

STATE OF SOUTH DAKOTA  
William J. Janklow, Governor

DEPARTMENT OF WATER AND NATURAL RESOURCES  
Warren R. Neufeld, Secretary

GEOLOGICAL SURVEY  
Duncan J. McGregor, State Geologist

Open-File Report No. 30-UR

HYDROLOGY OF WALL LAKE

by

Kelly Carter

and

Assad Barari

Science Center  
University of South Dakota  
Vermillion, South Dakota  
1981

## CONTENTS

	Page
INTRODUCTION . . . . .	i
Coring the lake bottom . . . . .	4
Water budget of the lake . . . . .	4
CONCLUSIONS AND RECOMMENDATIONS . . . . .	5
REFERENCES CITED . . . . .	6

## ILLUSTRATIONS

### Figures

1. Map showing location of test holes drilled in the vicinity of Wall Lake . . . . .	2
2. Depth contour map of Wall Lake and the location of coring sites . . . . .	3

## APPENDICES

A. Logs of test holes drilled in the Wall Lake area . . . . .	7
B. General description of cores from Wall Lake . . . . .	14
C. Water levels for Wall Lake . . . . .	16
D. Daily precipitation and evaporation at Sioux Falls, South Dakota . . . . .	17

## INTRODUCTION

This report contains the results of a hydrological study conducted by the South Dakota Geological Survey from July 2, to July 16, 1979, in the vicinity of Wall Lake, Minnehaha County, South Dakota. The purpose of the study was to identify the extent of the ground water connection to the lake.

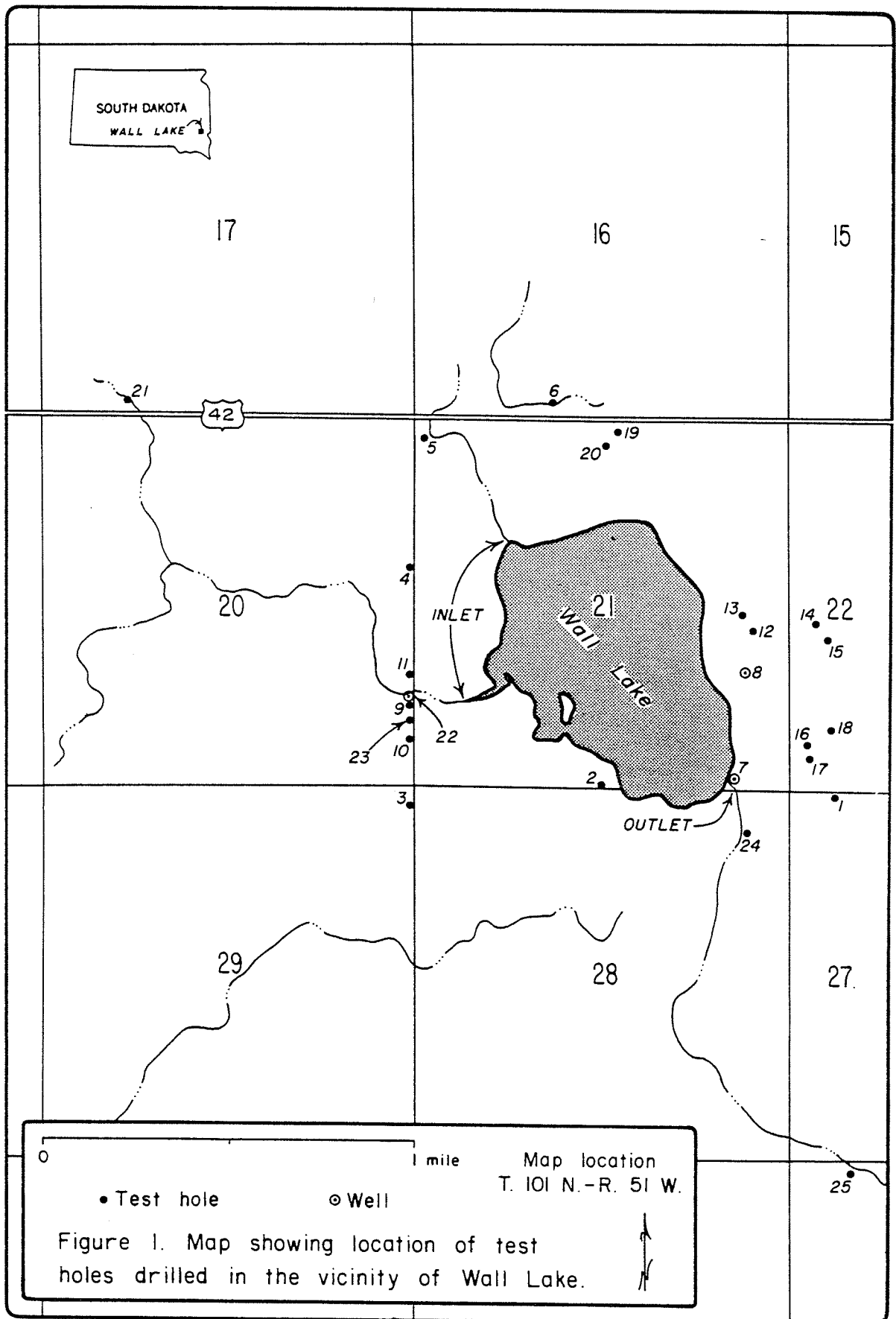
The project was financed by Minnehaha County, the Minnehaha Conservation District, the East Dakota Conservancy Sub-District, and the South Dakota Geological Survey.

Wall Lake is located approximately 10 miles west of Sioux Falls on Highway 42 (fig. 1). Wall Lake is a natural lake of glacial origin; its existence is due to the action of glacial ice which covered this part of the State in the geologic past. The terrain is undulating to nearly flat, with a relief of approximately 60 feet. At a pool elevation of 1559.5 feet above the mean sea level, the lake has a surface area of approximately 225 acres and an average depth of 9 feet (Corps of Engineers, 1979). The lake has approximately 4 square miles of contributing drainage area. Figure 2 shows the depth contour map of Wall Lake. There are two small inlets to the lake. The inlets are located on the northwest and west edges of the lake. The surface outlet to the lake is located on the southeast edge of the lake (fig. 1).

Twenty-five test holes were drilled in the area to identify the extent of the ground water connection to the lake. Observation wells were constructed in three of the test holes. The logs of the test holes are in appendix A (for map location, see fig. 1).

The results of drilling revealed that there is a small outwash deposit (sand and gravel) along the west inlet to the lake. Test hole 22 (app. A, fig. 1) penetrated a layer of sand and gravel which was 21 feet thick from a depth of 1 foot to 22 feet below the land surface. Also, layers of silty sand and gravel were penetrated from a depth of 22 to 45 feet. The depth to water in this observation well was 5.94 feet from the casing top. The sand and gravel thickness decreases in a very short distance from this location (see test holes 9, 10, 11, and 23, app. A). Test hole 10, located approximately 600 feet to the south, and test hole 11, located approximately 400 feet to the north of test hole 22, had no sand and gravel layers. Likewise, test hole 21, approximately 1 mile to the northwest and in the same drainage-way did not penetrate any sand and gravel layer.

However, test hole 8 located east of the lake, penetrated a sand and gravel layer from a depth of 6 to 17 feet. The water level in this observation well was 8.32 feet. Test hole 7, located along the outlet of the lake, had a sand and gravel layer from a depth of 1 to 9 feet. The remaining test holes drilled in



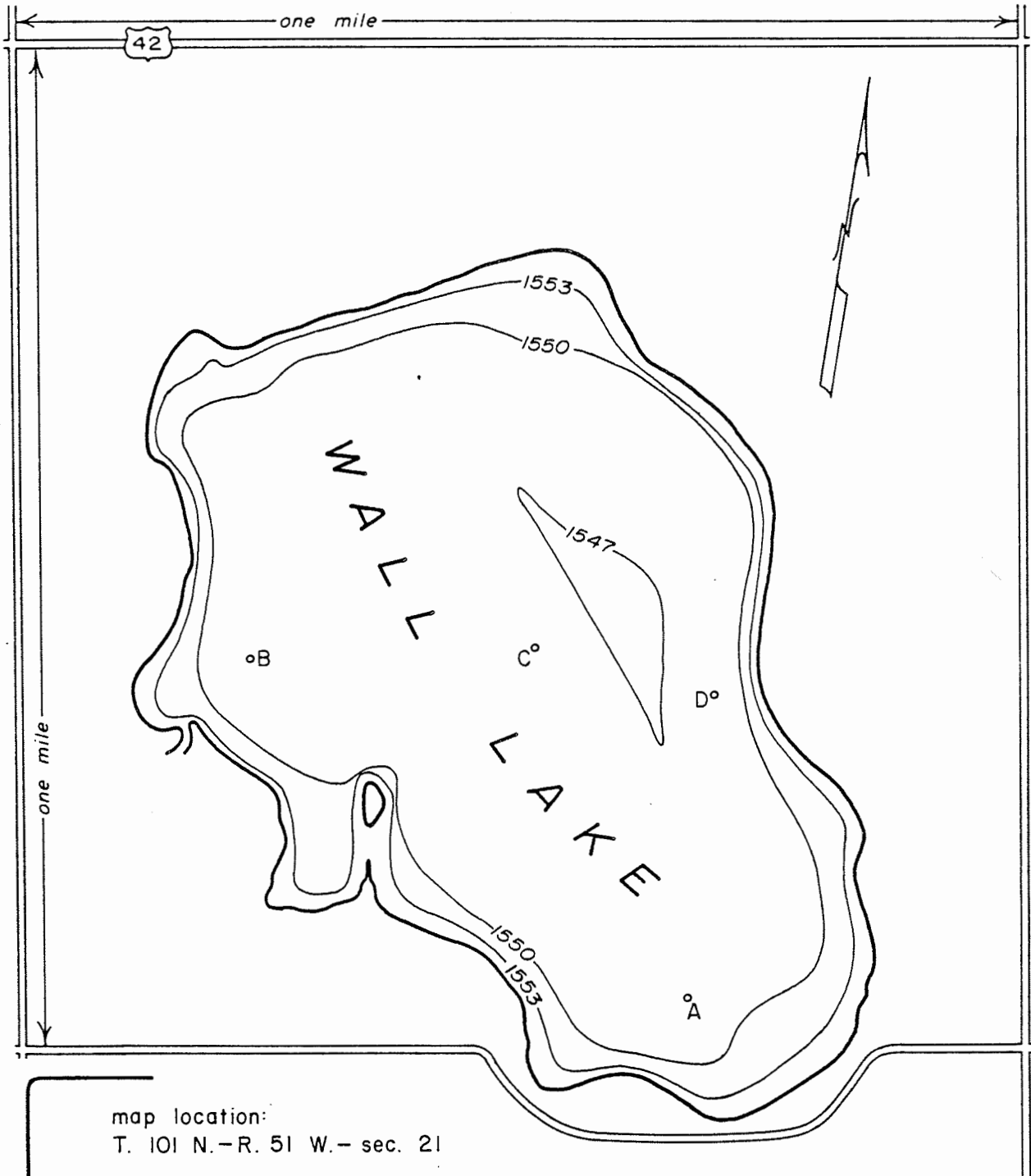


Figure 2. Depth contour map of Wall Lake and the location of coring sites. (from Corps of Engineers, 1979).

the area did not penetrate any significant thicknesses of sand and gravel.

### Coring the Lake Bottom

In February 1980, four sites were chosen for coring the lake sediments. Figure 2 shows the location of the sites. The descriptions of the cores are listed in appendix B. The core samples were sent to the U.S. Corps of Engineers in Omaha for analysis, and the results of these analyses are in an Addendum to the Wall Lake Dredging Feasibility Study by the Corps of Engineers.

### Water Budget of the Lake

In order to determine the net ground water flow to Wall Lake, the following calculations are made:

$$\Delta h = P + R_i - R_o + G_n - E$$

where

$\Delta h$  is the change in the lake level  
P is the precipitation  
 $R_i$  is runoff into the lake (surface water)  
 $R_o$  is runoff out of the lake  
 $G_n$  is net ground-water movement (into or out of the lake)  
E is the lake evaporation

All variables are expressed in terms of inches of lake level rise or fall.

No precise lake level measurements were available. The only available data were obtained from the South Dakota Department of Wildlife, Parks and Forestry (app. C). For calculation purposes, it was assumed all measurements on the lake level were made in the morning before any precipitation and evaporation had occurred.

The precipitation and evaporation data were obtained from the Sioux Falls weather station (app. D). Pan evaporation data were converted to lake evaporation by using the conversion factor 0.72 (Kohler and others, 1959), and components of inflow and outflow to the lake from July 3 to July 19, 1979 were:

Precipitation was .12 inches (app. D)  
Evaporation was 4.56 inches (app. D)  
Lake level evaporation was 3.28 inches ( $4.56 \times 0.72 = 3.28$ )  
Lake level fluctuation was -.6 inches (app C)

No significant surface inflow and outflow to the lake was observed during this period. Consequently, the previous equation could be simplified to:

$$\Delta h = F + G_n - E$$

By substituting the proper values, into the above equation, one obtains

$$\begin{aligned} -6 &= 0.12 + G_n - 3.28 \\ -2.84 &= G_n \end{aligned}$$

That is, the lake level dropped 2.84 inches (.24 feet) due to the net ground-water exchange. This decline taken over the entire area of the lake would amount to 61.20 acre feet.

$$\begin{aligned} \text{Lake Area} \times \text{Change of Lake Level} &= \text{Net Change} \\ 255 \times -0.24 &= -61.20 \text{ acre-feet} \end{aligned}$$

It should be noted that (1) the above calculation does not identify the actual ground-water recharge and discharge to and from the lake rather it gives the net ground-water exchange; (2) neither the lake level nor the surface recharge and discharge to the lake were precisely measured; and (3) the surface area of the lake was assumed to have stayed constant even though the area would have varied with the fluctuation in lake level.

Precipitation from July 26 to August 2, 1979, was 1.60 inches, and the lake level rose 4 inches during the same period (app. B). The 4-inch rise occurred even though there was 1.48 inches ( $2.06 \times 0.72 = 1.48$  inches) of evaporation. During this period no surface inflow and outflow was measured to calculate the ground-water's contribution. In any case, the data indicate that the lake level responded rapidly to precipitation. This probably indicates that the surface water contribution to the lake was more significant than that of the ground water during from July 26 to August 2, 1979.

#### CONCLUSIONS AND RECOMMENDATIONS

The results of test drilling in the area do not show any important ground-water connections to the lake. A few test holes and calculations based on limited data do show some ground-water connection to the lake .

It is recommended that more accurate lake level data be collected, and that precipitation data should be collected near the lake so as to be more representative of the Wall Lake area. The inflow and outflow should be measured. Ground-water levels should be monitored in the observation wells. Together, this

additional information would refine the different components of the lake's water budget.

#### REFERENCES CITED

Corps of Engineers, 1979, Wall Lake dredging feasibility study, Wall Lake, South Dakota, 22 p.

----- Addendum to the Wall Lake feasibility study, 15 p.

Kohler, M. A., Nordenson, T. J., and Baker, D. R., 1959, Evaporation maps for the United States: U.S. Weather Bureau technical Paper no. 37, 13 p., pls. 1-4.

U.S. Department of Commerce, Climatological data for South Dakota: July 1979, v. 84, no. 7, and August 1979, v. 84, no. 8.



APPENDIX A

Logs of test holes drilled in the Wall Lake area  
(for map location, see fig. 1)

The locations are given as quarter sections, section number, township, and range.

All elevations have been estimated using a 7 1/2 minute topographic base and are presented in feet above mean sea level.

Test Hole 1

Location: NE NW NW NW sec. 27, T. 101 N., R. 51 W.

Elevation: 1580

Date Drilled: July 5, 1979

0- 1 Topsoil  
1- 13 Clay, brown, silty, sandy, pebbly (oxidized till)  
13- 70 Clay, gray, silty, sandy, pebbly (unoxidized till)

\* \* \* \*

Test Hole 2

Location: SW SW SW SE sec. 21, T. 101 N., R. 51 W.

Elevation: 1560

Date Drilled: July 5, 1979

0- 1 Topsoil  
1- 18 Clay, yellow-brown, sandy, pebbly (oxidized till)  
18- 31 Clay, brown, silty, sandy, pebbly  
31- 60 Clay, dark gray, silty, sandy, pebbly

\* \* \* \*

Test Hole 3

Location: SE NE NE NE sec. 29, T. 101 N., R. 51 W.

Elevation: 1602

Date Drilled: July 5, 1979

0- 1 Topsoil  
1- 23 Clay, yellow, silty, sandy, pebbly  
23- 60 Clay, dark gray with rust spots, sandy, silty, pebbly

\* \* \* \*

Test Hole 4

Location: NE SE SE NE sec. 20, T. 101 N., R. 51 W.

Elevation: 1576

Date Drilled: July 6, 1979

Test Hole 4 -- continued.

0- 10 Sand, brown to orange, fine, gravel, well-rounded  
10- 27 Clay, yellow, sandy, silty, pebbly (weathered till)  
27- 57 Clay, gray, sandy, silty, pebbly (till)

\* \* \* \*

Test Hole 5

Location: NW NW NW NW sec. 21, T. 101 N., R. 51 W.

Elevation: 1570

Date Drilled: July 9, 1979

0- 1 Topsoil, black, sandy  
1- 5 Sand, fine to medium, with clay  
5- 21 Clay, yellow-brown, silty, sandy, pebbly (weathered  
till)  
21- 66 Clay, gray, silty, sandy, pebbly (till)

\* \* \* \*

Test Hole 6

Location: SE SW SE SW sec. 16, T. 101 N., R. 51 W.

Elevation: 1573

Date Drilled: July 9, 1979

0- 3 Topsoil, black, sandy  
3- 16 Clay, brown, sandy, silty, pebbly (weathered till)  
16- 67 Clay, brownish-gray, sandy, silty, pebbly (till)

\* \* \* \*

Test Hole 7

Location: SE SW SE SE sec. 21, T. 101 N., R. 51 W.

Elevation: 1560

Date Drilled: July 9, 1979

0- 1 Topsoil, black, sandy  
1- 9 Sand, fine to medium, with clay, buff colored  
9- 22 Clay, yellow-brown, silty, sandy, pebbly (weathered  
till)  
22- 76 Clay, gray, silty, sandy, pebbly (till)

Observation well placed in the shallow sand

\* \* \* \*

Test Hole 8

Location: SE SW NE SE sec. 21, T. 101 N., R. 51 W.

Elevation: 1572

Date Drilled: July 10, 1979

0- 3 Topsoil, black, clayey, sandy  
3- 6 Clay, yellow, sandy

Test Hole 8 -- continued.

6- 17 Sand, fine, gravel, well-rounded  
17- 65 Clay, brown to gray, silty, very sandy and pebbly  
65 Very hard rock, possibly quartzite or granite

Observation well 1: 15 feet of plastic casing and 3-foot sandpoint

\* \* \* \*

Test Hole 9

Location: NE NE SE SE sec. 20, T. 101 N., R. 51 W.

Elevation: 1562

Date Drilled: July 10, 1979

0- 1 Clay, yellow, silty, sandy, pebbly (weathered till)  
1- 7 Sand, fine with silt  
7- 13 Gravel, fine to medium, with sand, fine to coarse  
13- 15 Clay, yellow, silty, sandy, pebbly  
15- 31 Gravel, fine to medium, with sand and silt  
31- 86 Clay, gray, silty, sandy, and very pebbly (till)

\* \* \* \*

Test Hole 10

Location: NE SE SE SE sec. 20, T. 101 N., R. 51 W.

Elevation: 1571

Date Drilled: July 10, 1979

0- 20 Clay, brown, sandy, pebbly (weathered till)  
20- 57 Clay, gray, sandy, pebbly (till)

\* \* \* \*

Test Hole 11

Location: SE SE NE SE sec. 20, T. 101 N., R. 51 W.

Elevation: 1570

Date Drilled: July 10, 1979

0- 1 Topsoil  
1- 11 Clay, yellow-brown, silty, sandy, pebbly (weathered till)  
11- 66 Clay, gray, silty, sandy, pebbly (till)

\* \* \* \*

Test Hole 12

Location: SW NE NE SW sec. 21, T. 101 N., R. 51 W.

Elevation: 1582

Date Drilled: July 11, 1979

0- 3 Topsoil, black, clayey  
3- 11 Clay, brown, sandy, pebbly

Test Hole 12 -- continued.

11- 18 Sand, fine to gravel, well-rounded  
18- 67 Clay, gray, sandy, silty, pebbly (till)

\* \* \* \*

Test Hole 13

Location: SW SE SE NE sec. 21, T. 101 N., R. 51 W.

Elevation: 1579

Date Drilled: July 11, 1979

0- 1 Topsoil, black, sandy, silty  
1- 5 Sand, rust, fine to gravel  
5- 20 Clay, yellow, silty, sandy, very pebbly (weathered  
till)  
20- 50 Clay, gray, silty, sandy, pebbly (till)  
50- 66 Clay, gray, silty, very sandy, pebbly

\* \* \* \*

Test Hole 14

Location: SW NW NW SW sec. 22, T. 101 N., R. 51 W.

Elevation: 1580

Date Drilled: July 11, 1979

0- 3 Topsoil, black, sandy  
3- 6 Sand, rusty, fine, gravel, well-rounded  
6- 15 Clay, brown, sandy, silty, pebbly (weathered till)  
15- 67 Clay, gray, sandy, silty, pebbly (till)

\* \* \* \*

Test Hole 15

Location: SE NW NW SW sec. 22, T. 101 N., R. 51 W.

Elevation: 1567

Date Drilled: July 11, 1979

0- 1 Topsoil, black, clayey, sandy  
1- 15 Clay, yellow-brown, silty, sandy, pebbly (weathered  
till)  
15- 76 Clay, gray, silty, sandy, somewhat pebbly (till)

\* \* \* \*

Test Hole 16

Location: NW SW SW SW sec. 22, T. 101 N., R. 51 W.

Elevation: 1580

Date Drilled: July 11, 1979

0- 2 Topsoil, black, clayey, sandy  
2- 6 Clay, yellow, silty  
6- 19 Sand, fine to gravel, silty, well-rounded

Test Hole 16 -- continued.

19- 24 Clay, brown, sandy, silty, pebbly (weathered till)  
24- 57 Clay, gray, sandy, silty, pebbly (till)

\* \* \* \*

Test Hole 17

Location: NW SW SW SW sec. 22, T. 101 N., R. 51 W.

Elevation: 1580

Date Drilled: July 12, 1979

0- 1 Topsoil, black, sandy  
1- 9 Clay, yellow, silty, sandy, pebbly (weathered till)  
9- 24 Clay, yellow, silty, sandy, very pebbly  
24- 33 Clay, gray, silty, sandy, very pebbly (till)  
33- 56 Sand, silt to medium, subrounded with much gray clay  
(sandy till)

\* \* \* \*

Test Hole 18

Location: SE NW SW SW sec. 22, T. 101 N., R. 51 W.

Elevation: 1570

Date Drilled: July 12, 1979

0- 4 Topsoil, black, clayey  
4- 7 Clay, yellow, silty  
7- 21 Clay, brown, sandy, silty, pebbly (weathered till)  
21- 67 Clay, gray, sandy, silty, very pebbly after 25 feet  
(till)

\* \* \* \*

Test Hole 19

Location: SE NE NE NW sec. 21, T. 101 N., R. 51 W.

Elevation: 1560

Date Drilled: July 12, 1979

0- 1 Topsoil, black, sandy, clayey  
1- 15 Clay, buff, silty, sandy, pebbly (weathered till)  
15- 55 Clay, gray, silty, sandy, pebbly (till)  
55- 76 Sand, gray, very clayey, silty (very sandy till)

\* \* \* \*

Test Hole 20

Location: NW SE NE NW sec. 21, T. 101 N., R. 51 W.

Elevation: 1560

Date Drilled: July 12, 1979

0- 4 Topsoil, black, sandy  
4- 7 Clay, dark brown, sandy, silty  
7- 13 Clay, brown, sandy, silty, pebbly

Test Hole 20 -- continued.

13- 17 Sand, gray, fine, silty  
17- 25 Clay, brown, sandy, silty, pebbly  
25- 27 Clay, black, very little sand or silt  
27- 60 Clay, gray, sandy, pebbly, very silty (till)

\* \* \* \*

Test Hole 21

Location: SE SE SW SW sec. 17, T. 101 N., R. 51 W.

Elevation: 1575

Date Drilled: July 12, 1979

0- 3 Topsoil, black, silty, sandy  
3- 25 Clay, yellow-brown, silty, sandy, pebbly (weathered  
till)  
25- 46 Clay, gray, silty, sandy, pebbly (till)

\* \* \* \*

Test Hole 22

Location: NE NE SE SE sec. 20, T. 101 N., R. 51 W.

Elevation: 1561

Date Drilled: July 13, 1979

0- 1 Topsoil, black, sandy  
1- 15 Sand, rusty, fine, gravel  
15- 22 Sand, medium, silt  
22- 45 Silty sand and gravel, somewhat sorted in layers,  
3 to 5 feet thick  
45- 66 Clay, gray, silty, sandy, pebbly (till)

Observation well 2: 38 feet of plastic casing and  
3-foot sandpoint

\* \* \* \*

Test Hole 23

Location: SE NE SE SE sec. 20, T. 101 N., R. 51 W.

Elevation: 1570

Date Drilled: July 13, 1979

0- 5 Sand, rusty, fine to coarse, silty  
5- 24 Clay, brown, sandy, pebbly  
24- 33 Sand, fine, gravel, silty, well-rounded  
33- 35 Sand, gray, fine, very silty  
35- 57 Clay, gray, sandy, silty, pebbly (till)

\* \* \* \*

Test Hole 24

Location: SE NW NE NE sec. 28, T. 101 N., R. 51 W.

Elevation: 1560

Date Drilled: July 13, 1979

0- 1	Topsoil, black, clayey, sandy
1- 21	Clay, yellow, silty, sandy, pebbly (weathered till)
21- 56	Clay, gray, silty, sandy, pebbly (till)

\* \* \* \*

Test Hole 25

Location: NW NE NW NW sec. 34, T. 101 N., R. 51 W.

Elevation: 1550

Date Drilled: July 16, 1979

0- 3	Clay, brown, sandy
3- 6	Sand, fine, gravel, well-rounded
6- 30	Clay, grayish-brown, sandy, silty, pebbly
30- 45	Clay, gray, sandy, silty, pebbly (till)
45- 52	Silt, sandy, some clay samples
52- 67	Clay, gray, sandy, silty, gravelly (till)

\* \* \* \*

## APPENDIX B

### General Description of cores from Wall Lake

February 22, 1980

U.S. Army Corps of Engineers  
Omaha District  
215 North Seventeenth Street  
Omaha, NE 68102

ATTENTION MROED-HF (John Anderson)

Dear Mr. Anderson:

Under separate cover the cores taken from the Wall Lake are being shipped to your office.

The locations of the sample sites are plotted on the enclosed air photo. In all samples the upper 6 inches to a foot of the sediments might have been compacted during the coring. The general descriptions of the sites and samples are:

#### SITE A

Located approximately 400 feet east-northeast of the Roller Rink which is located on the southwest shore of the lake.

Sample A was collected from Site A. The depth to the bottom of the lake from the surface of the ice was approximately 11 feet. The core is approximately 26 inches long. This sample had more sand than any other sample collected from the lake.

#### SITE B

Located approximately 450 feet east-northeast of the inlet to the lake located on the west side of the lake. The depth to the bottom of the lake from the surface of the ice was approximately 11 feet. Three samples were collected from this site.

Sample B was 23 inches long.  
Sample B2 was 18 inches long.  
Sample B3 was 16 inches long.

It was intended that the top of Sample B2 to start from 23 inches below the bottom of the lake, but some caving



Appendix B -- continued.

had occurred and Sample B2 might have some sediments from the upper deposits. The same problem exists in Sample B3.

#### SITE C

Located approximately 1600 feet east of the inlet located on the west side of the lake. The depth to the bottom of the lake from the surface of the ice was 12 feet 6 inches.

Two samples were collected from this site:

Sample C1 was 32 inches long.

Sample C2 was 24 inches long.

It was intended that the top of Sample C2 start from 32 inches below the bottom of the lake, but some caving had taken place and Sample C2 might have some sediments from the upper deposits.

#### SITE D

Located approximately 225 feet west of the east shore of the lake. The depth to the bottom of the lake from the surface of the ice was 12 feet 6 inches.

Sample D was collected from Site D.

The core is 2 feet 3 inches long.

If you have any further questions, please feel free to call or write our office.

Sincerely,

Assad Barari  
Geologist

For the State Geologist



South Dakota  
Department of  
Wildlife, Parks and Forestry

APPENDIX C  
Water Levels for  
Wall Lake

Division of Administration

September 24, 1979

Mr. Assad Barari  
South Dakota Geological Survey  
University of South Dakota  
Vermillion, SD 57069

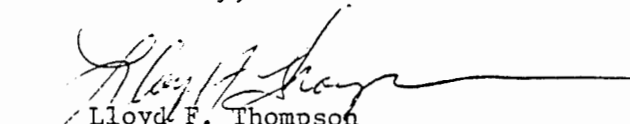
Dear Mr. Barari:

I am submitting the measurements taken by our Conservation Officer stationed at Sioux Falls. Be advised that these are more of an estimate than a measurement. No precision instruments were used to obtain them.

Wall Lake - Minnehaha County - 1979

July 3,	12,	19,	26,	August 2
-2 in.	-5 in.	-8 in.	-8 in.	-4 in.

Sincerely,

  
Lloyd F. Thompson  
Deputy Secretary

LFT/ld

APPENDIX D

Daily precipitation and evaporation at  
Sioux Falls, South Dakota\*

Day of Month	Precipitation in inches	Evaporation in inches
July 1	.01	.31
2		.34
3		.36
4	Trace	.41
5		.25
6	Trace	.32
7		.17
8		.19
9		.22
10	Trace	.27
11		.34
12	.04	.37
13	.09	.30
14		.31
15		.31
16		.34
17		.25
18		.15
19	.08	.33
20	.31	.23
21	.11	.39
22	.38	--
23		.30
24	.02	.37
25		.09
26		.29
27	Trace	.27
28		.14
29	1.59	--
30	.01	.86
31		.35
August 1		.15
2	.35	.35

\*U.S. Department of Commerce, Climatological Data for South Dakota, July 1979, v. 84, no. 7, and August 1979, v. 84, no. 8