon and in the C horizon. Hawick soils and Estherville soils are in similar positions on the landscape. Regal soils are downslope.

Typical pedon of Estherville sandy loam, 2 to 6 percent slopes, 2,560 feet west and 20 feet south of the northeast corner of sec. 23, T 122 N, R 29 W.

## Estherville-Hawick Complex, 2 to 6 Percent Slopes

This map unit consists of somewhat excessively drained Estherville soil and excessively drained Hawick soil. The areas vary in shape and range from 10 to 200 acres in size.

Estherville soil makes up about 55 percent of the map unit, and Hawick soil makes up about 35 percent. The soils are gently undulating. Estherville soil is in lower lying positions on toe slopes and in swales and on longer, smooth side slopes. Hawick soil is on more sloping, convex knolls and ridges. The individual areas of the soils are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

## Fairhaven Series

The Fairhaven series consists of deep, well drained soils. Permeability is moderate in the upper part and rapid in the lower part. The soils are on outwash plains and valley trains. They formed in a loamy mantle and the underlying sandy glacial outwash. The slopes range from 0 to 6 percent.

Fairhaven soils are similar to Dakota soils and commonly are adjacent to Biscay, Cylinder, and Estherville soils. Fairhaven and Dakota soils formed in similar material, but Dakota soils have an argillic horizon. Fairhaven soils and Estherville soils are in similar positions on the landscape. Biscay and Cylinder soils are downslope.

Typical pedon of Fairhaven loam, 0 to 2 percent slopes, 360 feet east and 130 feet south of the northwest corner of sec. 7, T 122 N, R 28 W.

## Hawick Series

The Hawick series consist of deep, excessively drained, very rapidly permeable soils on outwash plains and stream terraces. The soils formed in sandy outwash. Slopes range from 2 to 40 percent.

Hawick soils are similar to and are adjacent to Estherville soils. Estherville soils have a loamy mantle 10 to 20 inches thick. They and Hawick soils are in similar positions on the landscape.

Typical pedon of Hawick loamy sand, 6 to 12 percent slopes, 350 feet north and 2,290 feet west of the southwest corner of sec. 7, T 126 N, R 32 W.

## Histosols and Haplaquolls, Ponded

This map unit consists of level, organic and mineral soils in shallow ponds, sloughs, and undrained closed depressions that are filled with water throughout most of the year. Some of the areas go dry late in summer or in years of drought, but most areas have open water during the growing season. The vegetation in the shallower parts and around the edges in an area consists of cattails, reeds, hedges, and other water-tolerant plants.

Included in this mapping are areas of sandy, loamy, organic, and calcareous mucky lake sediments. Open water normally covers the central part of a mapped area.

Most areas are left undeveloped. The areas generally are excellent habitat for wildlife. They provide nesting, mating, and escape areas for waterfowl, furbearers, and upland game.

This map unit was assigned to capability subclass VIIw.

## Hubbard Series

The Hubbard series consists of deep, excessively drained, rapidly permeable soils on outwash plains. The soils formed in thick sandy outwash. Slopes range from 0 to 12 percent.

Hubbard soils are similar to Hawick soils and commonly are adjacent on the landscape to Duelm and Isan soils. Hawick soils have carbonates within a depth of 30 inches. Duelm and Isan soils are in lower positions than Hubbard soils.

Typical pedon of Hubbard loamy sand, 0 to 2 percent slopes, 75 feet south and 2,275 feet west of the northeast corner of sec. 18, T 123 N, R 27 W.

## Isan Series

The Isan series consists of deep, poorly drained and very poorly drained, rapidly permeable soils on outwash plains and stream terraces. The soils formed in thick sandy outwash. Slopes range from 0 to 2 percent.

Isan soils are adjacent to Duelm, Hubbard, and Nymore soils. Duelm soils have redder hue and higher chroma in the upper part of the B horizon, and they are upslope from Isan soils. Hubbard and Nymore soils do not have mottles within a depth of 40 inches. They are in higher positions on the landscape.

Typical pedon of Isan loamy sand, 1,770 feet west and 1,480 feet south of the northeast corner of sec. 32, T 126 N, R 28 W.

## Mayer Series

The Mayer series consists of deep, poorly drained and very poorly drained soils. The soils have moderate permeability in the upper part and rapid permeability in the underlying material. They are on outwash plains and stream terraces. The soils formed in a loamy mantle overlying calcareous sandy outwash. Slopes range from 0 to 2 percent.

These soils are taxadjuncts to the Mayer series because they do not have strongly contrasting particle-size classes in the control section. This difference, however, does not affect the use or behavior of the soils.

Mayer soils are similar to Biscay and Regal soils and commonly are adjacent on the landscape to Biscay, Estherville, and Osakis soils. Biscay soils are not calcareous in the upper part and are in positions similar to those of Mayer soils. Regal soils have a loamy mantle that is less than 20 inches thick. Estherville and Osakis soils are in higher positions on the landscape than Mayer soils.

Typical pedon of Mayer loam, 2,180 feet west and 1,050 feet north of the southeast corner of sec. 26, T 124 N, R 35 W.

For more detailed information, see the Soil Conservation Service Soil Survey of Stearns County, Minnesota dated May, 1985.

# APPENDIX B

## BACKGROUND DATA ON WATER QUALITY, FISH AND WILDLIFE AND DEVELOPMENT HISTORY

# WATER QUALITY DATA FROM MPCA

STORET RETRIEVAL DATE 88/10/08
MINNESOTA POLLUTION CONTROL AGENCY
WATER QUALITY DATA FROM THE LAKE FILE

PGM=ALLPARM

73-0038
45 22 00.0 094 16 30.0 3
LAKE: CARNELIAN 4 MI N KIMBALL PRAR.
27145 MINNESOTA STEARNS
AREA: 66.4 HECTARE M 070317
MEAN DEPTH: - M MAX DEPTH: 9.8 M
21MINNL 810820 07010203 HQ
0000 FEET DEPTH

/TYPA/AMBNT/LAKE

INDEX
MILES

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INITIAL DATE | | | | 81/06/30 | 81/06/30 | 81/06/30 | 81/06/30 | 81/06/30 | 81/06/30 | 81/06/30 | 81/06/30 | 81/06/30 |
| INITIAL TIME | | | | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 |
| MEDIUM | | | | WATER | WATER | WATER | WATER | WATER | WATER | WATER | WATER | WATER |
| DEPTH-FT(SMK) | | | | 0 | 3 | 6 | 9 | 13 | 16 | 19 | 22 | 26 |
| 00008 | LAB | IDENT. | NUMBER | 129295 | | | | | | | | |
| 00010 | WATER | TEMP | CENT | 21.5 | 21 5 | 21.5 | 21.0 | 20.0 | 19.5 | 19.0 | 18.5 | 18.0 |
| 00011 | WATER | TEMP | FAHN | 70.7$ | 70.7$ | 70.7$ | 69.8$ | 68.0$ | 67.1$ | 66.2$ | 65.3$ | 64.4$ |
| 00029 | FIELD | IDENT | NUMBER | 101 | | | | | | | | |
| 00078 | TRANSP | SECCHI | METERS | 3.50 | | | | | | | | |
| 00080 | COLOR | PT-CO | UNITS | 10 | | | | | | | | |
| 00098 | VSAMPLOC | DEPTH | METERS | 00 | 1.00 | 2.00 | 3.00 | 4 00 | 5.00 | 6.00 | 7.00 | 8.00 |
| 00300 | DO | | MG/L | 10 0 | 10.0 | 10.0 | 10.3 | 9.6 | 9.0 | 8.4 | 7.6 | 4.6 |
| 00301 | DO | SATUR | PERCENT | 111.1$ | 111.1$ | 111.1$ | 114.4$ | 104.3$ | 95.7$ | 89.4$ | 80.0$ | 48.4$ |
| 00403 | LAB | PH | SU | 7.9 | | | | | | | | |
| 00410 | T ALK | CACO3 | MG/L | 140 | | | | | | | | |
| 00605 | ORG N | N | MG/L | .540 | | | | | | | | |
| 00610 | NH3+NH4- | N TOTAL | MG/L | .040 | | | | | | | | |
| 00612 | UN-IONZD | NH3-N | MG/L | .001$ | | | | | | | | |
| 00619 | UN-IONZD | NH3-NH3 | MG/L | 002$ | | | | | | | | |
| 00625 | TOT KJEL | N | MG/L | .580 | | | | | | | | |
| 00630 | NO2&NO3 | N-TOTAL | MG/L | .01K | | | | | | | | |
| 00665 | PHOS-TOT | | MG/L P | 021 | | | | | | | | |
| 32211 | CHLRPHYL | A UG/L | CORRECTD | 3 85 | | | | | | | | |
| 32218 | PHEOPHTN | A | UG/L | .10 | | | | | | | | |
| 81903 | SAMPLE | DEPTH | TOTAL FT | 30.0 | | | | | | | | |

# DNR FISHERIES LAKE SURVEY DATA

I. History

A. Carnelian Lake is a hardwater lake of moderate phosphorus fertility.

B. Water clarity is average or better.

C. A steady increase in residential development has occurred within the last twenty years.

D. The ecological and management classification is Centrarchid (Largemouth Bass).

E. The lake has been managed for bass and panfish, northern pike, and occasional walleye stockings.

F. Northern pike has been stocked primarily to reduce number of panfish.

G. A marsh to the south of the lake (connected to the lake sometime before 1975), is a spawning area for northern pike. This has contributed largely to the sudden increase in the northern pike population.

H. For many years a largemouth bass spawning area has periodically been posted.

II. Past and Existing Problems

A. Centrarchid species are slow growing, abundant, and the average is small.

B. Previous inadequate spawning areas hampered the northern pike population. Since then, adequate spawning habitat has greatly increased the northern pike population (actually an overabundance).

C. There is limited spawning habitat for walleyes. Natural reproduction is occurring in spite of high northern pike population.

D. The lake has a reduced forage base compared to 1975 levels.

E. With the increase in yellow perch levels, and the decrease in northern pike levels, the establishment of a fishable walleye population may be possible.

III. Lake Management and Recommendations

A. The lake should be managed for largemouth bass, northern pike and panfish, with the intent to reduce the large northern pike level to an average level.

B. Encourage the removal of roughfish by commercially licensed fisherman.

C. Continue posting the largemouth bass spawning area, with annual evaluations in order to determine the need for future posting.

D. No stocking of walleyes while northern pike is in abundance.

E. Determine the feasibility of periodic blocking of the access to the northern pike spawning area in order to control the northern pike population.

IV. Water Quality Data of 1981

Total Alkalinity: 128 ppm
pH: 8.45
Limits of Thermocline: 20 to 28 ft.
Water Color: Clear-Green
Turbidity: Secchi disc reading of 9.0 ft.

Cause of color and/or turbidity: Algae, light bloom (in 1981).

V. Conclusion

Resurvey in 1987 in order to evaluate and implement any lake management recommendations.

Source: All the above information was taken from a Fisheries Lake Survey Report from August 11 to August 14 in 1981.

# PLANNING AND INFORMATION CENTER DATA (PIC) - 1986

## NET CATCH DATA

Gill Nets — No. of sets: 6 — Gill Net Survey Date: 8/11/81

| Species | # Fish | # Per Set | Total Pounds | Pounds Per Set |
|---|---|---|---|---|
| White Sucker | 6 | 1.0 | 11.00 | 1.83 |
| Black Bullhead | 175 | 29.2 | 63.00 | 10.50 |
| Brown Bullhead | 2 | 0.3 | 1.00 | 0.17 |
| Yellow Bullhead | 17 | 2.8 | 9.75 | 1.63 |
| Northern Pike | 101 | 16.8 | 159.00 | 26.50 |
| Yellow Perch | 2 | 0.3 | 0.30 | 0.05 |
| Walleye | 6 | 1.0 | 12.30 | 2.05 |
| Bluegill Sunfish | 164 | 27.3 | 19.50 | 3.25 |
| Black Crappie | 10 | 1.7 | 3.80 | 0.63 |

Trap Nets — No. of sets: 6 — Trap Survey Date: 8/11/81

| Species | # Fish | # Per Set | Total Pounds | Pounds Per Set |
|---|---|---|---|---|
| White Sucker | 1 | 0.2 | 1.50 | 0.25 |
| Black Bullhead | 8 | 1.3 | 3.25 | 0.54 |
| Brown Bullhead | 5 | 0.8 | 4.75 | 0.79 |
| Yellow Bullhead | 23 | 3.8 | 10.05 | 1.68 |
| Northern Pike | 7 | 1.2 | 7.50 | 1.25 |
| Yellow Perch | 3 | 0.5 | 0.45 | 0.08 |
| Largemouth Bass | 2 | 0.3 | 0.35 | 0.06 |
| Green Sunfish | 1 | 0.2 | 0.10 | 0.02 |
| Bluegill Sunfish | 86 | 14.3 | 13.25 | 2.21 |

## FISH STOCKING DATA

| Year | Species | Size | # Released |
|---|---|---|---|
| 70 | Northern Pike | Adult | 60 |
| 70 | Northern Pike | Fingerling | 10,500 |
| 71 | Northern Pike | Adult | 92 |
| 71 | Northern Pike | Fingerling | 11,000 |
| 73 | Northern Pike | Adult | 120 |
| 73 | Northern Pike | Fingerling | 41,720 |
| 73 | Walleye | Adult | 65 |
| 74 | Northern Pike | Adult | 120 |
| 74 | Walleye | Fingerling | 516 |
| 75 | Northern Pike | Adult | 58 |
| 79 | Walleye | Fingerling | 2,964 |

## PHYSICAL CHARACTERISTICS FOR LAKE CARNELIAN

Lake Type: Panfish Lake
Dominant Forest/Soil Type: DECID/SAND
Size of Lake: 180 Acres
Maximum Depth: 32.0 Feet
Shorelength: 2.9 Miles
Median Depth: 25.0 Feet

Lake Contour Map Number: C0781 (available at cost from Documents Division
Phone: 612-297-3000)

## DEVELOPMENT CHARACTERISTICS FOR LAKE CARNELIAN

Shoreland Zoning Classification: RECREATIONAL DEVELOPMENT

| Development | Seasonal Homes | Permanent Homes | Total Homes |
|---|---|---|---|
| 1967 | 40 | 9 | 49 |
| 1982 | 40 | 36 | 76 |

## DNR SECTION OF FISHERIES INFORMATION FOR LAKE CARNELIAN

Survey Date: 8/11/1981

### Water Chemistry

Secchi Disk: 9.0 Feet
Water Color: Clear-Green
Cause of Water Color: Algae, light bloom
% Littoral: 39

### LAKE DESCRIPTION

Surface Water Area: 164 Acres
Management Class: Walleye-Centrarchid
Ecological Type: Roughfish-Gamefish
Accessibility: Public access point at south end of lake; private cottages.

PERMIT DAIA FOR LAKE CARNELIAN

Summary of DNR Permit.

Applications issued or denied as of June 1986 for Lake Carnelian

| Permit Types | Number Issued | Number Denied |
|---|---|---|
| Public (Protected) Waters Permits | | |
| Encroachment | 1 | 0 |
| Sand Blanket | 1 | 0 |
| General Appropriation Permits | 0 | 0 |

# APPENDIX C

# CLIMATOLOGICAL DATA

## St. Cloud WSO Airport, MN  Monthly Precipitation

| #### | YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7294 | 1887 | 0.90 | 1.01 | 0.14 | m | m | m | m | m | m | m | m | m | m |
| 7294 | 1888 | m | m | 1.60 | m | m | m | m | m | m | m | m | m | m |
| 7294 | 1890 | m | m | m | m | m | m | m | 2.20 | m | m | m | m | m |
| 7294 | 1893 | 1.00 | 0.90 | 0.90 | 5.74 | 2.62 | 0.54 | 3.67 | 2.41 | 0.81 | 1.68 | 0.81 | 1.36 | 22.44 |
| 7294 | 1894 | 0.81 | 0.00 | 2.55 | 4.93 | 8.54 | 4.15 | 0.51 | 0.90 | 2.12 | 1.95 | 0.72 | 0.69 | 27.87 |
| 7294 | 1895 | 0.48 | 0.70 | 0.24 | 2.30 | 3.99 | 2.55 | 3.16 | 2.28 | 3.84 | 0.00 | 0.94 | 0.00 | 20.48 |
| 7294 | 1896 | 1.05 | 0.18 | 3.05 | 6.31 | 2.57 | 5.00 | 2.32 | 1.66 | 2.59 | 4.30 | 2.76 | 0.00 | 31.79 |
| 7294 | 1897 | 2.75 | 1.40 | 4.53 | 1.56 | 1.96 | 6.77 | 12.81 | 2.48 | 4.18 | 1.69 | 0.60 | 0.28 | 41.01 |
| 7294 | 1898 | 0.00 | 1.78 | 1.75 | 0.32 | 2.96 | 3.73 | 1.83 | 3.34 | 2.28 | 4.17 | 1.85 | 0.00 | 24.01 |
| 7294 | 1899 | 0.30 | 1.05 | 2.22 | 2.22 | 3.79 | 2.78 | 4.51 | 7.91 | 0.95 | 7.94 | 1.10 | 0.36 | 35.14 |
| 7294 | 1900 | 0.27 | 0.45 | 1.40 | 0.81 | 0.20 | 2.05 | 4.28 | 9.28 | 7.12 | 2.39 | 0.58 | 0.86 | 29.69 |
| 7294 | 1901 | 0.42 | 0.00 | 1.34 | 2.00 | 1.21 | 4.67 | 2.38 | 1.54 | 3.25 | 0.76 | 0.50 | 0.23 | 18.30 |
| 7294 | 1902 | 0.30 | 0.00 | 0.35 | 0.88 | 2.79 | 2.92 | 4.75 | 2.32 | 2.19 | 1.63 | 1.53 | 1.43 | 21.09 |
| 7294 | 1903 | 0.20 | 0.33 | 2.75 | 3.74 | 5.46 | 1.28 | 10.53 | 2.64 | 5.20 | 2.80 | 0.25 | 0.55 | 35.73 |
| 7294 | 1904 | 0.35 | 0.18 | 1.06 | 1.37 | 2.95 | 3.89 | 5.87 | 6.00 | 3.02 | 5.01 | 0.08 | 0.39 | 30.17 |
| 7294 | 1905 | 0.49 | 0.36 | 0.60 | 2.06 | 5.47 | 7.42 | 5.41 | 6.96 | 3.38 | 3.13 | 1.41 | 0.00 | 36.69 |
| 7294 | 1906 | 1.20 | 0.26 | 1.03 | 1.68 | 6.50 | 7.61 | 3.17 | 3.42 | 4.33 | 3.22 | 1.15 | 0.54 | 34.11 |
| 7294 | 1907 | 1.80 | 0.78 | 0.75 | 0.21 | 3.53 | 5.05 | 2.22 | 3.55 | 5.15 | 1.67 | 3.57 | 0.26 | 28.54 |
| 7294 | 1908 | 0.29 | 0.69 | 1.44 | 3.21 | 6.77 | 6.82 | 2.55 | 1.60 | 2.74 | 1.64 | 1.09 | 0.47 | 29.31 |
| 7294 | 1909 | 1.56 | 1.21 | 0.14 | 1.57 | 3.34 | 4.84 | 3.08 | 2.43 | 4.06 | 0.71 | 2.10 | 1.63 | 26.67 |
| 7294 | 1910 | 0.65 | 0.46 | 0.18 | 1.52 | 1.90 | 1.85 | 0.63 | 3.90 | 2.53 | 0.47 | 0.31 | 0.24 | 14.64 |
| 7294 | 1911 | 0.55 | 0.37 | 0.87 | 2.19 | 5.86 | 5.28 | 3.33 | 3.56 | 3.41 | 4.87 | 1.65 | 0.75 | 32.69 |
| 7294 | 1912 | 0.26 | 0.10 | 0.28 | 2.96 | 9.68 | 2.29 | 5.23 | 4.79 | 1.78 | 0.68 | 0.01 | 0.82 | 28.88 |
| 7294 | 1913 | 0.42 | 0.37 | 0.48 | 2.91 | 4.26 | 3.05 | 9.49 | 2.61 | 4.12 | 2.27 | 1.23 | 0.00 | 31.21 |
| 7294 | 1914 | 0.88 | 0.35 | 0.95 | 2.42 | 2.79 | 8.35 | 0.90 | 3.37 | 6.49 | 1.59 | 0.23 | 0.05 | 28.37 |
| 7294 | 1915 | 0.33 | 1.29 | 0.54 | 2.83 | 3.97 | m | 4.26 | 1.62 | 3.41 | 2.62 | 2.13 | 0.70 | m |
| 7294 | 1916 | 2.16 | 0.37 | 1.38 | 1.92 | 5.86 | 6.04 | 3.21 | 4.65 | 2.98 | 1.71 | 0.00 | 0.74 | 31.02 |
| 7294 | 1917 | 1.85 | 1.09 | 2.98 | 2.69 | 1.02 | 4.65 | 3.35 | 2.61 | 1.39 | 1.04 | 0.05 | 0.44 | 23.16 |
| 7294 | 1918 | 0.48 | 0.27 | 0.72 | 1.79 | 4.14 | 1.64 | 4.43 | 3.21 | 0.84 | 3.23 | 2.99 | 0.72 | 24.46 |
| 7294 | 1919 | 0.30 | 2.22 | 1.17 | 2.53 | 2.85 | 5.30 | 3.83 | 2.10 | 0.80 | 2.18 | m | 0.42 | m |
| 7294 | 1920 | 1.61 | 0.66 | 3.14 | 1.53 | 4.61 | 10.56 | 0.75 | 0.89 | 3.87 | 2.62 | m | 0.76 | m |
| 7294 | 1921 | 0.29 | 0.00 | 0.80 | 1.21 | 2.07 | 3.18 | 2.86 | 1.70 | 6.10 | 0.80 | 1.02 | 0.52 | 20.55 |
| 7294 | 1922 | 1.88 | 2.94 | 1.39 | 1.25 | 2.01 | 4.50 | 0.86 | 1.16 | 0.74 | 2.37 | 4.16 | 0.20 | 23.46 |
| 7294 | 1923 | 1.42 | 0.25 | 0.20 | 2.66 | 2.49 | 5.17 | 3.26 | 1.00 | 0.93 | 0.42 | 0.57 | 0.17 | 18.54 |
| 7294 | 1924 | 0.14 | 0.35 | 0.95 | 3.26 | 1.80 | 5.17 | 1.49 | 4.76 | 4.63 | 0.76 | 0.52 | 1.04 | 24.87 |
| 7294 | 1925 | 0.39 | 0.37 | 0.34 | 2.16 | 1.07 | 4.96 | 4.63 | 1.29 | 2.46 | 0.44 | 0.50 | 0.51 | 19.12 |
| 7294 | 1926 | 0.98 | 0.44 | 0.89 | 0.08 | 0.98 | 4.67 | 4.31 | 7.22 | 10.72 | 1.22 | 1.53 | 0.32 | 33.36 |
| 7294 | 1927 | 0.41 | 0.31 | 1.73 | 3.31 | 2.98 | 3.04 | 2.74 | 2.18 | 2.55 | 1.97 | 1.93 | 1.75 | 24.90 |

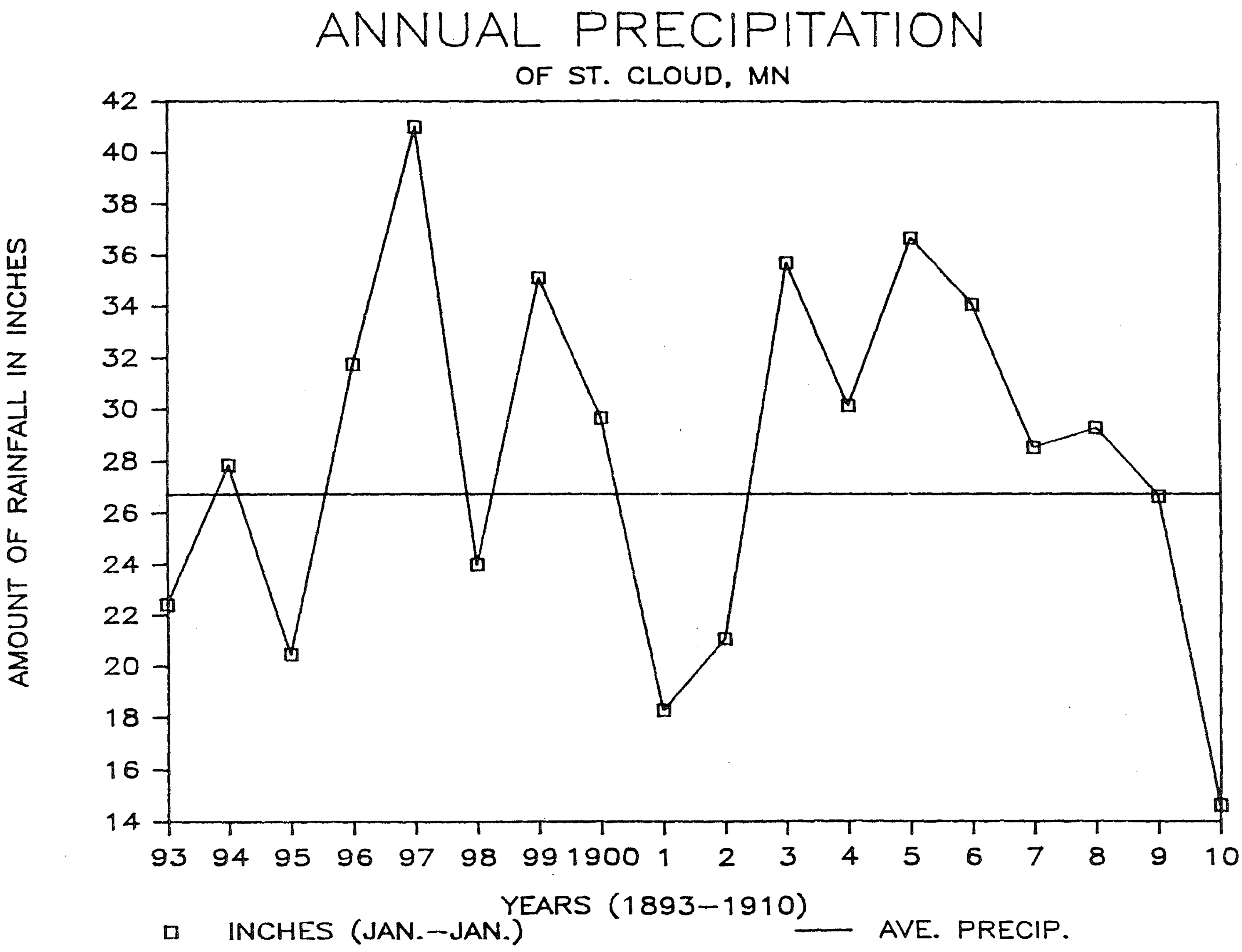
| #### | YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7294 | 1928 | 0.40 | 0.88 | 0.39 | 2.31 | 1.34 | 3.61 | 4.62 | 5.28 | 4.28 | 2.15 | 0.81 | 0.71 | 26.78 |
| 7294 | 1929 | 0.93 | 0.50 | 1.19 | 1.40 | 2.10 | 1.19 | 2.37 | 1.97 | 6.60 | 2.11 | 0.67 | 0.57 | 21.60 |
| 7294 | 1930 | 0.82 | 0.96 | 0.73 | 0.59 | 3.61 | 2.89 | 2.17 | 1.46 | 3.10 | 1.43 | 1.78 | 0.08 | 19.62 |
| 7294 | 1931 | 0.07 | 1.35 | 1.30 | 0.96 | 1.81 | 2.94 | 1.37 | 2.65 | 1.56 | 3.54 | 4.02 | 0.31 | 21.88 |
| 7294 | 1932 | 1.02 | 0.26 | 0.73 | 1.16 | 4.32 | 3.55 | 3.94 | 2.52 | 0.78 | 1.46 | 1.51 | 0.23 | 21.48 |
| 7294 | 1933 | 0.48 | 0.27 | 0.84 | 0.46 | 4.22 | 1.96 | 5.75 | 0.42 | 1.36 | 1.46 | 0.54 | 0.43 | 18.19 |
| 7294 | 1934 | 0.74 | 0.05 | 0.82 | 0.25 | 1.01 | 3.89 | 1.30 | 1.84 | 6.12 | 2.83 | 1.32 | 0.82 | 20.99 |
| 7294 | 1935 | 0.89 | 0.27 | 1.28 | 2.02 | 1.97 | 4.41 | 4.02 | 6.30 | 0.90 | 2.18 | 0.57 | 0.95 | 25.76 |
| 7294 | 1936 | 0.79 | 1.10 | 1.30 | 2.25 | 4.05 | 0.80 | 0.94 | 4.98 | 2.15 | 0.54 | 1.89 | 1.53 | 22.32 |
| 7294 | 1937 | 1.04 | 0.76 | 0.37 | 3.18 | 5.72 | 2.43 | 2.43 | 5.12 | 1.26 | 1.03 | 0.49 | 0.33 | 24.16 |
| 7294 | 1938 | 0.41 | 0.64 | 2.07 | 3.62 | 6.80 | 4.29 | 4.87 | 2.84 | 3.16 | 0.34 | 1.43 | 0.67 | 31.14 |
| 7294 | 1939 | 1.26 | 1.20 | 0.27 | 1.96 | 2.72 | 6.91 | 2.74 | 3.17 | 1.39 | 1.22 | 0.00 | m | m |
| 7294 | 1940 | 0.26 | 0.84 | 1.93 | 2.48 | 2.21 | 2.84 | 3.39 | 3.61 | 1.07 | 2.66 | 3.14 | 0.57 | 25.00 |
| 7294 | 1941 | 0.86 | 0.95 | 0.72 | 2.08 | 5.23 | 6.19 | 1.23 | 5.83 | 5.02 | 3.28 | 0.01 | 0.86 | 32.26 |
| 7294 | 1942 | 0.02 | 0.26 | 1.94 | 1.87 | 4.47 | 3.21 | 3.45 | 3.28 | 4.89 | 0.38 | 0.16 | 1.11 | 25.04 |
| 7294 | 1943 | 0.77 | 0.67 | 1.61 | 0.87 | 6.18 | 2.90 | 3.16 | 1.36 | 0.68 | 2.30 | 1.54 | 0.01 | 22.05 |
| 7294 | 1944 | 0.63 | 1.37 | 1.07 | 3.48 | 5.11 | 5.57 | 5.19 | 3.67 | 2.55 | 0.07 | 1.11 | 0.41 | 30.23 |
| 7294 | 1945 | 0.87 | 1.29 | 2.07 | 1.91 | 2.08 | 6.58 | 4.22 | 1.96 | 3.06 | 0.33 | 1.60 | 1.74 | 27.71 |
| 7294 | 1946 | 0.43 | 1.14 | 0.64 | 1.00 | 4.41 | 5.73 | 1.86 | 0.77 | 4.19 | 4.24 | 1.35 | 0.85 | 26.61 |
| 7294 | 1947 | 0.31 | 0.23 | 0.63 | 4.40 | 2.38 | 3.55 | 1.75 | 2.90 | 1.63 | 1.10 | 2.15 | 0.03 | 21.06 |
| 7294 | 1948 | 0.16 | 1.42 | 1.89 | 2.09 | 0.32 | 4.38 | 2.86 | 2.89 | 2.13 | 0.51 | 1.74 | 0.39 | 20.78 |
| 7294 | 1949 | 1.61 | 0.21 | 1.76 | 0.97 | 2.04 | 3.77 | 5.93 | 1.43 | 2.34 | 2.28 | 1.13 | 0.94 | 24.41 |
| 7294 | 1950 | 2.12 | 0.31 | 2.44 | 3.32 | 5.54 | 1.33 | 1.72 | 0.46 | 1.79 | 3.76 | 1.98 | 1.80 | 26.57 |
| 7294 | 1951 | 0.35 | 2.76 | 2.41 | 2.26 | 2.87 | 7.85 | 4.73 | 4.95 | 2.75 | 3.14 | 1.54 | 1.65 | 37.26 |
| 7294 | 1952 | 1.33 | 0.70 | 1.97 | 0.92 | 2.25 | 9.08 | 3.40 | 6.95 | 0.07 | 0.07 | 0.47 | 0.13 | 27.34 |
| 7294 | 1953 | 0.92 | 1.61 | 1.19 | 3.52 | 2.83 | 9.34 | 2.01 | 3.86 | 0.99 | 0.51 | 1.55 | 1.40 | 29.73 |
| 7294 | 1954 | 0.49 | 0.57 | 1.62 | 5.31 | 4.46 | 6.90 | 3.13 | 2.94 | 3.96 | 2.23 | 0.38 | 0.21 | 32.20 |
| 7294 | 1955 | 0.57 | 1.58 | 0.73 | 1.17 | 0.88 | 2.90 | 8.00 | 5.43 | 2.10 | 1.99 | 1.26 | 1.35 | 27.96 |
| 7294 | 1956 | 1.01 | 0.22 | 1.13 | 2.01 | 2.69 | 5.46 | 4.79 | 7.55 | 1.88 | 1.08 | 2.34 | 0.33 | 30.49 |
| 7294 | 1957 | 0.40 | 1.10 | 2.03 | 0.90 | 4.58 | 8.54 | 2.07 | 6.35 | 3.88 | 0.94 | 1.28 | 0.38 | 32.45 |
| 7294 | 1958 | 0.69 | 0.23 | 0.69 | 2.03 | 2.05 | 2.25 | 2.63 | 6.95 | 4.97 | 1.44 | 1.75 | 0.16 | 25.84 |
| 7294 | 1959 | 0.20 | 0.58 | 0.10 | 0.34 | 5.70 | 2.42 | 2.64 | 4.36 | 2.20 | 1.85 | 0.30 | 1.69 | 22.38 |
| 7294 | 1960 | 0.92 | 0.09 | 0.75 | 1.81 | 4.29 | 2.68 | 2.35 | 4.47 | 1.71 | 0.32 | 1.31 | 0.55 | 21.25 |
| 7294 | 1961 | 0.07 | 0.38 | 0.57 | 2.18 | 2.77 | 2.60 | 3.15 | 2.58 | 2.96 | 2.11 | 0.68 | 0.80 | 20.85 |
| 7294 | 1962 | 0.67 | 1.40 | 1.12 | 1.13 | 8.01 | 2.93 | 6.20 | 3.21 | 3.71 | 0.19 | 0.44 | 0.13 | 29.14 |
| 7294 | 1963 | 0.43 | 0.40 | 1.39 | 2.91 | 5.79 | 2.51 | 2.04 | 5.90 | 3.40 | 0.60 | 0.76 | 0.66 | 26.79 |
| 7294 | 1964 | 0.18 | 0.04 | 1.22 | 3.31 | 3.62 | 1.30 | 1.71 | 6.66 | 1.38 | 0.19 | 0.98 | 0.58 | 21.17 |
| 7294 | 1965 | 0.48 | 0.91 | 3.43 | 3.44 | 6.78 | 6.43 | 4.66 | 4.65 | 4.94 | 0.94 | 1.55 | 1.11 | 39.32 |
| 7294 | 1966 | 0.70 | 1.17 | 1.53 | 1.66 | 2.22 | 3.18 | 3.51 | 4.67 | 0.95 | 1.41 | 0.49 | 0.79 | 22.28 |
| 7294 | 1967 | 1.99 | 0.75 | 0.39 | 1.05 | 0.82 | 7.00 | 0.59 | 4.72 | 1.43 | 1.14 | 0.14 | 1.12 | 21.14 |
| 7294 | 1968 | 0.86 | 0.21 | 1.17 | 4.51 | 2.80 | 6.98 | 1.95 | 2.13 | 4.74 | 5.80 | 0.58 | 1.95 | 33.68 |

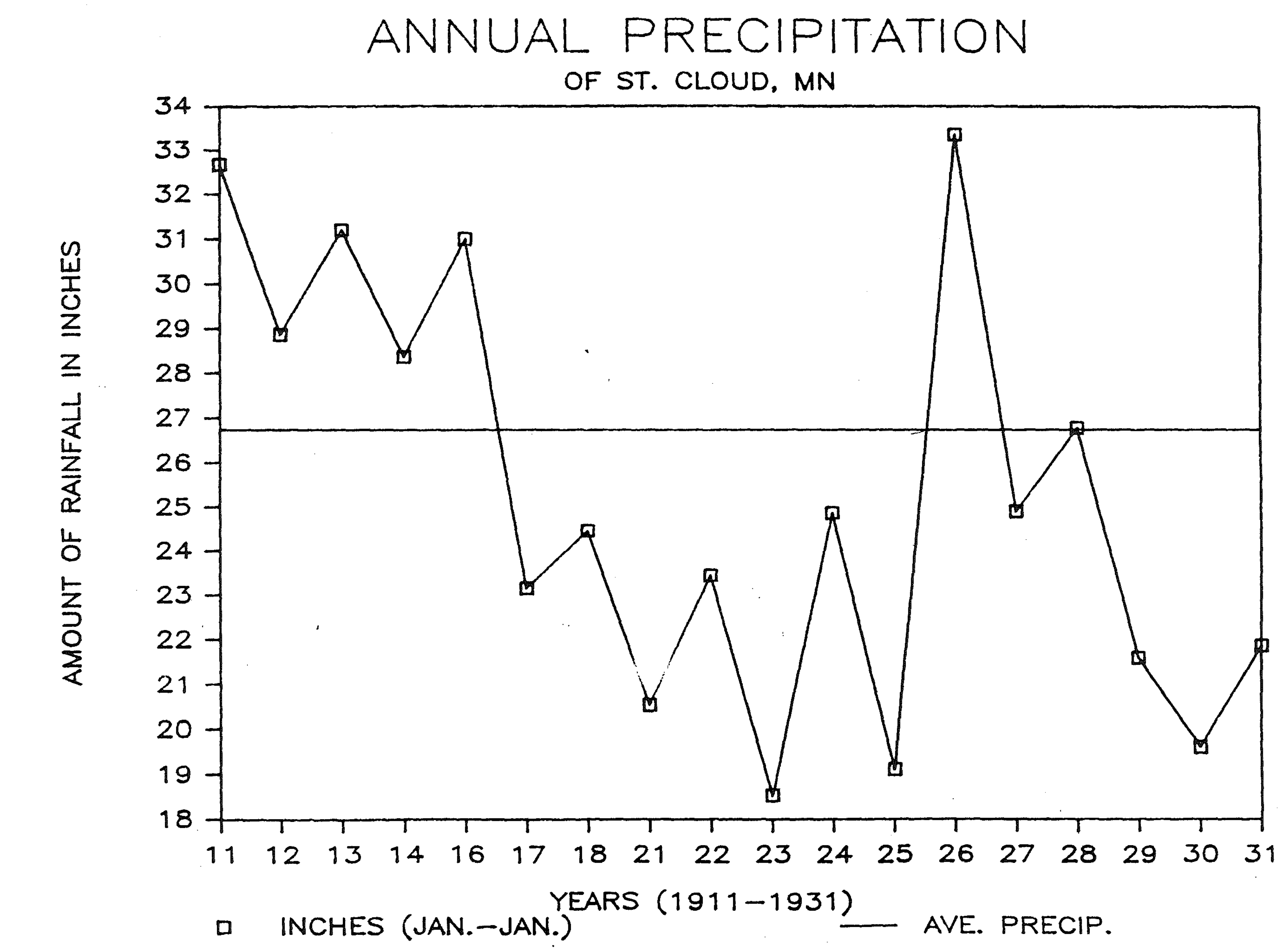
| #### | YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7294 | 1969 | 2.52 | 0.69 | 0.47 | 3.48 | 2.16 | 2.27 | 2.81 | 2.16 | 1.71 | 1.29 | 0.38 | 2.04 | 21.98 |
| 7294 | 1970 | 0.24 | 0.18 | 1.05 | 3.01 | 2.52 | 3.43 | 3.26 | 1.73 | 1.66 | 5.10 | 2.73 | 0.24 | 25.15 |
| 7294 | 1971 | 0.86 | 1.53 | 0.31 | 1.66 | 3.86 | 6.49 | 2.28 | 2.79 | 3.12 | 6.16 | 2.56 | 0.39 | 32.01 |
| 7294 | 1972 | 0.55 | 0.47 | 1.56 | 1.59 | 3.30 | 1.91 | 7.26 | 4.94 | 1.64 | 2.54 | 0.74 | 1.31 | 27.81 |
| 7294 | 1973 | 0.52 | 0.31 | 1.40 | 1.65 | 2.89 | 2.92 | 2.94 | 4.27 | 2.80 | 3.13 | 1.64 | 0.73 | 25.20 |
| 7294 | 1974 | 0.09 | 0.83 | 0.88 | 1.16 | 3.26 | 4.36 | 2.25 | 3.20 | 1.97 | 1.58 | 1.29 | 0.54 | 21.41 |
| 7294 | 1975 | 2.39 | 0.40 | 1.75 | 3.69 | 3.02 | 5.78 | 0.21 | 4.83 | 2.27 | 1.08 | 3.24 | 0.28 | 28.94 |
| 7294 | 1976 | 0.85 | 0.83 | 1.78 | 0.92 | 0.93 | 4.84 | 1.92 | 0.60 | 1.37 | 0.44 | 0.14 | 0.31 | 14.93 |
| 7294 | 1977 | 0.58 | 0.98 | 3.03 | 3.17 | 3.57 | 3.48 | 4.27 | 6.10 | 2.34 | 2.93 | 3.74 | 1.40 | 35.59 |
| 7294 | 1978 | 0.19 | 0.17 | 0.81 | 3.49 | 3.20 | 6.04 | 4.43 | 2.88 | 4.59 | 0.14 | 0.95 | 1.02 | 27.91 |
| 7294 | 1979 | 1.28 | 1.67 | 3.02 | 0.74 | 5.17 | 6.34 | 1.21 | 4.88 | 1.58 | 4.36 | 0.62 | 0.31 | 31.18 |
| 7294 | 1980 | 1.17 | 0.84 | 0.76 | 0.48 | 1.62 | 6.06 | 1.28 | 7.01 | 5.99 | 0.71 | 0.20 | 0.22 | 26.34 |
| 7294 | 1981 | 0.44 | 1.10 | 1.05 | 3.29 | 1.40 | 6.65 | 1.92 | 0.00 | 1.26 | 4.40 | 0.45 | 1.04 | 23.00 |
| 7294 | 1982 | 0.97 | 0.13 | 1.75 | 0.97 | 3.91 | 2.53 | 3.90 | 3.37 | 4.38 | 4.52 | 2.31 | 1.72 | 30.46 |
| 7294 | 1983 | 0.61 | 0.13 | 2.60 | 1.57 | 2.39 | 9.52 | 2.21 | 3.48 | 6.55 | 3.09 | 3.11 | 0.92 | 36.18 |
| 7294 | 1984 | 0.67 | 0.87 | 0.65 | 4.16 | 2.02 | 8.11 | 2.94 | 2.57 | 3.39 | 5.84 | 0.17 | 1.81 | 33.20 |
| 7294 | 1985 | 0.43 | 0.23 | 1.70 | 3.83 | 2.81 | 5.28 | 2.80 | 4.57 | 9.48 | 1.28 | 1.43 | 0.57 | 34.41 |
| 7294 | 1986 | 0.72 | 0.83 | 0.89 | 5.55 | 2.36 | 3.75 | 7.54 | 5.18 | 6.03 | 0.49 | 1.05 | 0.35 | 34.74 |

Note: Values in hundredths of inches; 'm' = missing; 'e' = estimated; '####' is the National Weather Service Coop Station Number.

All data were supplied to this State Climatology Office by the National Climate Data Center, NOAA, Asheville, NC, 28801. "Certified Data" can only be supplied by NCDC directly.

State Climatology Office, Minnesota Department of Natural Resources - Waters, Jim Zandlo, (612) 296-4214.


ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
93 94 95 96 97 98 99 1900 1 2 3 4 5 6 7 8 9 10
YEARS (1893–1910)
INCHES (JAN.–JAN.)
AVE. PRECIP.


ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
34
33
32
31
30
29
28
27
26
25
24
23
22
21
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19
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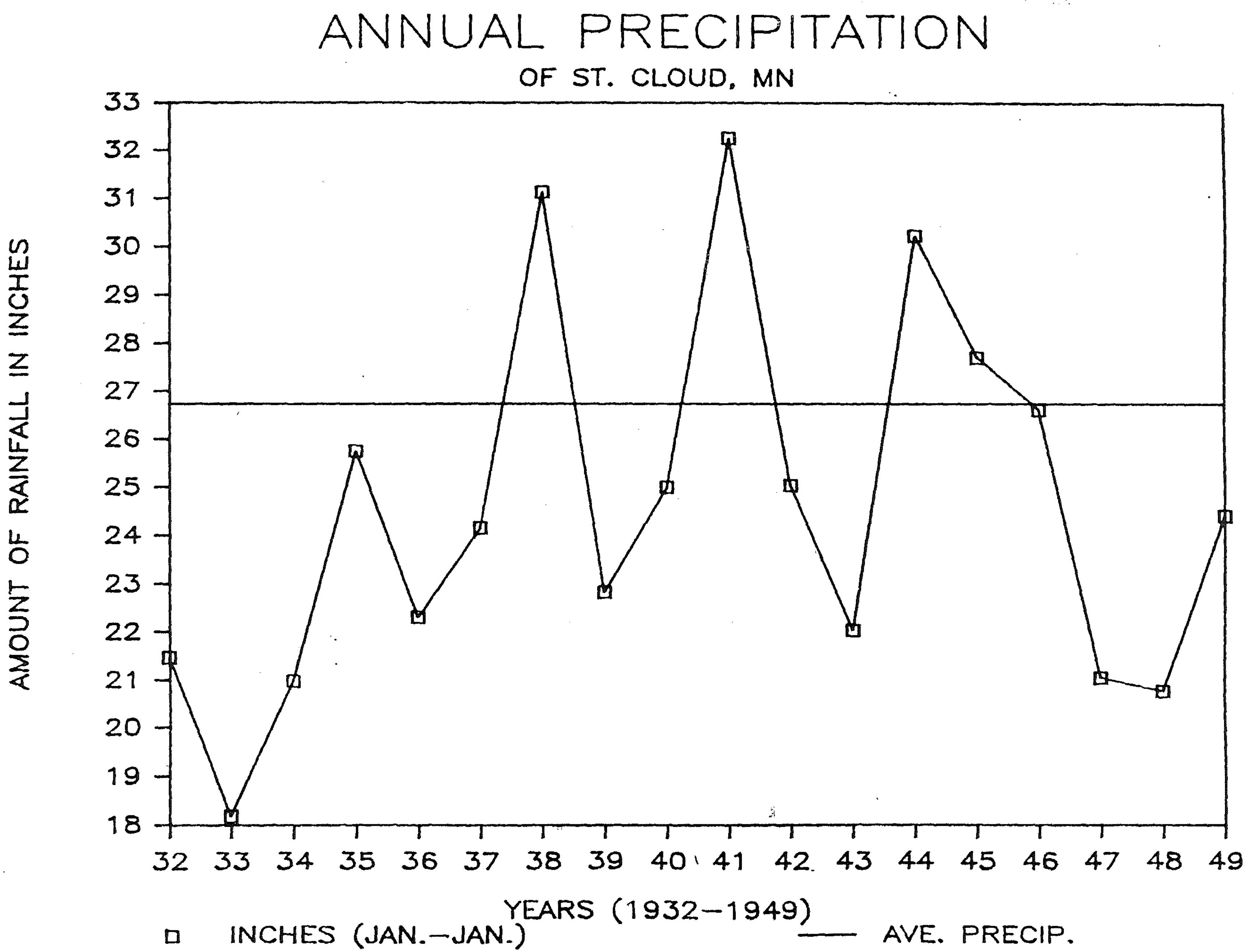
11 12 13 14 16 17 18 21 22 23 24 25 26 27 28 29 30 31
YEARS (1911–1931)
INCHES (JAN.–JAN.)
AVE. PRECIP.


ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
33
32
31
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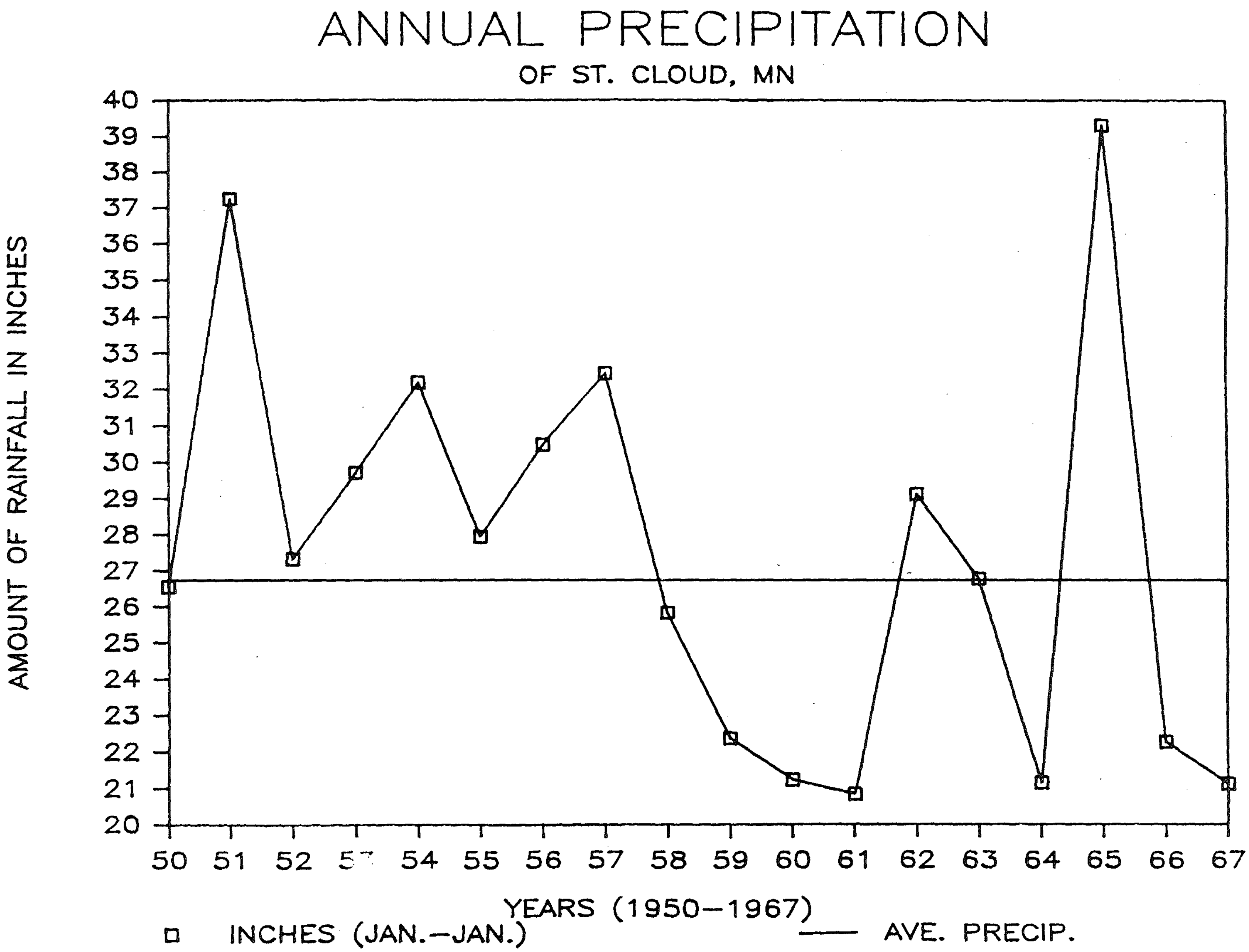
27
26
25
24
23
22
21
20
19
18
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
YEARS (1932–1949)
INCHES (JAN.–JAN.)
AVE. PRECIP.


ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
40
39
38
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32
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26
25
24
23
22
21
20
50
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61
62
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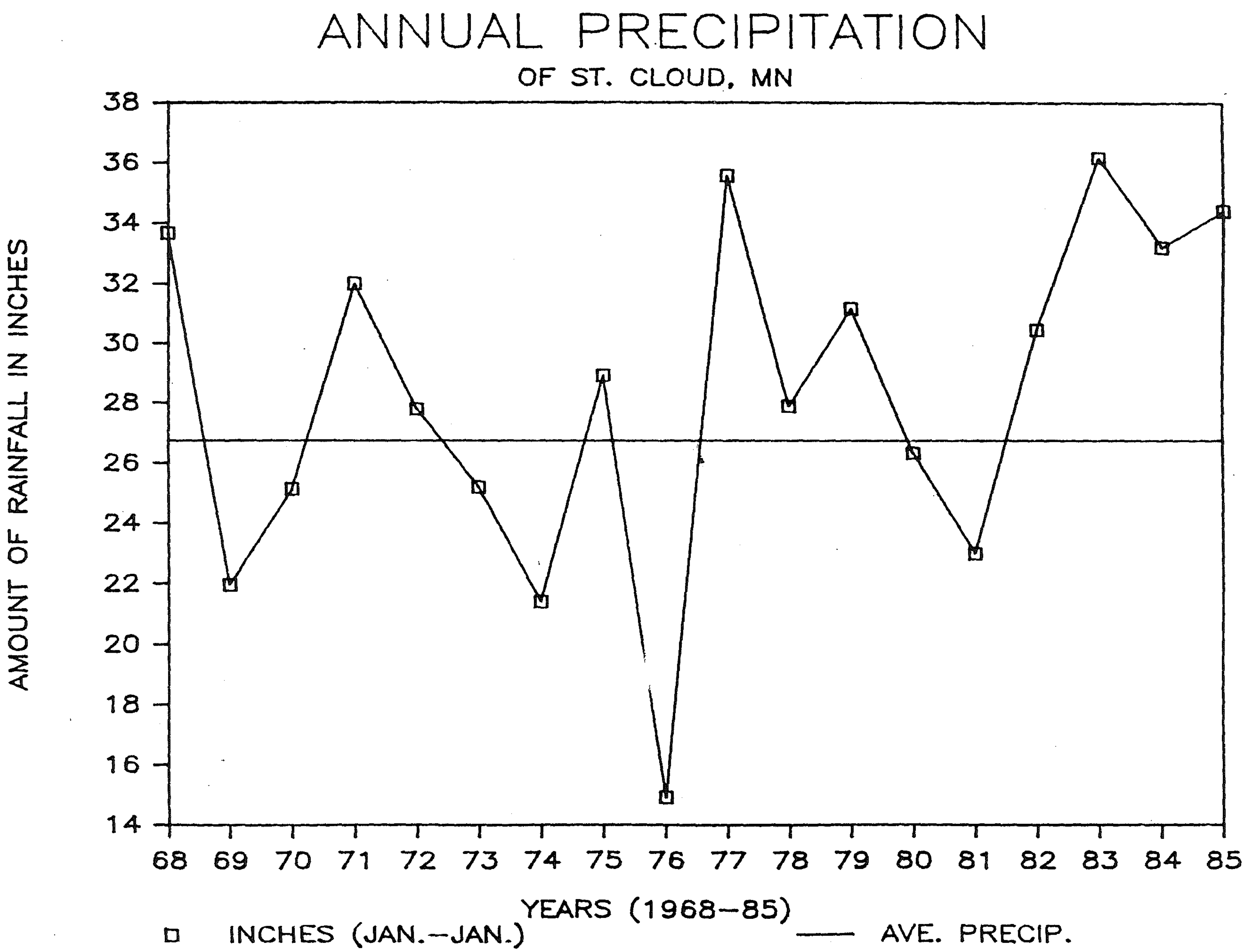
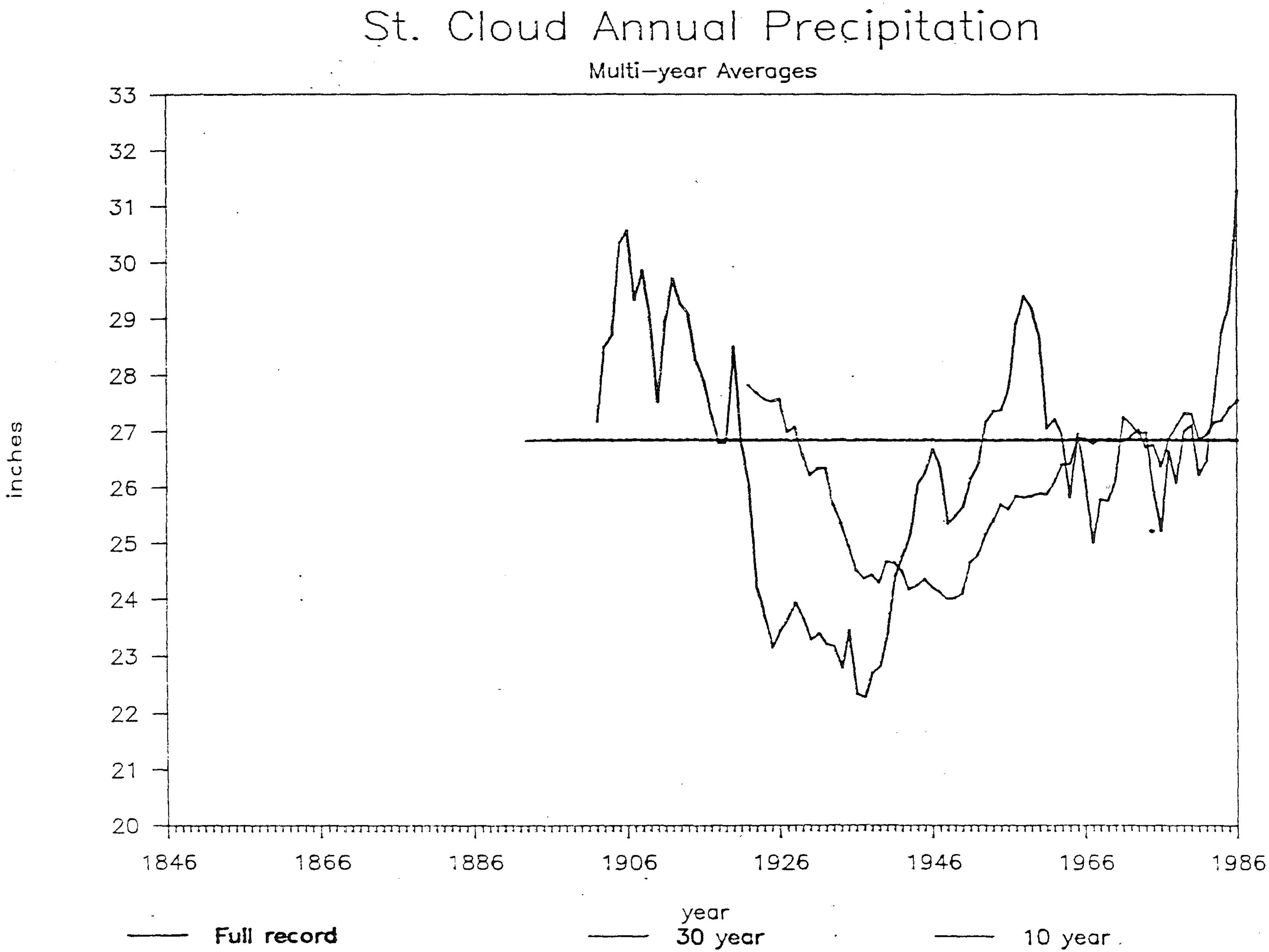
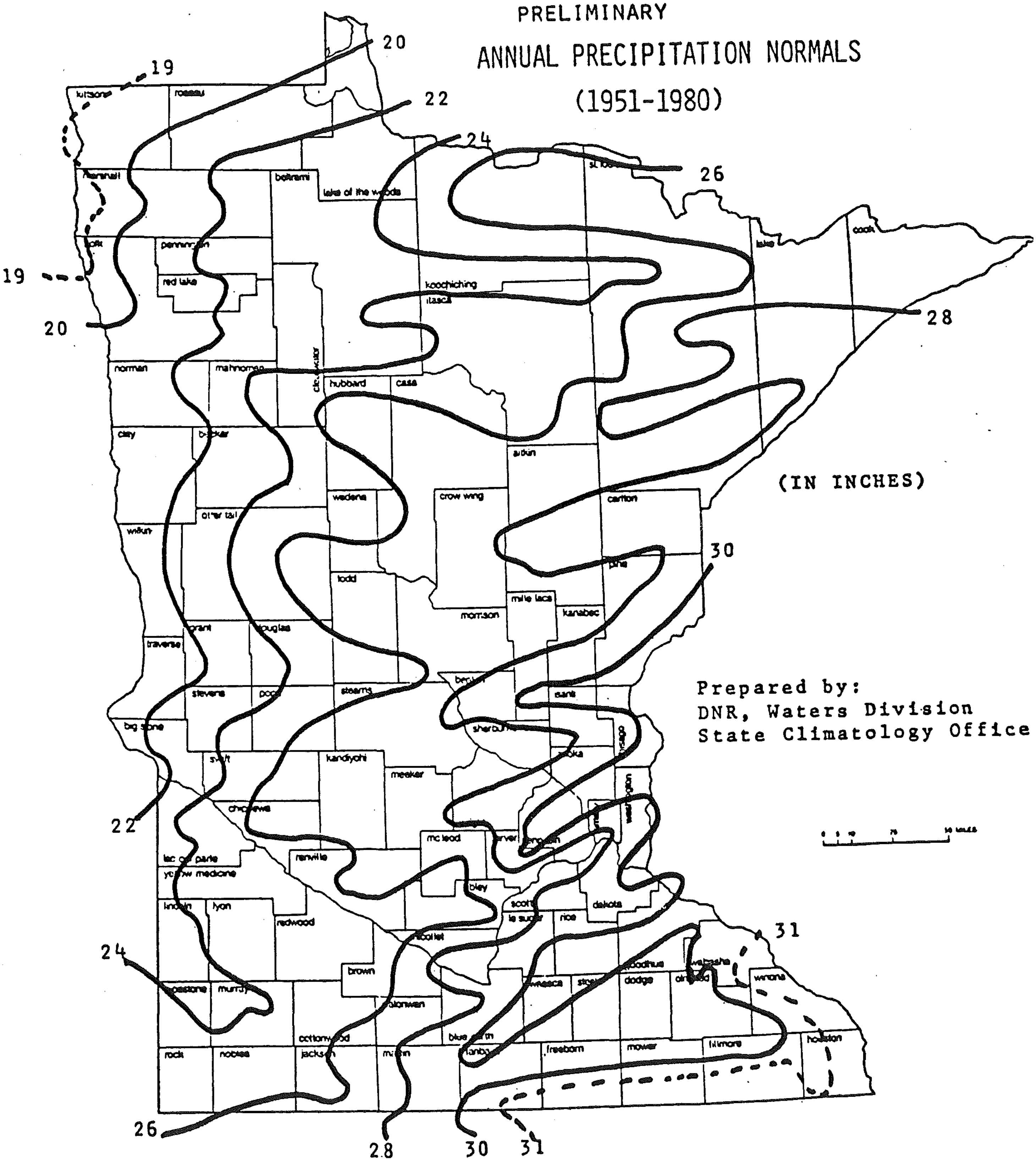
64
65
66
67
YEARS (1950–1967)
INCHES (JAN.–JAN.)
AVE. PRECIP.


ANNUAL PRECIPITATION
OF ST. CLOUD, MN
38
36
34
32
30
28
26
24
22
20
18
16
14
AMOUNT OF RAINFALL IN INCHES
68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85
YEARS (1968–85)
INCHES (JAN.–JAN.)
AVE. PRECIP.


St. Cloud Annual Precipitation
Multi-year Averages
33
32
31
30
29
28
27
26
25
24
23
22
21
20
inches
1846
1866
1886
1906
1926
1946
1966
1986
year
Full record
30 year
10 year

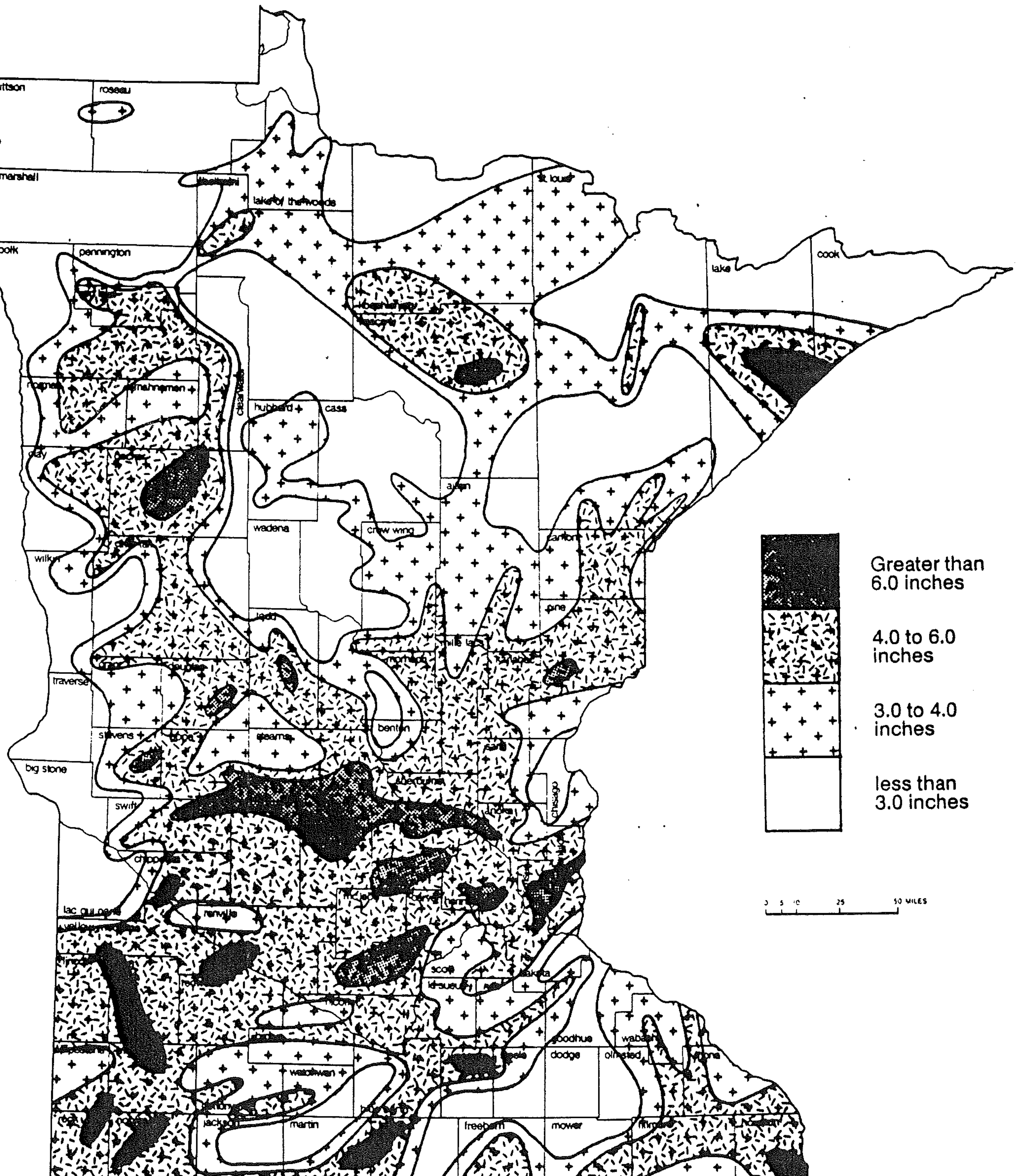
PRELIMINARY

# ANNUAL PRECIPITATION NORMALS (1951-1980)



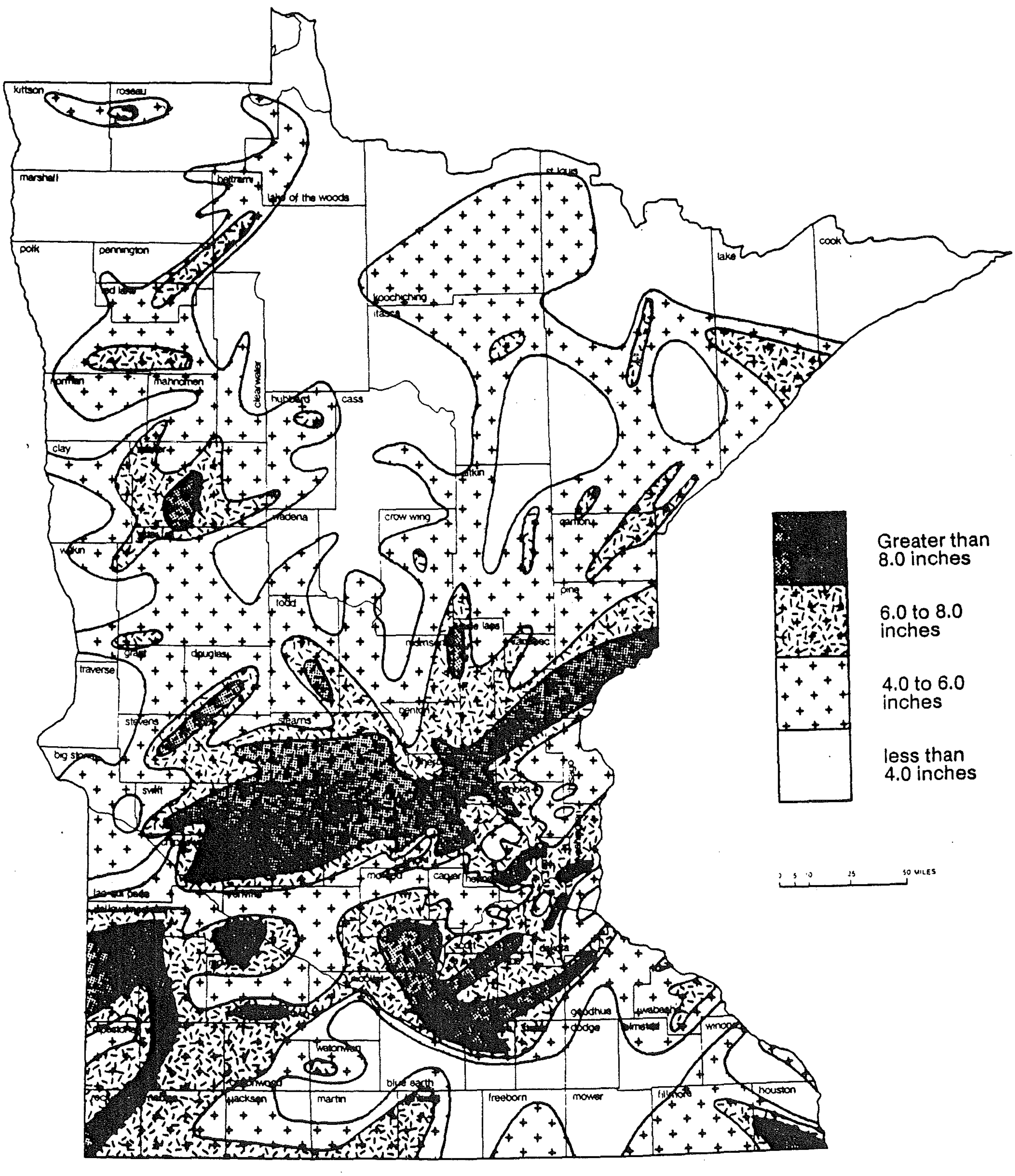

Prepared by:
DNR, Waters Division
State Climatology Office

# AVERAGE ANNUAL DEPARTURE FROM NORMAL PRECIPITATION FOR 1977 - 1986 (10 YEARS)




Prepared by: DNR, Division of Waters, State Climatology Office

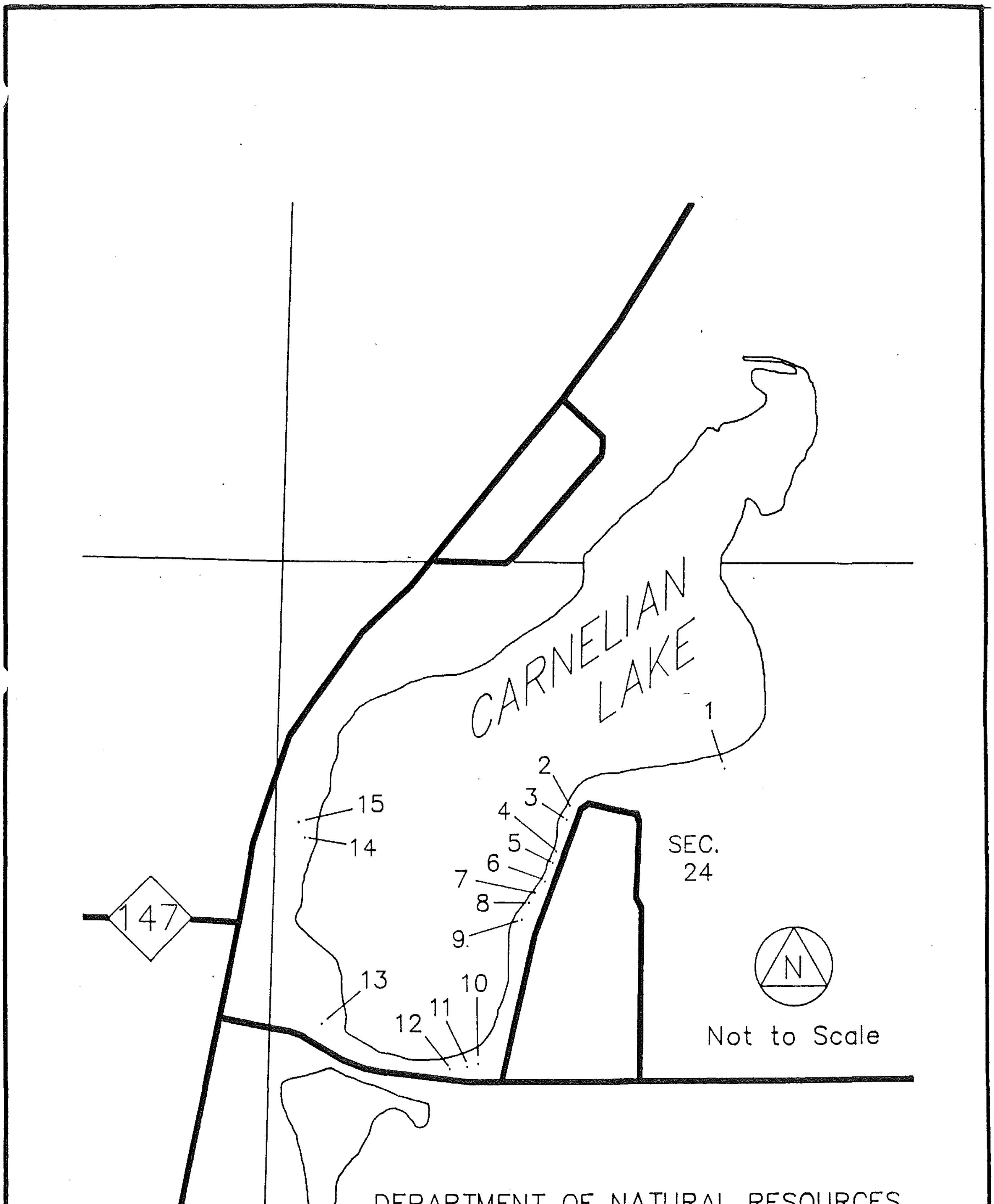
# AVERAGE ANNUAL DEPARTURE FROM NORMAL PRECIPITATION FOR 1982 - 1986 (5 YEARS)



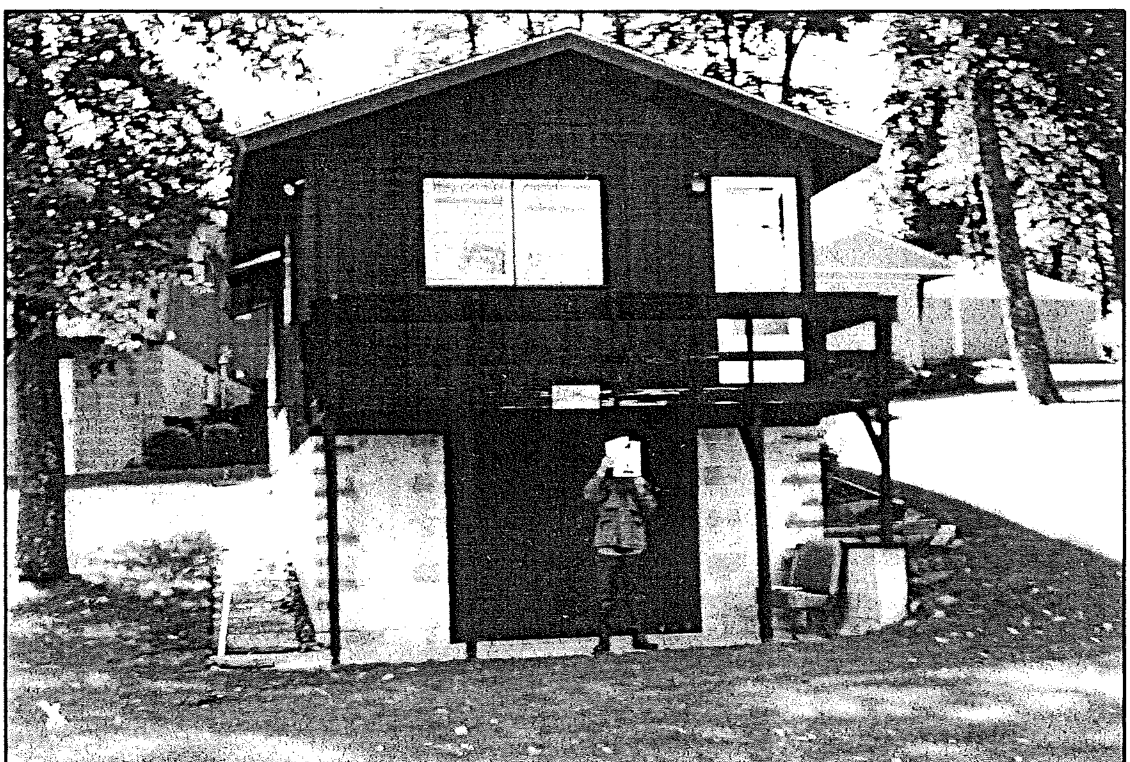

Prepared by: DNR, Division of Waters, State Climatology Office

# APPENDIX D

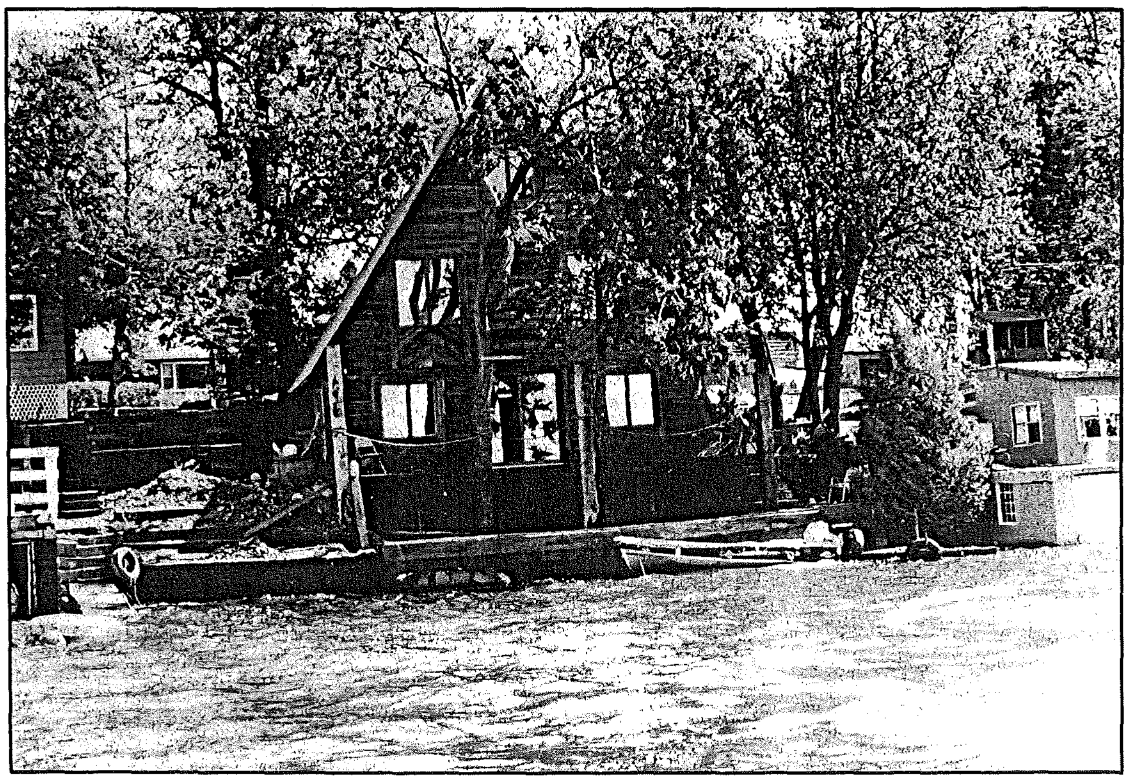
## FACT SHEET FOR EACH POTENTIALLY DAMAGED STRUCTURE


CARNELIAN LAKE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
SEC. 24
147
N
Not to Scale
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS

| | |
|---|---|
| Structure number : | 1 |
| Name : | McConnell, John |
| Address : | R.R. 1<br>Kimball, MN 55353-9801 |
| Legal Description : | Stanley's Subdivision<br>N. 1/2, Sec. 24, Twp. 122, R. 29<br>Lot 3 |
| Walkout/1stFl Elev : | 1135.41 |
| Grd Elev : | |
| Basement : | YES |
| Walkout : | YES |
| Market Value | |
| Buildings : | $7,695.00 |
| Land : | |
| Total : | |
| Flood Insurance : | NO |



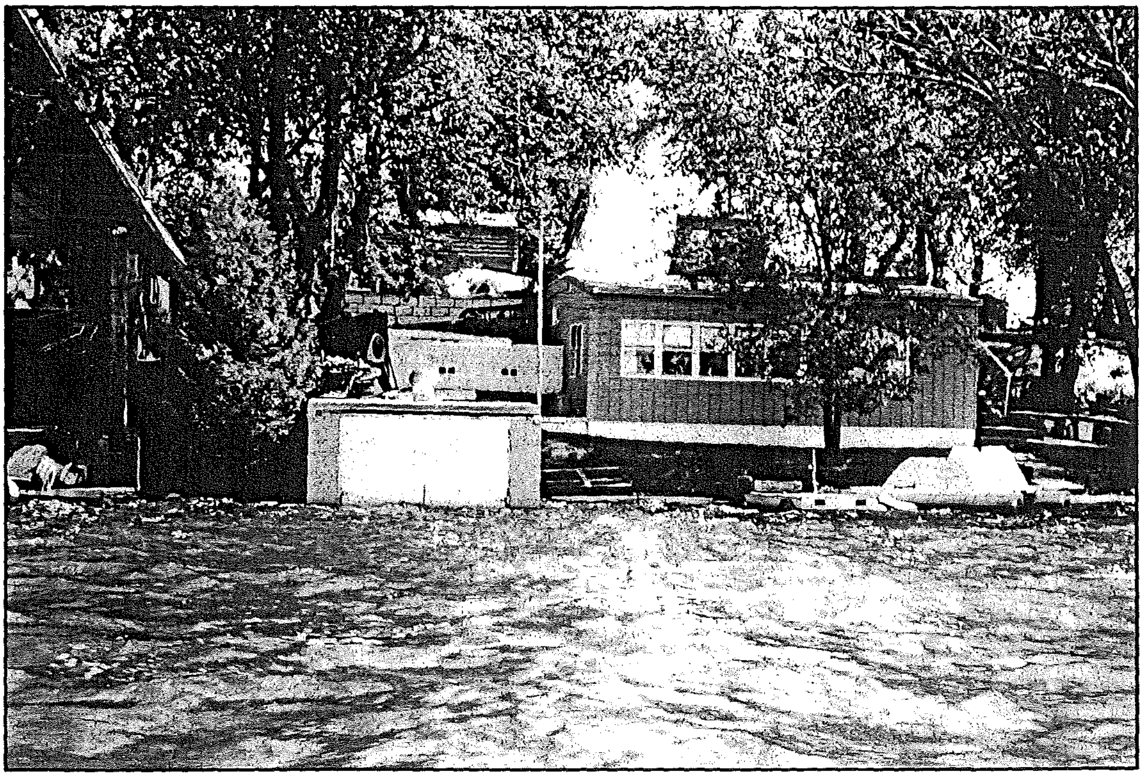
| | |
|---|---|
| Structure number : | 2 |
| Name : | Lynch, Loren O. |
| Address : | 1232 Coon Rapids Blvd.<br>Coon Rapids, MN 55433-5359 |
| Legal Description : | First Addition To Hentages Lake Shore Lots<br>N. 1/2, Sec. 24, Twp. 122, R. 29<br>Lot 3 |
| Walkout/1stFl Elev : | 1140.1 |
| Grd Elev : | 1133.9 |
| Basement : | NO |
| Walkout : | YES |
| Market Value | |
| Buildings : | $17,236.00 |
| Land : | $8,964.00 |
| Total : | $26,200.00 |
| Flood Insurance : | NO |



| | |
|---|---|
| Structure number : | 3 |
| Name : | Waldorf, C. |
| Address : | 15 McKinley Pl. N.<br>St. Cloud, MN 56301-3385 |
| Legal Description : | First Addition To Hentages Lake Shore Lots<br>N. 1/2, Sec. 24, Twp. 122, R. 29<br>Lot 4 |
| Walkout/1stFl Elev : | 1137.07 |
| Grd Elev : | 1135.9 |
| Basement : | NO |
| Walkout : | NO |

Market Value

| | |
|---|---|
| Buildings : | $5,880.00 |
| Land : | $9,320.00 |
| Total : | $15,200.00 |
| Flood Insurance : | NO |



Structure number : 4

Name : Hamilton's, J.
Address : 1433 Pinewood Dr.
St. Paul, MN 55119

Legal Description : First Addition To Hentages Lake Shore Lots
N. 1/2, Sec. 24, Twp. 122, R. 29
lot 6

Walkout/1stFl Elev : 1135.36
Grd Elev : 1135.93

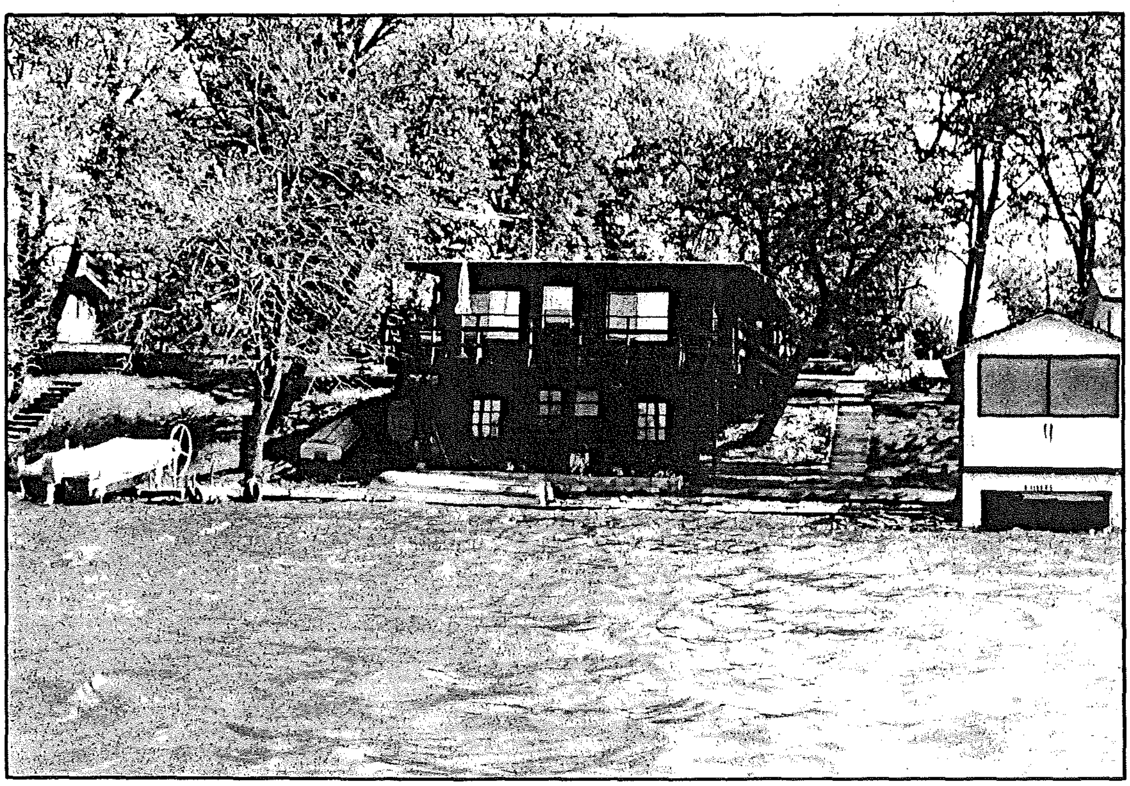
Basement : YES
Walkout : YES

Market Value

Buildings : $19,200.00
Land : $9,000.00

Total : $28,200.00

Flood Insurance : NO

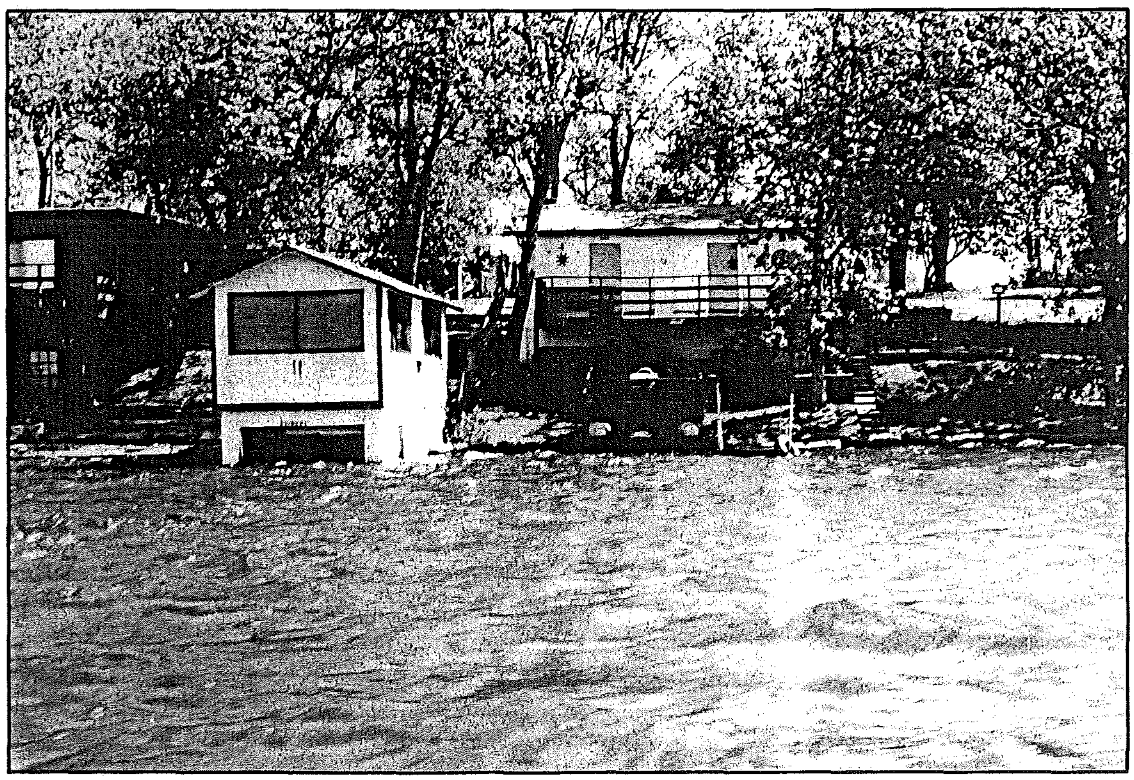


| | |
|---|---|
| Structure number : | 5 |
| Name : | Roiger, Donald D. |
| Address : | 1745 B. Oak View Lane<br>Plymouth, MN 55441 |
| Legal Description : | First Addition To Hentages Lake Shore Lots<br>N. 1/2, Sec. 24, Twp. 122, R. 29<br>Lot 7 |
| Walkout/1stFl Elev : | 1136.5 |
| Grd Elev : | 1127.5 |
| Basement : | NO |
| Walkout : | YES |

Market Value

| | |
|---|---|
| Buildings : | $12,400.00 |
| Land : | $9,000.00 |
| Total : | $21,400.00 |

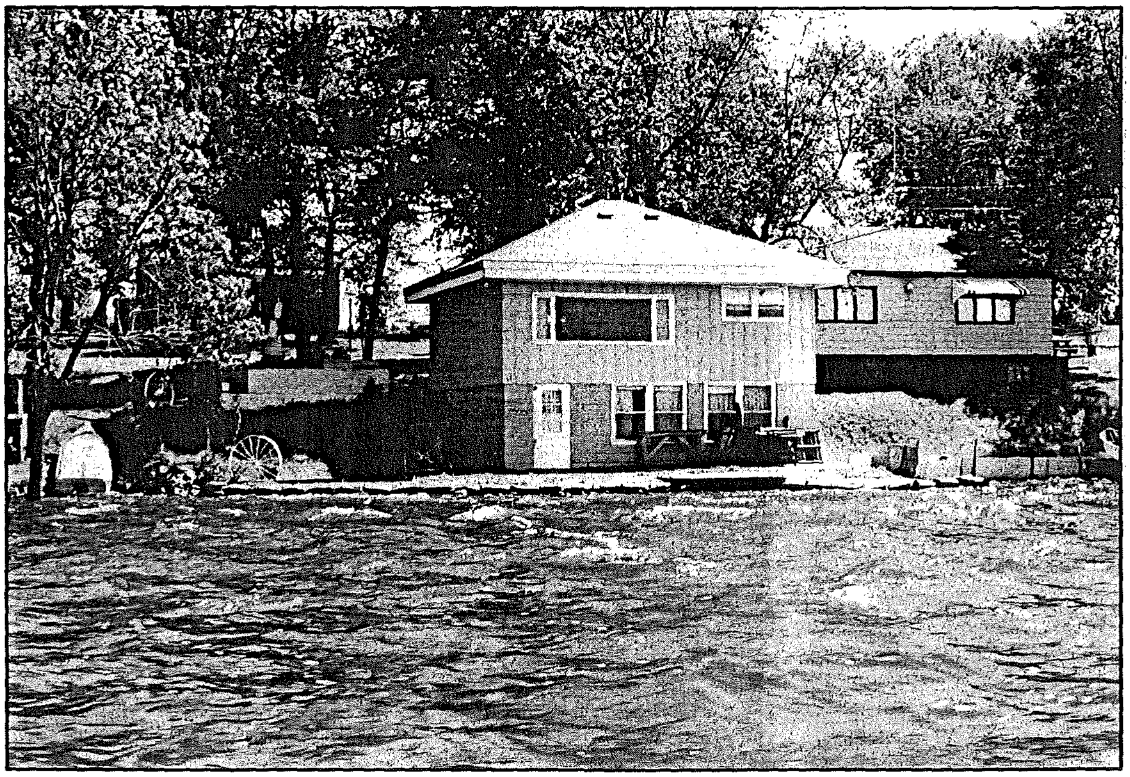
| | |
|---|---|
| Flood Insurance : | NO |



| | |
|---|---|
| Structure number : | 6 |
| Name : | Oman's, Lester O. |
| Address : | 2737 Alabama Ave. So.<br>St. Louis Park, MN 55416-1801 |
| Legal Description : | First Addition To Hentages Lake Shore Lots<br>N. 1/2, Sec. 24, Twp. 122, R. 29<br>Lot 9 |
| Walkout/1stFl Elev : | 1134.32 |
| Grd Elev : | |
| Basement : | YES |
| Walkout : | YES |

Market Value

| | |
|---|---|
| Buildings : | $17,238.00 |
| Land : | $8,962.00 |
| Total : | $26,200.00 |
| Flood Insurance : | NO |

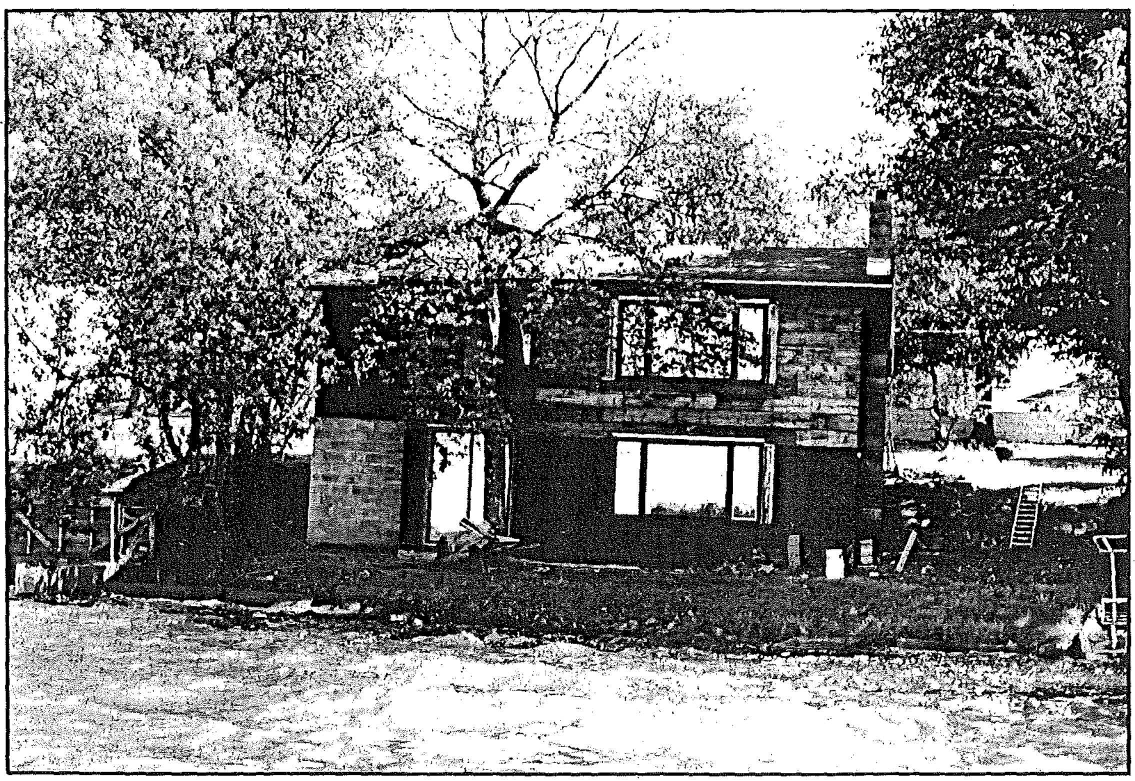


| | |
|---|---|
| Structure number : | 7 |
| Name : | Hoefer, D. |
| Address : | Rt. 1 Box 181<br>Kimball, MN 55353-9801 |
| Legal Description : | Second Addition To Hentages Lake Shore Lots<br>N. 1/2, Sec. 24, Twp. 122, R. 29<br>Lot 3 |
| Walkout/1stFl Elev : | 1136.5 |
| Grd Elev : | 1135.7 |
| Basement : | YES |
| Walkout : | YES |

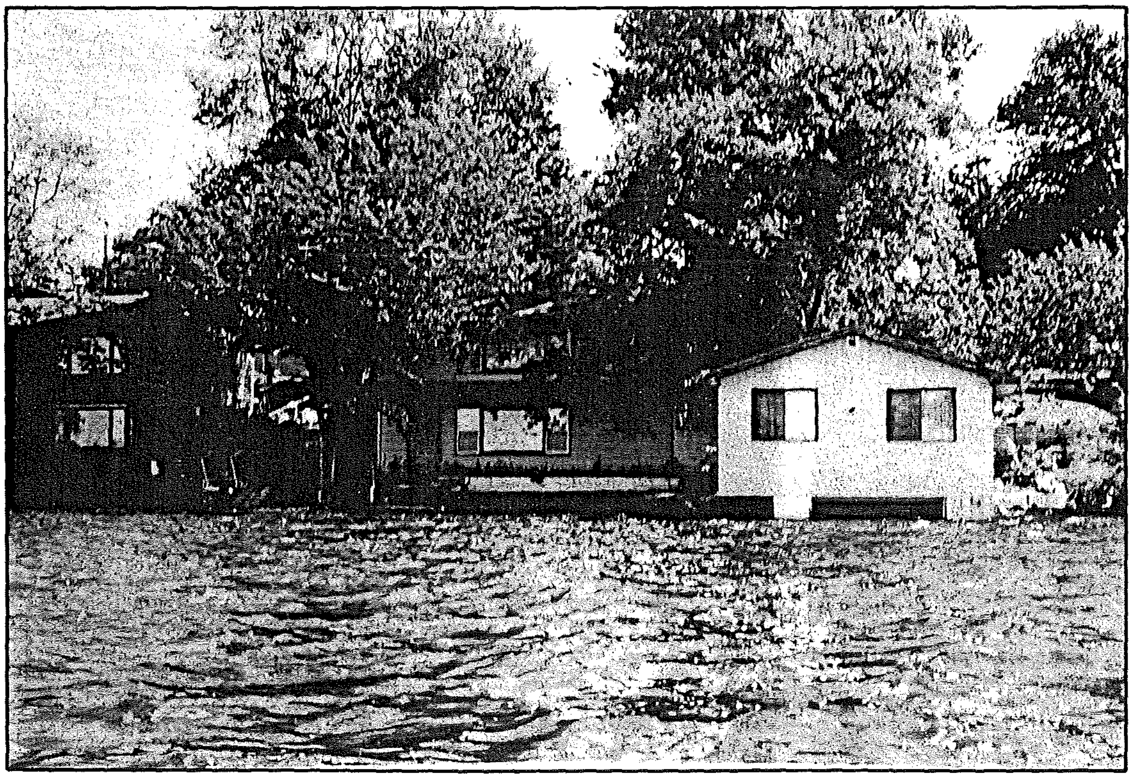
Market Value

| | |
|---|---|
| Buildings : | $17,600.00 |
| Land : | $9,200.00 |
| Total : | $26,800.00 |

| | |
|---|---|
| Flood Insurance : | NO |



| | |
|---|---|
| Structure number : | 8 |
| Name : | Gilkerson, Wendell |
| Address : | 4301 Upton Ave. N.<br>Minneapolis, MN 55412-1009 |
| Legal Description : | Second Addition To Hentages Lake Shore Lots<br>N. 1/2, Sec. 24, Twp. 122, R. 29<br>Lot 4 And N. 2 Of Lot 5 |
| Walkout/1stFl Elev : | 1135.74 |
| Grd Elev : | 1134.1 |
| Basement : | YES |
| Walkout : | YES |
| Market Value | |
| Buildings : | $40,900.00 |
| Land : | $13,700.00 |
| Total : | $54,600.00 |
| Flood Insurance : | NO |



Structure number : 9

Name : Petty, John
Address : R.R. 1 Box 179
Kimball, MN 55353-9801

Legal Description : Second Addition To Hentages Lake Shore Lots
S. 1/2, Sec. 24, Twp. 122, R. 29
Lot 9 And N. 2 Of Lot 10

Walkout/1stFl Elev : 1135.53
Grd Elev :

Basement : YES
Walkout : YES

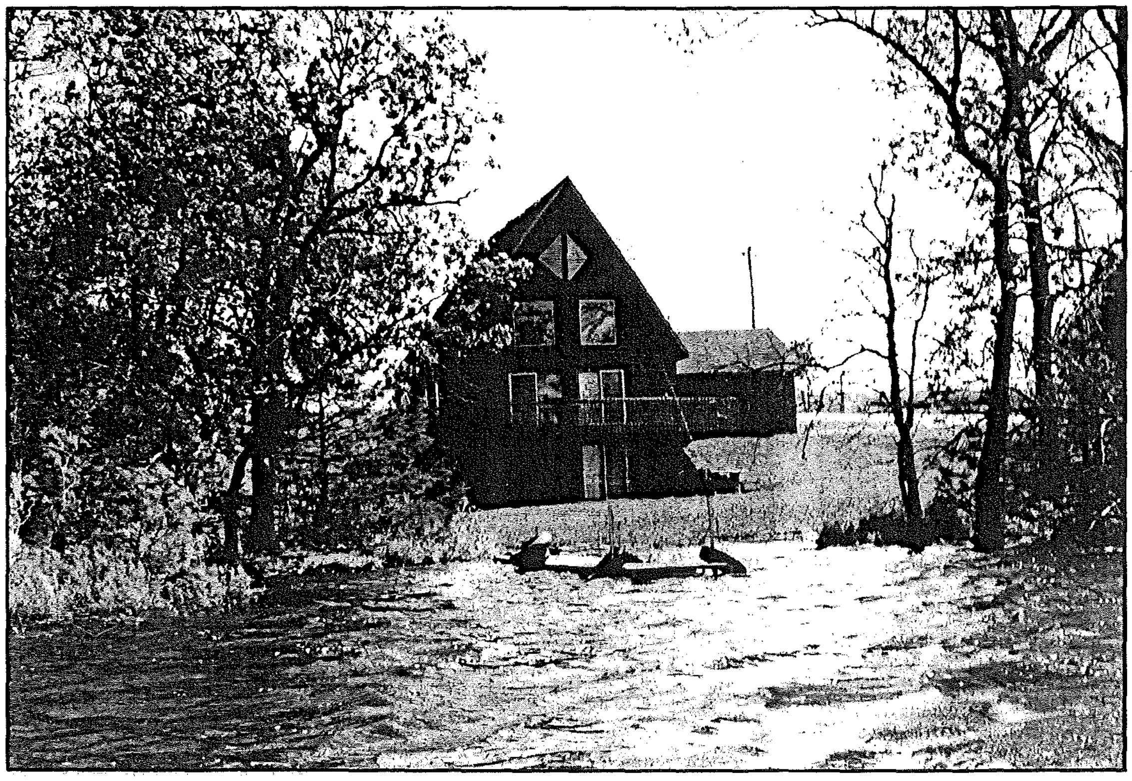
Market Value

Buildings : $32,800.00
Land : $12,000.00

Total : $44,800.00

Flood Insurance : NO

| | |
|---|---|
| Structure number : | 10 |
| Name : | Linn, R. & Neva |
| Address : | 10133 Noble Ave. N.<br>Brooklyn Park, MN 55443-1315 |
| Legal Description : | Fourth Addition To Hentages Lake Shores Lots<br>S. 1/2, Sec. 24, Twp. 122, R. 29<br>Lot 6 |
| Walkout/1stFl Elev : | 1135.89 |
| Grd Elev : | |
| Basement : | YES |
| Walkout : | YES |
| Market Value | |
| Buildings : | $55,500.00 |
| Land : | $12,600.00 |
| Total : | $68,100.00 |
| Flood Insurance : | NO |



| | |
|---|---|
| Structure number : | 11 |
| Name : | Cummings, R. |
| Address : | 5517 37 Ave. S.<br>Minneapolis, MN 55417-2105 |
| Legal Description : | Sec. 24, Twp. 122, R. 29<br>.22 A. W. 75 Ft. Of E. 125 Ft.<br>Of Lot 2 Lying N. Of Road |
| Walkout/1stFl Elev : | 1130.8 |
| Grd Elev : | 1130.6 |
| Basement : | NO |
| Walkout : | NO |

Market Value

| | |
|---|---|
| Buildings : | $300.00 |
| Land : | $500.00 |
| Total : | $800.00 |

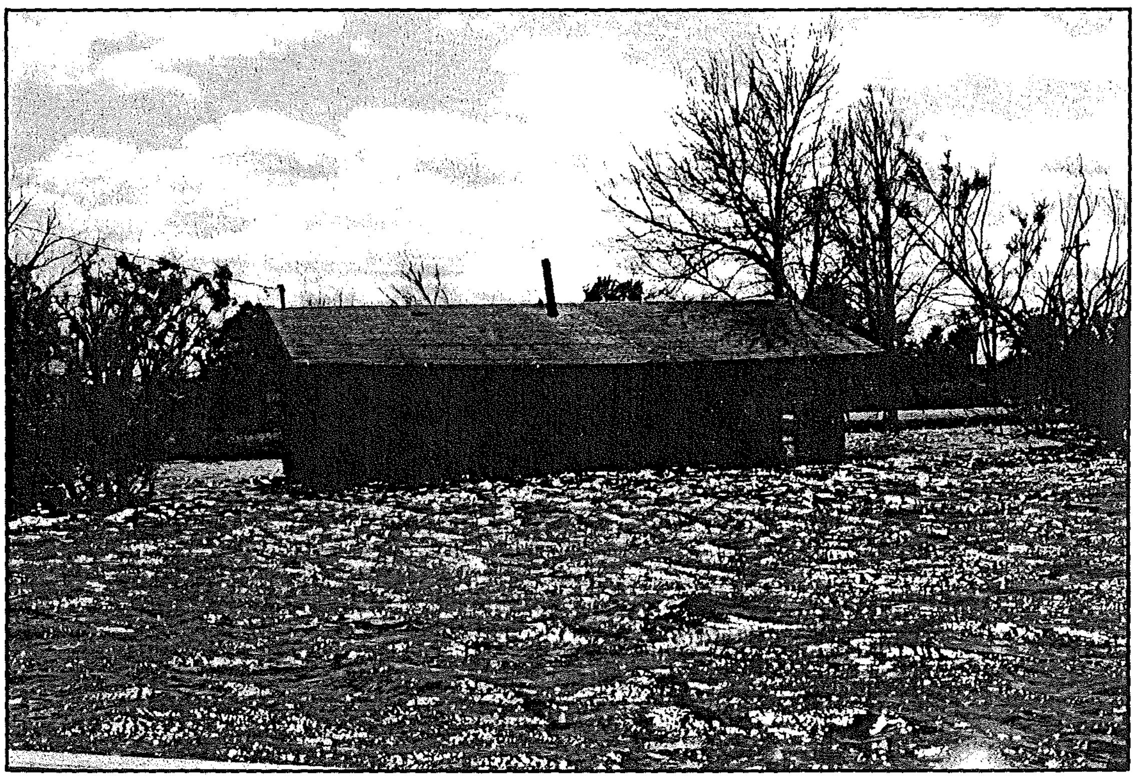
Flood Insurance : NO

| | |
|---|---|
| Structure number : | 12 |
| Name : | Chadwick, D. |
| Address : | 7106 23rd Ave. N.E.<br>Stacy, MN 55079 |
| Legal Description : | Sec. 24, Twp. 122, R. 29<br>.22 A. At N. 80 Ft. Strip Of E. 350 Ft.<br>Of Lot Lying N. Of Road |
| Walkout/1stFl Elev : | 1130.49 |
| Grd Elev : | 1130.4 |
| Basement : | NO |
| Walkout : | NO |

Market Value

| | |
|---|---|
| Buildings : | $300.00 |
| Land : | $500.00 |
| Total : | $800.00 |

Flood Insurance : NO

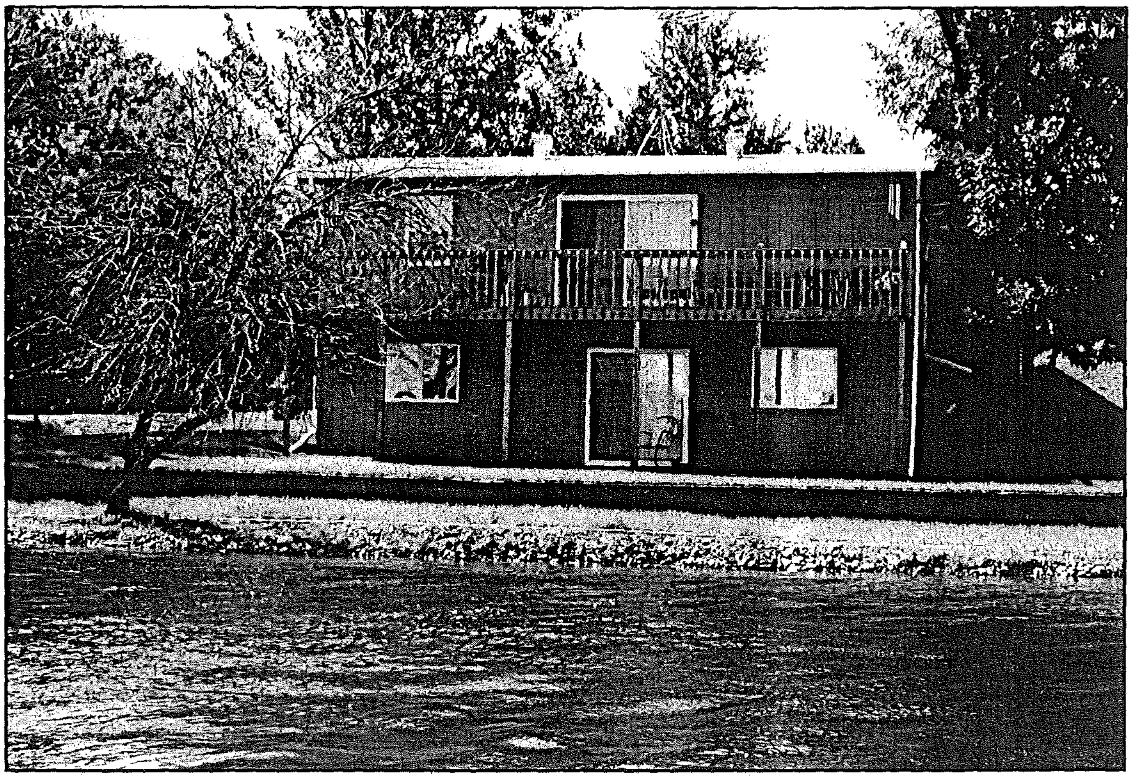


| | |
|---|---|
| Structure number : | 13 |
| Name : | Pickle, M. & B. |
| Address : | 8217 Rhode Island Ave. So.<br>Minneapolis, MN 55438-1148 |
| Legal Description : | Sec. 24, Twp. 122, R. 29<br>.20 A. Of Government Lot 2 Lying S'ly Of Lot 4<br>Of Mozena Mound Addition And N'ly Of CL Of Road |
| Walkout/1stFl Elev : | 1137.13 |
| Grd Elev : | |
| Basement : | YES |
| Walkout : | YES |

Market Value

| | |
|---|---|
| Buildings : | $20,800.00 |
| Land : | $12,100.00 |
| Total : | $32,900.00 |

| | |
|---|---|
| Flood Insurance : | NO |

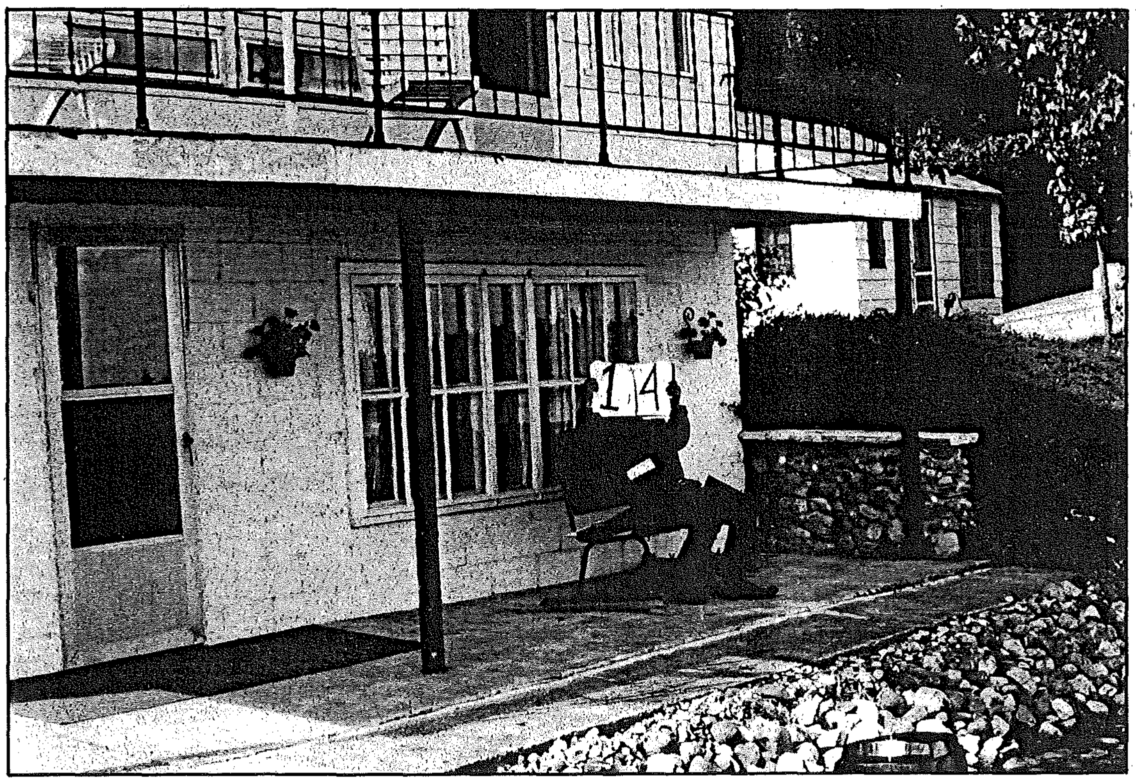


| | | |
|---|---|---|
| Structure number : | 14 | |
| Name : | Pitschka, Ernest | |
| Address : | R.R. 1 Box 20<br>Kimball, MN 55353-9801 | |
| Legal Description : | Sec. 24, Twp. 122, R. 29<br>.52 A. N. 100 Ft. Of S. 626 1/2 Ft.<br>Of Lot 1 | |
| Walkout/1stFl Elev : | 1134.15 | |
| Grd Elev : | | |
| Basement : | YES | |
| Walkout : | YES | |

Market Value

| | |
|---|---|
| Buildings : | $25,800.00 |
| Land : | $18,000.00 |
| Total : | $43,800.00 |

Flood Insurance : NO



| | |
|---|---|
| Structure number : | 15 |
| Name : | Beste, W.H. |
| Address : | 743 Mary St.<br>St. Paul, MN 55119-3852 |
| Legal Description : | Sec. 24, Twp. 122, R. 29<br>.26 A. N'ly 50 Ft. Of S. 676 1/2 Ft.<br>Of Government Lot 1 |
| Walkout/1stFl Elev : | 1138.14 |
| Grd Elev : | 1136.7 |
| Basement : | NO |
| Walkout : | NO |

Market Value

| | |
|---|---|
| Buildings : | $4,600.00 |
| Land : | $9,000.00 |
| Total : | $13,600.00 |

Flood Insurance : NO

# APPENDIX E

## ROAD PROFILE/ACCESS ROAD ON SOUTH END OF LAKE CARNELIAN

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WATERS

# 73-38

# CARNELIAN LAKE

STEARNS COUNTY

## ROAD PROFILE

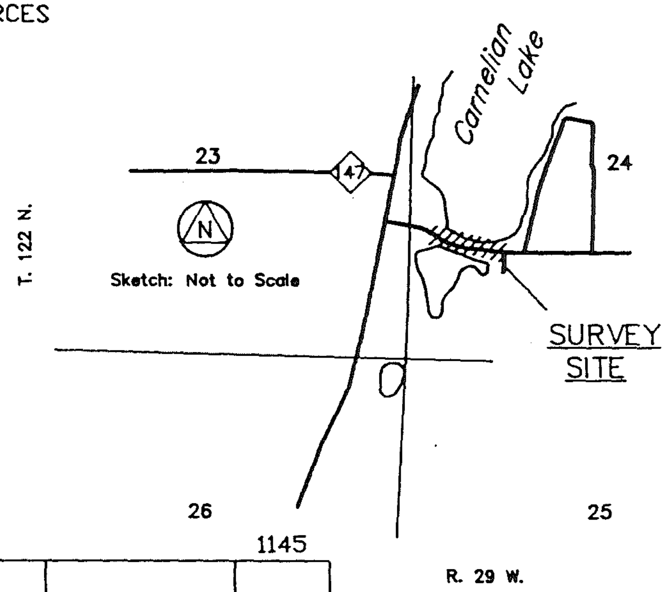
SEC. 24, T. 122 N., R. 29 W.

REQ.: 87-

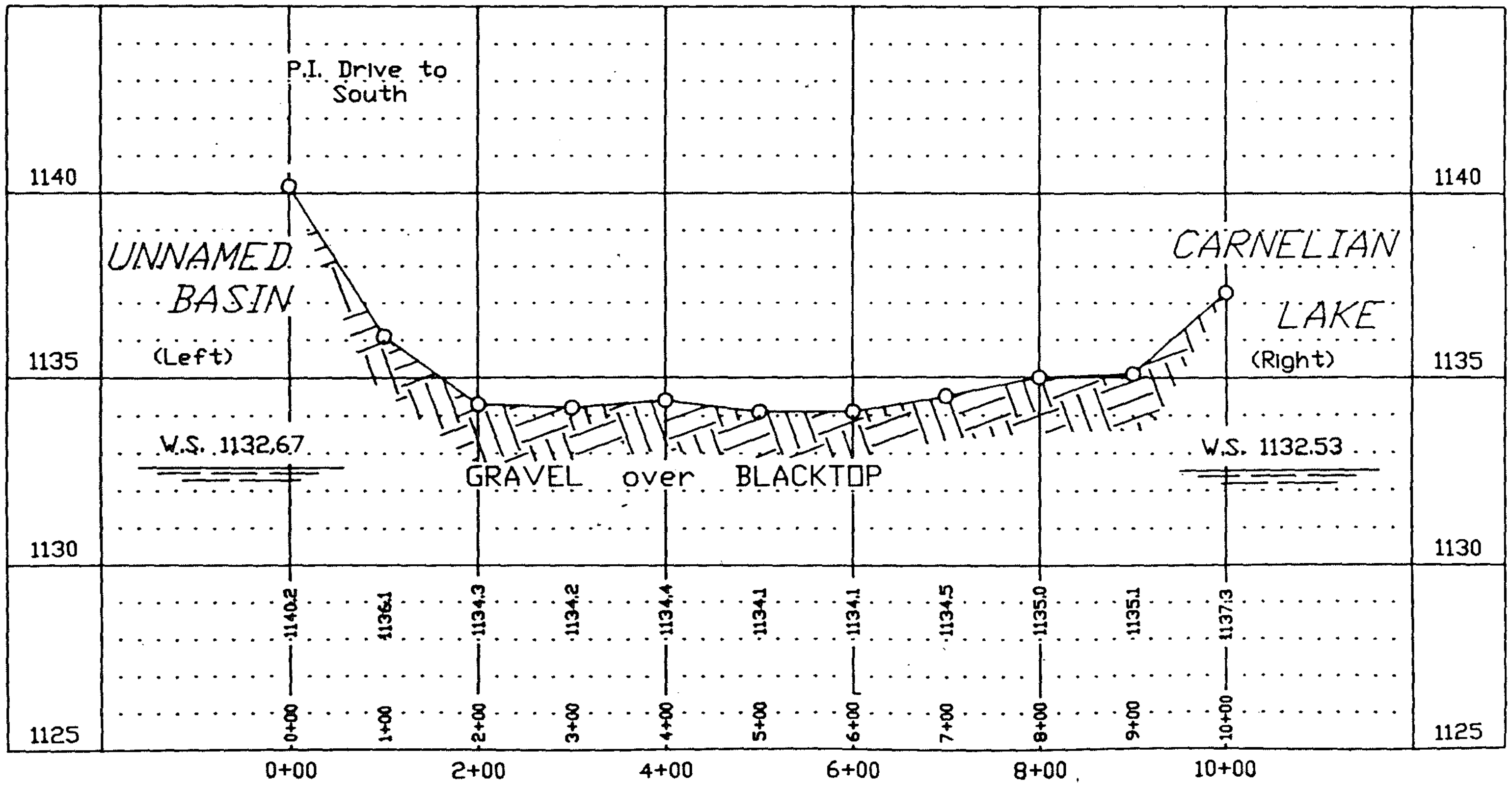
SURVEY: RRP 9-3-86

DRAWN: JAJ 12-3-86

DATUM: NGVD 1929 from Carnelian Lake Gage




**NOTE: Ultimate Lake Runout Elevation 1145 ±5 Feet**




ROAD PROFILE (24' Wide)

SCALE

Horizontal 1" = 200'

Vertical 1" = 5'

# QUATERNARY GEOLOGY OF MINNESOTA

The Quaternary Period comprises the "Great Ice Age" or Pleistocene Epoch, which began about 2 million years ago and ended only about 10 thousand years ago. It also includes the Holocene or Recent Epoch, which spans the last 10 thousand years. By comparison with bedrock formations in Minnesota, which range from about 100 million to more than 3,500 million years in age, Quaternary formations represent only a very small part of the state's geologic history. However, glacial drift spread by Pleistocene ice sheets covers most of Minnesota and ranges to hundreds of feet in thickness, so that Quaternary geology is the major influence on topography, soils, water, and land uses--in short, the environment of Minnesota.

Quaternary geologic units are unconsolidated sedimentary materials deposited by water, wind and plant growth, and by glacial ice and meltwaters. This map portrays the distribution of Quaternary formations. Outcrops of bedrock, which are common only in the northeast and along larger river valleys in the south, are not shown on this map.

## HOLOCENE DEPOSITS

hp — PEAT—Accumulations of partially decayed vegetation, especially mosses, reeds and sedges, in wet, poorly-drained areas. Peat is valuable as an organic soil conditioner and chemical feedstock and as a potential energy resource. It is a very poor base for roads and other construction.

ha — ALLUVIUM—Sand and gravel, locally interbedded with silt, clay and organic material, deposited on present floodplains. Sand and gravel deposits, copious shallow ground water and flat terrain make alluvial plains attractive for urban and industrial development, but they are flood-prone, and sensitive to pollution. They are valuable for agriculture and wildlife.

## PLEISTOCENE DEPOSITS

There were four major ice advances in North America during the Pleistocene Epoch: the Nebraskan, Kansan, Illinoisan and Wisconsinan Glaciations. Each lasted tens of thousands of years and was followed by a warmer period when the ice melted. Each deposited sediments, called drift, over vast areas. Drift deposited during the last stage of the Wisconsinan Glaciation covers most of Minnesota and conceals evidence of older ice advances except in the southeast and southwest corners of the state.

### Redistributed Drift

Some drift deposited by glaciers was quickly eroded, transported and redeposited by water and wind in lakes, on floodplains and on land beyond the margin of the ice.

pl — GLACIAL LAKE DEPOSITS—Clay, silt and sand with local gravel bars and beaches deposited on the beds and margins of extensive lakes that existed when outlets for meltwater were blocked by ice or by glacial deposits which have now eroded away. Major glacial lakes were: Lake Agassiz in northwestern and north-central Minnesota, Lakes Upham and Aitkin northwest of Duluth, and Lake Minnesota south of Mankato. Due to the prevalence of fine silt and clay, glacial lake deposits present drainage and construction problems and tend to be poor ground-water sources. They form extensive areas of flat farmland, notably the Red River Valley.

pt — TERRACE DEPOSITS—Stratified sand and gravel with some interbedded silt and clay occurring along stream valleys above the level of present floodplains. During glacial melting, stream-flow was larger than at present, and floodplains were built up by glacial sediments. Recent streams have cut into older floodplains leaving remnants as terraces. Terrace tops are commonly flat and well drained. They are attractive for residential and industrial development, but they also contain valuable sand and gravel resources.

pe — LOESS—Eolian silt and fine sand blown from unvegetated drift exposed along major glacial streams. Loess is shown on the map for areas where it is commonly more than 2 meters (6.5 feet) thick. Excellent agricultural soils are formed in loess.

po — OUTWASH—Sand, silt and gravel carried from glaciers by meltwater and spread over wide areas. The deposits are typically sorted into discontinuous and interfingering beds of silt, sand and gravel called stratified drift. Outwash plains have flat topography, sandy soils, and many gravel deposits. Shallow ground water is commonly abundant for irrigation.

### Late Wisconsinan Drift Deposited Directly From Glaciers

The ice of each glaciation accumulated in northern Canada and moved southward in a complex series of tongue-like extrusions or lobes. Near the center of ice accumulation, the moving ice scoured the land surface down to hard bedrock and picked up a load of rock fragments and soil. Farther from the center the ice deposited this drift from its base. Areas of ice-scoured, exposed bedrock occur mainly in northeastern Minnesota; deposition predominated throughout the rest of the state. Drift deposited directly from ice is called till. In general, till is an unsorted mixture of all sizes of rock from boulders to clay and "rock flour." It tends to be stiff, stony and impervious. Till of different lobes differs in composition depending on the geology "upstream" along the path of the advancing ice.

Till deposited from the base of an ice lobe forms a smooth to undulating blanket called a ground moraine. Such till is stiff and compact; it yields little ground water.

Till deposited at ice margins or from stagnating masses of melting ice forms irregular pitted to hilly topography with many ponds and lakes. These landforms are called end moraines, recessional moraines and stagnation moraines. These deposits may contain pockets of sand, gravel and boulders with some local ground water.

pms / pmh — DES MOINES LOBE TILL—Smooth to undulating moraine (pms) and pitted to hilly moraine (pmh). The Des Moines lobe is the most recent glacial lobe. It advanced through the Red River Valley into Iowa. Sublobes extended eastward into the St. Louis River basin and northeastward across Minneapolis and St. Paul, incorporating drift from earlier lobes. Des Moines lobe till is typically clay-rich. It is mainly composed of gray (olive-brown where oxidized) calcareous silt and clay, with lesser amounts of sand and gravel. Shale and limestone are diagnostic.

pss / psh — SUPERIOR LOBE TILL—Smooth to undulating moraine (pss) and pitted to hilly moraine (psh). Ice of the Superior lobe moved out of the Lake Superior basin in several pulses, spreading westward across the Mille Lacs area and southward across the Minneapolis-St. Paul area. It interacted with the partly contemporaneous Rainy lobe along the Laurentian Divide. Superior lobe till is generally reddish-brown, sandy to stony, and non-calcareous; it contains abundant fragments of volcanic, granitic, gabbroic and metamorphic rocks, red sandstone and conglomerate. Where it incorporates earlier lake deposits, it is locally silty or clayey.

prs / prh — RAINY LOBE TILL—Smooth to undulating moraine (prs) and pitted to hilly moraine (prh). The Rainy lobe moved southward into Minnesota along a broad front from Lake of the Woods almost to Lake Superior, where it met ice from the Lake Superior basin along the Laurentian divide and moved southwestward. It advanced to the vicinity of Little Falls overriding drift and perhaps encountering ice remaining from the earlier Wadena lobe. Part of the Rainy lobe drift area was later overridden by the St. Louis sublobe of the Des Moines lobe. Rainy lobe till is grayish brown (moderate brown where oxidized), non-calcareous and generally sandy with abundant fragments of granitic, metamorphic and greenstone volcanic rocks.

pws / pwh — WADENA LOBE TILL—Smooth to undulating moraine (pws) and pitted to hilly moraine (pwh). The Wadena lobe was the earliest of the Late Wisconsinan glacial lobes. A large remnant of its till and outwash survives in northwest-central Minnesota in an area that was not overridden by any of the three later lobes. A large drumlin field indicates movement of ice from the north or a little east of north. Wadena lobe till is gray (yellowish brown where oxidized) and calcareous with fragments of igneous and metamorphic rocks, some limestone and little or no shale.

### Pre-Late Wisconsinan Materials

At one time or another, prior to the Late Wisconsinan, all of Minnesota must have been covered by glaciers. Evidence is concealed beneath Late Wisconsinan drift except in the southwestern and southeastern corners of the state where there are deposits of weathered and stream-dissected drift that are older than Late Wisconsinan and could be Illinoisan or Kansan in age.

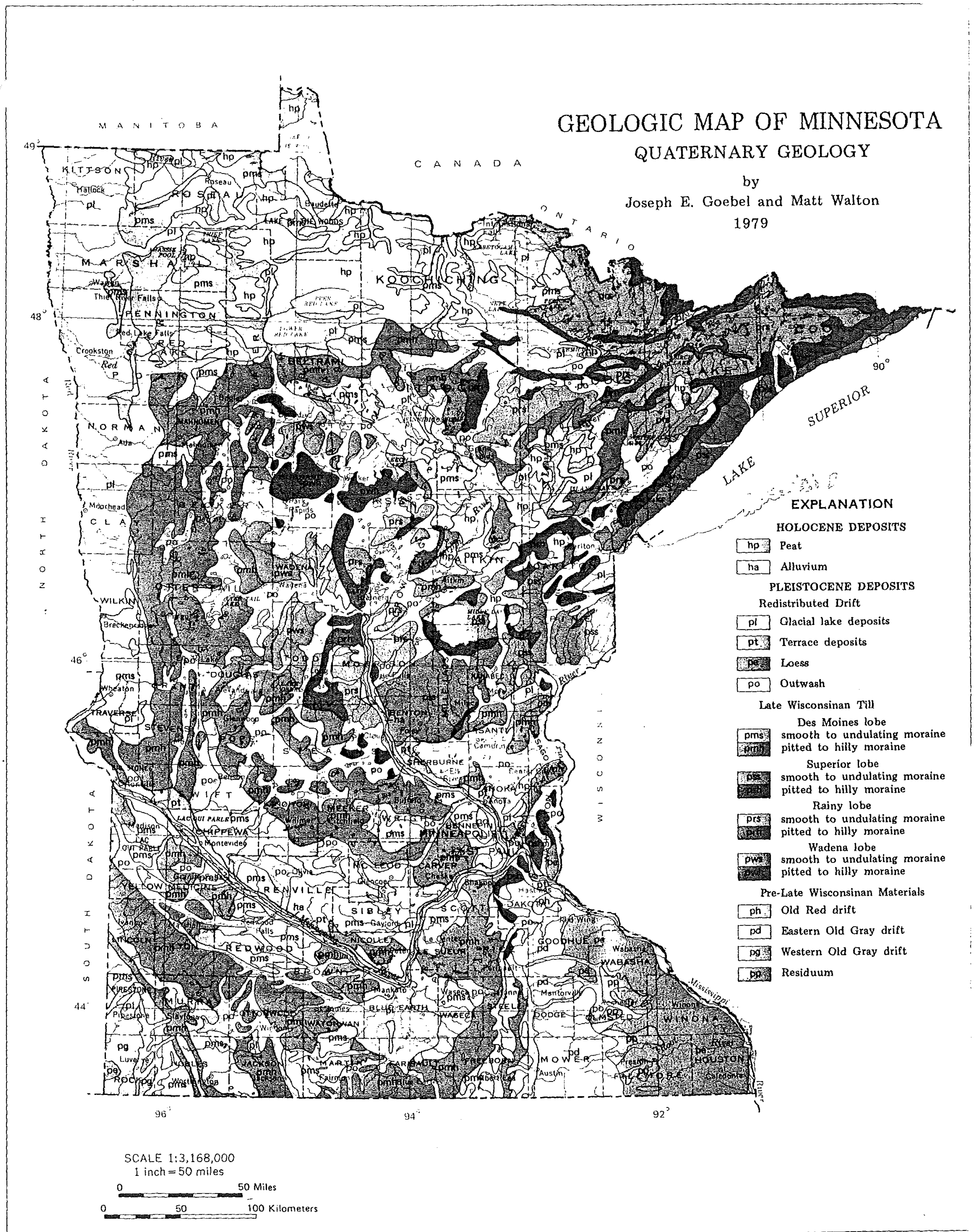
ph — OLD RED DRIFT—Moderate to dusky-brown till and outwash found mainly in Dakota and southern Washington Counties. Fragments of gabbro, felsite and red sandstone are notable. Some exposures show a distinct weathered profile overlain by younger drift.

pd — EASTERN OLD GRAY DRIFT—Moderate yellowish-brown weathered silty till and outwash. It contains fragments of igneous and metamorphic rocks, limestone and sandstone, but lacks shale. It appears to underlie Old Red Drift in southern Dakota County.

pg — WESTERN OLD GRAY DRIFT—Dark-gray, strongly weathered clayey, stream-dissected till and outwash with fragments of quartzite, granite and limestone.

pp — RESIDUUM—Soils of uncertain age and origin, including some old weathered drift and loess, on weathered pre-Quaternary rocks.

Minnesota Geological Survey
University of Minnesota
Matt Walton, Director




Published with the support of the Legislative Commission on Minnesota Resource

APPENDIX F

GEOLOGIC MAP OF MINNESOTA

Minnesota Geological Survey
University of Minnesota
Matt Walton, Director



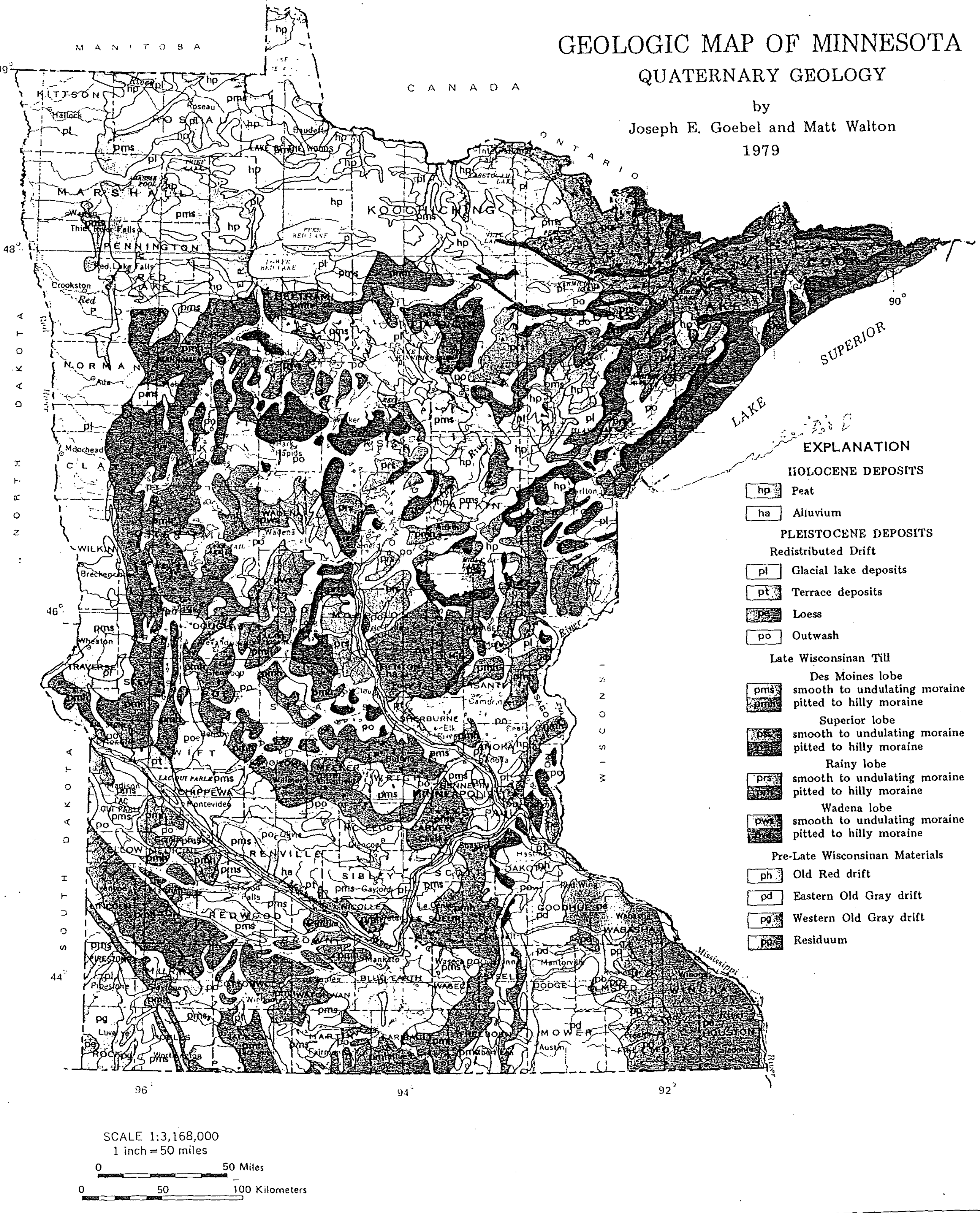
# GEOLOGIC MAP OF MINNESOTA

## QUATERNARY GEOLOGY

by

Joseph E. Goebel and Matt Walton

1979




### EXPLANATION

**HOLOCENE DEPOSITS**

- hp — Peat
- ha — Alluvium

**PLEISTOCENE DEPOSITS**

Redistributed Drift

- pl — Glacial lake deposits
- pt — Terrace deposits
- pe — Loess
- po — Outwash

Late Wisconsinan Till

Des Moines lobe
- pms — smooth to undulating moraine
- pmh — pitted to hilly moraine

Superior lobe
- pss — smooth to undulating moraine
- psh — pitted to hilly moraine

Rainy lobe
- prs — smooth to undulating moraine
- prh — pitted to hilly moraine

Wadena lobe
- pws — smooth to undulating moraine
- pwh — pitted to hilly moraine

Pre-Late Wisconsinan Materials

- ph — Old Red drift
- pd — Eastern Old Gray drift
- pg — Western Old Gray drift
- pr — Residuum

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DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WATERS

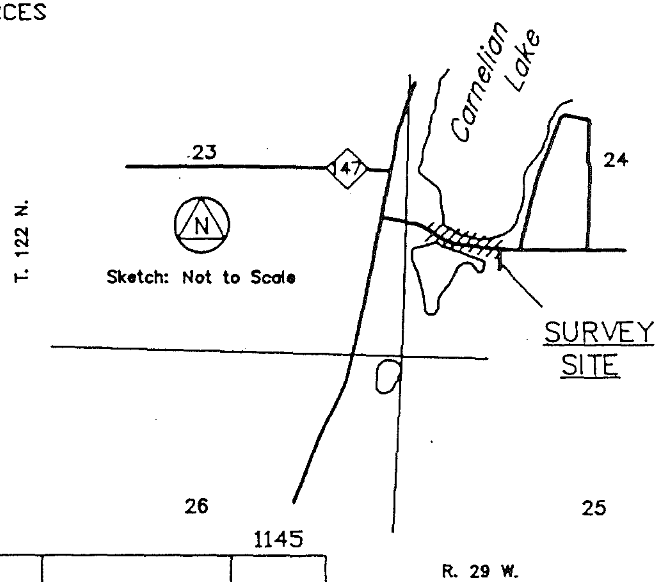
# 73-38
# CARNELIAN LAKE
STEARNS COUNTY
## ROAD PROFILE
SEC. 24, T. 122 N., R. 29 W.

REQ.: 87-

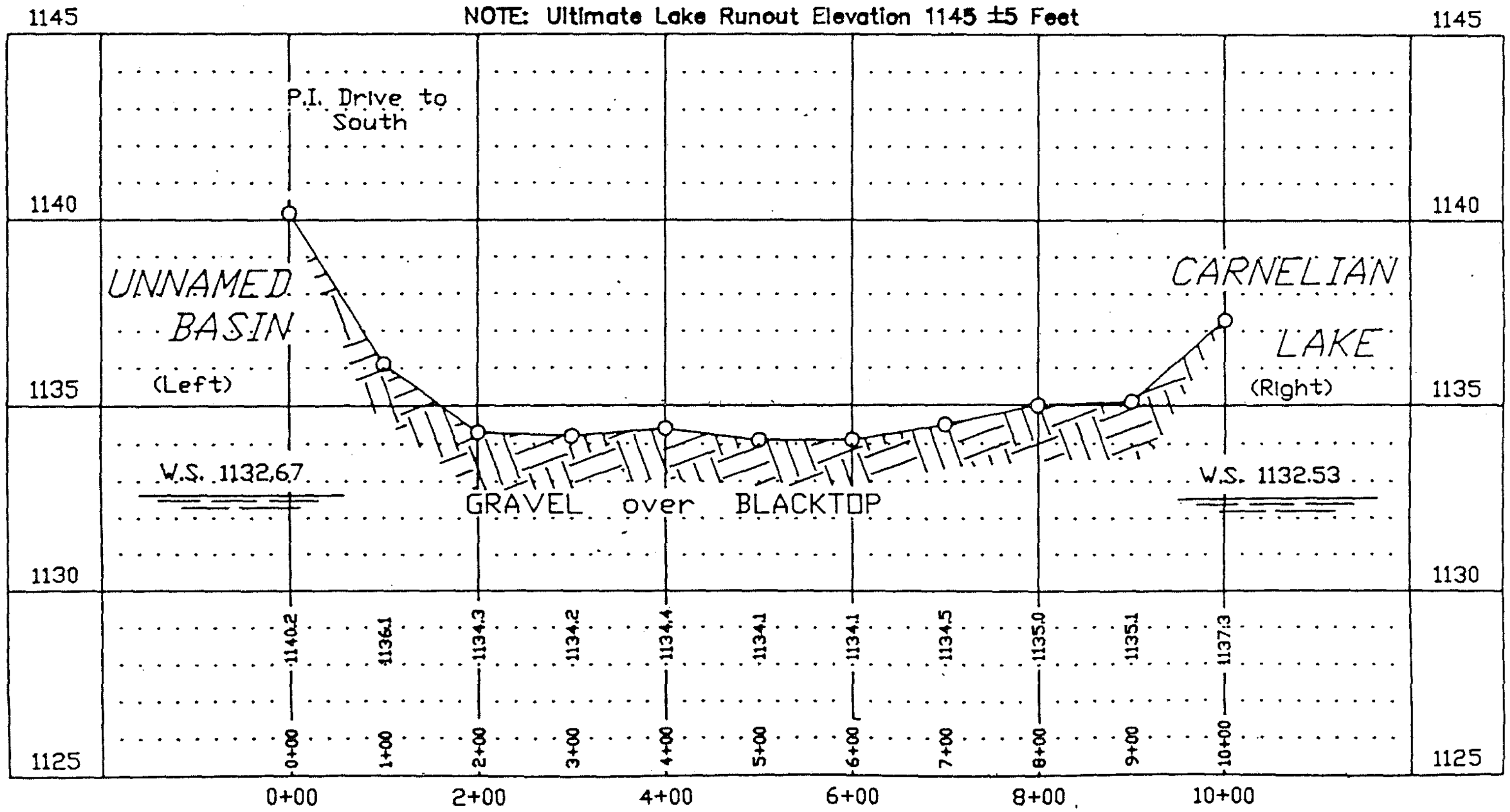
SURVEY: RRP 9-3-86

DRAWN: JAJ 12-3-86

DATUM: NGVD 1929 from Carnelian Lake Gage




NOTE: Ultimate Lake Runout Elevation 1145 ±5 Feet




ROAD PROFILE (24′ Wide)

SCALE

Horizontal 1″ = 200′

Vertical 1″ = 5′

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