No. 865-3Water Division No. 3 Big Sioux River
(Blanks to be Filled by the Engineer for the W. R. C.)STATE WATER RESOURCES COMM.
PIERRE SOUTH DAKOTA**APPLICATION FOR PERMIT****To appropriate Water within the State of South Dakota**

(NOTE—Draw a line through items not applicable.)

1. Name of applicant South Dakota Department of Game, Fish and Parks
Postoffice address Pierre, County Hughes, State South Dakota

- I. If a corporation _____
(a) Name of same _____
(b) Date and place of incorporation _____
(c) Amount of capital stock _____
(d) Amount paid in _____
(e) Names and addresses of directors _____

(NOTE—A certified copy of articles of incorporation must accompany the application.)

II. Method of accomplishing the work and financial resources of the applicant:

- (a) Method of accomplishing work: (Whether by contract, employment of others, or by direct labor)

- (b) Cash on hand, \$ _____ (c) Treasury stock, \$ _____
(d) Bonds to be issued, \$ _____ (e) Other resources, \$ _____

2. Name of diversion work BEAVER LAKE - Minnehaha
As required to fill lake to outlet level - approximately 975
3. Amount of water claimed acre feet per year cubic feet per second _____
4. Source of water supply Local watershed run-off
One point in the watershed located in the NE $\frac{1}{4}$ SE $\frac{1}{4}$ of Sec. 14,
5. Location of point of diversion T 102, R 52
_____ on _____ bank _____ County.
6. Annual period or periods during which water is to be used all year round
7. To be used for:

I. Irrigation or domestic use; Gravity, overhead sprinkling or combination system?

- (a) Number of acres to be irrigated _____ acres.

- (b) Legal subdivisions to be irrigated _____

(NOTE—A list of lands to be irrigated, giving each subdivision and fraction with acreage thereof, should be written here, or may be appended as a part of this application. Same must also be shown on accompanying map.)

- (c) Statement as to domestic use (giving location, etc.) To the ordinary high water mark
of the inundated portions of Sec. 14 and 15, T 102, R 52

II. Stockwatering, mining, milling, power, fish culture, fire protection and public recreation:

- (a) Nature of use
- Public recreational purposes

Name any of the above uses claimed

- (b) Amount of power to be generated _____ horse power.

Amount claimed for engine cooling _____

- (c) Location of plant _____

- (d) Method of developing power _____

- (e) Point where water will be returned to stream _____

8. Estimated cost of work:

(a) Head Gates, \$----- (b) Pumping plant, \$-----
(c) Fluming, \$----- (d) Canal-earth, \$----- Rock, \$-----
(e) Other structures ----- \$----- Total, \$-----

9. Description of diversion works:

I. Nature of works: (Reservoir, dam, ditch, flume, pumping plant, etc.)

II. Dimensions of works. Information requested not applicable. Beaver Lake is a
(a) Dam: Height ----- feet; length at bottom ----- feet; length at top -----

----- feet; thickness at bottom ----- feet; thickness at top -----
feet; slope at front water face -----; slope at back face -----
material used in construction -----

(b) Reservoir: Capacity when filled ----- acre feet. Surface area at highwater
mark 320 ----- acres.

DEPTH AT OUTLET-Feet	SURFACE AREA AT EACH ----- FEET DEPTH AT OUTLET--ACRES	ACRE-Feet CAPACITY

(c)* Head gate: Width ----- feet; height ----- feet;
Material -----

(d) Canal: Total length ----- miles.

LOCATION BELOW HEADGATE	DEPTH	BOTTOM WIDTH	WIDTH AT WATER-LINE	GRADE PER MILE
At ----- Mile	----- feet	----- feet	----- feet	----- feet
At ----- Mile	----- feet	----- feet	----- feet	----- feet
At ----- Mile	----- feet	----- feet	----- feet	----- feet
At ----- Mile	----- feet	----- feet	----- feet	----- feet
At ----- Mile	----- feet	----- feet	----- feet	----- feet
At ----- Mile	----- feet	----- feet	----- feet	----- feet

(Give dimensions where reductions in size are made.)

10. Time required for completion of work ----- years. Not applicable - a meandered lake

11. Time required for complete application of water to the proposed beneficial use ----- years.

12. Choice of newspaper for publication of notice of intention to appropriate -----

STATE OF SOUTH DAKOTA

County of Hughes } ss.

I, Walter J. Fillmore, being first duly sworn
on my oath depose and say: That my relation to the above described undertaking is that of owner, that I have
read the above foregoing statement, examined the map accompanying the same, and that I know of my own
personal knowledge that the matters therein stated and shown are true.

Signed *WJ Fillmore*

Subscribed and sworn to before me this 25 day of September 1964

Edward B. Johnson
Notary Public (or other qualified officer.)

Remarks by State Water Resources Commission:

"Vested right" claimed

STATE OF SOUTH DAKOTA

County of

Hughes

ss.

Pierre, South Dakota, December 20, 1962

This is to certify that the foregoing application was received by the Commission at 4:00 o'clock

a.m. upon the 27th day of September, 1961.

State Water Resources Commission

By:

for Chief Engineer, Executive Officer

Number of permit 865-3

Date of first receipt of application September 27, 1961

Date of return to applicant for correction, amendments or changes required as follows: , 19

Date of receipt of corrected application , 19

Date from which applicant may claim right 1889, 19

Approved December 20, 1962, Recorded in Book 7 Page 295

This is to certify that we have examined the foregoing application for a permit to appropriate water of the State of South Dakota, and we hereby grant the same as stated herein, subject, however, to the following limitations and conditions:

1st. The equivalent of at least one-fifth of the work above specified is ~~to be~~ completed ~~on or before~~

2nd. The whole of said work is ~~to be~~ completed ~~on or before~~

3rd. The limit of time for proof of beneficial use of water appropriated in accordance herewith is

Completed, 19
4th. The water appropriated shall be used for the purpose of public recreation

5th. The prior right of all persons who, by compliance with the laws of the State of South Dakota, have acquired a right to the use of water must not be injuriously affected by this appropriation.

6th. The amount of the appropriation herein granted shall not exceed 975 acre feet annually ~~cubic feet per second~~; neither shall it exceed the capacity of the above described system of diversion works, nor the least amount of water that experience may hereafter indicate as necessary for the production of crops in the exercise of the best husbandry; and further, said appropriation must be limited to not more than one-seventieth (1/70) of one cubic foot of water per second of time for each acre of land to which water is actually

used for public recreation

and beneficially applied for irrigation on or before June 30, 1955; said water to be used during the following described annual period:

continuously
Witness my hand this 20th day of DECEMBER, 1962.

State Water Resources Commission

By:

Chief Engineer, Executive Officer

Certificate of Construction Issued December 20, 1962

Water License Issued December 20, 1962

Permit No. 865-3Water Division No. 3 Big Sioux River Water District**Certificate of Completion of Works**

TO ALL WHOM IT MAY CONCERN:

This is to Certify, That the Department of Game, Fish and Parks

of Pierre, County of Hughes, and State of South Dakota,
 the holder of Vested Right of Permit No. 865-3, issued upon Application
 No. 865-3, bearing date of priority of 1889, authorizing the diversion of
975 acre feet annually ~~XXXXXX~~ of the waters of the local watershed
 County of Minnehaha, State of South Dakota, at a point in the
NE $\frac{1}{4}$ SE $\frac{1}{4}$ Section 14, T102N, R52W

for public recreation
 purposes, has fully complied with the provisions of the laws of the State of South Dakota relating to proof of
recognized as satisfactory
 completion of the works of diversion set out and described in said Permit; that said works are ~~recognized as satisfactory~~
~~XXXXXX~~ for diverting and conveying to the place of intended use 975 acre feet annually ~~XXXXXX~~
~~XXXXXX~~ of water; and that the ~~XXXXXX~~ use of said water are described as follows,
to be used in place for public recreation
 to-wit:

Witness my hand this 20th day of December A. D. 19 62

State Water Resources Commission

J. W. GRIMES
 Chief Engineer, Executive Officer

STATE OF SOUTH DAKOTA

WATER LICENSE No. 865-3

WHEREAS, On the 27th day of September A. D. 1961
the Department of Game, Fish and Parks

of Pierre County of Hughes and State of
South Dakota Vested Right
duly made application (No. 865-3) to us for a permit to use 975 acre feet
annually the local watershed
of the waters of
County of Minnehaha, State of South Dakota, for public recreation
purposes; and

WHEREAS, On the 20th day of December A. D. 1962
Vested Right / Permit No. 865-3 was issued to said applicant... for the diversion of said water, recognizing
completion of the works of diversion therein described on or before the
water and application to beneficial use of said
and,

WHEREAS, On the 27th day of September A. D. 1961
the holder... of said permit duly made proof of the completion of adequate works for the diversion of 975 acre feet
annually of said waters as evidenced by our Certificate No. 865-3
dated December 20, 1962 confirming the completion of works of sufficient capacity for
diverting and conveying to the place of intended use 975 acre feet annually
priority of 1889 of water, with date of
and,

WHEREAS, On the 27th day of September A. D. 1961
proof was duly made of the application to beneficial use of 975 acre feet annually
to be used in place for public recreation

NOW, THEREFORE, By the virtue of the authority vested in us by the laws of the State of South Dakota,
We hereby grant and confirm to the Department of Game, Fish and Parks
of Pierre Vested Right
the holder and owner of said/permit No. 865-3

a water right, dating from 1889 to the use of 975 acre feet
annually
~~which is to be used~~ of the waters of the local watershed

In the County of Minnehaha and State of South Dakota, or so much thereof as may be
necessary for the purposes hereinbelow mentioned, to be diverted at a point in the NE¹ SE¹,
Section 14, T 10² N, R 52 W

and ~~which is to be used~~ stored in place

for the purpose of public recreation

subject, however, to the laws of the State of South Dakota applicable to a license for the use of the waters of the
State, and subject, also to the local or community customs, rules and regulations which have been or may be
adopted from time to time by a majority of the users from a common source of supply, canal or lateral from
which such water may be taken, when such rules and regulations have for their object the economical use of such
water.

WITNESS, My hand and seal of our office at Pierre, South Dakota,
this 20th day of December A. D. Nineteen
Hundred and Sixty-Two.

State Water Resources Commission

By:

J. W. GRIMES
Chief Engineer, Executive Officer

STATE OF SOUTH DAKOTA

Water License No. _____

To _____

Source of Supply _____

County _____

Am't _____ c. f. s.

Point of Diversion _____

Place of Use _____

Purpose _____

Date of Priority _____

Recorded _____

in Book _____ of _____ Page _____

Location No.

Water Division No. Water District

Proof of Application of Water to Beneficial Use

PETITION OF HOLDER

Ques. 1. State your name, residence, occupation and postoffice address.

Ans. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota

Ques. 2. If acting in behalf of a corporation, state its name, principal place of business (if a foreign corporation, give name and postoffice of statutory agent,) your position with reference to same, and your authority for appearing in its behalf.

Ans.

Ques. 3. State date of posting and date of recording notice of appropriation.

Ans.

Ques. 4. State source of water supply and give exact location of point of diversion.

Ans. Local watershed run-off - One point in the watershed located in the NE 1/4 SE 1/4

Sec. 14, T. 102 R. 52

Ques. 5. Describe your works of diversion giving length and height of each di. n and state amount of water they are capable of conveying from point of diversion to place of use, and give name of canal or ditch or other works by which water is conducted to such place of use, and date of completion of same.

Ans. A meandered lake - depth 5 feet - 320 acres

Ques. 6. State for what purpose water is used and describe place of use. (If for irrigation, name each subdivision in which used, and number of acres in each subdivision that have ACTUALLY been irrigated with said water.)

Ans. Fish and wildlife propagation, conservation and recreation

Ques. 7. If for other than irrigation purpose, state how applied, amount of horse power generated, etc.

Ans. Used in place in lake or reservoir

Ques. 8. What is the minimum amount of water required for the use specified above?

Ans. As required to fill lake to outlet level - approximately 975 acre feet per year

Ques. 9. If you are not the person or representative of the corporation to whom above mentioned permit was originally issued, please state how ownership was acquired by present holder.

Ans.

Ques. 10. State when, how, in what amount and to what extent, the water diverted under above mentioned permit has been used.

Ans. ----- A meandered lake. Used by the public for uses specified except for -----
that amount lost by evaporation and seepage -----

(Sign) *W. H. Moore*

I hereby certify that the foregoing testimony was read to the above subscriber before its signing, that I believe him to be the person he represents himself to be, and that said testimony was subscribed and sworn to before me, at my office in ----- Pierre -----, County of ----- Hughes -----

State of South Dakota, on this ----- 25 ----- day of ----- September ----- A. D. 19----- 64 -----
----- } Witnesses. *Edward Johnson* -----
----- } ----- 12-6-65 -----

I, the undersigned, do hereby certify that I am a duly qualified elector residing in the immediate vicinity of the diversion works designated in the foregoing testimony, that I have no interest in the works, water or land above described, that I have read the foregoing testimony and that I know of my own personal knowledge that the matters therein stated are true.

Location No.-----	
PROOF OF APPLICATION OF WATER TO BENEFICIAL USE	
PETITION OF HOLDER	
Amount of Water ----- c. f. s.	
Source -----	
County -----	
Purpose -----	
Place of Use -----	

Date of recording -----	

Received and filed -----	

March 15, 1963

Mr. Walter J. Fillmore, Director
Department of Game, Fish and Furks
Pierre, South Dakota

Dear Walt:

Enclosed are your permit to appropriate water, certificate of
completion of works, and water license for the following
applications:

<u>No.</u>	<u>Lake</u>	<u>County</u>
857-3	Cell Rapids Dam	Minnehaha
858-3	Garretson Dam	Minnehaha
859-3	Baltic Dam	Minnehaha
860-3	Grass Lake	Minnehaha
861-3	Diamond Lake	Minnehaha
862-3	Clear Lake	Minnehaha
863-3	Lost Lake	Minnehaha
864-3	Vall Lake	Minnehaha
✓ 865-3	Beaver Lake	Minnehaha
866-3	Todd Lake	Clerk

Sincerely,

J. W. CHIMES
Chief Engineer and
Executive Officer

JWC:mf

COPY

865-3

 **Department of
Water & Natural Resources**

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

December 29, 1986

Steve Becker
Rural Route
Humboldt, SD 57035

Dear Mr. Becker:

Enclosed you will find a copy of the rules indicating how to petition the Water Management Board for a declaratory ruling, as we discussed in our phone conversation of December 23, 1986.

You can request that the Water Management Board clarify Water Right No. 865-3, held by the SD Department of Game, Fish and Parks by setting an outlet elevation on Beaver Lake, and state why you feel this should be done. You may also wish to have others concerned about this matter included in your petition. Also be sure to send a copy of the petition to the Department of Game, Fish and Parks.

Please make your request to the Water Management Board but send the letter and petition to:

John Hatch, Chief Engineer
Water Rights Division
SD Dept. of Water & Natural Resources
Joe Foss Bldg.
Pierre, SD 57501

We will forward the material to the board members.

If we can be of further assistance, please contact our office.

Sincerely,



Tom Brandner
Natural Resources Engineer
605 773-3352

Enclosure



Department of Water & Natural Resources

Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

September 21, 1988

Richard Beringson, Secretary
Department of Game, Fish and Parks
Anderson Building
445 E Capitol
Pierre SD 57501

Dear Mr. Beringson:

I am writing to notify you that pursuant to the Notice of Intent to Validate Vested Water Right Claims dated June 20, 1988 that I intend to oppose validation of all Department of Game, Fish and Parks Vested Water Right Claims for lakes for the following reasons:

1. Until the outlet elevation for each lake is surveyed and the outlet elevation is set by the Water Management Board.
2. To allow the Vested Water Right Claim to be amended, if necessary, as follows:
 - a) Include the outlet elevation;
 - b) To correct the amount of water claimed;
 - c) To add the qualification that a vested claim is subject where necessary to installation of a concrete outlet structure to assure retention of the outlet as the established elevation; and
 - d) To add any amendments and qualifications necessary to clarify a Vested Right Claim.

Also, that I intend to oppose validation of all Department of Game, Fish and Parks Vested Water Right Claims for dams to allow the Vested Water Right Claim to be amended, if necessary, as follows:

1. To include the spillway elevation;
2. To correct the amount of water claimed; and
3. To add any amendments and qualifications necessary to clarify a Vested Right Claim.

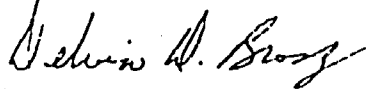


September 21, 1988
Richard Beringson, Secretary
Page 2

We will be working with your staff on these validations. We have already discussed setting outlet elevations before validating claims for lakes. Although the work necessary to complete the validation process will take several years to complete, the results should be of benefit to the public and to your Department. As the work is completed to validate each claim, the claim will be presented to the Water Management Board for validation.

Please advise if you have any questions.

Very truly yours,

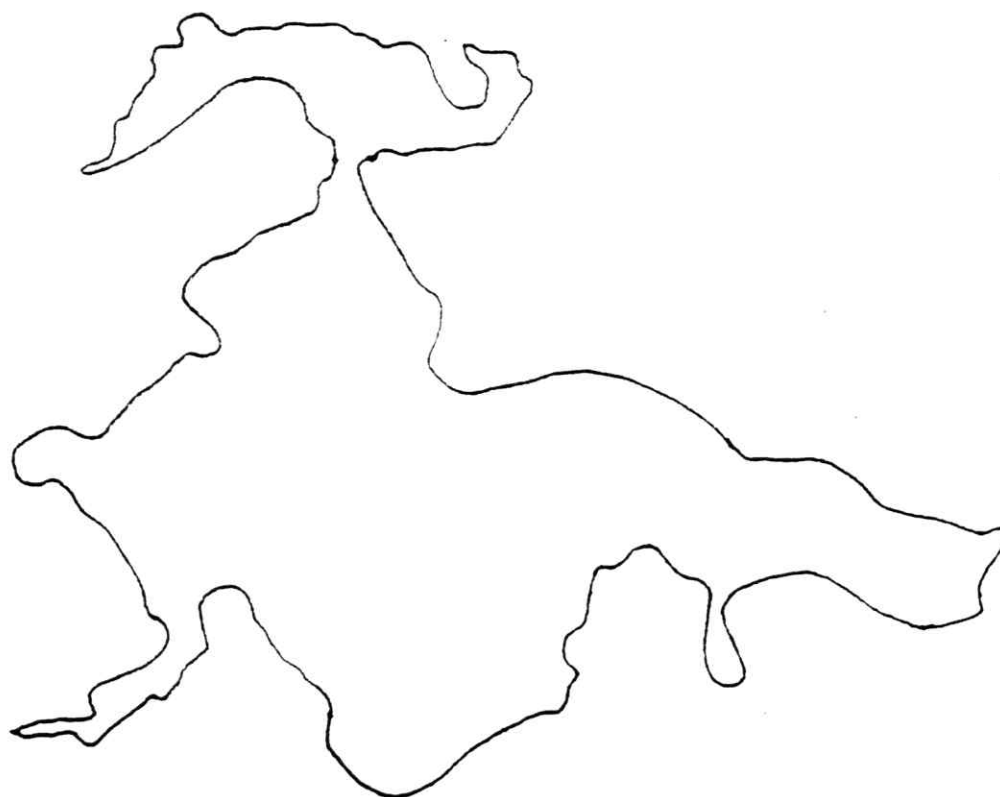


for JOHN HATCH, Chief Engineer
Water Rights Division
605 773-3352

cc: Ron Koth, Department of Game, Fish and Parks

ORDINARY HIGH WATER MARK
INVESTIGATION
BEAVER LAKE

OCTOBER 1988



MINNEHAHA COUNTY

DIVISION OF WATER RIGHTS



**Department of
Water & Natural Resources**

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ABSTRACT

This report contains the results of an investigation performed to determine the Ordinary High Water Mark (OHWM) and outlet elevation for Beaver Lake in Minnehaha County. The primary factors involved in determining the OHWM for Beaver Lake were 1) the lake's hydrologic characteristics, 2) historical evidence of past lake elevations, and 3) the physical features such as boulder lines, soil changes, beach scarps and erosional characteristics found around the lake.

Based on the findings in this report, the recommended Ordinary High Water Mark Elevation for Beaver Lake is 1651.6 feet above mean sea level (msl) and the recommended outlet elevation is 1651.7 feet msl. The present overflow elevation is 1652.5 ft. msl.

INTRODUCTION

The original request for the establishment of an Ordinary High Water Mark (OHWM) and outlet elevation on Beaver Lake was presented via a petition by Humboldt Township, the City of Humboldt, and area riparian landowners pursuant to SDCL 43-17-28. SDCL 43-17-21 requires the Water Management Board to establish the OHWM on public lakes when requested to do so.

South Dakota Codified Law 43-17-2 provides that a landowner of an upland area, if it borders on a navigable lake or stream, has jurisdiction to the edge of the lake or stream at the low water mark. However, all navigable rivers and lakes are public highways within 50 feet landward from the water's nearest edge, provided that the outer boundary of such public highway may not expand beyond the OHWM or contract within the Ordinary Low Water Mark (OLWM).

Therefore, the public has a right to use, for public purposes, a strip of land up to 50 feet wide below the OHWM starting at the water's edge or the OLWM. The private adjoining landowner may also use this 50 foot strip of land for any purpose not inconsistent with the rights of the public. Such uses may include cutting the grass for forage or for livestock grazing.

If the water of a navigable lake rises above the OHWM, the public still enjoys use of the entire lake, but access to the lake must be by public right-of-way or by permission of the riparian landowner (SDCL 43-17-29).

The OHWM according to SDCL 43-17-20(2) is defined in decisions rendered by the courts of this state.

In the case of Flisrand v Madison, 35 SD 457, 152 N.W. 796, 800-801 (1915) the Court wrote:

" Neither high or low water mark means the highest or lowest point reached by the waters of a lake during periods of extreme and continued freshets, or periods of extreme and continued drought, but does mean the high and low points of variation of such waters under ordinary conditions, unaffected by either extreme. "

In the Anderson v Ray case, 37 SD 17, 156 N.W. 591 (1916) the Court wrote:

" In the case of freshwater rivers, and lakes in which there is no ebb and flow of the tide, but which are subject to irregular and occasional changes of height, without fixed quantity or time, except that they are periodical, recurring with the wet or dry seasons of the year - high water mark,

as a line between the riparian owner and the public, is to be determined by examining the beds and banks, and ascertaining where the presence and action of the water are so common and usual, and so long-continued in all ordinary years, as to mark upon the soil of the bed a character distinct from that of the banks, in respect to vegetation, as well as respects the nature of the soil itself. "

The South Dakota Supreme Court gave further definition to "Ordinary High Water Mark" in the Waubay Lake case by stating:

".....under ordinary circumstances, the OHWM will be set at a level where there is a distinct mark which evidences erosion, and changes in the character of the soil, and destruction of terrestrial vegetation, which have occurred under the ordinary and continuous conditions of the lake, disregarding periods of extreme and periodic freshets, and disregarding the highest water mark which does not evidence erosion and soil changes and destruction of vegetation occasioned under ordinary conditions. If a single distinct mark, occasioned under ordinary circumstances and evidencing all the factors delineated above does not exist, i.e., there is conflicting evidence of the role of the OHWM, it is the level where significant major, and substantial terrestrial vegetation ends, that the OHWM is to be set. " (cites omitted).

GENERAL INFORMATION

Beaver Lake is located in Minnehaha County within Sections 10, 11, 14, 15, 22 and 23 of Township 102 North, Range 52 West. It is approximately one mile southeast of the town of Humboldt and 16 miles northwest of the city of Sioux Falls.

At the proposed OHWM elevation, the lake covers about 350 surface acres with a storage capacity of approximately 2150 acre-feet. Recharge is primarily through surface runoff and precipitation falling directly on the lake. No significant aquifer connection is evident. The lake has a small drainage basin, approximately 3.8 square miles, although the exact size is hard to determine because of the various sloughs and depressions in the basin area. It also has a small watershed to lake area ratio of 2430 acres/350 acres or 6.9. A small ratio favors low sediment deposition into the lake, but it also reduces the available runoff supplied to the lake. The Soil Conservation Service estimates that approximately one inch of water is added to a lake annually for each ratio unit indicated. Thus in this case, runoff would add roughly 7 inches annually to Beaver Lake (State Lakes Preservation Committee, 1977).

Beaver Lake is classified recreationally as a warm water marginal fishery with a major winter kill occurring approximately every 5 years. A lake priority system was established for lakes in the Coteau region of the eastern part of the state based on lake quality criteria and cultural factors such as lake depth & size, water quality, near by population density, public accessibility and use, and recreational facilities (Appendix A). The lakes were divided into 4 groups with Group 1 having the most desirable overall characteristics and Group 4 the least desirable features. Beaver Lake fell into Group 3 on this range (State Lakes Preservation Committee, 1977).

In 1867, a meandered survey was conducted on Beaver Lake (Figure 1). The meander line traverse varies between approximately 1648 and 1652 feet msl. The original meander line did not include the northern slough portion of the lake. It should be noted that a meander line is not a boundary line. It defines neither the boundaries of the lake nor the extent of the area of land which is owned by the abutting landowner, but is a means of determining the amount of land subject to sale. The title of adjacent landowners is not limited to the meanderline. The riparian landowner has absolute ownership down to the OHWM regardless of where the meanderline is located and has qualified ownership from the OHWM down to the OLWM. There are concurrent public and private rights in the area between the OHWM and OLWM. Below the OLWM the state holds title to the bed of the lake.

WATER RIGHTS

The South Dakota Department of Game, Fish and Parks holds Vested Water Right Claim No. 865-3 for Beaver Lake. The amount of water claimed is an amount "as required to fill lake to outlet level - approximately 975 acre-feet per year" to be used in place for public recreation. A priority date of 1889 is claimed for this vested right. The town of Humboldt has a vested right claim for 0.22 cubic feet per second (cfs) of ground water at a diversion point about 1 1/2 miles northwest of Beaver Lake. No other water right permits are located in the immediate vicinity (WRD Permit Files, 1988).

GEOLOGY

Beaver Lake is located at the southern edge of the Coteau des Prairie section of the Central Lowland Physiographic Province. The Big Sioux River provides the major drainage in the county. The surficial deposits of this area are primarily Pleistocene glacial deposits with small areas of interglacial material and recent alluvium.

Minnehaha County was covered by the succession of the Nebraskan, Kansan, Illinoian and Wisconsin glaciers which deposited drift on

top of the underlying Quartzite or Cretaceous chalks and shales where present. During the most recent glacial episode, the Wisconsin stage, the glacier overrode the western one-third of the county as far east as Skunk Creek. Therefore the eastern part of the county has a more mature drainage while the west projects a more youthful landscape with few well defined drainage patterns. The Beaver Lake area was covered by the Cary end moraine which deposited till containing numerous small undrained depressions. A landscape was formed containing unconsolidated and unsorted material consisting of silt, clay, and sand & gravel (SCS Minnehaha County Soil Survey, 1964).

Beaver Lake itself is considered a kettle lake formed by the melting out of a large block of stagnant ice which was buried in the glacial drift. The lake bottom in these deposits is usually shaped like a saucer or a round bottomed "kettle". As the ice block melted and the overlying drift collapsed the morainal depression was left forming the lake basin (Rothrock & Newcomb, 1926).

Well logs from the area suggest there is no significant hydrologic connection between the lake and any glacial aquifer (WRD well log files, 1988). The nearest well, approximately 1/2 mile west of the lake, indicates till may be over 100 feet thick at the lake location. Similar profiles exist in other well logs in the area. The State Lakes Preservation Committee report also concluded that no aquifer connection was present. A U.S. Fish and Wildlife wetland area located only 200 yards north of the lake remains over 6 feet above the level of Beaver Lake although the two water bodies are in close proximity. This also suggests there is not a significant ground water connection to Beaver Lake.

SOILS

Kranzburg and Buse soils cover most of the Beaver Lake drainage basin. Other minor soils are LaPrairie, Hidewood, and Parnell (Figure 2).

Kranzburg soils are deep, well-drained silty soils found extensively on the upland areas of the basin. They are fertile and usually cultivated. The Buse soils are thinner and often excessively drained. They are usually formed on hill slopes, are often stony and of low fertility. The soils are usually left in pasture or hay.

LaPrairie, Hidewood and Parnell soils are located in swales, stream channels and depressions. The soils range from moderately well drained, somewhat poorly drained to poorly drained, respectively. They form from sediments deposited in low lying areas, and are high in organic matter. The LaPrairie and

Hidewood soils are usually cultivated with yields depending upon degree of wetness. Parnell soils are the most poorly drained and are cultivated only in dry years (SCS Minnehaha County Soil Survey, 1964).

BASIN HYDROLOGY

Lake water levels fluctuate in response to the hydrologic factors affecting the lake. These factors include: precipitation falling directly on the lake, drainage basin runoff, evaporation, surface water outflow and ground water movement. A qualitative assessment of these factors in the Beaver Lake area follows.

As noted earlier, the groundwater contribution to or from the lake appears to be minimal as the lake is underlain by a relatively impermeable layer of glacial till isolating aquifers from the lake bed. A small amount of flow may escape through the moderately permeable material in the outlet, but such outflow could have only a minor impact.

Precipitation falling directly on the lake is multiplied by the surface area of the lake to produce the volume of water added directly to the lake from precipitation. The area annual precipitation has been collected by the National Weather Service (NOAA, 1891-1987) for a 97 year period (1891-1987) from 1 to 4 recording stations (Appendixes B1 & B2).

The station's average annual precipitation was statistically analyzed using the Weibull probability method to determine the probability distribution for annual precipitation accumulations on the lake (Graph 1 and Table 1).

Table 1

<u>Probability</u> (Percent)	<u>Annual Precipitation</u> (Inches)
2	38
10	32
20	29
50	24
80	20
95	16

Annual runoff can vary depending upon the antecedent moisture and ground cover conditions which affect the infiltration rate and the actual basin area contributing to the runoff. This is especially true in the Beaver Lake area where the youthful topography includes many depressions, and potholes which only contribute runoff to the lake if they are filled prior to other precipitation and runoff events.

A Soil Conservation Service (SCS) method for estimating annual runoff probabilities from the Beaver Lake watershed was used for a general assessment of runoff to Beaver Lake (Table 2). The calculations are based on an isogram No. of 3 and a soil cover complex number of 76. The percentage occurrence values mean the percent chance or probability that the given amount of runoff will be equalled or exceeded in any given year. The results are in acre-feet (Kent, 1971).

Table 2

<u>Basin Size (Sq. Miles)</u>	<u>Annual Yield</u>			
	Percent Chance Occurrence			
	<u>80</u>	<u>50</u>	<u>20</u>	<u>10</u>
3.8	53	134	349	578

For example, with a basin size of 3.8 square miles, the annual runoff to the lake should equal or exceed 134 acre-feet 50% of the time. The annual yield probability distribution is shown in Graph 2.

Evaporation is the major water loss component for Beaver Lake. The average annual evaporation in the area is 36 inches (Spuhler, Lytle, and Moe, 1971). Surface outflow from the lake is negligible. The present overflow elevation for the lake is 1652.5 feet msl, or 0.9 foot above the recommended OHWM. The evidence suggests that overflow does not occur very often.

A hydrologic analysis of the above variables cannot be used to quantify the probability the lake level will reach a particular elevation, such as the proposed OHWM or the present outlet, or to accurately predict a series of past or future levels because of the complexity of the hydrological variables involved. Qualitatively, it appears that the lake does not outflow often because it would require a number of successive high runoff years to sustain a "full" lake.

STREAM GAGE RECORDS

Recent high water levels in the Beaver Lake area gave rise to the OHWM request because of the problems caused to the City of Humboldt, the local township, and to area landowners. Gaging station runoff values on major streams in the Beaver Lake region attest to the unusual nature of the recent wet period. Appendix C shows the annual yield ranking for 5 gaging stations with 21 to 44 years of record. The station locations and years of record are as follows:

- (1) Skunk Creek at Sioux Falls (1949-1987)
- (2) Big Sioux River at Sioux Falls (1944-1987)
- (3) Little Vermillion River near Salem (1967-1987)
- (4) West Fork Vermillion River near Parker (1962-1987)
- (5) Vermillion River near Wakonda (1946-1987)

Table 3 reveals the striking nature of the recent wet period.

Table 3

Maximum Total Runoff
For 5 Consecutive Years

<u>Station</u>	<u>Group 1 Years</u>	<u>Group 1 Runoff (Acre-ft.)</u>	<u>Group 2 Years</u>	<u>Group 2 Runoff (Acre-ft.)</u>	<u>2nd Group % of 1st</u>
(1)	1983-1987	934,600	1950-1954	255,215	27
(2)	1983-1987	4,426,500	1950-1954	1,829,300	41
(3)	1983-1987	50,320	1969-1973	11,560	23
(4)	1983-1987	377,400	1969-1973	112,800	30
(5)	1983-1987	2,290,700	1950-1954	645,780	28

At all these stations, the 3 highest runoff years were 1984, 1986, and 1983 (in some varying order). Runoff for 1985 and 1987 were also in the upper 15 to 30 % of the annual totals. The second highest 5 consecutive years averaged only 30% as much runoff as the 1983-1987 period. Direct runoff to Beaver Lake is not included in these basins, but the stations record drainage in areas surrounding the lake (Figure 3) and their consistency indicates that runoff to Beaver Lake followed the same pattern. The figures help to emphasize the unusual nature of these recent consecutive wet years (USGS Water Resource Data, 1944-1987).

WATER QUALITY

Water quality data for Beaver Lake are listed below. The 1976 reading was listed in the State Lake Preservation Committee report and the recent measurements were taken by the Division of Water Rights.

Table 4

<u>Date</u>	<u>Total Dissolved Solids (PPM)</u>
8-18-76	5662
10-21-86	800
9-22-87	950
10-22-87	850
4-27-88	1400
9-27-88	1400

The values generally reflect the elevation changes of the lake. A 1976 aerial photograph shows the lake was substantially below the present elevation. From 1986 to the summer of 1987 water was flowing out of Beaver Lake, but the lake has not flushed since that time (WRD Lake Level & Water Quality Files, 1988).

Lakes occupying closed basins have a higher solids content than ones which flush seasonally. A concentration of solids approaching 5000 parts per million (PPM) is considered high for this region (State Lakes Preservation Committee, 1977). The data would indicate that Beaver Lake does not outflow very often, which would categorize the lake as nearly a closed basin. In lakes that do not flush often, salts accumulate as evaporation removes the water leaving the solids behind. The solids concentrations gradually increase because they are not transported with outflowing water.

Four other Minnehaha County lakes: Clear, Lost, Loss, and Wall Lakes, had a range of TDS values from approximately 850 to 1750 PPM in 1976 (Appendix D1). They were under essentially the same climatic conditions as Beaver Lake but had 4-6 times lower solids concentrations. From 1986 to the present, the above lakes had values from 350-1400 PPM, similar to Beaver Lake during its outflow period. This supports the evidence of Beaver Lake essentially being a closed basin.

HISTORICAL BACKGROUND

Lake Level Records

Actual measurements of the lake elevation have only been conducted since 1986. The Water Rights Division recorded the water levels listed in Table 5 below.

Table 5

<u>Date</u>	<u>Water Elevation (ft. msl)</u>
7-24-86	1652.8
10-21-86	1653.2
12-18-86	1652.9
1-13-87	1652.8
3-18-87	1652.6
4-30-87	1652.9
5-19-87	1652.8
6-23-87	1652.5
9-22-87	1651.9
10-22-87	1651.5
12-17-87	1651.5
4-8-88	1652.0
4-27-88	1651.9
5-11-88	1651.8
9-27-88	1650.1
10-12-88	1650.1
11-2-88	1649.9

Aerial Photographs

Aerial photographs of Beaver Lake covering 19 different years back to 1937 were examined. Most of the aerial photos were USDA black and white prints at a scale of 1 1/2 to 3 inches per mile. Actual lake elevations could not be discerned, but generalized estimates could be made. In 1962, the lake was close to the proposed OHWM level but appeared to be below it. In none of the photographs was the lake level high enough to overflow the outlet (WRD Aerial Photographs, 1937-1984).

The photographs are a qualitative addition to the actual lake measurements. The 19 additional years of record help to assess the probability of lake outflow and high water mark occurrences. Appendix E compiles the list of photographs viewed and includes a subjective ranking of past lake elevations.

Records Search and Personal Accounts

A search of records and publications was made which revealed little information about past hydrologic conditions at Beaver Lake. Survey plat maps from 1885, 1903, 1913 and 1981 were obtained (Appendix F). No particular information was derived from them other than to note that the slough attached at the north end of the lake was not included as part of the lake on any of the maps because it was not originally meandered, and that the 1903 map indicated Beaver Lake was dry (Minnehaha County Archives, 1987). A Humboldt resident, Arlene Reuter, was preparing a history of the town for a centennial celebration, and she recalled no relevant information on Beaver Lake in her search through old newspapers and records.

A number of local landowners and residents were contacted regarding any historic information on Beaver Lake. The following individuals, were contacted (WRD Personal Interviews, 1987):

Kenneth Reuter - Humboldt resident

D. J. Masters - Humboldt resident, operated the local newspaper until recently and was an area hunter-fisherman.

Bud Lewin - Humboldt resident

Al Ettledorf - Humboldt resident

Don & Ed Lias - Local landowners

Arlie Rehfeldt - Local Landowner

Steve Becker - Local landowner

Francis (Red) Ekanger - Humboldt resident and area
hunter-fisherman.

Orlando Voelker - Local Landowner

Game, Fish & Parks personnel

The main theme that reoccurred from these interviews was that the individuals could not personally recall seeing the lake overflow until 1984-1987. Mr. Voelker and Mr. Becker believed it possibly ran out sometime between 1917-1920. Don and Ed Lias did state they thought the lake overflowed for a short time in the 1940's. During the same period however, they recalled cutting land for hay which at the present overflow elevation would have been under water. Mr. Ekanger reported knowledge of an old boat ramp which now is still underwater or gone.

GF&P personnel from Sioux Falls did not have any recollection of past lake levels or outlet flows. They did take fish net surveys in 1956 and 1960 in which they made high water mark estimates at elevations between 1649.5 and 1651.5 feet msl. A GF&P survey taken in June of 1987 revealed that the maximum lake depth was 11 feet at a surface elevation of 1652.5 ft. msl. (Hanten, 1987).

These local accounts indicate that the lake has been dry in the past (1930's), and that it probably had not overflowed for 60 years or more.

Man Made Influences

Man made changes which may have influenced the OHWM of the lake are factors relating to the drainage basin size. Runoff to the lake depends upon the number of sloughs in the drainage that retain the precipitation runoff. As farming has intensified, more row crops are planted, wetlands are drained and grasslands broken up. All these factors lead to increased runoff and fewer non-contributing drainage areas. These changes have occurred over time and are not quantified here.

The slough connected to the north end of Beaver Lake receives over half the drainage to the lake. According to Mr. Becker, a crossing, with a 2 foot diameter culvert under it, was built over the narrow waterway between the main lake body and the slough to the north. The connecting point between the waterways was measured in June, 1987 at 1650.7 ft. msl while the crossing was still under water. Recently the road was built up to provide better access between farm fields. A WRD survey in October, 1988 indicated the new low point in the road was 1653.3 ft. msl and the water elevation 1650.1 ft. msl, but no culverts were visible.

It could not be determined if the culvert was still functioning, although the survey showed the lake and the slough were still at the same elevation. If the two water bodies are not connected, it will impact Beaver Lake's contributing drainage area.

According to Mr. Voelker, Mr. Becker and personal observation the outlet area had recently been plowed (in the past 10 years or so). It does appear that the outlet elevation may have been temporarily affected by the plowing which caused ridges in the channel and possible damming of outflow. There were no reports or indications of purposeful changing of the outlet elevation. Results of a special outlet study will be discussed in a later section.

LAKE INVESTIGATION

Elevation Reference

Elevations in this report are referenced to a Coast and Geodetic Survey Bench Mark located at Humboldt on the north wall of the State Bank building. The standard disk, located in the northeast corner of the building and 25 inches above the sidewalk, is stamped "Q 5 1925" at an elevation of 1700.853 feet mean sea level.

Investigation Dates

Field investigations were conducted at Beaver Lake on a number of dates, with the major work done on: January 13, 1987, June 23, 1987, September 22, 1987, May 5, 1988 and October 12, 1988.

OHWM Indicators

Physical evidence used to identify an OHWM include: erosion lines, beach scarps, sediment stratification, boulder lines, and terrestrial vegetation.

Erosion Lines and Beach Scarps

The Beaver Lake shoreline is composed of numerous outcrops of glacial till with mixed sand, silt and clay beaches found where the slopes are more gentle. Erosive effects of wave action on the shoreline are evident. Vertical beach scarps are ubiquitous around the lake. These wave cut cliffs range from a few inches in height to scarps over 6 feet tall (Photos 2-4). The base elevation of the toe of these scarps ranged from 1652.8 to 1654.0 ft. msl with the majority of them having a base of 1653.0 to 1653.2 ft. msl. The eroded shoreline appears not to be stabilized based on visible recent sloughing, unvegetated slopes and exposed plant roots hanging from the cliffs.

A lower level erosion line (change in slope) was visible in most areas around the lake at an elevation between 1651.3 and 1652.0 ft. msl with most of the slope change at 1651.5 - 1651.6 ft. msl. This change in slope coincides with a prominent boulder line to be discussed later.

Sediment Stratification

Stratification of a lake shore occurs when wave action erodes a shore removing the finer materials and carrying them out to greater lake depths. Boulders, pebbles and gravel may remain in place or move slightly. Sands can be transported along shore and continually sorted until a relatively homogenous size sand fraction remains. At Beaver Lake, a beach sand is found at the base of the scarps in most locations. A more heterogeneous mixture of sands, gravels, silts and clays are found on the lower part of the beach, with silts and clays more prominent as you extend farther into the lake. In the case of Beaver Lake, it appears that the 3-4 years of high water have erased the lower level evidence of beach sands and surface sediment stratification, and formed a new sand ridge below the recently cut cliffs. Significant amounts of previous shoreline material have been removed as evident in photos 9, 10, and 13 which show how soil material has been washed from below the shoreline trees.

Boulder Lines

Boulder lines, which develop as a result of ice action on the shoreline, are present at most locations around Beaver Lake. Ice movement at the shoreline of Beaver Lake can be explained by two main causes: (1) thermal expansion of the ice, and (2) wind action on the ice sheet.

Ice covering a lake will expand and contract upon an increase or decrease in temperature. These thermal stresses can cause tension cracks in the ice which fill with water and freeze, thus keeping the ice sheet from contracting in the coldest months. A significant expansion of the ice sheet can occur if the heating and cooling is repeated often.

In the spring when the temperatures rise, the thermal expansion causes a compressive force to be transmitted toward the shoreline, which can push shoreline material landward, building ice pushed ridges over time (Dionne, 1979).

Wind action, primarily in the spring, can also cause ice pushed boulder lines. The lake ice melts first near the shores because of the relatively rapid heating of the shoreline material and the shallow bottom. An open lane of water is formed which is further widened by a rise in the lake level from water added by the melting snow of the surrounding slopes. If the ice sheet remains

solid, strong winds can push the free floating ice about. Depending upon the wind velocity and direction, and the size of the ice sheet, shoreline material can be forced landward (Dionne, 1979).

Ice pushed boulder lines are present along much of the shore of Beaver Lake. A prominent ridge is located at elevations ranging from 1651.3 to 1652.0 ft. msl with a mean value of 1651.6 ft. msl (Photos 5-8).

Boulders at higher elevations were also found, but generally they were scattered about and usually not in a well defined line or ridge. Many of the upper boulders appeared to be "in place"; i.e., recent wave action has washed away the soil material leaving the boulders behind.

Terrestrial Vegetation

Terrestrial vegetation essentially ends at the beach scarp at elevations primarily from 1653.0 to 1653.5 ft. msl. The recent high water has destroyed any lower lying terrestrial vegetation that may have existed, and the vegetation is just now beginning to reestablish itself.

Trees, which are the largest and most permanent expressions of upland growth, are often used as an aid in determining the OHWM elevation. Records of high water levels are reflected in the well established trees growing along the upper limits of a lake's bed.

Trees around Beaver Lake were of little value in this OHWM determination. Nearly all the shoreline trees around the lake have been killed (Photos 9-13). The only prominent "ring" of trees around the lake is a band of young (less than 15-20 years old) trees at a base elevation of 1648.5 to 1649.5 ft. msl, which are still under water (Photos 11-12).

A 40+ year old cottonwood tree appears to be the oldest tree along the shore (Photo 13). Its base elevation is 1650.4 ft. msl, but as the photo shows, that elevation is below the root line. The recent high water has killed the tree and has washed all the soil from under the roots. Its original base elevation was approximately 1651.8 ft. msl which coincides with the boulder line found around the lake.

Water Marks on Boulders and Trees

There were many boulders and trees around Beaver Lake that showed signs of water elevations ranging from 1653.4 to 1653.9 ft. msl (Photos 13-14) which indicates lake levels from 1 to 1 1/2 feet above the present outflow elevation.

LAKE OUTLET

The Beaver Lake outlet is located on the east side of the lake and is found in the S1/2 NE1/4 SE1/4 of Section 14, T102N, R52W (Figure 4). The outlet gradually increases in elevation from the lake proper and reaches a high point of approximately 1652.5 ft. msl 650 feet northeast of the main lake body (Graph 3). As the graph shows the outlet is not a smooth transition but an area with various high points. This may be partially caused by the plow ridges in the channel. Additionally, the recent high water has filled the outlet area with weeds, cattails and reeds (Photo 1) which have formed a tangled mat on the surface in areas slightly raising the outlet and reducing the flow through it. The rough nature of the outlet area, multiple flow channels, and the weeds and other debris that have filled in make an accurate elevation determination difficult. The smooth dashed line on graph 3 represents an estimated outlet elevation of 1652.2 ft. msl prior to the plowing and recent outflow. This places the outlet 0.3 feet below the present overflow elevation. The 1652.2 ft. msl elevation is the maximum soil surface outlet elevation in the study discussed below.

In the initial request for a declaratory ruling and OHWM determination received in April, 1987 the petitioners stated:

....."because of years of erosion and sediment the natural drainage or overflow outlet of the lake has filled in causing the water level of the lake to far exceed its natural boundaries."

As noted earlier, Don and Ed Lias had asserted that the lake may have previously overflowed, but at a lower outlet elevation.

A special study was conducted to determine if the elevation of the Beaver Lake outlet has increased in recent years. Effects of sedimentation occurring as a result of agricultural activity increasing wind and water erosion were studied. The Water Rights Division contracted with the Plant Science Department of South Dakota State University (SDSU) to do the study. Professor Douglas Malo, an SDSU soil scientist and instructor conducted the research.

The results of Dr. Malo's investigation revealed that the outlet soils have developed in local alluvial and/or colluvial sediments that are underlain by glacial till. There is a layer with an increased sand and gravel content that separates the alluvium/colluvium from the till. In the outlet channel itself this occurred approximately 1.3 to 1.7 feet below the surface, or near elevation 1650.5 ft. msl at the highest overflow point.

The greatest depth of these alluvial and colluvial sediments at the outlet high point is 1.7 feet. Evidence indicates that the majority of this deposition occurred after the latest glaciation period but prior to man's cultivation of the area (approximately 100 years ago). The maximum thickness of the most recent (less than 100 years old) sediments was approximately 8-10 inches at the high point of the outlet area. The breakup of the area's natural grassland since farming began in the region accelerated the erosion potential significantly. The exact figure for the amount of sedimentation that has occurred in the last 100 years cannot be determined (Malo, 1988). Thus, the lowest possible elevation of the outlet prior to farming would have been 1651.4 ft. msl (Measured from the high point of the soil, not the overlying vegetation cover). Based on data variability and judgement, the amount of recent sediment deposited in the outlet was estimated at 6 inches.

The investigation also revealed that the amount of water flowing out the outlet in recent times has been very minor. Particle size data suggest most of the water in the outlet area has moved through the soil rather than over it, indicating a rather stable environment has existed at the outlet area in recent years. Data relating to soil pH, organic matter composition, and nitrate movement also support this conclusion (Malo, 1988). The high water of the mid 1980's which caused the lake to overflow for over 3 years was a very unusual event, and the OHWM appears to be below the present outlet elevation.

Past reports and personal observation indicated that the outlet had been plowed within the past 10 years. Moldboard plowing of portions of the outlet area has undoubtedly influenced soil properties to some extent, but it does not repudiate the general conclusions listed above.

The relationship between the outlet elevation and the OHWM are usually related in a lake which overflows at frequent intervals. On the majority of the previous OHWM investigations the Water Management Board has set the OHWM about 0.5 feet above the outlet (WRD OHWM Studies, 1988). This elevation usually accounts for wave action which affects the shoreline as the water is flowing through the outlet.

Two notable exceptions to this were Waubay Lakes (Day Co.) and Red Lake (Brule Co.) where the outlet elevations were considerably above the OHWM. The evidence supports setting the Beaver Lake OHWM elevation at 1651.6 ft. msl, which is below the present overflow elevation of 1652.5 ft. msl (Figure 5).

The initial request for the OHWM determination was based on local concerns over flood damage from high lake levels and included a request to lower the outlet elevation. Based on past OHWM

studies and the proposed OHWM for Beaver Lake, the outlet could possibly be lowered to 1651.1 ft. msl without affecting the OHWM. However, that would place the outlet below the maximum recent sedimentation level in the channel. Based upon available evidence, the outlet level should be set at 1651.7 ft. msl. This would remove 0.5 feet of material from the maximum soil surface outlet elevation of 1652.2 ft. msl. Such removal would only be recent outlet channel fill.

This removal would not impact the lake OHWM, would facilitate flow through the channel under very high water conditions, and should not affect the lake water quality.

CONCLUSIONS

Physical evidence reveals that water levels have impacted the lake shore to an approximate mean elevation of 1653.2 ft. msl. The prominent erosion scarp line and stratified beach sands at this elevation attest to this. The high water mark elevation also relates well to the overflow elevation of 1652.5 ft. msl. Dr. Malo's report on the outlet indicated that its elevation has definitely not increased by more than 0.7 to 0.8 feet over the past 100 years, indicating there has not been a major outlet elevation change which altered the OHWM. However, other evidence strongly suggests that the high water mark near 1653.2 ft. msl is not an ordinary high water mark, but is more of an extreme high water mark established by unusual conditions.

The outlet study does show that some of the sediment in the outlet may be of recent origin, placing the lowest possible elevation at 1651.4 ft. msl when farming began in the area. The primary physical evidence for an OHWM below the present outlet elevation is the presence of a fairly continuous boulder line around the lake at an average elevation of 1651.6 ft. msl.

The following evidence supports the fact that the lake outflows infrequently. It has done so only under extraordinary conditions.

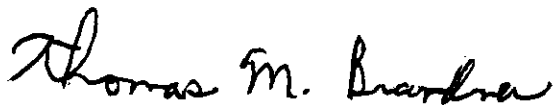
1. Dr. Malo's report concludes that soil conditions dictate that the outlet has been under very stable conditions recently, with very little flow over it.
2. Bank erosion is mostly recent with no indications that the scarps have been stabilized for any appreciable length of time.
3. Stream gaging stations data reveal that those years the outlet flowed (1984-1987) were extremely high runoff years for all the streams in the Beaver Lake region.
4. Water quality data indicate that Beaver Lake is basically a closed basin with little outflow to flush the salts from the water, thus its high Total Dissolved Solids concentration.

5. Beaver Lake area hydrology indicates that a number of continuous wet years are needed to make the lake overflow, but this frequency cannot be quantified.
6. Individuals with a knowledge of the past 50-65 year history of lake levels do not recall the lake overflowing until the recent wet period.

Different options are available regarding setting the outlet elevation. Some restructuring of the outlet is possible because the OHWM is slightly below the present outlet elevation. The channel could conceivably be cut to elevation 1651.1 ft. msl without affecting the OHWM, or the outlet could be left as is. Another option is to smooth the channel by removing the plow ridges and vegetative material to an elevation of 1652.2 ft. msl. The outlet elevation should be set at 1651.7 ft. msl based on the following:

1. It remains above the OHWM elevation and therefore will not alter the OHWM.
2. The evidence supports lowering the outlet elevation to an elevation more representative of past conditions.
3. No more than recently deposited (farming period) erosional material should be removed from the outlet area.
4. Removal of up to 0.8 (0.3 feet of debris plus 0.5 feet of sediment) from the outlet area will have little impact on lake water quality. However, any lowering of the outlet elevation will reduce flooding problems around the lake.

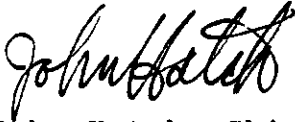
Based on the evidence available and the above comments, the Ordinary High Water Mark should be set at 1651.6 ft. msl and the outlet elevation at 1651.7 ft. msl.



Thomas M. Brandner
Natural Resources Engineer

Recommendations of Chief Engineer

1. That the OHWM for Beaver Lake, Minnehaha County be established at elevation 1651.6 ft. msl.
2. That the outlet elevation for Beaver Lake, Minnehaha County be set at 1651.7 ft. msl and that Vested Right Claim No. 865-3 be amended to establish the outlet elevation at 1651.7 ft. msl.
3. That Vested Water Right Claim No. 865-3 be amended to correct the amount of water claimed from 975 acre-feet annually to "sufficient water to fill Beaver Lake annually to the outlet elevation of 1651.7 ft. msl."
4. That Vested Water Right Claim No. 865-3 be amended with the qualification that No. 865-3 is subject to installation of a concrete outlet structure at elevation 1651.7 ft. msl.



John Hatch, Chief Engineer
DWNR, Water Rights Division

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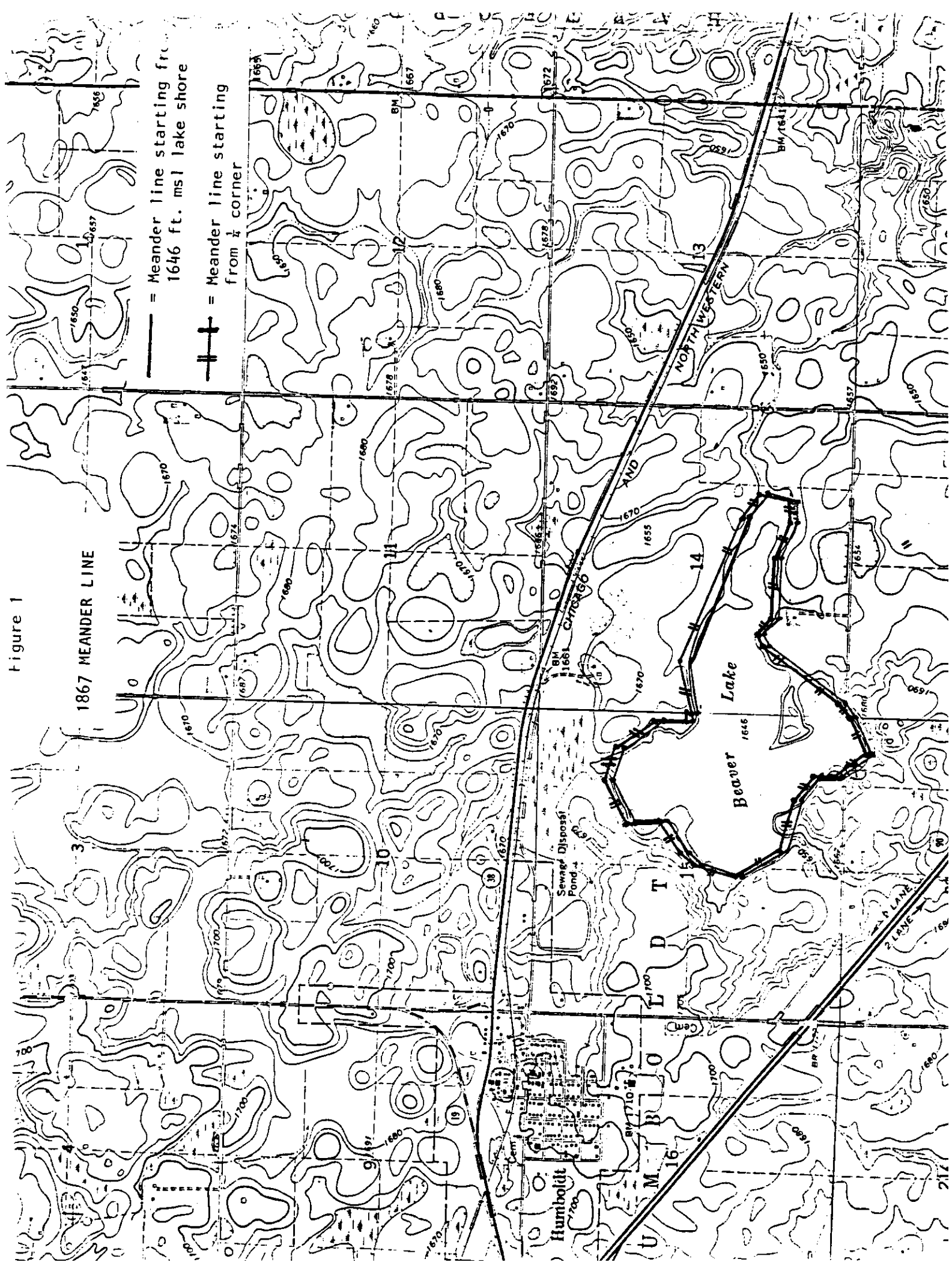
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Water Rights Division, 1988, Ordinary High Water Mark Studies, Joe Foss Bldg., Pierre, SD.

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Figure 1



BEAVER LAKE
DRAINAGE BASIN AREA
AND
SOIL ASSOCIATIONS

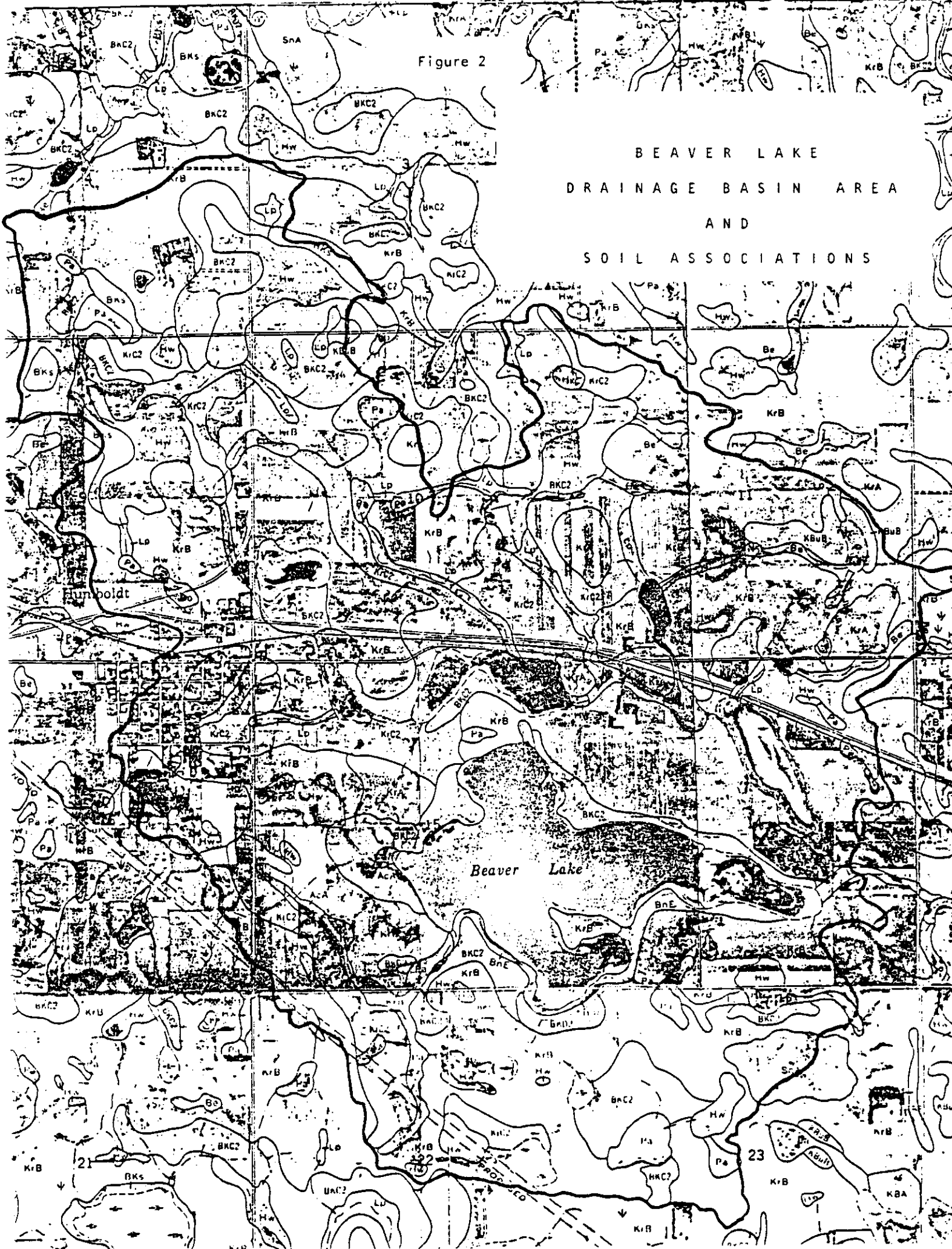


Figure 3

BEAVER LAKE AREA STREAM GAGING STATIONS

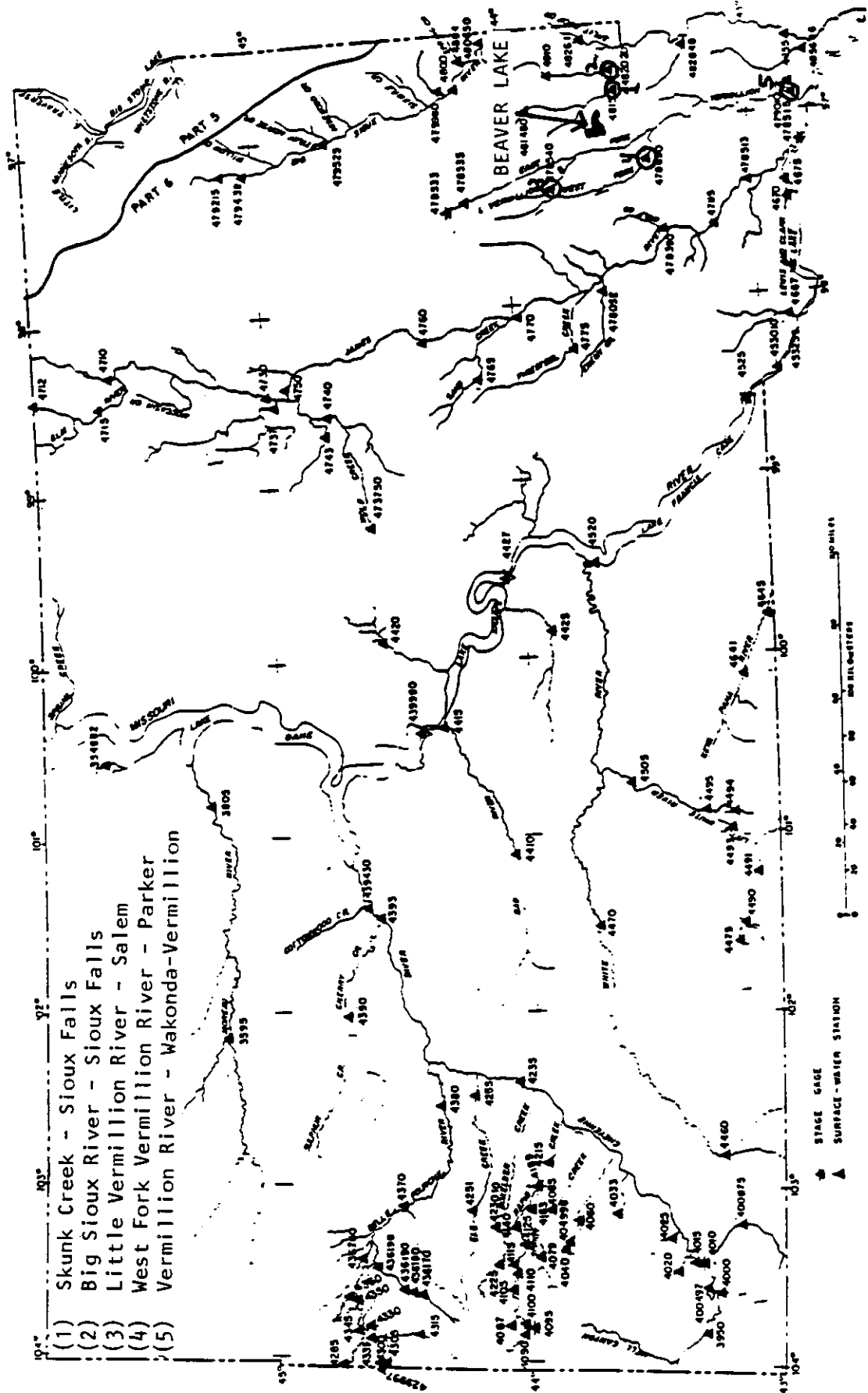


Figure 3.--Location of lake and stream-gaging stations.

Figure 4

BEAVER LAKE MAP

USGS TOPOGRAPHIC MAP

Scale (feet)

0 2000

Contour Interval: 10 Feet

HUMBOLDT

OUTLET AREA

Beaver Lake

CHICAGO

NORTH WESTERN

551 (GRASS LAKE)
6571 11 SE

SCALE 1:24 000

2'30"

859000m E

1 MILE

0 1000 2000 3000 4000 5000 6000 7000 FEET

0 1 2 3 4 5 6 7 8 9 10 KILOMETER

CONTOUR INTERVAL 10 FEET

DATUM IS MEAN SEA LEVEL

Heavy-duty

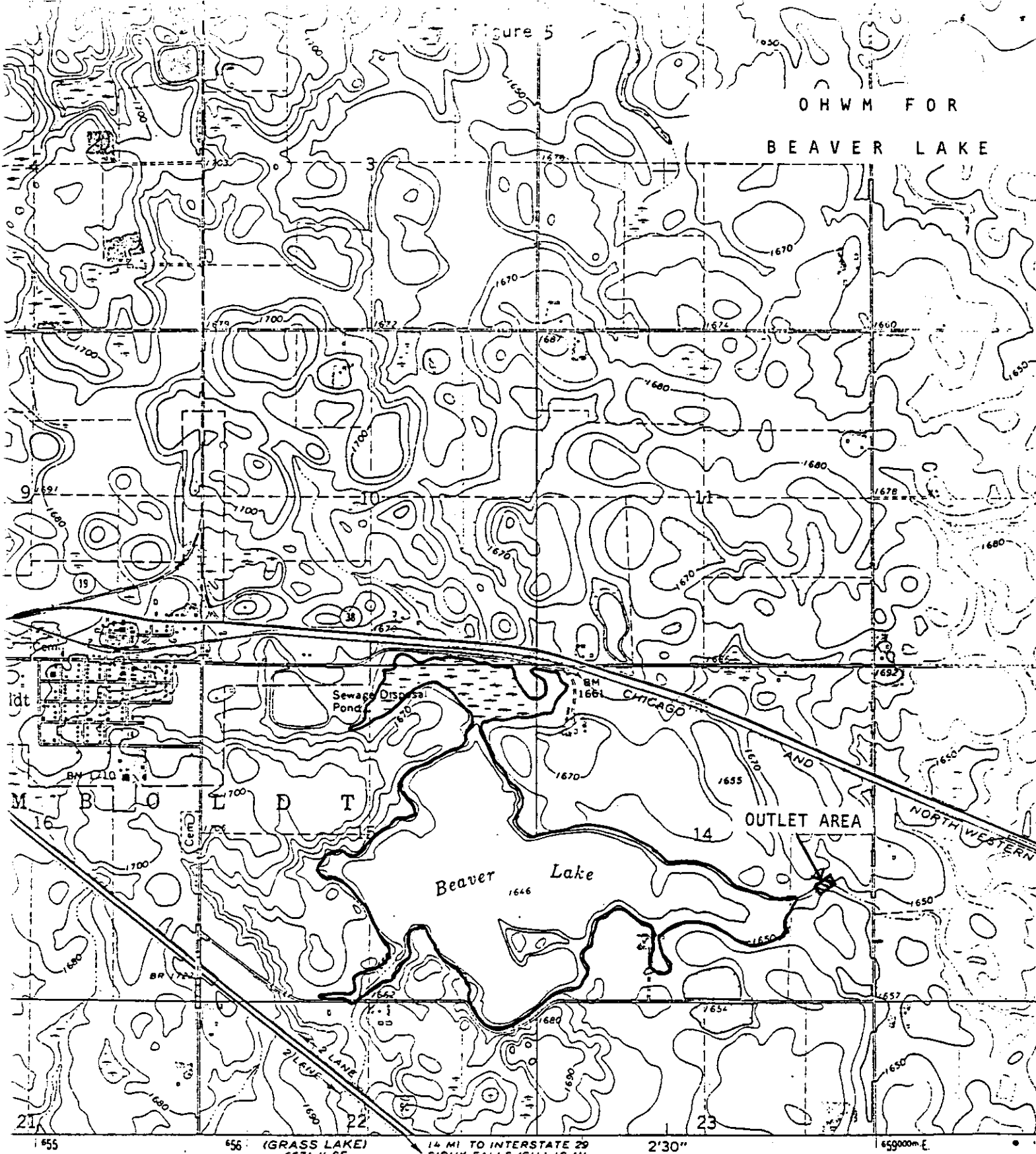
Medium-duty

Inter

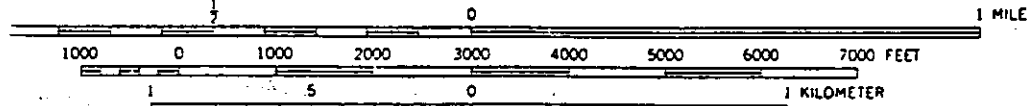
SOUTH DAKOTA

Figure 5

OHWM FOR
BEAVER LAKE



SCALE 1:24000



CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

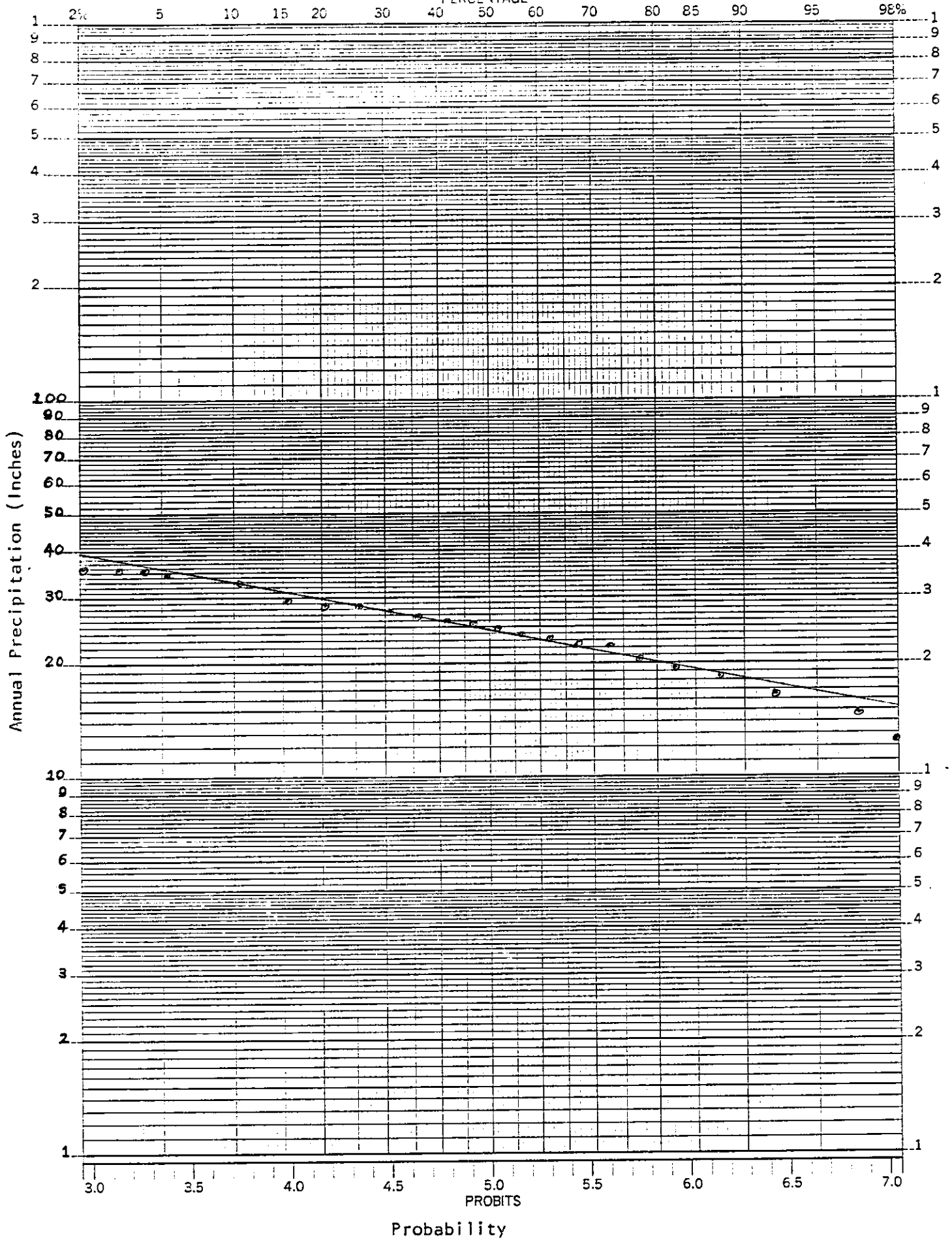


Heavy-d
Medium

Graph 1

ANNUAL PRECIPITATION PROBABILITY

PERCENTAGE



46 8080

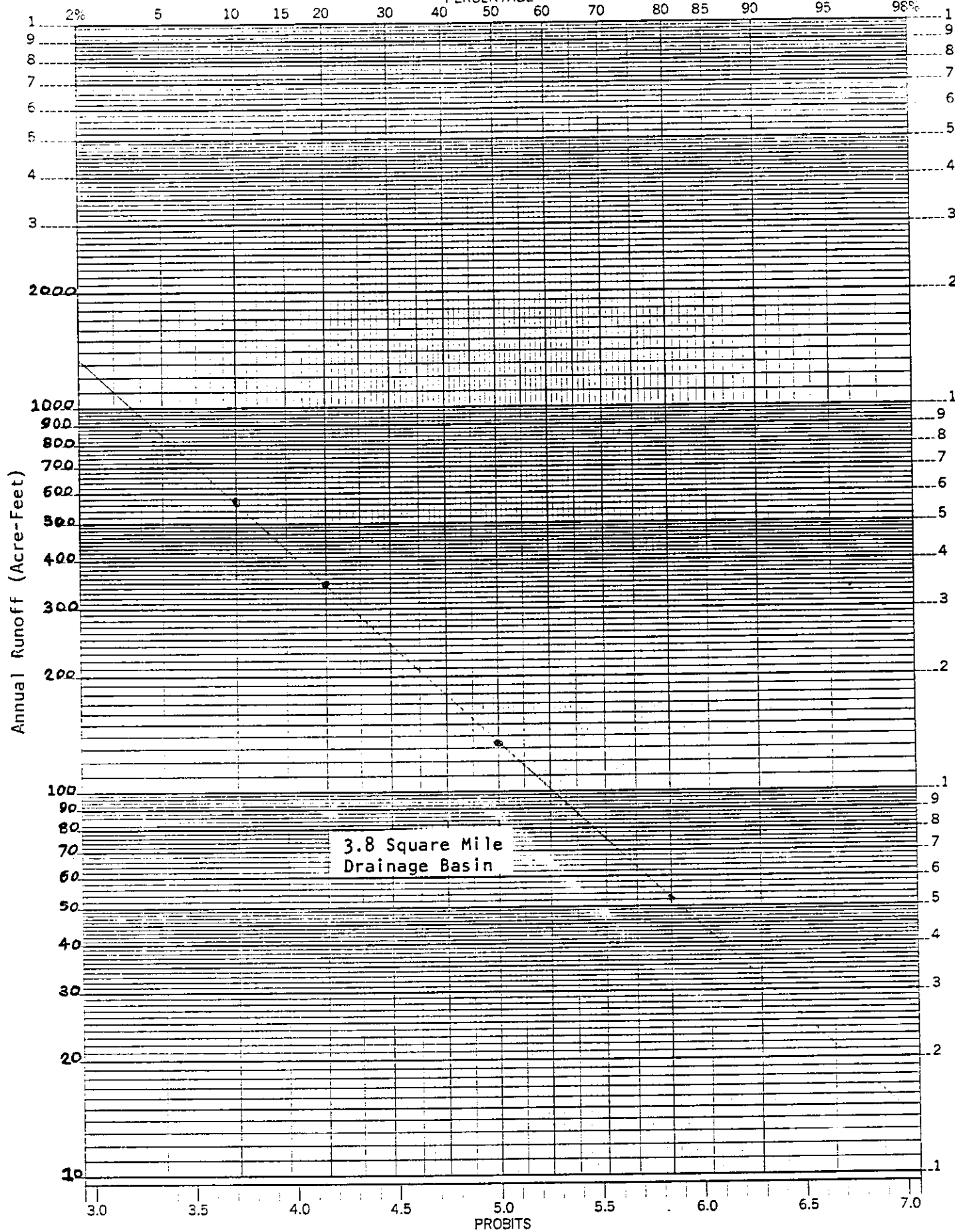
PROBABILITY X LOG CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Probability

Graph 2

ANNUAL YIELD PROBABILITY

PERCENTAGE

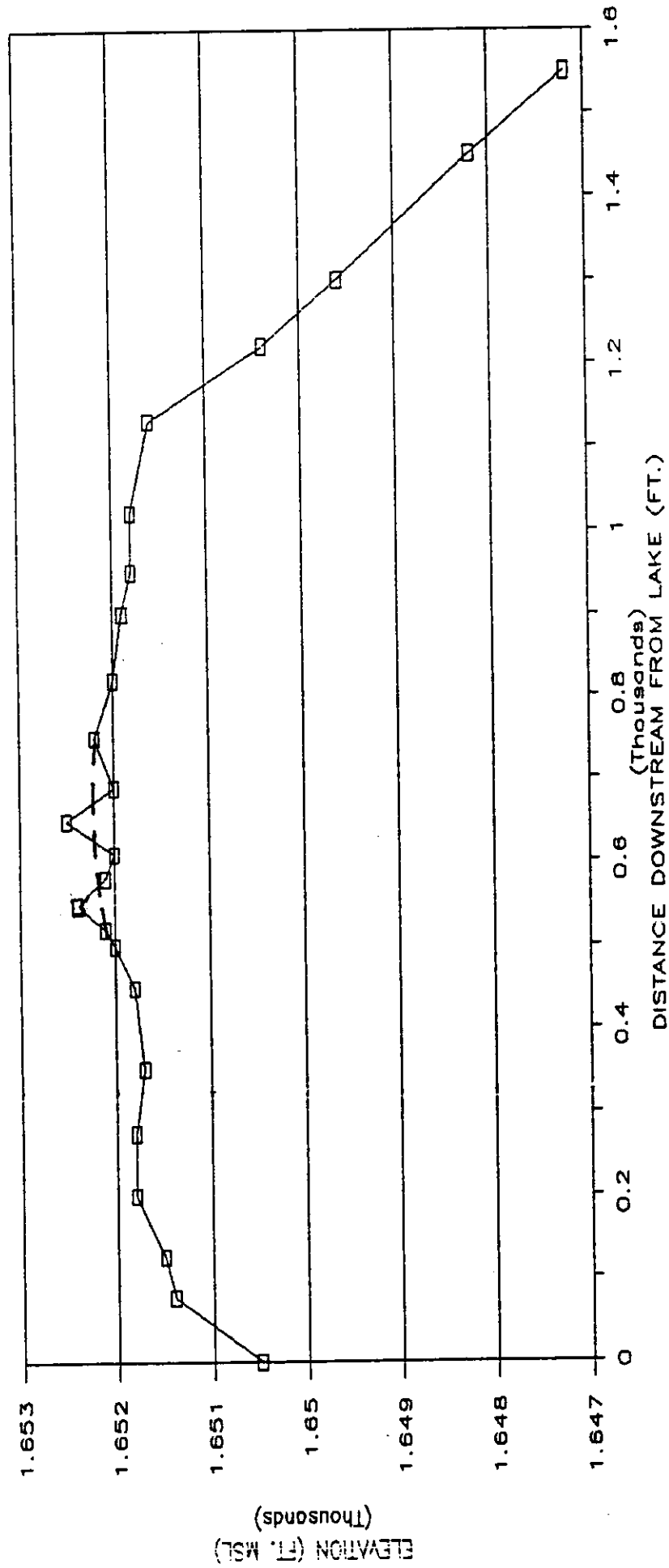


46 8080

PROBABILITY X LOG CYCLES
KEUTTEL & ESSER CO., MADE IN U.S.A.

Graph 3

BEAVER LAKE OUTLET CHANNEL



Appendix A

LAKE PRESERVATION AND RESTORATION

Lake Priority Criteria

The Coteau-lake district contains more than 200 public lakes. All of course do not possess the combination of characteristics which endear them to the general public. As noted earlier (see text, p. 12), the legislative directive required the development of criteria for choosing the lakes which should be given priority for lake improvement. Therefore, in an effort to identify and highlight the more important lakes, a lake priority system was developed which combined merits of general lake quality and factors of cultural importance. Various criteria such as lake depth, lake size, water quality, nearby population density, access, present usage, and recreation facilities were balanced according to relative importance (Fig. 3.1). The criteria of lake depth and fisheries classification were weighted most heavily in the quality regime, while the criteria of public water per capita and public facility investment dominates the cultural regime (see below).

Since data used to assign points were in many cases scant or incomplete, consecutive numerical rankings were discouraged. Rather, lake priority groupings were developed based on score ranges, whereby:

75-100 = Group 1	35-49.5 = Group 3
50-74.5 = Group 2	0-34.5 = Group 4

Group 1 represents lakes which possess the most desirable overall characteristics; Group 4 the least desirable; Groups 2 and 3 lakes of intermediate favor.

The willingness of local interests (cabin-owners and local governmental entities) to provide funds for a lake preservation or restoration proposal, however, will have a major impact on state priorities for lake improvement.

The criteria are described as follows:

Lake Depth is by far the most important characteristic affecting water quality. Deeper lakes intersect groundwater supplies to a greater degree and are thus recharged in greater proportion by sources generally considered to be of high quality. Moreover, the insulating capacity of deeper waters retard nutrient release from the bottom deposits. In combination, the above factors render the deeper lakes:

1. less subject to winterkill and more supportive of highly valued game fish
2. less subject to algal bloom and turbidity
3. more suitable for recreational activity and

WATER QUALITY FORM

LAKE _____		COUNTY _____	
Quality Rating _____		Cultural Rating _____	
<u>Lake Depth</u> 0 0-3 ft 6 3-6 ft 12 7-9 ft 17 > 9 ft		<u>Public Accessibility</u> 0 none 4 Section Line only 6 Public Access area 9 Public Access (2 or more pts)	
<u>Lake Size</u> 0 < 100 acres 2 100-200 acres 4 200-500 acres 5 500-1000 acres 6 > 1000 acres (if 3' depth)		<u>Population within 15-mile radius</u> 0 0-3,500 2 3,500-10,000 3 10,000-20,000 5 > 20,000	
<u>Public Water per Capita</u> <u>acres/capita within 40-mile radius</u> 0 > 1.0 4 .5-1.0 7 .25-.5 10 .1-.25 13 < .1		<u>Public Usage</u> 0 Fair 3 Slight 6 Moderate 9 Severe	
<u>Recharge Quality</u> 0 Primarily Surficial Recharge evident 3 Limited Groundwater Recharge evident 7 Moderate Groundwater Recharge evident 12 Extensive Groundwater Recharge evident		<u>Public Facility Investment</u> <u>Acres</u> 0 none 1 0-5 2 5-40 3 40-100 4 > 100	
<u>Fisheries Classification</u> 0 Wildlife 8 Warm Water Marginal 12 Warm Water Semi-permanent 17 Warm Water Permanent		<u>Facilities</u> 0 none 1 Access 2 Boat Ramp 4 Basic Facilities 6 Amenities short of bathing facilities 9 Amenities including bathing facilities	
Quality Rating _____ out of 5?	Total _____ out of 100	Cultural Rating _____	out of 48

Figure 3.1. The form used to tabulate relative value scores for the Coteau lakes.

4. more permanent thus retaining recreational value during periods of drouth.

An average depth of 9 ft received the maximum point assignment for two reasons. Ninety-five percent of the meandered Coteau lakes have average depths of less than 9 ft. Secondly, nine feet appears to be a natural dividing line between shallow and deep Coteau lakes (Fig. 3.2).

Lake Size relative to lake depth, is of minor importance as a determinant of lake water quality. Therefore, fewer points were allotted this criterion. A lake of 200 acres appears to be the critical size from the standpoint of recreational activity. Moreover, the Department of Game, Fish and Parks considers the 200 acre lake to be the minimum for purposes of park development. Shallow lakes of less than 3 ft average depth were given zero scores, since increased lake size attended by shallow depth results in an increased vulnerability to wave generated turbidity.

Recharge Quality Lakes which receive a large proportion of recharge from groundwater are generally of better quality than lakes which are recharged from poorer quality surface waters. This criteria was not given the full complement of points since aquifers have only been cursorily mapped in some areas.

Fisheries Classification Inherently, the combined factors of depth, susceptibility to drouth, and nutrient availability yield the fisheries classification employed by the Department of Game, Fish and Parks for management purposes. Thus, indirect measures of depth and recharge quality are obtained and given additional weight in this category. The criterion is based on winterkill of fishes, grading from the frequent-kill wildlife lakes to those lakes which sustain a permanent fisheries. The fisheries classification provides an accurate measure of general lake quality and therefore a full complement of points was allotted this criterion.

Public Accessibility Topographic maps were used to assess section line access. Questionnaires were sent to local conservation officers asking for verification of section line access and additional information pertaining to the degree of public access. Fewer points were allotted this criterion due to overlap with criteria listed below.

Public Water per Capita In an effort to provide an objective index of potential lake usage the following radii were drawn for each lake:

40 mile radius -- to provide an index of general lake usage, data were computed within this radius to determine the relationship between the total acreage of public waters (marginal classification or better) and total population.

15 mile radius -- the municipal population within this abridged radius was computed to provide a measure of immediate population pressure.

Populations for the 40-mile radius were roughly calculated by obtaining county census data thence assuming uniform population distribution and gridding that portion of the county intersected by the radius. Lake areas were obtained from Game, Fish and Parks files or from topographic maps. Point assignments were arbitrarily designated based on the range of values obtained. This criterion was heavily weighted, since population pressure is a major concern in any lake management effort.

Public Usage Public usage of lakes is a difficult criterion to assess, since only limited data are available. The public usage criterion is a relative measure based on estimates provided by local conservation officers. Fewer points were allotted to this criterion due to the relative nature of the information and the overlap of the other criteria.

Public Facility Investment Data for this criterion were compiled in part by:

- Department of Environmental Protection personnel using unpublished inventory materials provided by the Department of Game, Fish and Parks;
- Inspection of the Game, Fish and Parks' information pamphlet entitled, "South Dakota Guide to State Public Shooting Areas and Federal Waterfowl Production Areas"; and
- Inquiry directed toward local Game, Fish and Parks personnel

The criterion was divided into two categories; the first based on acreage, the second on facilities. Recreational areas with bathing facilities were considered major areas. Basic facilities consist of toilets, table and garbage units. The acreage investment surrounding the lake was subdivided by potential use, where:

- 0-5 acres - potentially suitable for boat ramp access;
- 5-40 acres - potentially suitable for minor recreational development;

40-100 acres - potentially suitable for major recreational development;

100 acres - constitutes a major investment in natural resource preservation.

Nearly a full complement of points were allotted to this criterion, since public facilities greatly influence lake usage.

Redundancy of measure does occur, since some of the criteria overlap. Taken as a whole however, the four criteria assigned to each regime provide a useful index of both lake quality and public amenity. Restoration efforts should logically be directed toward the more highly grouped lakes, although not exclusively, since sufficient local interest toward a lake of lower grouping would warrant a feasibility study.

Lake Groups

Group 1

Big Stone (RB)	Kampeska (CD)
Brant (LK)	Madison (LK)
Clear (FL)	Pickereel (DA)
Cochrane (DU)	Poinsett (HN)
Enemy Swim (DA)	Roy (ML)

Group 2

Alice (DU)	Hendricks (BG)	Red Iron, N (ML)
Blue Dog (DA)	Herman (LK)	Red Iron, S (ML)
Buffalo, N (ML)	Loss (MH)	Round (CD)
Buffalo, S (ML)	Minnewasta (DA)	Round (DU)
Bullhead (DU)	Nine Mile (ML)	School (DU)
Campbell (BG)	Norden (HN)	Sinai (BG)
Clear (DU)	Oakwood, E (BG)	Traverse (RB)
Clear (MH)	Oakwood, W (BG)	Wall (MH)
Cottonwood (ML)	Pelican (CD)	Waubay, N (DA)
Dry (HN)	Punished Woman (CD)	Waubay, S (DA)

Group 3

Albert (HN)	Four Mile (ML)	Mud (RB)
Almos (ML)	Goldsmith (BG)	Oak (BG)
Badger (KG)	Green (LK)	Oliver (DU)
Bailey (CK)	Gross (MC)	Round (CK)
Beaver (MH)	Henry (KG)	Round (LK)
Bullhead (ML)	High (ML)	St. John (HN)
Campbell Slough (DA)	Horseshoe (CD)	Six Mile (ML)
Clear (HN)	Ketchum (DU)	Spirit (KG)
Coteau, S (DU)	Lions & Bollinger (MC)	Summit (GT)
Cottonwood, N (F)	Lone Tree (DU)	Thisted (KG)
Crooked (GT)	Marsh (HN)	Twin (Chain) (MR)
Drywood, N (RB)	McKilligans (CD)	WhiteStone (RB)
Fish (DU)	Medicine (CD)	Willow (CK)
Florence (HN)		

PUBLIC ACCESSIBILITY	
None	Section line only
Public access area	Public access - 2 or more pts.
Public water - 40 mile radius	
> 1 acre/capita	
5-1.0	
.25-.5	
1-1.25	
< 1	
POPULATION WITHIN 15-MILE RADIUS	
0-3,500	
3,500-10,000	
10,000-20,000	
$> 20,000$	
PUBLIC USAGE	
Rate	
Slight	
Moderate	
Severe	
PUBLIC FACILITY INVESTMENT	
acreage - none	
0-5	
5-40	
40-100	
> 100	
facilities - none	
- Access	
- Boat Ramp	
- Basic facilities	
- Amenities short of bathing facilities	
- Amenities including bathing facilities	
DRAINAGES (approx.)	
ACRES PER ACRE	

MINER COUNTY (cont Inued)[illegible]

MOODY COUNTY

Poison (106-58-28)

FOREWORD

In an effort to identify and highlight the more important Coteau lakes, a lake priority system was developed which combined merits of general lake quality and factors of cultural importance. A copy of the form used to tabulate scores is presented in Chapter III. Since the data used to tabulate scores were in many cases scant or incomplete, consecutive numerical rankings were discouraged. Rather, lake groupings were developed based on score ranges, whereby:

75-100 = group 1
50-74.5 = group 2
35-49.5 = group 3
0-34.5 = group 4.

The scores developed from the quality and cultural categories are listed below (lakes listed alphabetically). The values used to score the quality regime may be found in Chapter II, Table 2.2. The values used to score the cultural regime are tabulated in this appendix.

SCORES USED IN LAKE GROUPING

Lake	Quality (52 possible)	Cultural (48 possible)	Total (100 possible)
Abraham (ML)	19	4	23
Albert (GT)	11	2	13
Albert (HN)	23	20	43
Alice (DU)	33	22	55
Almos (ML)	30	10	40
Anderson (DA)	0	4	4
Antelope (CK)	13	4	17
Antelope (DA)	0	10	10
Astoria (DU)	0	11	11
Badger (KG)	22	18	40
Badus (LK)	18	12	30
Bailey (CK)	23	24	47
Bde-Saka (RB)	17	6	23
Beaver (MH)	18	30	48
Belview (MR)	0	9	9
Big Stone (RB)	47	33	80
Bitter (DA)	12	4	16
Bitter (MR)	8	21	29
Blackrush (CK)	0	8	8
Black Slough (DA)	3	4	7
Black Slough (GT)	0	3	3
Black Slough, E (GT)	0	0	0
Blue Dog (DA)	41	25	66
Brant (LK)	46	37	83
Briggs (DU)	14	18	32
Brush (BG)	7	18	25
Brush, E #1 (BG)	3	11	14
Brush, E #2 (BG)	3	11	14
Brush (Twin)(KG)	3	7	10
Buffalo (MH)	0	23	23
Buffalo, N (ML)	45	11	56
Buffalo, S (ML)	42	17	59
Bullhead (DU)	40	27	67
Bullhead (ML)	29	14	43
Bullhead (RB)	20	6	26
Campbell (BG)	26	32	58
Campbell Slough (DA)	31	10	41
Center (MR)	0	11	11
Cherry (CK)	21	12	33
Clear (CK)	8	8	16
Clear (DU)	26	24	50
Clear (HN)	22	14	36
Clear (MH)	18	35	53
Clear (ML)	52	28	80
Clubhouse (RB)	9	14	23
Cochrane (DU)	45	32	77
Coteau, E (DU)	3	8	11
Coteau, N (DU)	3	10	13
Coteau, S (DU)	21	21	42
Coteau, W (DU)	3	12	15

ANNUAL PRECIPITATION TOTALS

Appendix B1*

YEAR	SIoux FALLS	CANISTOTA	MONTROSE	COLTON	SALEM	AVERAGE
1987	18.7		20.4	26.3		21.8
1986	30.5	27.8	32.1	38.6		32.2
1985	27.2	26.9		25.9		26.7
1984	29.6	29.0		28.9		29.2
1983	26.8	25.0		25.3		25.7
1982	33.3	32.8		41.0		35.7
1981	18.1	20.7		20.8		19.9
1980	13.8	17.6		17.5		16.3
1979	32.3	25.1		31.6		29.6
1978	23.2	27.3				25.2
1977	31.6	34.8				33.2
1976	11.4	13.5				12.5
1975	26.1	25.9				26.0
1974	17.0	16.9				17.0
1973	28.2	23.1				25.6
1972	26.4	22.0	23.8		27.6	25.0
1971	23.6	20.3	23.2		25.1	23.0
1970	27.4	23.1	22.6		30.7	25.9
1969	26.6	31.7	23.8		28.6	27.7
1968	27.8	27.2	28.6		26.1	27.4
1967	16.4	14.0	16.3		18.5	16.3
1966	20.8	17.9	18.4		16.5	18.4
1965	27.9	27.3	28.2		19.1	25.6
1964	22.6	17.3	19.0		19.0	19.5
1963	21.0	21.6			29.1	23.9
1962	30.5	33.2			36.0	33.2
1961	23.1	20.8			25.9	23.2
1960	27.5	28.4			29.5	28.5
1959	29.8	26.6			29.1	28.5
1958	15.3	14.9			17.4	15.9
1957	28.2	26.8			27.9	27.6
1956	22.7	19.6			20.0	20.8
1955	18.2	18.2			18.5	18.3
1954	24.7	21.3			26.0	24.0
1953	30.1	22.4			31.3	27.9
1952	18.9	8.4			17.0	14.8
1951	30.8	19.8			32.9	27.8
1950	21.2	23.0			24.4	22.9
1949	20.8	15.7			21.2	19.2
1948	27.6	29.7			28.0	28.4
1947	25.6	21.4			25.2	24.1
1946	26.3	31.4			29.0	28.9
1945	25.4	21.5			21.0	22.6
1944	32.2	36.9			40.3	36.4
1943	23.5	25.4			21.9	23.6
1942	27.9	26.3			31.7	28.6
1941	20.7	17.7				19.2
1940	26.6	28.0				27.3
1939	25.3	18.5				21.9
1938	29.4	22.9				26.1
1937	27.7	28.4				28.0
1936	25.3	15.8				20.5
1935	32.3	24.9				28.6
1934	24.6	23.1				23.9
1933	20.7	17.9				19.3
1932	27.7	24.8				26.2
1931	17.7	15.2				16.5
1930	23.8	21.9				22.8
1929	34.1	27.1				30.6
1928	26.2	23.5				24.9
1927	24.0	21.0				22.5
1926	24.6	20.6				22.6
1925	20.0	14.7				17.4
1924	20.3	17.8				19.0
1923	29.2	19.9				24.6
1922	23.1					23.1
1921	24.2					24.2
1920	32.9					32.9
1919	27.9					27.9
1918	25.6					25.6
1917	19.5					19.5
1916	22.3					22.3
1915	29.4					29.4
1914	26.6					26.6
1913	27.0					27.0
1912	24.6					24.6
1911	34.6					34.6
1910	16.9					16.9
1909	36.0					36.0
1908	33.0					33.0
1907	20.7					20.7
1906	32.9					32.9
1905	35.5					35.5
1904	20.1					20.1
1903	30.9					30.9
1902	25.9					25.9
1901	22.5					22.5
1900	29.1					29.1
1899	29.0					29.0
1898	26.9					26.9
1897	25.5					25.5
1896	30.1					30.1
1895	20.3					20.3
1894	10.4					10.4
1893	22.3					22.3
1892	23.9					23.9
1891	18.8					18.8
AVERAGE	25.2	22.9	23.3	28.4	25.6	24.8

Appendix B2

ANNUAL PRECIPITATION DATA
RANKED BY YEARLY AVERAGE

POSITION	YEAR	AVERAGE	POSITION	YEAR	AVERAGE
1	1944	36.4	50	1928	24.9
2	1909	36.0	51	1912	24.6
3	1982	35.7	52	1923	24.6
4	1905	35.5	53	1921	24.2
5	1911	34.6	54	1947	24.1
6	1962	33.2	55	1954	24.0
7	1977	33.2	56	1963	23.9
8	1908	33.0	57	1892	23.9
9	1920	32.9	58	1934	23.9
10	1906	32.9	59	1943	23.6
11	1986	32.2	60	1961	23.2
12	1903	30.9	61	1922	23.1
13	1929	30.6	62	1971	23.0
14	1896	30.1	63	1950	22.9
15	1979	29.6	64	1930	22.8
16	1915	29.4	65	1945	22.6
17	1984	29.2	66	1926	22.6
18	1900	29.1	67	1901	22.5
19	1899	29.0	68	1927	22.5
20	1946	28.9	69	1893	22.3
21	1942	28.6	70	1916	22.3
22	1935	28.6	71	1939	21.9
23	1960	28.5	72	1987	21.8
24	1959	28.5	73	1956	20.8
25	1948	28.4	74	1907	20.7
26	1937	28.0	75	1936	20.5
27	1953	27.9	76	1895	20.3
28	1919	27.9	77	1904	20.1
29	1951	27.8	78	1981	19.9
30	1969	27.7	79	1964	19.5
31	1957	27.6	80	1917	19.5
32	1968	27.4	81	1933	19.3
33	1940	27.3	82	1949	19.2
34	1913	27.0	83	1941	19.2
35	1898	26.9	84	1924	19.0
36	1985	26.7	85	1891	18.8
37	1914	26.6	86	1966	18.4
38	1932	26.2	87	1955	18.3
39	1938	26.1	88	1925	17.4
40	1975	26.0	89	1974	17.0
41	1970	25.9	90	1910	16.9
42	1902	25.9	91	1931	16.5
43	1983	25.7	92	1980	16.2
44	1965	25.6	93	1967	16.3
45	1973	25.6	94	1958	15.9
46	1918	25.6	95	1952	14.8
47	1897	25.5	96	1976	12.5
48	1978	25.2	97	1894	10.4
49	1972	25.0			

AVERAGE	24.8
STD	5.4
VAR	28.8
MIN	10.4
MAX	36.4
TOTAL	2404.8
COEF. VAR. : STD/AVG	0.218

Appendix C

ANNUAL YIELD (ACRE-FEET) RANKING

POSITION	YEAR	SKUNK CREEK SIOUX FALLS
1	1984	292800
2	1983	222800
3	1986	221000
4	1987	105300
5	1962	96000
6	1952	95000
7	1985	92500
8	1951	91000
9	1969	83240
10	1960	80100
11	1957	77700
12	1979	64690
13	1972	51700
14	1949	49000
15	1973	42600
16	1978	42500
17	1953	40200
18	1982	29500
19	1954	29000
20	1970	28400
21	1965	23500
22	1980	18300
23	1971	18000
24	1950	15000
25	1961	13000
26	1966	11900
27	1964	11000
28	1958	10400
29	1974	10200
30	1956	9900
31	1963	9800
32	1967	8500
33	1955	8200
34	1976	6830
35	1959	6700
36	1975	5200
37	1968	3200
38	1977	1710
39	1981	1120

AVERAGE	51987
STD	64830.802356
VAR	4203032934.1
MIN	1120
MAX	292800
TOTAL	2027490
COEF. VAR. :STD/AVG	1.25

ANNUAL YIELD (ACRE-FEET) RANKING

POSITION	YEAR	BIG SIOUX R. SIOUX FALLS
1	1986	1386000
2	1984	1088000
3	1983	781300
4	1985	684600
5	1952	671600
6	1969	613000
7	1962	587600
8	1951	497100
9	1987	484600
10	1972	442900
11	1979	421000
12	1948	419800
13	1947	397000
14	1978	390900
15	1944	355100
16	1945	340100
17	1965	302400
18	1953	290100
19	1973	279700
20	1957	277100
21	1946	241900
22	1960	234900
23	1954	229200
24	1970	225300
25	1949	195900
26	1966	177400
27	1982	173500
28	1980	169000
29	1963	153600
30	1950	141300
31	1967	131800
32	1971	130200
33	1961	118900
34	1964	114600
35	1977	76300
36	1974	75000
37	1976	64700
38	1955	63280
39	1975	62800
40	1958	60980
41	1956	41680
42	1981	36510
43	1968	35100
44	1959	24510

AVERAGE	311097
STD	281828.00682
VAR	79427025431
MIN	24510
MAX	1386000
TOTAL	13688260
COEF. VAR. :STD/AVG	0.91

ANNUAL YIELD (ACRE-FEET) RANKING

POSITION	YEAR	L. VERMILLION R. SALEM
1	1984	17970
2	1986	11730
3	1983	11280
4	1978	5690
5	1969	5310
6	1985	4710
7	1987	4630
8	1982	3040
9	1979	2640
10	1970	2470
11	1973	1640
12	1971	1360
13	1977	1100
14	1972	780
15	1967	300
16	1980	62
17	1976	32
18	1974	4
19	1981	0
20	1975	0
21	1968	0

AVERAGE	3559
STD	4652.955114
VAR	21649991.293
MIN	0
MAX	17970
TOTAL	74748
COEF. VAR. :STD/AVG	1.31

ANNUAL YIELD (ACRE-FEET) RANKING

POSITION	YEAR	W. VERMILLION R. PARKER
1	1984	145400
2	1983	98000
3	1986	84600
4	1962	64500
5	1969	46200
6	1978	41700
7	1979	34000
8	1987	25000
9	1985	24400
10	1972	19700
11	1973	15700
12	1970	15700
13	1971	15500
14	1966	6900
15	1967	6200
16	1982	6150
17	1976	4900
18	1977	4600
19	1964	3400
20	1965	3100
21	1963	2800
22	1980	1900
23	1975	1300
24	1974	1100
25	1968	1100
26	1981	14

AVERAGE	25918
STD	35177.707766
VAR	1237471123.7
MIN	14
MAX	145400
TOTAL	673864
COEF. VAR.:STD/AVG	1.36

ANNUAL YIELD (ACRE-FEET) RANKING

POSITION	YEAR	VERMILLION R. WAKONDA
1	1984	877400
2	1983	574100
3	1986	423500
4	1962	269700
5	1960	241300
6	1951	233400
7	1969	222500
8	1985	209300
9	1987	206400
10	1952	173000
11	1979	167300
12	1978	138700
13	1947	116400
14	1954	107800
15	1948	106600
16	1972	102700
17	1973	95000
18	1949	92100
19	1953	80890
20	1971	62000
21	1965	60100
22	1961	58600
23	1957	57400
24	1970	54500
25	1950	50690
26	1966	47200
27	1982	38200
28	1967	37400
29	1946	32620
30	1980	32200
31	1963	31500
32	1955	27200
33	1976	24400
34	1964	21500
35	1974	17800
36	1959	14400
37	1958	13400
38	1968	9300
39	1975	8600
40	1977	7200
41	1956	7100
42	1981	6450

AVERAGE	122806
STD	165162.86144
VAR	27278770800
MIN	6450
MAX	877400
TOTAL	5157850
COEF. VAR. :STD/AVG	1.35

Appendix D1

Chemical Water Quality

FOREWORD

The following table manifests a fairly complete and current inventory of available chemical quality data as obtained by various agencies and researchers for the lakes of the Prairie Coteau. The data will enable lake planners and researchers to quickly characterize and compare the lakes of the Coteau region.

Further information may be obtained from the source as referenced. Refer to the bibliography for the title of the reference in question. The unpublished references are described as follows:

1. Barr - Kelton Barr, University of Minnesota. Masters Candidate, Department of Geology
2. East Dakota Conservancy Sub-District (Brookings) - Chemical quality data obtained in a coordinated effort with the Department of Environmental Protection (Pierre).
3. Game, Fish and Parks (Pierre) - Chemical quality data obtained during the ongoing water quality survey initiated in 1972. Scattered bits of data prior to 1972 were obtained from the lake files.
4. South Dakota Geological Survey (Vermillion) - Data lifted from either the Water Quality Laboratory files or the general lake files.
5. State Chemical Laboratory (Vermillion) - Lifted from inactive file data. Current analyses are no longer kept on file.
6. United States Geological Survey -
 - a. For Deuel and Hamlin Counties - Jack Kume, Vermillion office.
 - b. For Clark County - Bud Hamilton, Huron office.
 - c. For Marshall County - Neil Koch, Huron office.

TABLE EXPLANATION

Date = date of sampling

Depth = depth in the water column from which the sample was taken (meters)

Temp = temperature of water at time of sampling (degrees Celsius)

pH = negative logarithm of the hydrogen ion concentration. More simply stated: pH is a measure of acidity using a scale of 1-14, where 1 represents the most acidic value and 14 the least acidic value. The half way point (i.e., pH = 7) represents a neutral value where the basic properties of water equal the acidic properties. A pH below 7 is considered acidic, a pH above 7 would be considered basic.

The pH of lake waters vary with algal activity. Before daylight, the pH will be most acidic (approx. pH = 6) due to the respiration, but by late afternoon the pH may soar into the basic range (approx. pH = 9) due to the photosynthetic process whereby H^+ ions are drawn from the calcium bicarbonate species (see Total Alkalinity below) leaving the waters more basic, with calcium carbonate the dominant salt. The process is, of course, reversed as photosynthesis wanes and respiration again becomes the dominant biotic activity.

SD = sechhi disk transparency; a relative measure of transparency taken by submersing a 20-cm diameter disk (alternately quartered in black and white paint) to the limit of visibility. Example: > 60 cm = eutrophic.

DO = oxygen dissolved in water. Low levels of O_2 (< 3 mg/l) can cause die-off of fishes.

Chl_a = most abundant and important pigment used by algae in photosynthesis. The measurement provides an indication of the severity of algal bloom.

Example: 20 μ g/l = eutrophic.

Major salt constituents:

Mg^{++} = magnesium

Na^+ = sodium

K^+ = potassium

Ca^{++} = calcium

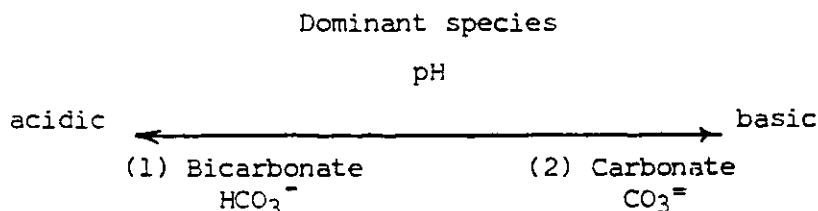
$SO_4^{=}$ = sulfate

Cl^- = chloride

$HCO_3^- + CO_3^{=}$ = carbonates

These dissolved constituents, in a variety of combinations, are largely responsible for the solid content of water. As solids concentrations increase, due primarily to evaporation, the $MgSO_4$ salt becomes dominant due to its high solubility. In contrast, $CaCO_3$ will precipitate when moderate concentrations are reached, e.g., 1000 mg/l. The carbonates have not been listed in this appendix. Rather, total alkalinity has been substituted due to a more frequent measurement. Total alkalinity is expressed as $CaCO_3$ and as such cannot be used directly in the summation of constituents (Ca^{++} listed separately). However, a crude estimate of the carbonate weight can be arrived at by multiplying the total alkalinity by 0.6 (relative weight of the $CO_3^{=}$ fraction). A summation of the estimated carbonate weight and the weights of the other major constituents will then approximate the Total Dissolved Solids as obtained by oven-evaporation.

Alkal Total = total alkalinity expressed as $CaCO_3$. There are two principal species of alkalinity; both coexist, but dominance of any given species is pH dependent.



For convenience sake, both the carbonate and bicarbonate fractions of total alkalinity are expressed by weight as $CaCO_3$. These species combine with calcium to form an important buffer system whereby hydrogen ions are released to the photosynthetic community upon demand. Thus, when an algal bloom is in progress, the daytime waters will become basic due to the uptake of H^+ ions and consequent conversion of bicarbonate to carbonate. The process is reversed at night when H^+ ions are released by the then dominant biotic activity, i.e., respiration.

Cond = The electrical conductivity of lake water expressed in micromhos (μ mhos). Provides a quick estimate of Total Dissolved Solids. In fresh waters (< 2500 mg/l TDS) total dissolved solids usually range between 60 and 80 per cent of the conductivity.

TDS = Solids dissolved in water obtained by oven-evaporation. Lake waters vary seasonally and climatically due to the variability in evaporation rates. Moreover, lake waters with closed basins have higher solids content than lakes which flush seasonally. A solids concentration of 5000 mg/liter is considered high for this lake district. A solids concentration of 10,000 mg/l is considered to be the upper allowable limit for fish production, but growth impairment may occur before such a concentration is reached (Rosen et al, 1974).

Nutrient Series: The two most important elements required for photosynthesis are phosphorus and nitrogen. These, of course, exist in many forms as described below.

- a) P-total = total phosphorus expressed as phosphorus (includes both dissolved and organic). Example: 0.03 mg/l considered high.
- b) P-ortho = dissolved phosphorus readily available for algal uptake. Example: 0.01 mg/l considered high.
- c) NO₃- N+NO₂-N = dissolved nitrogen expressed as nitrogen. Readily available for algal uptake. Example: 0.1 mg/l considered high.
- d) NH₃-N = dissolved ammonia as nitrogen. Readily available for algal uptake. Example: 0.1 mg/l considered high.
- e) N_K-N = organic nitrogen + dissolved ammonia. The addition of c and e will approximate total nitrogen. Example: 0.5 mg/l considered high.

The organic forms of phosphorus and nitrogen are those which are tied up in living or decaying plant and animal matter.

Equivalent Units

- 1 meter (m) = 3.28 feet
- 1 centimeter (cm) = 0.01 meter
- 1 gram (g) = 15.43 grains or 0.035 ounces
- 1 milligram (mg) = 0.001 gram
- 1 microgram (μ g) = 0.001 mg
- 1 liter (l) = 1.06 quarts
- 1 hectare = 2.47 acres
- 1 sq. kilometer = 0.38 sq. mi.

APPENDIX D1

Date	Depth (m)	Temp (°C)	SpH	Chla (µg/l)	Na ⁺	K ⁺	Mg ⁺⁺	Ca ⁺⁺	SO ₄ ²⁻	Cl ⁻	Alkal Cond. total	TDS	P total	P ortho	NO ₃ -N	NO ₂ -N	NH ₃ -N	NH ₄ -N	Reference
Clear Lake (103-51-5)(474 acres)																			
4-22-74	10.6	9.9	-	8.2	80						258	362	.97	.07	.2	.60	8.6		National Eutrophication Survey, 1974
7-12-74	24.5	9.9	18	16.4	1693						276	787	1.40	.47	.14	.10	1.0		
9-20-74	15.5	9.4	10	8.0	300						276	498	1.62	.73	.04	.06	-		Hayden, 1976
8-18-76											1121	936							
Lost Lake (101-52-4)(77 acres)																			
8-18-76											274	1744							Hayden, 1976
Lost Lake (103-52-34)(90 acres)																			
8-18-76											975	847							Hayden, 1976
Wall Lake (101-51-21)(198 acres)																			
10-23-64	8	8.6		11.8		46	27	86	70	462	173	1150	.11	.06	1.14				Petri and Larson
2-18-65	1	7.6		9.2		61	34	115	94	610	255	1460	.26	.22	.07				
5-26-65	17	7.6		6.0		38	23	75	67	398	172	1090	.10	.04	.75				
9-13-65	17	8.9		9.1		40	25	83	58	424	160	1080	.26	.10	.66				
4-22-74	11.2	-	228	-	5.1						167	654	.84	.31	.04	.08	1.4		National Eutrophication Survey, 1974
4-22-74	1.6	11.1		9.2							169	754	.84	.76	.06	.09	1.4		
7-11-74	25.4	9.1	122	7.6	111						173	1270	.21	.13	.09	.25	2.6		
7-11-74	.6	25.4	9.1	7.8							175	1270	.19	.12	.05	.21	2.1		
7-11-74	2	25.4	9.1	7.6							178	1270	.19	.12	.05	.21	2.2		
9-20-74	17.5	9.1	94	8.2	50						171	1081	.20	.06	.02	.14	3.4		
9-20-74	2.3	17.5	9.1	8.4							173	1083	.27	.08	.02	.14	3.3		Hayden, 1976
11-20-76											1621	1338							
Beaver Lake (102-52-14)(224 acres)																			
8-18-76											5310	5662							Hayden, 1976

Appendix foreword contains table explanation
Concentrations reported as mg/l unless otherwise noted

Appendix D2

Lake Typology

northern Coteau are notable among others in that they are the least intensively cultivated (see Table 2.2). Better water quality of these northern lakes apparently reflects this disparity, although other factors such as smaller immediate watershed size and more extensive aquifer connection must also be considered.

In order to preserve the lakes of the Coteau, it is of paramount importance that minerogenic sedimentation be minimized. The present rate of senescence could probably be cut in half if proper watershed treatment were realized. Based on a 1 mm annual deposition rate, a uniform removal of 3 feet of sediment from the lake basin by dredging would restore the lake to an equivalency condition of 1800 years ago.

Table 2.1 presents the Trophic State Index (TSI) values, based on limited available data, for some representative Coteau lakes.* The TSI values which range from 0-100, provide an index of potential nuisance algal bloom conditions. Higher values indicate greater potential for nuisance algal blooms. For a discussion concerning the causal factors of TSI for selected individual lakes, see Chapter III.

Table 2.1. Trophic State Indexes for representative Coteau lakes (Carlson, 1974).

<u>Lake</u>	<u>TSI</u>	<u>Lake</u>	<u>TSI</u>	<u>Lake</u>	<u>TSI</u>
Herman	85	Poinsett	70	Round (DU)	59
Wall	81	Big Stone	69	Roy	59
Kampeska	78	Hendricks	67	Cochrane	56
Madison	78	Minnewasta	65	Alice	56
Traverse	76	Bullhead (DU)	63	Red Iron, S.	56
Campbell	74	Waubay, N.	61	Buffalo, S.	53
Oakwood, W.	73	Pelican	61	Enemy Swim	53
Oakwood, E.	73	Blue Dog	61	Punished Woman	49
Norden	73	Buffalo, N.	61	Clear (ML)	49
Brant	73				

Lake Typology Methods

The Lake Typology Table (immediately following) will enable researchers or planners to quickly characterize a lake-watershed complex for management purposes. A brief explanation of each parameter follows:

1. Surface Area = Area of the lake given in both acres and square miles as planimetered by Game, Fish and Parks or estimated by the grid method from topographic maps.

*More data must be collected to adequately characterize the Coteau lakes with regard to Trophic Status.

2. Depth = Average and maximum depths (feet) taken from the files of Game, Fish and Parks.
3. Fisheries Classification = A Department of Game, Fish and Parks classification based on a lake's ability to sustain a fisheries. Taken from the Department of Environmental Protection -- Surface Water Quality Standards - Ch. 34:04:02, where:

WWP = Warm-water permanent - no winterkill

WW_sP = warm-water semi-permanent - winterkill approx. every 10 years

WWM = Warm-water marginal - winterkill approx. every 5 years

and Wf = Wildlife, other than fishes.

Note: as waters become more permanent, greater protection against pollution is provided by the Department of Environmental Protection.

4. TDS = Solids dissolved in water measured by oven-evaporation (mg/liter). Lake waters vary seasonally and climatically due to variability in evaporation rates. Moreover, lake waters with closed basins have higher solids content than lakes which flush seasonally. A solids concentration of 5000 mg/liter is considered high for the Coteau lake district. A solids concentration of 10,000 mg/l is considered to be the upper allowable limit for fish production, but growth impairment may occur before such a concentration is reached (Ryder et al, 1974). The concentration listed is merely a representative value arbitrarily chosen from Appendix II.
5. TSI = A trophic state index (index of nutrient availability) calculated for representative recreational lakes. A scale from zero to 100 is used, zero being the least trophic and 100 the most trophic. Values as listed were obtained by averaging open-water surface phosphorus concentrations and entering such values into Carlson's (1974) equivalency equation for phosphorus (see text, p. 28).
6. Aquifer Connection = The writer made subjective value judgements based on aquifer information gleaned from the following sources:

Adolphson and Ellis, 1964
Barari, 1971a
Barari, 1971b
Barari, 1971c
Christensen, 1976
Flint, 1955
Hamilton, 1976
Hedges, 1962
Jorgensen, 1965
Koch, 1975
Kume, 1976
Leap, 1972
Leap, 1974
Lee et al, 1958

Lee and Harris, 1960
Rothrock, 1934
Schroeder, 1976
Steece et al, 1958a
Steece et al, 1958b
Tipton et al, 1958a
Tipton et al, 1958b
Tipton and Stockdale, 1971
Tipton and Wilson, 1958a
Tipton and Wilson, 1958b
Tipton and Wong, 1959
Wong, 1960a
Wong, 1960b

The lakes were arbitrarily categorized as follows:

O = Primarily Surficial Recharge

L = Limited Groundwater Recharge

M = Moderate Groundwater Recharge

and E = Extensive Groundwater Recharge.

7. Outlet = This parameter provides an indication of outflow frequency as determined from topographic maps and local inquiry. A relative scale of 1-10 was used to depict the degree to which a lake is closed (10 indicating an infrequent overflow). An upper case C indicates a completely closed system. Lakes at the upper end of the scale are more susceptible to salt accumulation. The index is provided merely for rapid assessment of lake character and should not be used in any quantitative ranking or characterization scheme.

8. Contributing Watershed = The land surface (sq. miles) surrounding the lake which contributes water, via surface-runoff, to the lake (see Plate I).

All watersheds, with the exception of Lake Traverse, were delineated using 7½' USGS Topographic maps. A larger scale (1:250,000 Army Map Service) map was used to complete the Lake Traverse watershed. Delineated areas were then traced upon constant weight tracing paper (Albanene #10-7155) and weighed with a Mettler H-5 Analytical balance. Calculations for total area were made by correlating total weight with a standard area weight.

Many wetlands, sloughs, closed basins, and otherwise ambiguous areas of drainage exist in the Coteau area due to the "youthful" nature of the terrain.*

*with reference to geological time.

Several subjective judgements were made since the ambiguous drainage prevents clear-cut delineation.

Three general rules of exclusion were adopted:

- (1) exclude peripheral closed depressions
- (2) exclude interior closed depressions in excess of 160 acres
- and (3) exclude upstream lake watersheds with watershed area/lake area ratios of less than five, since lakes with the smaller ratios generally retain rather than contribute waters which fall within their boundaries.

9. Immediate Watershed* = That portion of the Contributing Watershed (free of substantial lakes or sloughs) from which direct, unimpeded surficial runoff drains into the lake (sq. miles).

Topographic maps (7½') were used to distinguish between the immediate watershed and the contributing watershed. Again, drainage ambiguities necessitated many subjective judgements. Wetlands or lakes of substantial size were deleted from the contributing watershed.

10. W_C/L = The ratio of Contributing Watershed Area to Lake Area. A rough estimate of surficial recharge is thus provided: For every unit indicated, approximately 1 inch of water is added to the lake (SCS, 1973). Example: The W_C/L for Lake Campbell = 118 or 9.8 ft. of water supplied annually to the lake via runoff.
11. W_iL^* = The ratio of Immediate Watershed Area to Lake Area. As the values increase, the potential for sediment input also increases.
12. Slope* = An indication of average per cent slope within the immediate watershed was obtained by randomly selecting one-half or more of the mile sections therein. A line drawn from the highest point to the lowest point within a given section (7½' quadrangle) provided an index of slope, calculated as follows (Salsbury, 1976):

$$S = \frac{\text{drop (feet)}}{\text{distance between pts (feet)}}$$

As the slope increases, the potential for sediment input also increases.

13. Soil Drainage* = An arbitrary value based on watershed soil texture and structure, where

1. Sandy-granular soil = excellent (E)
2. Clayey-platy soil = poor (P)
3. Intermediates thereof = Good (G)
and Fair (F)

*Calculated for representative recreational lakes only

Greater amounts of runoff will occur as the soil drainage decreases.

These estimates were obtained by submitting a copy of the immediate watershed to the District Conservationist (SCS) and requesting a general soil drainage value.

14. Land Use* = Land use estimates (cultivated vs. non-cultivated) for immediate watersheds were supplied by the District Conservationist. Cultivated land is far more susceptible to soil loss than noncultivated land (see Table 1.2).

Example: C₇₀ = 70% cultivated, 30% non-cultivated.

Lake Typology

The tables presented on the pages following will enable researchers or planners to quickly characterize a lake-watershed complex for management purposes.

*Calculated for representative recreational lakes only

LAKE TYPOLOGY

Minnehaha COUNTY

Surface Area	Depth avg max	Fisheries Class	TDS	TSI	Aquifer Connection	Outlet	Contributing Watershed Size	W _c /L	Immediate Watershed Size	W _t /L	Slope	Soil Drainage	Land Use
Beaver (102-52-15) 224 (.35) 5 7		WMM	5662		0	I ₄	3.18	9.08					
Buffalo (104-52-10) 337 (.62) 2		WF			0	I ₄	17.78	28.67					
Clear (104-52-36) 474 (.74) 3 7		WMM	936		0	I ₄	7.97	10.50					
Diamond (104-52-5) 250 (.39) 2		WF			0	I ₄	1.64	4.20					
Grass (102-52-34) 200 (.31) 3 5		WF			0	I ₃	6.90	22.25					
Huntimer, W (104-51-4) 22 (.03) 2		WF			0	I ₃	0.79	26.33					
Loss (101-52-4) 77 (.12) 6 9		WMM	1734		0	I ₃	1.91	15.91					
Quilt (103-52-34) 90 (.14) 5 7		WMM	847		L	I ₄	1.76	12.57					
Wall (101-52-21) 198 (.31) 7 14		WMS _P	950	81	M	I ₂	4.81	15.51	4.09	13.6	3.0%	P	C70
Poison (106-58-28) 106 (.16) 2		WF			0	I ₃	1.28	8.00					

Moody COUNTY

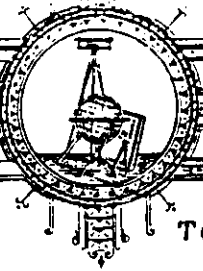
See pp. 66-70 for Table explanation.

Appendix E

Aerial Photograph Record

Ranking of Beaver Lake water elevations from highest to lowest based on interpretation of past aerial photographs.

<u>Air Photo Date</u>	<u>Elevation Ranking</u>
6-1984	1
6-9-83	2
10-28-62	3
8-27-51	4
9-25-53	5
1961	6
5-26-70	7
7-14-79	8
5-1-71	9
5-11-76	10
6-1982	11
8-29-56	12
7-7-68	13
3-30-73	14
8-1980	15
5-15-75	16
7-1981	17
7-18-40	18
10-29-37	19



HUMBOLDT



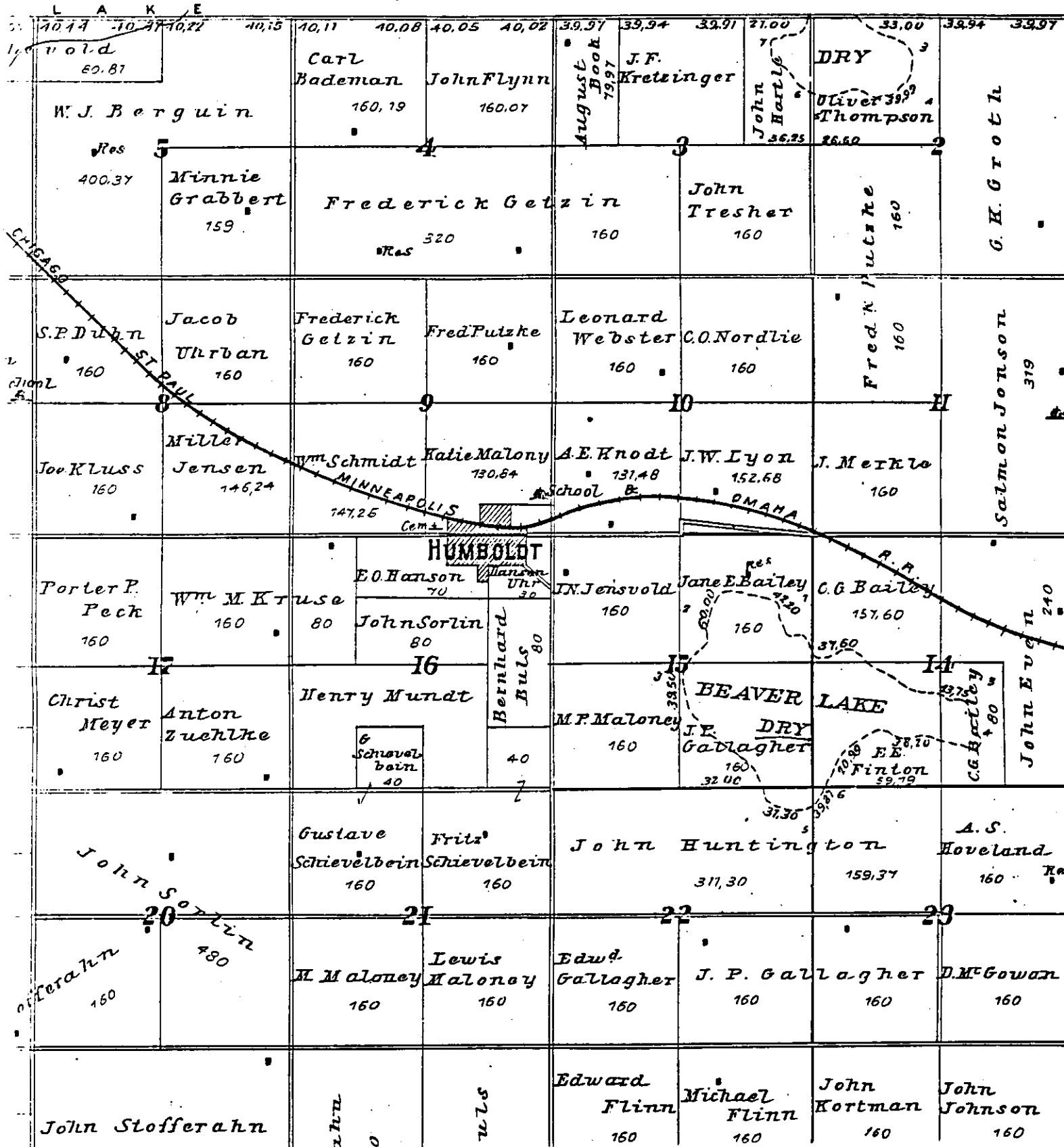
TOWNSHIP

Township 102 North.

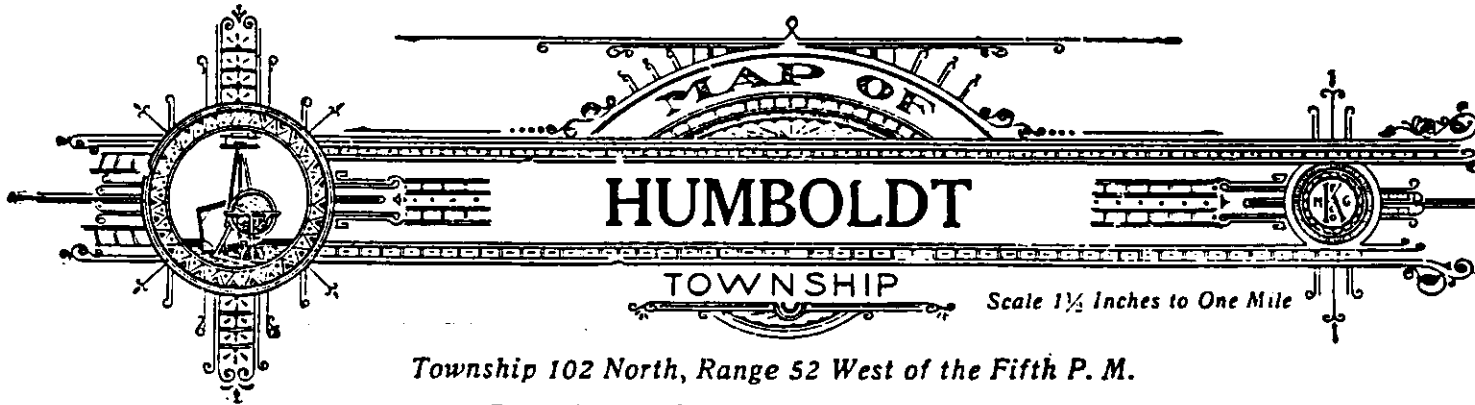
Scale 2 inches to 1 Mile

Range 11 West of the 5th P.M.

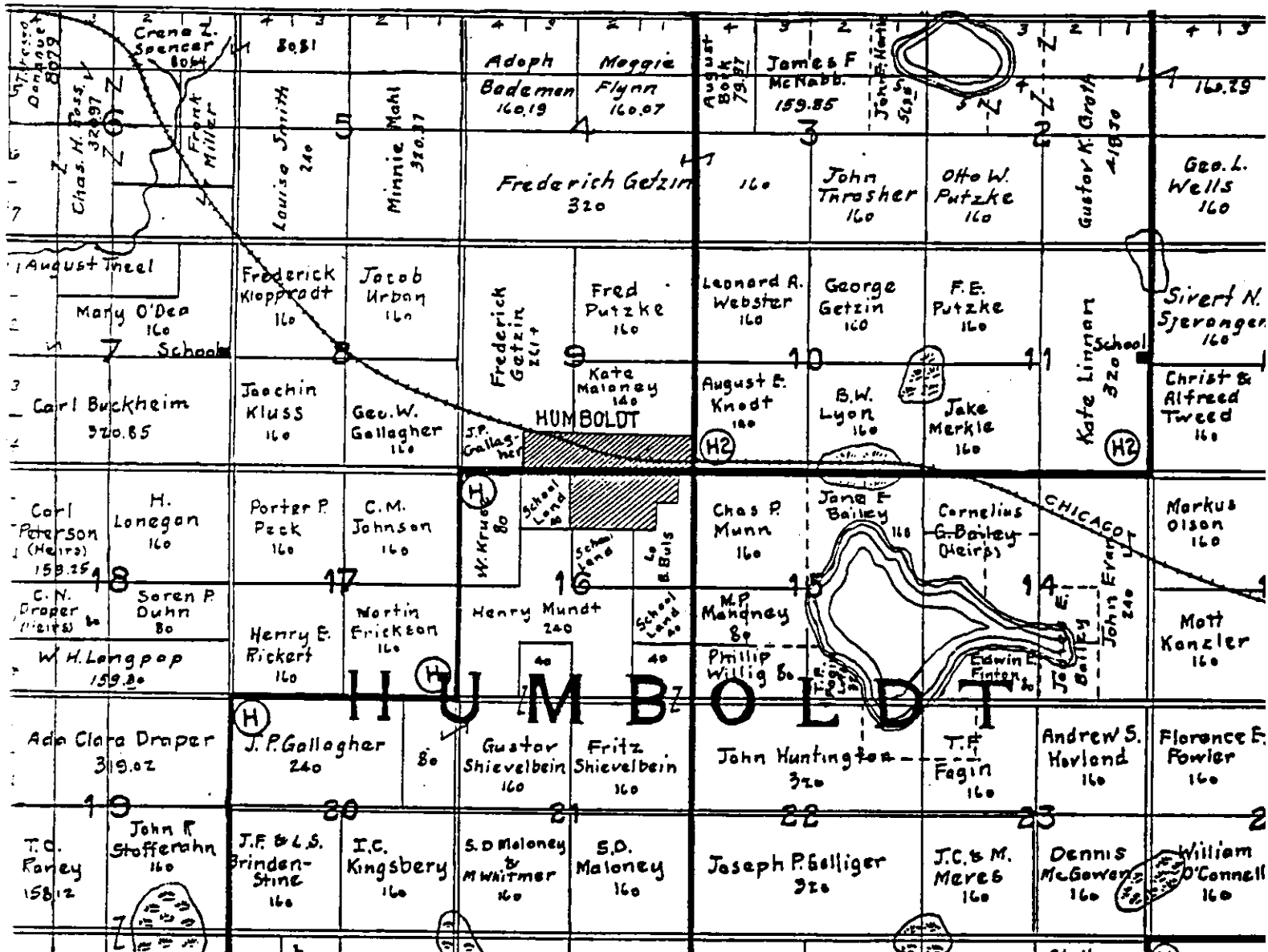
Map Year : 1903



Map Year : 1913



Clear Lake Township



HUMBOLDT

Map Year : 1981

T.102 N.-R.52 W.

SEE PAGE 24

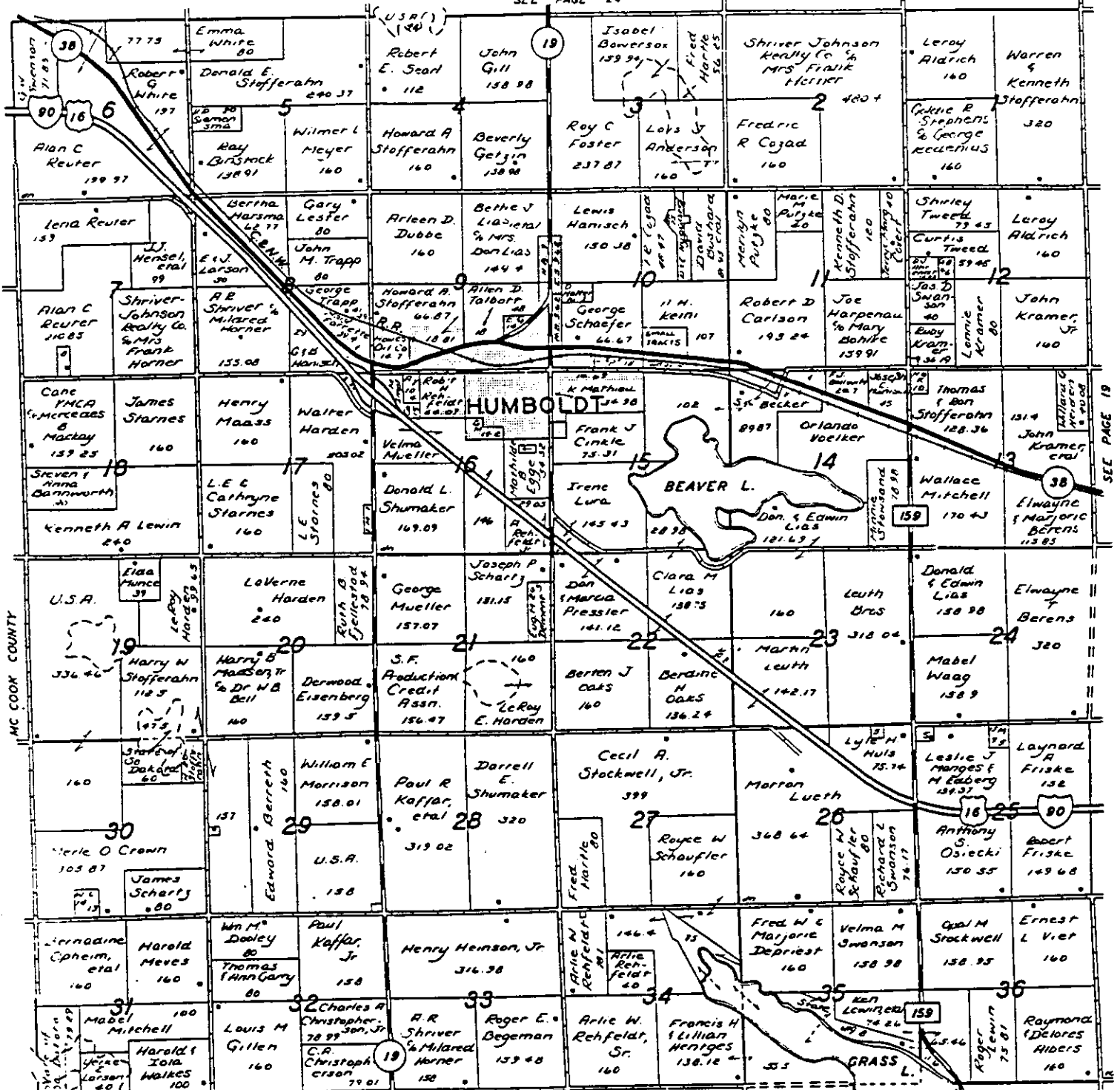




Photo # 1 Outlet area, near center of photo; S1/2 NE1/4
SE1/4, Sec. 14, T102N, R52W.



Photo # 2 Beach scarp at elevation 1653.1 ft. msl.
Boulder line at elevation 1651.7 ft. msl.



Photo # 3 Beach scarp at elevation 1653.0 ft. msl.



Photo # 4 Beach scarp at elevation 1653.4 ft. msl.



Photo # 5 Boulder line at elevation 1651.4 ft. msl.



Photo # 6 Boulder line at elevation 1651.6 ft. msl.



Photo # 7 Boulder line at elevation 1651.6 ft. msl.



Photo # 8 Boulder line at elevation 1651.5 ft. msl.



Photo # 9 Shoreline tree with soil-washed exposed roots.
 Base elevation of exposed roots 1652.1 ft. msl.
 Base elevation of tree prior to erosion -
 1653.6 ft. msl.



Photo # 10 Shoreline tree with soil-washed exposed roots.
 Base elevation of exposed roots 1652.1 ft. msl.
 Base elevation of tree prior to erosion -
 1653.5 ft. msl.



Photo # 11 Ring of inundated shoreline trees with base elevations 1648.5 to 1649.5 ft. msl.



Photo # 12 Ring of inundated shoreline trees with base elevations 1648.5 to 1649.5 ft. msl.



Photo # 13 Shoreline cottonwood tree over 40 years old,
 Three foot diameter. Base elevation of
 exposed roots - 1650.4 ft. msl. Base elevation
 of tree prior to erosion - 1651.8 ft. msl.
 High water mark on tree 1653.6 ft. msl.



Photo # 14 Shoreline boulders. High water mark elevation
 on rocks - 1653.4 ft. msl.

AGENDA

WATER MANAGEMENT BOARD MEETING DECEMBER 7 & 8, 1988

Place: Room Dakota A, Howard Johnsons, 3300 W Russell, Sioux Falls SD
Scheduled Hearing Times are Estimates and May be Delayed due to Prior Agenda Items

December 7, 1988

- 8:00 am Call to Order
Approval of October 5 & 6 1988 Board minutes
Set May 10 & 11, 1989 meeting location (Pierre Suggested)
Status and review of water rights litigation -- Harold Deering and John Guhin
Request to Advertise Proposed Revisions to:
1) General Rules Chapter 74:02:01 -- Del Brosz
2) Safety of Dams Rules Chapter 74:02:08 -- Tim Schanl
Discussion on Superfund Report -- Susan Bowar
Administer Oath to the Water Rights Staff
- 8:15 am Consider Establishing the Ordinary High Water Mark and Setting the Outlet Elevation for Lake Oliver in Deuel County -- Tim Tollefsrud
Reconsider Flood Control Permit Application No. FC-8, Deuel County - Deferred from September 1987 Board meeting -- Tim Tollefsrud
- 9:00 am Cancellation Considerations
- 9:15 am Consider Establishing the Ordinary High Water Mark and Setting the Outlet Elevation for:
1) Cottonwood Lake in Sully County -- David Brown
2) Fish Lake in Aurora County - Deferred from October 1988 Board meeting --- David Brown
- 9:30 am Consider Request for Variance from Spillway Requirements for Opal Dam, Department of Game, Fish & Parks -- Tim Schaal
- 9:45 am Break
- 10:00 am Introduction of Water Rights Staff, Board and Legislative Oversight Committee
Consider New Permit Applications and Vested Right Validations
- 10:30 am Consider Water Permit Application No. 5208-3 and Future Use Permit Application No. 5209-3, Kingbrook Rural Water System - Automatic Delay from the October 1988 Board meeting -- Jim Goodman
- 11:00 am Consider an Intercounty Drainage Dispute in Roberts and Grant Counties - Automatic Delay from the October 1988 Board meeting -- Tim Tollefsrud
- 12:00 Lunch
- 1:00 pm Consideration of Findings of Fact, Conclusions of Law and Final Decision on Denial of Extension of Time to Construct Works specified on Permit Nos. 40-2A and 1812-2, Robert and Mark Tubbs
- 1:15 pm Reconsider Water Permit No. 5189-3, Isabelle Fryer - Deferred from the October 1988 Board meeting -- Ron Duvall
Reconsider Cancellation of Water Permit No. 4780-3, Vincent and Isabelle Fryer -- Ron Duvall

2:00 pm Consider Water Permit Application No. 1443-1, Minerva Explorations Limited -
Automatic Delay from October 1988 Board meeting -- Ken Buhler

Recess

December 8, 1988

Reconvene

8:00 am Consider Establishing the Ordinary High Water Mark and Setting the Outlet
Elevation for Beaver Lake in Minnehaha County -- Tom Brandner

9:45 am Break

10:00 am Consider Ground Water Discharge Plan Application No. GWD4-88, Bond Gold-Richmond
Hill, Inc.

10:30 am Consider Proposed Revisions to Underground Storage Tank Rules Chapter 74:03:28

Adjourn

proposed project, reclamation and the project's location within the Spearfish Canyon area.

Deb Rogers questioned Mr. Muhm on several aspects of the proposed project.

Mr. Muhm stated Minerva will appear again, before this Board to obtain the necessary groundwater discharge permit for this project.

Meeting recessed at 9:45 am.
Meeting reconvened at 10:05 am.

Mr. Freeman MOVED, SECONDED by Mr. Lloyd to CONTINUE the hearing on Water Permit Application No. 1443-1 until the Board can be provided with sufficient information to determine whether the requested appropriation of water will be for beneficial use and in the public interest.

Mr. Truhe stated he felt it was unfair and improper under the statutes to put a mining company in a position where you can not get a water appropriation permit unless you supply information which is not germane to the issuance of the water permit.

Chairman Gunderson administered the oath to Deb Rogers.

Ms. Rogers stated she did not feel there was adequate information to decide if the water permit was in the public interest and if the water will be put to beneficial use.

During the discussion of the motion to continue the hearing, the Board members made the following comments:

1. That an application for a mining permit does not need to be filed before the mining operation water permit application is scheduled for hearing. However, definite plans for the mining and processing operation should be finalized.
2. When discharge permits will be required, the water permit applicaiton and discharge permit applications should be considered by the Board at the same time.
3. That the Board should not approve a water permit application until the Board knows how the water will be used and what will be done with the water after it is used.

Chairman Gunderson called for a vote on the motion to CONTINUE. MOTION CARRIED with Mr. Brink and Mrs. Loucks voting NO.

The Board also requested that a rule be drafted to outline Board policy on future projects where a water permit and discharge permits will be required. A proposed ruled will be advertised for hearing at the March Board meeting.

Ordinary High Water Mark and Outlet Elevation for Beaver Lake
Tom Brandner presented the report prepared for the Ordinary High Water Mark (OHWM) and Outlet Elevation for Beaver Lake (copy on file).

In answer to a question from Tom Stofferahn, Humboldt Township Board, Mr. Brandner stated the elevation on the north side of the slough at the bridge is 1652.0. The road itself is close to the high water mark in the center section.

Mr. Stofferahn stated if the elevation is set at 1651.6, then the bridge and road would be subject to being under water if it reaches that level again. It is a great expense to the township to raise the road two or three. Mr. Stofferahn stated he would like to see the elevation lowered.

Mr. Hatch stated that over 950 people were given notice of the OHWM hearing. Mr. Guhin stated the Board needs to establish who is a party to this hearing from this point on.

Mr. Brink MOVED, SECONDED by Mr. Lloyd that only those persons registered for the hearing today will be considered parties of record for the OHWM of Beaver Lake. MOTION CARRIED.

David Gienapp stated he was representing Steve Becker landowner around Beaver Lake.

Mr. Brandner stated that the area encompassed by the OHWM includes Beaver Lake and the slough area on the Becker property. The vested water right would include this area also.

Mr. Hatch stated the water right would be to the top of the outlet elevation.

Chairman Gunderson administered the oath to Rod DeMent.

Mr. DeMent marked the area of the culvert on Figure 5 of the report.

Mr. Brandner stated the culvert is located in the bottom of the tributary at elevation 1647.2. The elevation drops considerably, about 4 or 5 feet, once it is past the outlet area. Mr. Brandner stated he thought Mr. DeMent was concerned that the water backs up behind the culvert on the west side of the road because of capacity.

Mr. DeMent stated he wanted to make sure the water would drain.

In answer to a question from Dan Pressler, Mr. Hatch stated that the public has access to a 50 foot corridor above the waters edge when you are below the OHWM, but only up to the OHWM. The public can not cross private property to get to a lake. They must go through a public access area unless permission is granted from the landowner. The road in section 22 would be considered public access to the water. Once the water is below the 50 foot strip and the upper edge was away from the public right of way, people could no longer gain access from the road.

Mr. Guhin stated he agreed with Mr. Hatch's statements which are addressed in 43-17-2.

Chairman Gunderson administered the oath to W. L. Beckstrom.

Mr. Beckstrom stated he owns land in Hartford Township. Mr. Beckstrom stated he believed a dike was put in illegally to artificially raise and flood the area around Beaver Lake.

Mr. Brandner stated he was not aware of any dike.

Chairman Gunderson administered the oath to Orlando Voelker.

Mr. Voelker stated he owns the land on the north side of Beaver Lake and has sold it on contract to Steve Becker. Mr. Voelker stated he was unaware of any dike. The road going from Humboldt to Hartford was Highway 38. Mr. Voelker stated he moved to the area in the spring of 1934. The water has never been anywhere near the road which was the main highway at that time. If the OHWM is established at the proposed elevation the water will be in the slough area north of Beaver Lake. Will that be part of the lake? His dad bought the land in 1934. It was farmed until he sold the land. They paid taxes every year.

Mr. Guhin stated there is a public trust imposed between the high and low water mark, so a person can be an owner and still have public trust imposed upon it. If the slough area is found to be part of the navigable lake, the area below the OLWM is in the ownership of the State of South Dakota. The area between the low and high water mark would have the public trust imposed upon it with Mr. Becker being the owner. The fact that they have paid taxes all of the time is evidence for the Board.

Mr. Hatch stated the slough will be included within the OHWM elevation as proposed. When land was originally platted and the meanderline established, the meanderline only established a means of quantifying the number of acres for sale. The land below the Ordinary Low Water Mark is held in trust for the public by the State. The land between the OHWM and the OLWM is common use land, in that the public has the right to be within the 50 foot strip around the land, but the adjacent landowner actually owns the land. It is a difficult concept to understand. The landowner has paid taxes and the public has a dual right to be on the land at least within fifty feet of the waters edge or below the OHWM. Until the OHWM is set the specific elevations are not known especially in adjacent low lands around the lake.

Ron Koth, Dept of Game, Fish and Parks stated he supported the staff recommendations for the OHWM on Beaver Lake. The soils study conducted by Dr. Malo, SDSU, cleared up any questions the Department of Game, Fish and Parks had concerning the outlet and where it may or may not have been in the past and what has happened in recent years. Mr. Koth stated that Beaver Lake contributes over \$100,000 annually to the county in recreational benefits.

Bond Gold-Richmond Hill, Inc., Request

Pete Fuller stated he was representing Bond Gold-Richmond Hill, Inc. and their Ground Water Discharge Plan Application No. GWD4-88. They would request a continuance of that hearing until the March, 1989 Board meeting.

Mr. Brink MOVED, SECONDED by Mr. Rollag to continue the Ground Water Discharge Plan Application No. GWD4-88 until the March, 1989 meeting. MOTION CARRIED.

Meeting recessed at 11:45 am.
Meeting reconvened at 1:00 pm.

In the absence of Chairman Gunderson, Vice-chairman Freeman presided over the meeting.

Mr. Hatch stated the first petition received on April 16, 1987 was for a declaratory ruling requesting the Board to set the outlet elevation on Beaver Lake and establish an OHWM. The petition was submitted by Humboldt Township, the Town of Humboldt, Don Lias, Ed Lias, Steve Becker and Arlie Rehfeldt. The petition seeks to lower the elevation of Beaver Lake by 4 to 5 feet. The first petition opposing the lowering of the lake was received July 6, 1987. In September, 1987 another petition was received with over 900 signatures of people opposed to lowering the outlet elevation for Beaver Lake. This petition requested that the OHWM and outlet for Beaver Lake be set in such a manner that no dredging of the existing outlet of the lake take place.

Mr. Hatch stated he would like the report entitled Sedimentation in Beaver Lake Outlet - Minnehaha County, South Dakota by Dr. Malo introduced into the record.

David Gienapp representing Steve Becker stated they are not pro or con to the OHWM or the report. They are concerned with 40 acres of Mr. Beckers land which has never been part of Beaver Lake. This land is shown in Figure 5 and is the marsh area located to the north. In dry years they have used the land. There is a private road across the inlet which is not really indicated on the map. There is a culvert through the road.

Chairman Gunderson administered the oath to Steve Becker.

Mr. Becker stated he has owned the property on the north side of Beaver Lake since 1979. He had no knowledge that the Department of Game, Fish and Parks had a vested right to anything on his property. In 1981 all of the marsh area was dry. They put in ditches and channels so the water would run to the inlet that feeds into the lake. Mr. Becker explained the riprapping they did to maintain the road which he uses for farming. The Corps of Engineers told Mr. Becker he was within his legal rights to maintain the crossing. Mr. Becker was told that he had to remove the rebar which he put in. When the old road was taken out there was a steel culvert underneath the surface. Below that was a concrete culvert and below that a wooden culvert. The road has been there a long time. Mr. Becker put in a bigger culvert to allow the water to flow into the lake.

Mr. Becker stated that taxes have been paid on that land for a long time and now he will lose any say over what happens. What will that do to the value of his property? It is close to his house and farm buildings. It is a meandered lake which never

extended north of the road and it should not extend there now. This is an unusually high water situation.

Mr. Hatch submitted aerial photos taken in 1956, 1962 and 1983. Mr. Hatch stated the photos show that the water has been high in the area and the slough area has been part of the lake. The 1956 picture shows a distinct separation between the two areas. Mr. Hatch stated during the drier times when there is a distinct separation between Beaver Lake and the slough area, then the 50 foot strip of land would not extend the right-of-way of the public into the slough area. When the water level drops and there is a distance between the OHWM elevation and the water level of 50 feet or more the public's right of access is restricted to 50 feet. The 1962 photo shows the area connected and the public right-of-way would be to the OHWM. Mr. Hatch stated the public right-of-way would not extend to the slough area all of the time, only during high water periods.

Mr. Hatch stated if the marsh area is deep enough to maintain water, then it is and has been part of the lake.

Mr. Guhin stated the Board does have jurisdiction to determine whether or not the slough area is part of Beaver Lake. It is a separate determination that will have to be made on the record.

Mr. Pressler stated he felt photo No. 13 showed a lot about what the boundary of the lake used to be. The big cottonwood tree indicates something about past water levels.

Mr. Brandner stated the tree is above the OHWM and was probably killed from the recent high water in 1983 and 1984.

Some discussion followed concerning old Highway 38.

Vice-Chairman Freeman administered the oath to Roger Parham.

Mr. Parham stated he was National Director of the Izaak Walton League. Mr. Parham stated they would like the results of the investigation to be looked at favorably by the Board. Many of his group signed the petition. They would like to see the lake remain the same and let nature take its course.

Vice-Chairman Freeman administered the oath to John Donovan.

Mr. Donovan stated he was president of the Minnehaha County Sportsman Conservation Club. The club was responsible for the submission of the large petition. Mr. Donovan stated he hoped that the wishes of the all those sportsman will be honored even though they are not all present. Mr. Donovan stated he can remember back in 1952 and 1953, taking his duck boat through the water way. If the two bodies of water had never been connected there would never have been the need for a culvert or road there. Mr. Donovan did not know the date of when the road was put in.

Mr. Voelker stated the road was there when he moved there in 1934.

Vice-Chairman Freeman administered the oath to Ken Mathew.

Mr. Mathew stated he was a landowner on the west end of the slough. Mr. Mathew stated the road was constructed to make access to the land across the tip of the lake. If he did not need it for access to his land, it would not be there. It has nothing to do with connecting the two lakes. The water level goes up and down. If it rains and gets wet, he gets water on his land for 6 or 3 months. Mr. Mathew questioned the signatures on the petitions. He felt many of them did not even know where Beaver Lake is. Mr. Mathew stated he felt Game and Fish were pushing for more access or slough area. The State would not have put a road on the north side if it was going to be put under water.

Mr. Donovan stated the petition which his group submitted did not ask for the lake to be drained 2 to 4 feet.

Vice-Chairman Freeman administered the oath to Ron Schauer.

Mr. Schauer stated he was a local conservation officer for Minnehaha County. Mr. Schauer stated that in 1987 they received a call from Mr. Becker expressing concern over the high level of the lake. They met with Mr. Becker at the outlet. The Department of Game, Fish and Parks did not initiate this incident. Mr. Schauer stated their original position was to let nature take its course. The lake has been down 4 1/2 feet since March of 1987.

Some discussion followed on the Beaver Lake outlet and runoff.

Vice-Chairman Freeman administered the oath to Dr. Doug Malo.

Dr. Malo stated he was a professor at SDSU and had prepared the report entitled Sedimentation in Beaver Lake Outlet. Dr. Malo stated Tom Brander and himself were to the site in May and prepared a report on the sedimentation. Dr. Malo stated that based on the detailed chemical and physical properties, such as particle size, PH, sand and gravel fractions, the data strongly suggests that only 6 inches of the outlet material are of recent nature. There is a definite color difference in the soil material. This overlies a dark black layer. This suggests that this is recent sediment from the surrounding hills. Dr. Malo stated at twenty inches deep, there was a layer of gravel which separated the sediments of silt and clay from the glacial till underneath. As a result, that served as a marker to separate the sediments that have been deposited since glacial times. There is at the most 20 inches of sediment overlying the material laid down 10,000 years ago. It is a small amount of sediment with 6 inches being recent. Six inches would be a very realistic removal consideration when trying to determine the outlet elevation. Six inches would be a little above the OHWM that is suggested.

Mr. Brandner stated the evidence shows that the OHWM is 1651.6 and the water flows into the slough at that depth. The slough should then be included in the OHWM.

Mr. Koth stated he supported the position of the Department.

Discussion continued on whether or not the slough should be included as part of Beaver Lake.

Mr. Geinapp stated that Mr. Becker's complaint is not to the proposed elevation of the OHWM. They do not feel that the elevation would cause more water into the slough. They are concerned with the changing of the water right which does not now encompass the slough area. They do not want the slough area designated as part of Beaver Lake.

Mr. Lloyd stated he felt that the landowners consideration should be a concern for the Board. He would like to see Mr. Becker keep jurisdiction on his land.

Mr. Brink stated he viewed the public perception of Beaver Lake not as including the slough area.

Mr. Brink MOVED, SECONDED by Mr. Rollag the following:

1. That the OHWM for Beaver Lake, Minnehaha County be established at elevation 1651.6 ft. msl.
2. That the outlet elevation for Beaver Lake, Minnehaha County be set at 1651.7 ft. msl.
3. That the area to be included within the OHWM is not to proceed northward of the narrowmost portion of Beaver Lake as shown on Figure 5.

Mr. Brink stated this would be excluding the area referred to as the slough area.

Mr. Koth stated he did not believe evidence was shown that would indicated that the slough area is a separate feature. There is evidence that shows it is a feature of the lake.

Vice-Chairman Freeman stated he felt there was testimony, that culverts were there. The road was there, although it may have been somewhat conflicting. The Board must make the determination as to whether or not it has been historically part of the lake.

In answer to a question from Mr. Hatch, Mr. Guhin stated the Board is called upon to find if in its jurisdiction that the slough is not a part of this lake. The Boards ability to make that decision, only allows the Board to act within the facts which are before them.

Mr. Hatch stated the staff takes direction from past decisions of the Board when they proceed on various investigations. This same question will come up again. In this case, the Board is finding that the slough area is not a part of Beaver Lake. The decision is specific to this lake.

Vice-Chairman Freeman called for a vote on the motion. MOTION CARRIED with Mrs. Loucks voting NO.

Mr. Brink MOVED, SECONDED by Mr. Rollag the following:

1. That Vested Water Right Claim No. 865-3 be amended to correct the amount of water claimed from 975 acre-feet annually to "sufficient water to fill Beaver Lake annually to the outlet elevation of 1651.7 ft. msl."
2. That Vested Water Right Claim No. 865-3 be amended with the qualification that Claim No. 865-3 is subject to installation of a concrete outlet structure at elevation 1651.7 ft. msl.

MOTION CARRIED

Vice-Chairman Freeman directed the Board attorney to prepare Findings of Fact, Conclusions of Law and a Final Decision on the OHWM for Beaver Lake.

Consideration of Proposed Revisions to Underground Storage Tank Rules Chapter 74:03:28

Vice-Chairman Freeman administered the oath to Bill Markley.

Mr. Markley stated the Board should have received a copy of the proposed revisions to the Underground Storage Tank Rules. Mr. Markley listed the newspapers in which the notice of this public hearing was advertised. Mr. Markley stated that 500 individual notices were mailed to interested parties. One letter was received from the Office of Code Counsel regarding style and form only. No written testimony was received for or against the proposed revisions.

Mr. Markley reviewed the proposed changes to Chapter 74:03:28 as petitioned. Mr. Markley stated that the Department supported the proposed change.

Mr. Markley stated a petition was received to Repeal Chapter 74:03:29 on Financial Responsibility. The Department does not agree with this course of action.

Vice-Chairman Freeman administered the oath to Doug Miller.

Mr. Miller presented the proposed modifications prepared by the Department. Mr. Miller stated staff is working on summarizing the Federal Rules into a more readable form for the public.

Vice-Chairman Freeman administered the oath to Don Rounds.

Mr. Rounds stated he was the Executive Director of the SD Petroleum Council. The Council was one of the petitioners for the change in 74:03:08. They concur with the proposed staff change.

Vice-Chairman Freeman administered the oath to Curt Neuharth.

Mr. Neuharth stated he was the Executive Director of the SD Petroleum Marketers Association. Mr. Neuharth stated his Association petitioned the Board to withdraw the financial responsibility regulations because the people were not able to obtain insurance for the financial responsibility and meet the criteria. Mr. Neuharth stated they are concurring with the



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Memo to File

Beaver Lake in Minnehaha County

VWR No. 865-3

The OHWM was set by the Water Management Board on December 8, 1988.

OHWM elevation 1651.6 fmsl NGVD29

The outlet elevation was set by the Water Management Board on December 8, 1988.

OHWM elevation 1651.7 fmsl NGVD29