

1190-3

1. Considered 5-12, 1965
2. Name of Applicant Patten Creek Watershed District
3. Post Office Address Hudson
4. Amount of water claimed 278 acs per annually
5. Source of water supply Patten Creek
6. Water to be used for Recreation

Acres to be irrigated _____

7. Water to be diverted and used in Linn County about 5N 5W miles _____ of Hudson

8. Proof of Publication Received ✓

Not Received _____

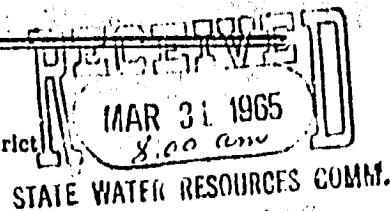
9. Application Approved _____

Subject to _____

Not Approved _____

Action deferred _____

10. Remarks:

No. 1190-3Water Division No. 3 BIG SIOUX RIVER District _____
(Blanks to be Filled by the Engineer for the W. R. C.)

APPLICATION FOR PERMIT To Appropriate Water within the State of South Dakota

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

1. Name of applicant Pattee Creek Watershed District
Postoffice address Hudson, County Lincoln, State S. Dak.

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 ^{Managers} ~~officers~~ E.L. Wiebersick Chr., Fairview, S.D.,Kerwin Ulrikson, Canton, S.D. Palmer Larson, Hudson, S. D.,Delbert Fowles, Hudson, S. D. Morris Christopherson, Hudson, S.D.

(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)

U. S. Govt. - State Contract

(b) Cash on hand, \$ _____

(c) Treasury stock, \$ _____

(d) Bonds to be issued, \$ _____

(e) Other resources, \$ _____

2. Name of diversion work DETENTION DAM P-13. Amount of water claimed 278 ACRE FEET ANNUALLY
cubic-feet-per-second4. Source of water supply PATTEE CREEK5. Location of point of diversion DAM IS LOCATED IN SE 4, SECTION 19, T47N, R48W
on _____ bank LINCOLN County.6. Annual period or periods during which water is to be used CONTINUOUSLY

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 list also be shown on accompanying map.)

(c) Statement as to domestic use (giving location, etc.) _____

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

(a) Nature of use public recreation
Nature, 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 _____

MAP NO 814-3

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.)

RESERVOIR

II. Dimensions of works.

(a) Dam: Height 13.0 feet; length at bottom 150.0 feet; length at top 96.0 feet; thickness at bottom 30.0 feet; thickness at top 17.0 feet; slope at front water face 3:1; slope at back face 2:1; material used in construction Earth compacted

(b) Reservoir: Capacity when filled 1110.30 acre feet. Surface area at highwater mark 92.67 acres.

DEPTH AT OUTLET-Feet	SURFACE AREA AT EACH DEPTH AT OUTLET--ACRES	ACRE-Feet CAPACITY
32	92.67	1110.30
28	74.23	776.50
24	61.15	505.74
20	48.05	303.34
16	34.77	163.70
12	21.31	69.54
8	8.22	18.18
4	0.51	1.02
0	0.00	0.00

(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 5 years.

11. Time required for complete application of water to the proposed beneficial use 5 years.

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

THE HURONITE, HURON, S. DAK.

STATE OF SOUTH DAKOTA

County of Lincoln

ss.

I, E. L. Weibersick, Chairman of Bd of Mgr

, 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

E. L. Weibersick

Subscribed and sworn to before me this 29th

day of March

1965

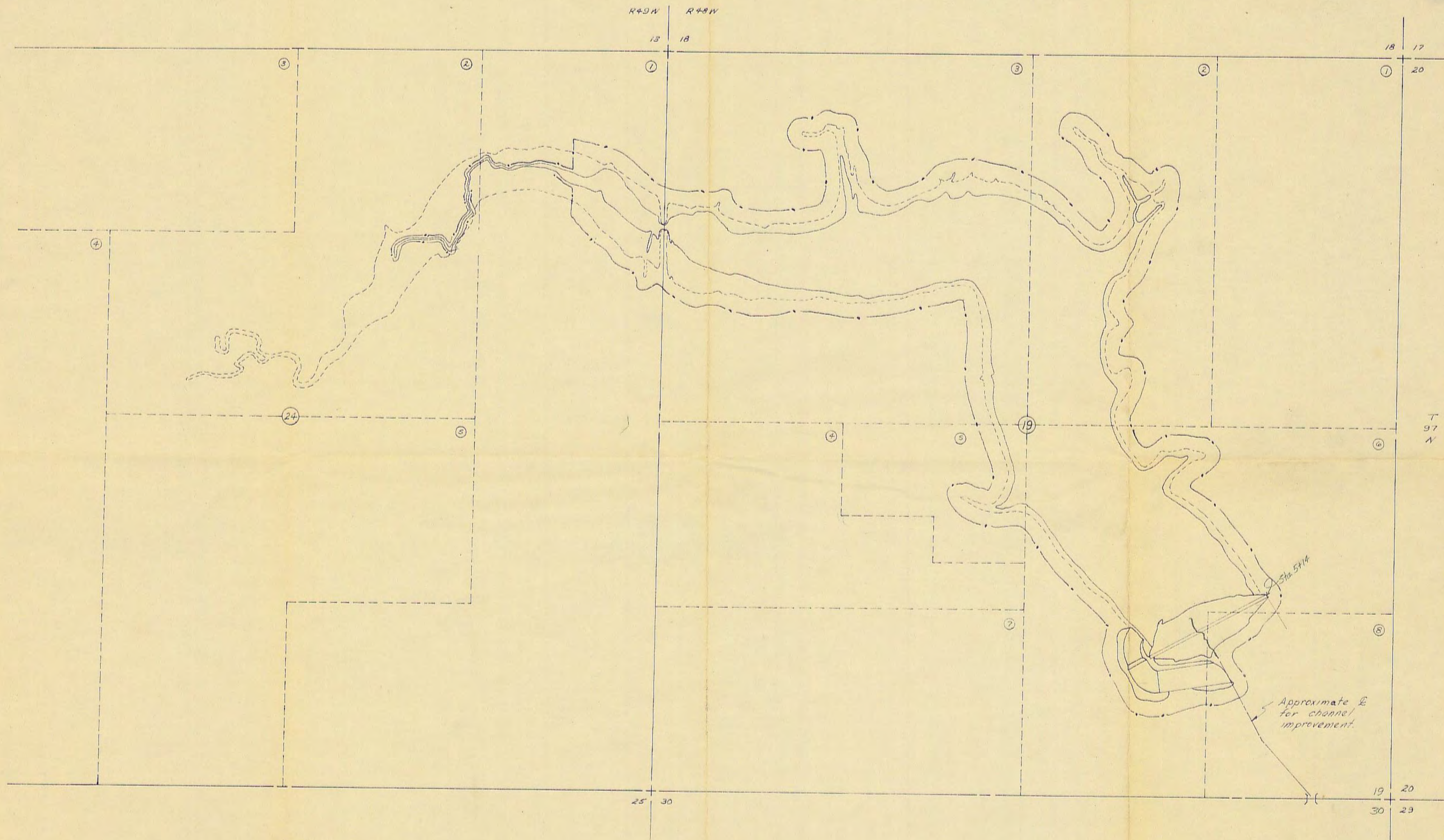
Notary Public (or other qualified officer.)

R. A. Kennedy

*Each diversion must have a headgate or measuring device.

My commission expires 10-24-66

NOTE: THIS DOCUMENT DOES NOT CONSTITUTE LEGAL
LAND DESCRIPTION AND CANNOT BE USED AS
SUCH.



LEGEND

- Permanent Pool El. 1376.0
- - - - - Crest of Emergency Spillway El. 1384.3
- . - . - . Approximate location of minimum lake line based on 100' horizontally from contour line designated as Crest of Emergency Spillway.

Note: The location of the contour lines, damsite and emergency spillway area are approximate.

Scale 1"=400'

ACQUISITION MAP DETENTION DAM P-1 PATTEE CREEK WATERSHED

Lincoln County South Dakota

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
Drawn	2/65	Title
Traced		Title
Checked		Sheet No.
		Drawing No.

MAP NO 814-3 (MPPL NO 1190-3) S-313B (APRIL 1963)

REPLACEMENT OF STORED WATER IN ~~LATE~~
DETENTION DAM F-1 FROM PATTEE CREEK
FLOWS IS LIMITED TO ONE FILLING OF
THE RESERVOIR PER CALENDAR YEAR.

STATE OF SOUTH DAKOTA } ss.
County of HUGHES

Pierre, South Dakota, MAY 17, 1965

This is to certify that the foregoing application was received by the Commission at 8:00 o'clock
9 a.m. upon the 31ST day of MARCH, 1965

State Water Resources Commission

By:

[Signature]
Chief Engineer, Executive Officer

Number of permit 1190-3

Date of first receipt of application MARCH 31, 1965

Date of return to applicant for correction, amendments or changes required as follows: APRIL 9, 1965

Date of receipt of corrected application APRIL 16, 1965

Date from which applicant may claim right MARCH 31, 1965

Approved MAY 12, 1965, Recorded in Book 7 Page 3

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 NOVEMBER 12, 1967

2nd. The whole of said work is to be completed on or before MAY 12, 1970

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

MAY 12, 1970

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 212 ACRES FEET ANNUALLY
~~one cubic foot 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 MAY 12, 1970; said water to be used during the following described annual period:

CONTINUOUSLY
Witness my hand this 12TH day of MAY, 1965

State Water Resources Commission

By:

[Signature]
Chief Engineer, Executive Officer

Certificate of Construction issued _____, 19____

Water License Issued _____, 19____

Permit No. 1190-3

Water Diversion No. 3 Big Sioux River Water District

CERTIFICATE OF CONSTRUCTION

This is to Certify, That the Department of Wildlife, Parks and Forestry

_____ the holder _____ of
Permit No. 1190-3, issued upon Application No. 1190-3, bearing date of priority of _____
March 31, 1965 authorizing the diversion of 278 acre feet annually of the waters of _____
Pattee Creek County of Lincoln, State of South Dakota at _____
1200 feet North and 1400 feet West of the SE corner, Section 19, T97N, R48W
_____, for public recreation

purposes, has _____ complied with the provisions of the laws of the State of South Dakota relating to proof of
completion of the works of diversion set out and described in said Permit; that said works are found in satisfactory
condition for diverting and storing 1110 acre feet of water.

Date July 5, 1978

By: WATER RIGHTS COMMISSION
John Hatch
JOHN HATCH, Chief Engineer

STATE OF SOUTH DAKOTA

WATER LICENSE NO. 1190-3

(1) WHEREAS, On the 31st day of March A. D. 19 65
Pattée Creek Watershed District

made Water Right Application No. 1190-3 for a permit to use 278 acre feet / annually ~~xxxxxx~~ of the waters
of Pattée Creek

County of Lincoln, State of South Dakota, for public recreation

_____ purposes; and

(2) WHEREAS, On the 12th day of May A. D. 19 65

Permit No. 1190-3, with a date of priority of March 31, 1965

was issued to said applicant s for the diversion of said water, and provided for the completion of construction of the water
supply system therein described on or before the 12th day of May A. D. 19 70 and for the
application to beneficial use of said water on or before the 12th day of May A. D. 19 70

Whereas, on April 18, 1966 the Department of Game, Fish & Parks (now known as Department
of Wildlife, Parks and Forestry) purchased the land and multiple purpose Detention Dam P-1,
located in SE $\frac{1}{4}$ Section 19, T97N, R48W,

and:

(3) WHEREAS, It is hereby certified that the applicant has complied with the provisions of the laws of the State of South Dakota
relating to completion of the construction of the water supply system and is entitled to divert 278 acre feet annually ~~xxxxxx~~

~~xxxxxx~~ for beneficial use and,

(4) WHEREAS, It is hereby certified that the applicant has complied with the provisions of the laws of the State of South Dakota
relating to the application of water to beneficial use of the following extent,

to be used for public recreation purposes.

(5) 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 Department of Wildlife, Parks and Forestry
_____ of Pierre, South Dakota
the holder s and owner s of said permit No. 1190-3 a water right, dating from March 31, 1965
_____ to use of 278 acre feet annually ~~xxxxxx~~ of the waters
of Pattee Creek
in the County of Lincoln and State of South Dakota, or so much thereof as may be necessary for the
purposes hereinbelow mentioned, to be diverted at 1200 feet North and 1400 feet West of the SE
corner of Section 19, T97N, R48W

~~xxxxxx~~ to be stored in place

for the purpose of public recreation

Subject to any limitations listed in Water Right Permit No. 1190-3 and subject to the laws of the State of South Dakota.

WITNESS, My hand and seal of our office at Pierre, South Dakota
this 5th day of July A. D.
Nineteen Hundred and Seventy-eight

WATER RIGHTS COMMISSION

By:

John Hatch
Chief Engineer, Executive Officer **JOHN HATCH**

on or before
(First Publication April 15, 1965)

APPROPRIATION OF WATER

Office of State Water Resources Commission,

Pierre, S. Dak., April 9, 1965

Notice is hereby given that the Pattee Creek Watershed District whose postoffice

address is Hudson S. Dak., has made an application in accordance with the provisions of the water laws of South Dakota for a permit to appropriate for beneficial use/ 1110 acre feet for initial fill, plus 278 acre annually 278 feet of water for second crop from the Pattee Creek through the Detention Dam P-1, the point of diversion of which is to be located ~~XXXXXX~~

~~Bank of said stream~~ in the ~~XXXXXX~~ SE 1/4 of Section 19 Twp. 97N Range 48W stored Said water to be used for the purpose of providing ~~XXXXXX~~ public recreation

~~XXXXXX~~ and for ~~XXXXXX~~

This application will be taken up by the State Water Resources Commission at their office at Pierre for consideration upon the 12th day of May, 1965, at 2 P. M. All interested persons may appear and be heard.

Appropriate action will be taken by the Water Resources Commission after suitable time has elapsed for the consideration of any or all information presented.

State Water Resources Commission

By:
BURTON F. JONES
Water Right Specialist

CC: Mr. William Emers, Publisher
The Hudsonite
Hudson, S. Dak.

PROOF OF PUBLICATION

STATE OF SOUTH DAKOTA }
 County Lincoln } ss.

No. 1190-3

Appropriation of Water

Office of State Water
Resources Commission,

Pierre, S. Dak., April 9, 1965

Notice is hereby given that the Pattee Creek Watershed District whose postoffice address is Hudson, S. Dak., has made an application in accordance with Section 61.0112 of Chapter 430 of the Session Laws of 1955 and the provisions of the water laws of South Dakota for a permit to appropriate for beneficial use 1110 acre feet for initial fill, plus 278 acre feet of water annually from Pattee Creek through the Detention Dam P-1, the point of diversion of which is to be located in the SE¼ of Section 19, Twp. 97N, Range 48W. Said water to be stored for the purpose of providing public recreation.

This application will be taken up by the State Water Resources Commission at their office at Pierre for consideration upon the 12th day of May, 1965, at 2 P. M. All interested persons may appear and be heard.

Appropriate action will be taken by the Water Resources Commission after suitable time has elapsed for the consideration of any or all information presented.

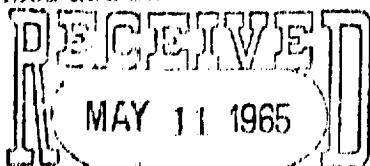
State Water Resources
CommissionBy: BURTON F. JONES
Water Right Specialist

15-22-29-6

Will Emmers being duly sworn, deposes and says the annexed printed copy of Notice of Intention to Appropriate Water was taken from the Hudsonite a newspaper which during the whole itme of publication of said notice herein after stated, has been and is printed and published in the city of Hudson County of Lincoln and State of South Dakota; that the said notice was published in said newspaper on the following dates:

April 15, 1965April 22, 1965April 29, 1965May 6, 1965

in each and every issue of the full number thereof, the first publication being made on the 15th day of April 1965 and the last publication on the 6th day of May 1965, upon which days or times of publication aforesaid the newspaper was regularly published, and that during the whole time of said publication he was Will Emmers the printer and publisher of the said newspaper.

Subscribed and sworn to before me this 10 day of May A. D. 1965

STATE WATER RESOURCES COMM

PIERRE SOUTH DAKOTA

Notary Public Lincoln County, S. D.

Permit No. 1190-3

Water Division 3 E.T.G SIOUX RIVER Water District

**REPORT OF EXAMINATION OF WORKS
AND/OR APPLICATION OF WATER TO BENEFICIAL USE**

Handwritten
by C.F.P.
Agency, Inc.

TO: Water Resources Commission, State Office Building No. 2, Pierre, South Dakota 57501

I have this day made a thorough examination of the water use system constructed by Pattee Creek
Watershed District of Hudson, S.D. holder _____
of Permit No. 1190-3, bearing date of priority of March 31, 1965
278 acre feet annually
authorizing the diversion of _____ ~~cubic feet per second~~ of the waters of Pattee Creek
for public recreation purposes, in Lincoln County.

I have to report on the condition of the same as follows:

The Water Use System consists of,

A. Works used to divert the water:
 Compacted earthen dam, 48 ft. high, 964 ft. long on top, 17 ft. wide on top,
 front slope 3:1 and 4:1, back slope $2\frac{1}{2}$:1.
 Crushed rock rip rap.
 Concrete drop inlet.
 Concrete reinforced pipe spillway.
 Grassed earth secondary spillway.

B. Works used to transport water to place of use, This is multiple purpose dam "Detention Dam" P-1. Across Pattee Creek. When full to the inlet level, the lake formed by the dam has a surface area of 92.7 acres and a capacity of 1110.0 acre-feet.

C. Works used to apply water to beneficial use. Capacity at secondary spillway elevation is 2044 acre-feet.

The system is in the following condition: Excellent

The point of diversion is located 1200 ft. North and 1400 Ft. west of the SE Corner of
Section 19, T97N, R48W.

The works are capable of diverting and conveying to the place of use storing 1110 acre-feet
Public Recreation
of water which is to be used for

Water has been put to beneficial use to the maximum extent as follows: for recreation purposes and sediment storage, a lake of 92.7 acres, (maximum depth - 32 ft.) has a capacity of 1110 acre feet. At approximate maximum flood elevation 199 surface acres in Section 19, T97N, R48W would be flooded, with a total capacity back of the dam of 3308 acre-feet.

On June 29, 1978 Mr. Earl Richter, SCS, Canton, S.D. called regarding the Water Right Permit No. 1190-3, stating he did not believe the Pattee Creek Watershed District owned a fee for Inspection of the Water Right. He stated he believed the Game Fish and Parks owned the permit since 1966.

Checking with the Dept. of GFD it was discovered they had ~~purchased~~ purchased it on April 18, 1966. Therefore the permit was transferred to them. No fee is required.

July 1, 1978
Betty Westlund

*Called Earl Richter 987-2629, July 1st. Informing him
of the transfer.*

NOTICE OF TRANSFER OF WATER PERMIT

TO: Water Rights Commission
P.O. Building
Pierre, South Dakota 57501

Date: July 5, 1978

This is to notify you that title to the lands described as follows:

SE $\frac{1}{4}$ Section 19, T97N, R48W

formerly owned by Pattie Creek Watershed District
has been transferred to Dept. Wildlife, Parks & Forestry, Pierre, SD
together with any rights to the beneficial use of water thereon as evidenced by
Water Right Permit No. 1190-3 as provided for in Section 61.0127 of the 1960
Supplement to the South Dakota Code of 1939.

You are therefore hereby requested to file this "Notice of Transfer of Water Permit" in its appropriate file at the Office of Water Rights Commission as evidence of the change of ownership.

~~A fee of Two Dollars and Fifty Cents (\$2.50) is hereto attached to cover filing fees as required under Section 61.0159 of the 1960 Supplement to the South Dakota Code of 1939.~~

STATE OF SOUTH DAKOTA)
 Hughes) SS.
County of McCook)

I, Jack Merwin, Sec of WPF 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, and I know of my own personal knowledge that the information herein stated is true.

Jack Merwin
(Signed)

Subscribed and sworn to before me this 24th day of August

19 78.

O. J. Trager
(Notary Public)

Can Exp 10-24-78

Investigating Engineers Report
Pattee Creek Watershed
Site P-1
(Lake Lakota)
Stilling Basin
Lincoln, County, South Dakota

I. Authority.

R. D. Swenson, state conservationist, South Dakota, appointed Gerald Younger, design engineer, Midwest TSC, Engineering Staff as the investigating engineer on August 14, 1979.

On December 22, 1980, R. D. Swenson appointed Dennis Hurtz, assistant head, Midwest TSC Design Staff as the investigating engineer to replace Gerald Younger due to Younger's transfer to Oklahoma.

The charge was to investigate and prepare a report on the rock riprap movement within the principal spillway outlet stilling basin in accordance with the National Engineering Manual, Part 504, Subpart A.

II. Investigating engineers activities.

A. Reviewed cross sections, photographs, original and subsequent calculations furnished by the South Dakota Design Staff relative to the stilling basin condition and design.

B. Reviewed preliminary comments prepared by Gerald Younger, including his report on observed field conditions (trip report dated October 18, 1979).

C. Reviewed present condition water surface profiles prepared by the South Dakota Design Staff.

D. Developed additional water surface profiles to simulate the as-built condition.

E. Reviewed all the available data, drawings, and correspondence dealing with the history, design, and performance of the structure.

F. Made an analysis to support conclusions.

G. Prepared an engineering report and abstract.

III. Description and history of the structure.

A. Pattee Creek watershed, site P-1, is a multiple-purpose floodwater retarding and recreation structure, with a drainage area of 8.89 mi². It is located in the SE $\frac{1}{4}$ sec. 19, T. 98 N., R. 48 W., Lincoln County, South Dakota.

Total storage (sediment and recreation) below the crest of the principal spillway is 1,110 acre feet and retarding storage is 934 acre feet. Maximum structure height is approximately 46 ft. The effective height is approximately 40 ft resulting in a product of storage times effective height of 81,760.

The structure has a top width of 17 ft. Side slopes are 2½:1 downstream with a 20-ft berm at approximately one-third height and 3:1 over 4:1 upstream with a 10-ft berm at approximately one-half height.

The principal spillway is described in section V B. The emergency spillway is a 150-ft wide vegetated channel with 4:1 side slopes and a 216-ft long level section.

The structure was designed as a class (a) hazard structure; however, the design indicates that the hydrology used was somewhat greater than the minimum required.

B. The site was investigated and the design prepared during the period 1960 to 1966. Construction was completed on May 3, 1967. Available documents did not show the dates that the drawings and specifications were approved by the state conservation engineer or the head, Engineering and Watershed Planning Unit.

In March and April of 1967, inflow into the reservoir disappeared indicating excessive seepage losses. The pool area was blanketed with compacted CL glacial till to a depth of 2 ft.

A wet area developed downstream from the dam and boils were observed in the principal spillway outlet plunge pool. On May 13, 1969, an investigation committee was appointed by the state conservationist to investigate the problem. Results of this investigation are contained in "Report of Investigation of Structure Deficiency" Pattee Creek watershed, site P-1, Lincoln County, South Dakota, July 1969. In summary the committee concluded and recommended:

1. Most seepage originates above the left abutment downstream from the dam.
2. Water losses are not excessive and the embankment is stable.
3. The plunge pool and outlet channel are not stable.
4. A filter with weighted riprap should be installed in the plunge pool and drainage should be provided to collect seepage from the downstream left abutment area.

C. Authorization to do additional work in the plunge pool and outlet channel and to install the recommended drainage for the downstream wet area was granted by the Administrator on November 18, 1969. Drawings and specifications for the additional work were prepared by South Dakota and coapproved by the Midwest Engineering and Watershed Planning Unit on April 16, 1970. They were subsequently revised to eliminate the drainage, due to objections by the South Dakota Game Fish and Parks Department and again coapproved on April 16, 1971.

The drawings and specifications were again revised to reduce the extent of work, since vigorous vegetative growth had stabilized the outlet channel. Coapproval was given on July 16, 1971. The additional work was completed in November 1971 and involved the installation of a stilling basin consisting of filter fabric, bedding, and rock riprap lining.

D. On July 11, 1979, South Dakota submitted data to the TSC regarding problems with the stilling basin performance and requested a review and comments. This request resulted in the appointment of an investigating engineer to evaluate the problem and is the subject of this report.

E. Substantial water loss from the reservoir has continued to be a problem. This problem is being investigated by another committee which was appointed by the state conservationist on February 24, 1976. The committee is in the process of preparing a final report.

IV. Description of problem.

A. The rock riprap has eroded from the downstream end slope of the stilling basin and formed a pile approximately 1.0 to 1.5 feet high in the outlet channel immediately downstream. The underlying filter fabric is exposed on the end slope. No other damage has occurred within the basin or within the downstream channel.

B. The damage apparently occurred in the spring of 1979 during full pipe flow discharge from the principal spillway.

V. Factors associated with the problem.

A. Outlet channel.

1. The original principal spillway outlet channel was constructed from station 3+65 (outlet end of principal spillway) to station 18+30 (natural channel). At station 3+55 the conduit invert elevation is 1341.50 and the channel invert elevation was 1339.50.

Channel data shown on the original drawings is as follows:

Required $Q = 133.1 \text{ ft}^3/\text{s}$
 $n = 0.04$
 $D = 2.2 \text{ ft}$
 $B = 14.0 \text{ ft}$
 $r = 1.62$
 $SS = 3:1$
 $A = 45.3 \text{ ft}^2$
 $S_o = 0.0034 \text{ ft/ft}$
 $V^0 = 2.98 \text{ ft/s}$
 $Q (\text{design}) = 135 \text{ ft}^3/\text{s}$

A bridge was located at station 16+45.2 with an invert elevation of 1335.2. There is no indication in the original design that this bridge caused any restriction to the flow.

No excavated stilling basin was provided. The design was to allow the basin to form by erosion from the conduit discharge.

2. Sometime during 1971, the county replaced the bridge with a 50-ft long 40-in by 65-in corrugated metal pipe arch. *A.C.P.*

3. In December 1979 the outlet channel was profiled and cross sectioned from station 3+65 to station 23+65 to represent present conditions. This survey shows that:

a. Invert of the CMP arch is at approximate elevation 1336.8 at centerline of road with a slope of 0.004 ft/ft.

b. Average grade from station 3+65 to 16+30 (CMP arch) is approximately 0.0021 ft/ft.

c. Average grade from station 16+30 to 22+65 is approximately 0.0048 ft/ft.

d. Channel width and side slopes have not changed any significant amount from the original constructed channel; however, as the grade indicates, channel filling has occurred.

4. In January 1980 Dwight Hale, design engineer, South Dakota prepared water surface profiles based on the new survey data. These profiles show that:

a. Present condition tailwater at the conduit outlet is elevation 1343.8 ($Q = 130 \text{ ft}^3/\text{s}$).

b. If the culvert were enlarged or removed to eliminate the restriction, the tailwater elevation would be 1342.0.

B. Principal spillway.

1. According to the drawings the design discharge of the principal spillway with reservoir at the emergency spillway crest (elevation 1384.3) is $133.1 \text{ ft}^3/\text{s}$.

2. The principal spillway consists of:

a. A single stage open top reinforced concrete riser 24.0-ft high with a 3.0 ft by 5.0 ft inside dimension. The top has a one-way flair to an inside dimension of 5.0 ft by 6.0 ft at the crest.

b. The conduit is 30 inches in diameter, reinforced concrete pipe 216-ft long.

3. According to Dwight Hale, the conduit has flowed full only two or three times during the life of the structure. This is primarily due to the continued seepage loss from the reservoir which greatly increases the amount of available storage. As far as could be determined, the only significant discharge since the stilling basin was installed occurred in the spring of 1979.

No factual information is available on the maximum reservoir stage however it was described as being well below the emergency spillway crest elevation.

4. The design grade on the outlet section of conduit was 2.0 percent. Present grade is not known. David J. Tokach, state conservation engineer, stated in a phone conversation on June 26, 1981, that he has looked at the conduit many times and is sure the outlet is still at some positive grade.

C. Stilling basin.

1. Notes for the stilling basin show that it was designed in accordance with DESIGN NOTE NO. 6, "Armored Scour Hole for Cantilever Outlet," dated October 1968. The design was based on a d_{50} rock size of 1.3 ft.

2. A letter from R. D. Swenson, state conservationist to Marion Strong, director, MTSC, dated July 11, 1979, and notes by Dwight Hale dated July 3, 1979, indicate that from a field inspection, the d_{50} size of the rock riprap removed from the basin appeared to be on the order of 0.5 ft.

3. A trip report by Gerald Younger, dated October 18, 1979, and based on a field inspection by Younger, John Swanda, Jr., and Dwight Hale indicated that the rock riprap was undersize.

4. Design notes for the stilling basin show that the tailwater was assumed to be at elevation 1341.5.

VI. Discussion of factors.

A. Criteria in effect at the time of the original design was ENGINEERING MEMORANDUM-27 (EM-27), "Limiting Criteria for the Design of Earth Dams," dated March 14, 1958. This criteria stated: "The invert of the cantilever outlet at its lower end shall be at least 1 ft above the grade of the downstream channel." The original design placed the invert 2.0 ft above the channel grade which was 0.2 ft below the design tailwater elevation of 1341.7.

ENGINEERING MEMORANDUM-27 (Rev.), "Earth Dams," dated March 19, 1965, stated that: "The invert of cantilever outlets of pipe drop inlets or culverts at its lower end is to be at least 1 ft above the tailwater elevation of the downstream channel at maximum discharge."

Present criteria, Technical Release No. 60, "Earth Dams and Reservoirs," dated June 1976 is essentially the same as stated in EM-27 (Rev.).

The original design would not satisfy present criteria with respect to conduit outlet invert elevation vs. tailwater elevation.

B. The hydraulic data for the original channel indicates the design assumed uniform flow. This assumption was checked by preparing two water surface profiles for the original design condition ($Q = 135 \text{ ft}^3/\text{s}$). Both profiles were started at station 18+30, one with a starting depth of 3.2 ft and the other with a starting depth of 1.2 ft. Both profiles converged to essentially the normal depth of 2.2 ft indicating that the original assumption was reasonably accurate.

An analysis was also made on the CMP arch culvert hydraulics, since it has a major impact on the tailwater elevation at the conduit outlet. The results of this analysis agreed closely with those prepared by Dwight Hale and used in his water surface profile computations (V A 4). This analysis also indicated that for a change in discharge from $130 \text{ ft}^3/\text{s}$ to $120 \text{ ft}^3/\text{s}$, the headwater elevation at the culvert would be lowered by approximately 0.6 feet. For a change from $120 \text{ ft}^3/\text{s}$ to $110 \text{ ft}^3/\text{s}$, the headwater would be lowered an additional 0.6 feet.

C. Maximum principal spillway discharge was checked using a riser entrance coefficient of 1.0, an "n" value of 0.013 for the conduit, and a reservoir stage at elevation 1384.3 (crest of emergency spillway). Discharge was calculated to be 127 ft³/s which compares reasonably close with the 133.1 ft³/s shown on the drawings. A full pipe flow discharge of approximately 120 ft³/s is obtained with the reservoir stage at elevation 1377.5 or 1.5 feet above the riser crest.

D. Tailwater at basin.

1. The original stilling basin design was as follows, (reference DESIGN NOTE NO. 6):

Q = 130 ft³/s
 Spillway outlet invert, elevation 1341.50
 Tailwater elevation 1341.50
 Outlet channel invert, elevation 1339.50
 D = 2.5 ft (conduit diameter)
 V = 26.5 ft/s (conduit discharge velocity)
 d₅₀ = 1.3 ft. (d₅₀ stone size)

$$\frac{Q}{D} = 52$$

$$m = 5.75$$

$$p = 2.5$$

$$\frac{h}{D^{1/3}} = 2.75$$

$$\frac{m}{p} = 2.3$$

$$h = 3.75 \text{ ft}$$

$$\frac{x}{\sqrt{p}} = 13$$

$$x = 20.55 \text{ ft, mod}$$

2. Using a tailwater elevation of 1341.7 as calculated for the original structure design (d = 2.2 ft) would result in: p = 2.3 ft, h = 3.75 ft, m = 5.95 ft, and x = 20.97 ft.

→ 3. For a tailwater elevation of 1343.8 from present condition profile results in: p = 0.20 ft, h = 3.75, m = 8.05 ft, and x = 40.68 ft.

4. For a tailwater elevation of 1342.0 p = 2.0 ft, h = 3.75 ft, m = 6.25 ft, and x = 21.45 ft.

5. Assuming that the discharge was 120 ft³/s and based on the culvert hydraulic analysis (VI B), the tailwater was 0.6 feet lower or elevation 1343.2; the basin parameters would be: p = 0.8 ft, h = 3.34 ft.

$$m = 7.04 \text{ ft } x = 23.24 \text{ ft}$$

6. For a discharge of 110 ft³/s and tailwater elevation 1342.6: p = 1.40 ft, h = 3.04 ft, m = 6.14 ft, and x = 18.22 ft.

E. Rock riprap size.

1. Assuming that the d_{50} rock size actually installed was 0.5 ft, instead of 1.3 ft, and using a tailwater elevation of 1341.50 results in the following basin dimensions:

$$\frac{Q}{D} = 52$$

$$p = 2.5$$

$$\frac{h}{D^{1/3}} = 4.65$$

$$m = 8.28$$

$$h = 6.28 \text{ ft}$$

$$x = \underline{24.71 \text{ ft}}$$

2. Using $d_{50} = 0.5 \text{ ft}$ and tailwater elevation 1343.8:
 $\rightarrow p = 0.20 \text{ ft}, h = 6.28 \text{ ft}, m = 10.58 \text{ ft}, \text{ and } x = \underline{51.38 \text{ ft}}.$

3. For d_{50} equals 0.5 ft and tailwater elevation 1342.0:
 $p = 2.0 \text{ ft}, h = 6.28 \text{ ft}, m = 8.78 \text{ ft}, \text{ and } x = \underline{25.75 \text{ ft}}.$

4. For $d_{50} = 0.5 \text{ ft}, Q = 120 \text{ ft}^3/\text{s}$, and tailwater elevation 1343.2:

$$p = 0.80 \text{ ft}, h = 5.93 \text{ ft}, m = 9.63 \text{ ft}, \text{ and } x = \underline{28.96 \text{ ft}}$$

5. For $d_{50} = 0.5 \text{ ft}, Q = 110 \text{ ft}^3/\text{s}$, and tailwater elevation 1342.6: $p = 1.40 \text{ ft}, h = 5.57 \text{ ft}, m = 8.67 \text{ ft}, \text{ and } x = \underline{22.40 \text{ ft}}.$



TABLE 3 - STRUCTURE DATA

Floodwater Retarding Structures and Water Supply Reservoirs

Pattee Creek Watershed, South Dakota

Lakota

Item	Unit	Structure Number				Total
		P-1	P-2	P-3	P-4	
Drainage Area	sq.mi.	8.89	4.54	1.08	2.08	16.57
Storage Capacity						
Sediment	ac.ft.	266	180	56	98	600
Floodwater	ac.ft.	934	480	114	220	1748
Water Supply	ac.ft.	844	-	-	-	844
Total	ac.ft.	2044	660	170	318	3192
Surface Area						
Sediment Pool	ac.	38	33	12	21	104
Floodwater Pool	ac.	135	72	25	40	272
Water Supply Pool	ac.	93	-	-	-	93
Volume of Fill	cu.yd.	163070	84200	42700	52900	342870
Elevation Top of Dam	ft.	1389.8	1335.9	1349.5	1285.5	xxxx
Maximum Height of Dam	ft.	48.0	41.5	33.0	27.5	xxxx
Emergency Spillway						
Crest Elevation	ft.	1384.3	1330.4	1344.0	1280.0	xxxx
Bottom Width	ft.	150	120	70	150	xxxx
Type	Veg	Veg	Veg	Veg	Veg	xxxx
Percent Chance of Use	4	4	4	4	4	xxxx
Av.Curve No.-Cond.II	73	74	76	76	76	xxxx
Emer.Spillway Hydrograph ^{2/}						
Storm Rainfall(6-hr.)	in.	5.4	5.4	7.9	5.4	xxxx
Storm Runoff ^{1/}	in.	2.36	2.21	4.70	2.62	xxxx
Velocity of Flow (v)	ft/sec	3.9	3.1	-	-	xxxx
Discharge Rate ^{1/}	cfs	289	114	-	-	xxxx
Maximum w.s. Elev. ^{1/}	ft.	1385.6	1331.2	-	-	xxxx
Freeboard Hydrograph						
Storm Rainfall(6-hr.)	in.	10.8	10.7	10.5	10.8	xxxx
Storm Runoff ^{1/}	in.	6.77	6.41	7.00	7.20	xxxx
Velocity of Flow(v)	ft/sec	8.4	9.3	7.4	7.9	xxxx
Discharge Rate ^{1/}	cfs	3040	3224	955	2360	xxxx
Max. w.s. Elev. ^{1/}	ft	1388.8	1335.2	1347.5	1283.8	xxxx
Principal Spillway						
Capacity-Low Stage, Max.	cfs	133	85	22	39	xxxx
Capacity Equivalents						
Sediment Volume	in.	0.56	0.72	0.94	0.90	xxxx
Detention Volume	in.	1.95	1.97	1.95	1.97	xxxx
Spillway Storage	in.	1.82	1.94	1.91	2.46	xxxx
Class of Structure		A	A	A	A	xxxx

^{1/} Maximum during passage of hydrograph.

^{2/} Will pass safely through FRS No.3 and No. 4.

Date February, 1964

CURVE NO. 1	CURVE NO. 2
$\Delta = 70^\circ$	$\Delta = 80^\circ$
$L = 240.91'$	$L = 176.84'$
$E = 270'$	$L = 140'$
$T = 160.1'$	$T = 72.7'$
P.C. = 1+00	P.C. = 1+70
P.T. = 3+20	P.T. = 2+40
P.I. = 2+60.1	P.I. = 2+10.7

ITEM		UNIT	QTY
1.	CONCRETE EXPOSED WALL (CLASSED 8" IN DIA. OUTLET TRENCH, EMBANKMENT SLOPES), 2000' MAX. PIPE LENGTH	CU. YD.	100.00
2.	CONCRETE EXPOSED WALL IN STREET CATCH BASIN AND DRAINAGE PUMP STATION	CU. YD.	10.00
3.	SCAFFOLDING: A. 1" WIDE SPILLWAY	CU. YD.	10.00
4.	B. 2" DEPTH	CU. YD.	10.00
5.	C. PIPE TRENCH	CU. YD.	10.00
6.	D. OUTLET CHANNEL	CU. YD.	10.00
7.	E. EMBANKMENT GRADE TRENCH	CU. YD.	10.00
8.	F. STRUCTURE	CU. YD.	10.00
9.	PIPE TRENCH MACGILL	CU. YD.	10.00
10.	CONCRETE SLABS 8"	CU. YD.	10.00
11.	PIPE AND REINFORCEMENT	CU. YD.	10.00
12.	TRASH RACKS (PER DETAIL)	CU. YD.	10.00
13.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
14.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
15.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
16.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
17.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
18.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
19.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
20.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
21.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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23.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
24.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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26.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
27.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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31.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
32.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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34.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
35.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
36.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
37.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
38.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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47.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
48.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
49.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
50.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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61.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
62.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
63.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
64.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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66.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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83.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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89.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
90.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
91.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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93.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
94.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
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97.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
98.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
99.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00
100.	10" DIA. 8" R.C. 12' LONG 12" DIA. 8" R.C. 12' LONG	CU. YD.	10.00

• FOR UNPRESTRESSED CONCRETE PIPE THE MINIMUM PIPE STRENGTH BY THE 3-EDGE BEARING TEST (ASTM C-49) SHALL BE 5500 POUNDS PER LINEAL FOOT TO PRODUCE A 0.01" CRACK. FOR PRESTRESSED CONCRETE PIPE, THE MINIMUM PIPE STRENGTH BY THE 3-EDGE BEARING TEST SHALL BE 5000 POUNDS PER LINEAL FOOT TO PRODUCE A 0.001" CRACK. THE JOINTS SHALL BE SMOOTH AND EQUAL TO THE STEEL JOINTS FOR A TOTAL OPENING OF 3.00 INCHES.

• THE ASBESTOS CEMENT PIPE SHALL BE CLASS 3000 JOINTS-GRAYVELL SEWER PIPE (80 EQUAL).

NOTES:

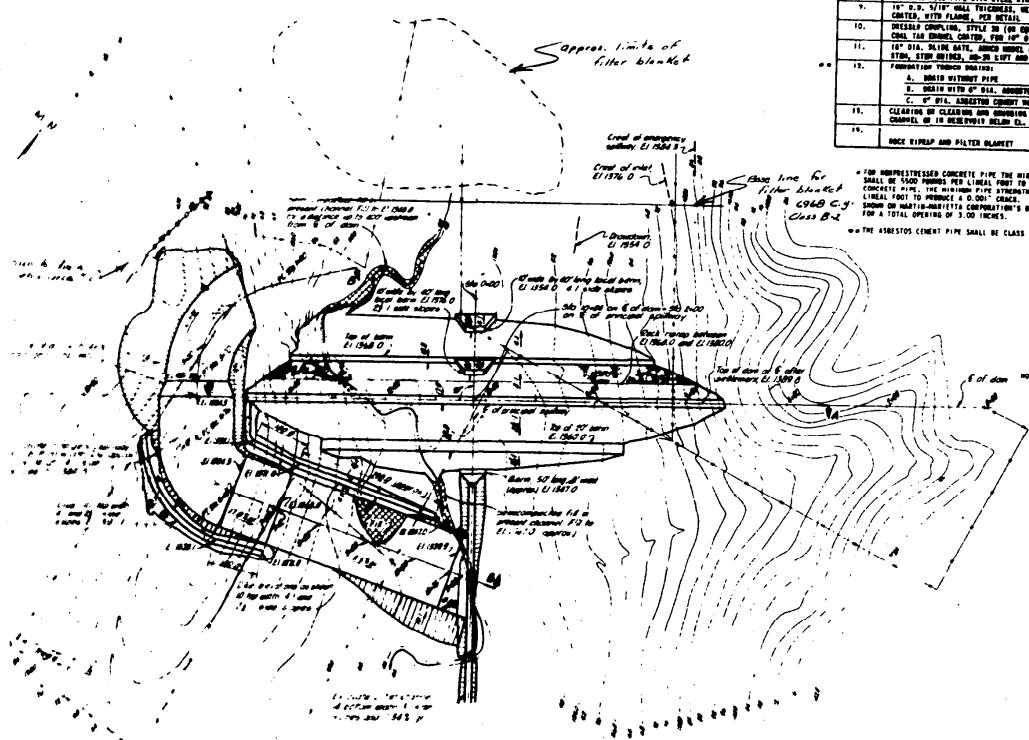
1. EXISTING FENCE IN THE CONSTRUCTION AREA TO BE REMOVED AND BALANCED BY THE CONTRACTOR.
2. SEE SHEET 4 FOR LOCATION OF DRAINAGE AREA AND TEST HOLES.
3. LEVEL TERRACES TO BE CONSTRUCTED THROUGHOUT DRAINAGE AREA AS DESIGNATED BY THE ENGINEER.

LEGEND
 ——— EXISTING FENCE

AS BUILT

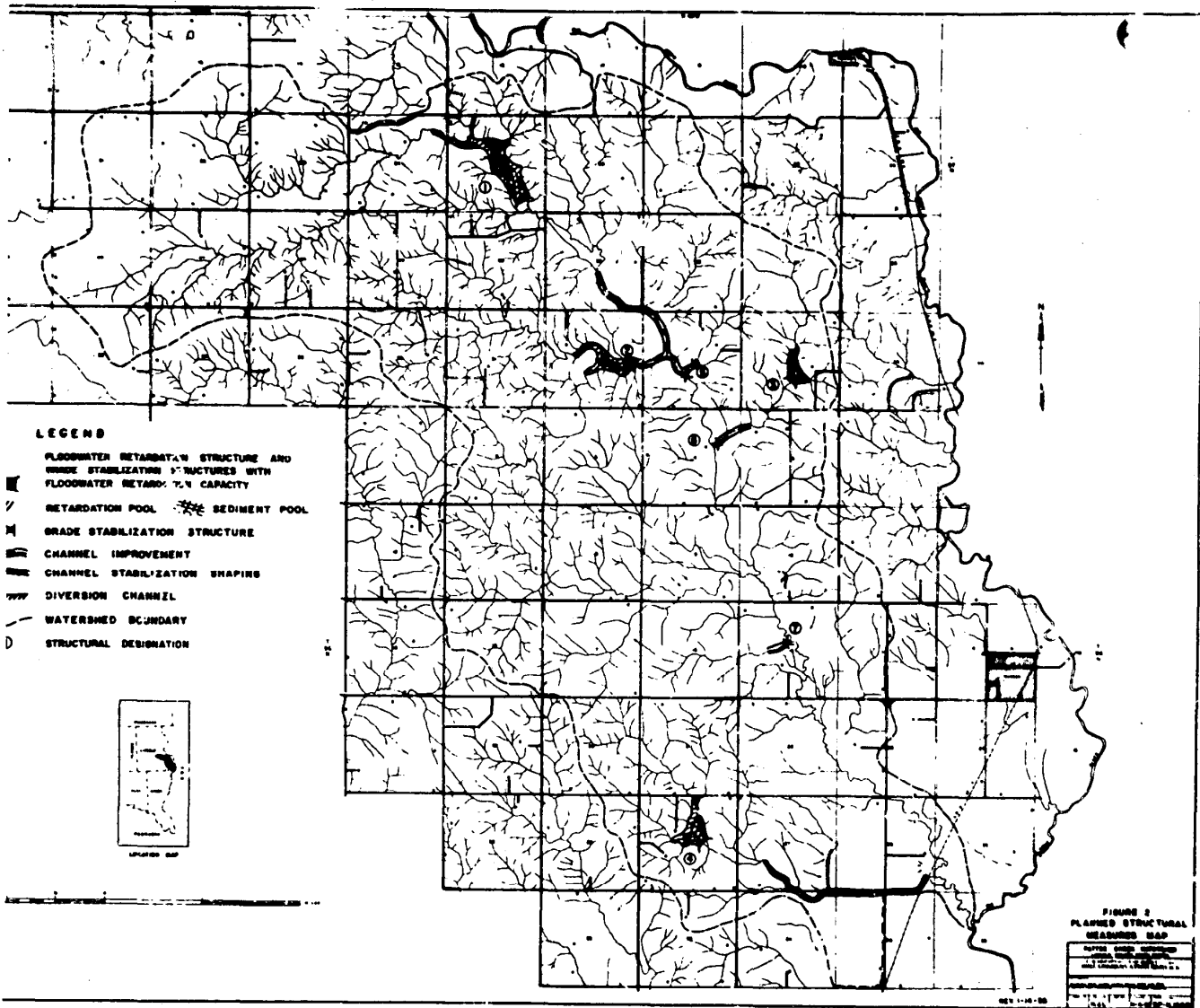
DETENTION DAM #1
(MULTIPLE PURPOSE STRUCTURE)
ATTN: CREEK INTERMED
L. County, South Dakota
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

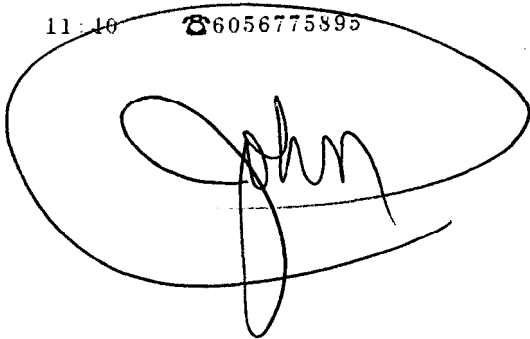
Origin: <u>RLH</u>	Assigned to: <u>WORTH, J. MARK</u>
Class: _____	Task: <u>RESEARCH</u>
Priority: _____	Due: _____
Character: <u>INT. SEC. AFF.</u>	File: <u>5E-1869</u>



TOPOGRAPHIC MAP OF DAM SITE
scale 1"=100'

Rev. 9-64
Rev. 8-69



DATE: 1-6-93TIME: 10:43 am

FAX TRANSMITTAL COVER SHEET

Please deliver the following page(s) immediately to:

TO:

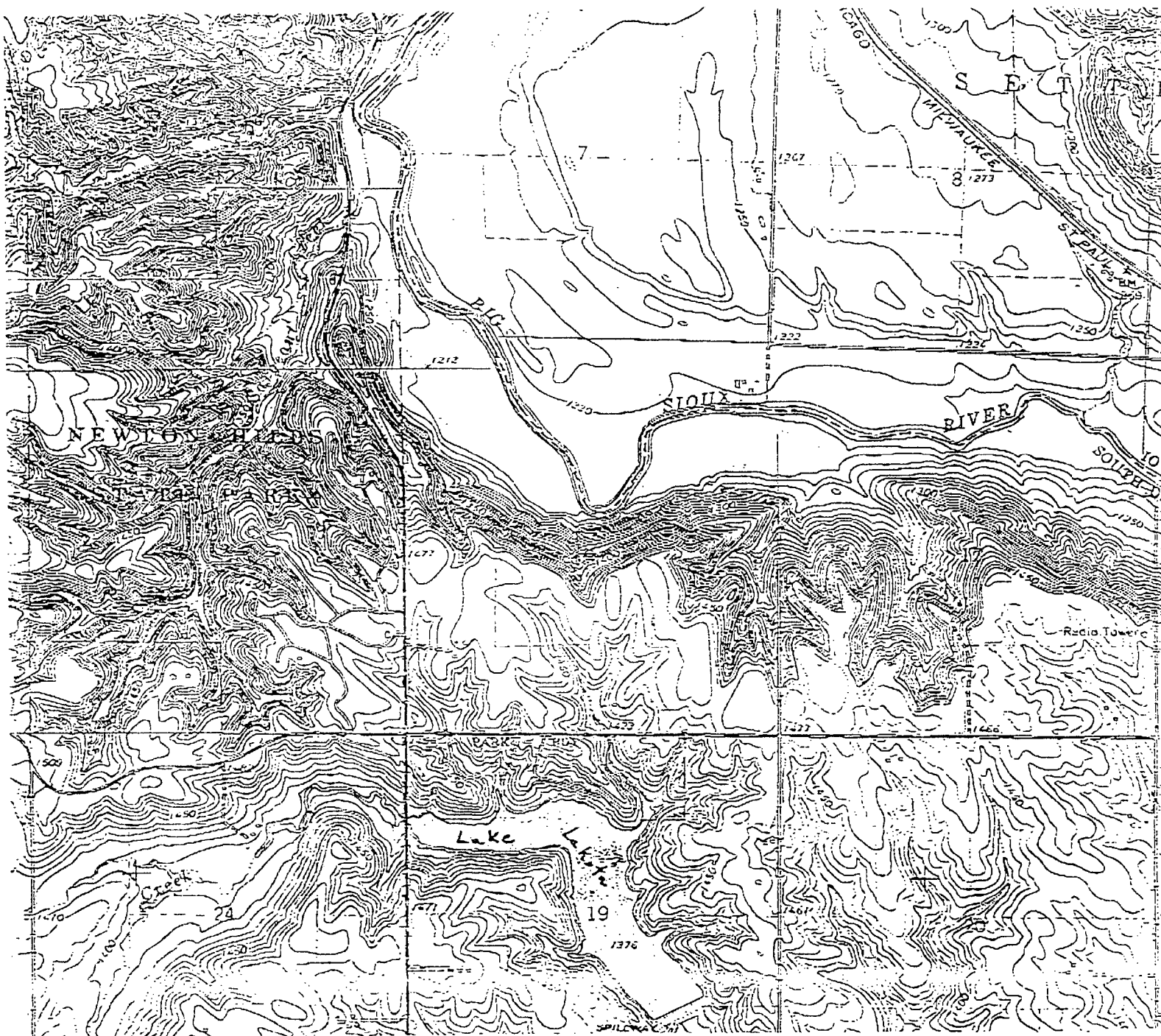
Name: Vicki MurrayLocation: DENRFax Number: 773-6035NUMBER OF PAGES (INCLUDING THIS COVER SHEET) 16

FROM:

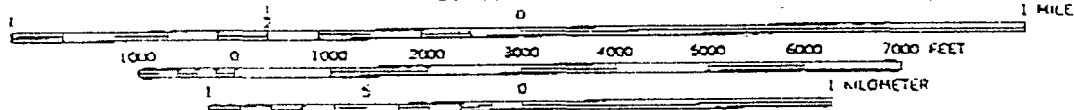
Derrick IlesSOUTH DAKOTA GEOLOGICAL SURVEY
USD Science Center
Vermillion, SD 57069FAX Number: (605) 677-5895
PHONE Number: (605) 677-5227

Messages:

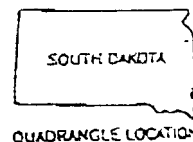
*More stuff for Robbie.**This is a complete set of what we
will hand out this afternoon.*



SCALE 1:24 000



CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

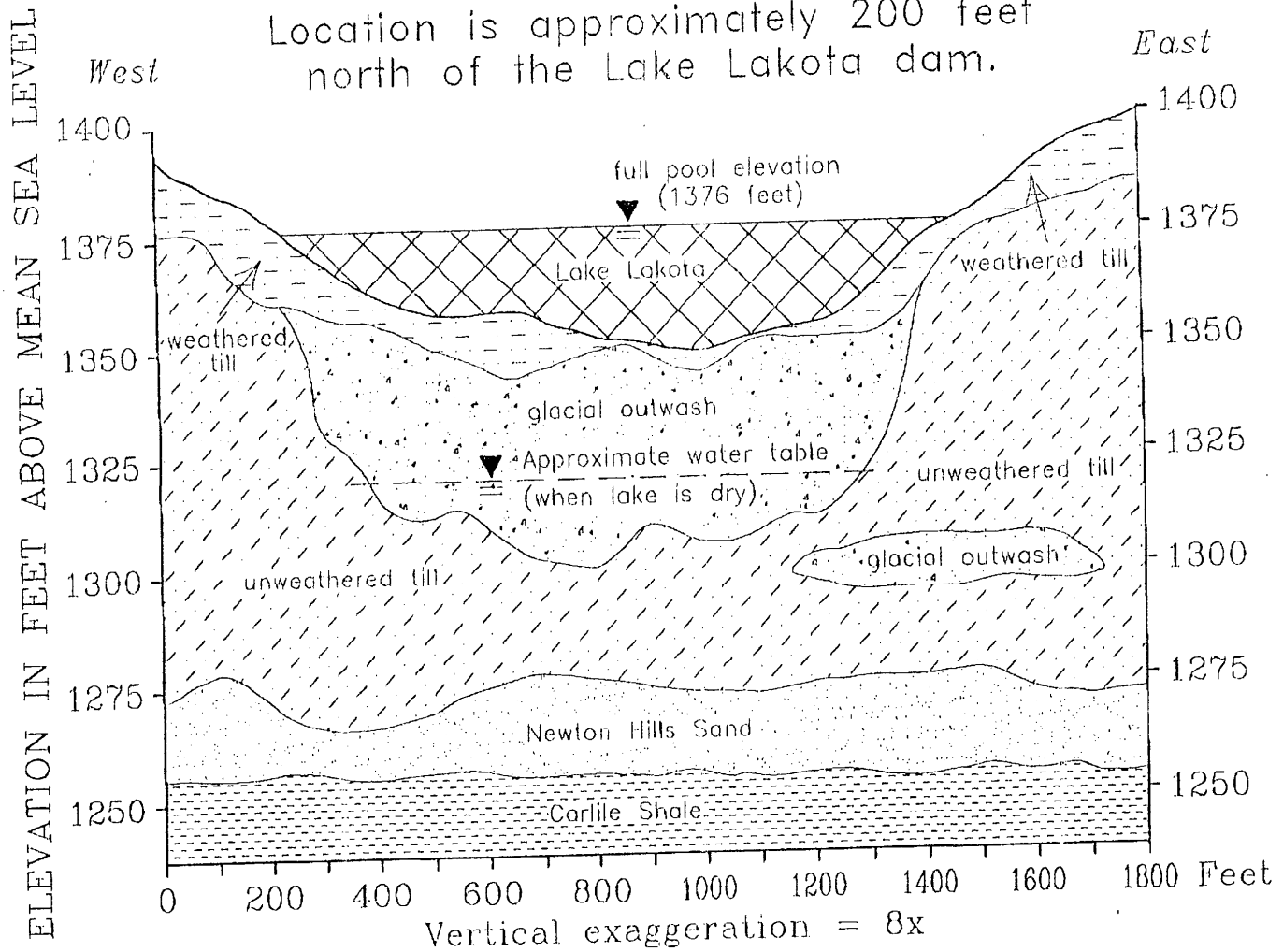


QUADRANGLE LOCATION

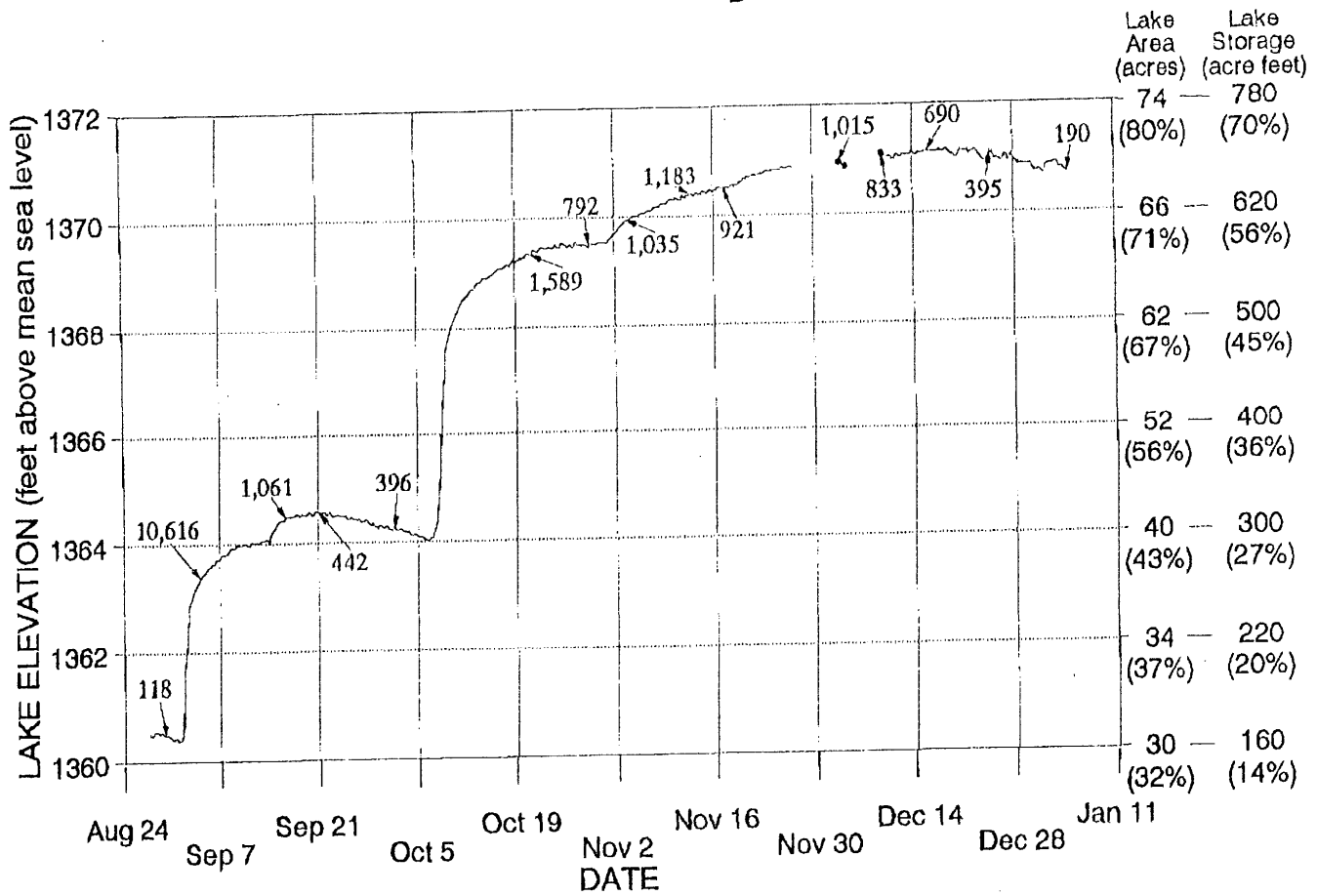
ALCESTER NE QUADRANGLE
SOUTH DAKOTA-IOWA
7.5 MINUTE SERIES (TOPOGRAPHIC)

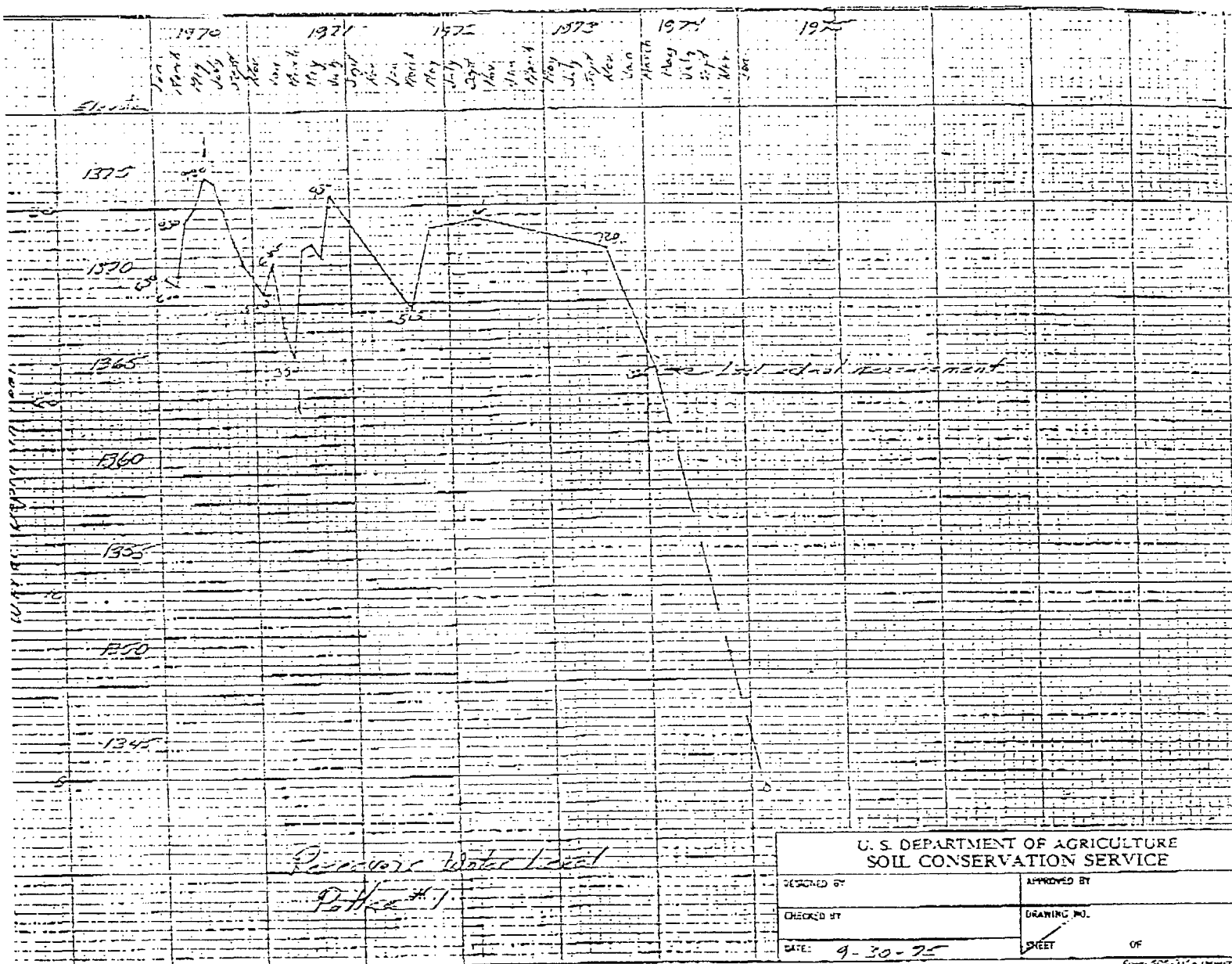
Generalized Geologic Cross Section

Location is approximately 200 feet north of the Lake Lakota dam.



Lake Lakota Hydrograph





Jan. 1, 1971
685 acre ft.
of water in
lake storage



March 1, 1971
380 acre ft.
of water in
lake storage



Loss of 305 acre feet
of water in 60 days - which
is 5.08 acre ft/day or 1854
acre feet/year (1150 gpm)
- loss is assumed to be
from seepage only.

Yearly Water Budget for Lake Lakota

Gains

Direct Precip = (2 ft x 90 acres) = 180 af/yr.
50% Runoff Probability = 332 af/yr.
180 + 332 = 512 acre feet/yr

Losses

Evaporation = 3 ft x 90 acres = 270 af/yr.
Seepage = 1854 af/yr.

270 + 1854 = 2124 acre feet/yr

Losses - Gains = 2124 - 512 = 1612 af/yr or 1,000 gpm

AVERAGE YEARLY WATER BUDGET FOR LAKE LAKOTA

WATER GAINS

- Average Direct Precipitation = 2 feet/year

(2 feet/year x 90 acres) = 180 acre feet per year

- 50% Runoff Probability = 332 acre feet per year

Total gain = 512 acre feet per year

WATER LOSSES

- Average Annual Evaporation = 3 feet/year

(3 feet/year x 90 acres) = 270 acre feet per year

- Seepage Loss = 1200 gpm = 1935 acre feet per year

Total loss = 2205 acre feet per year

NET WATER BUDGET

(Gains) + (Losses) = (512 acre feet) + (-2205 acre feet)

= -1693 acre feet per year

= -1050 gallons per minute

WORST CASE SCENARIO WATER BUDGET FOR LAKE LAKOTA

WATER GAINS

- Average Direct Precipitation ≈ 1 feet/year

(1 feet/year x 90 acres) ≈ 90 acre feet per year

- Runoff ≈ 0 acre feet per year

Total gain ≈ 90 acre feet per year

WATER LOSSES

- Average Annual Evaporation ≈ 3 feet/year

(3 feet/year x 90 acres) ≈ 270 acre feet per year

- Seepage Loss ≈ 1200 gpm ≈ 1935 acre feet per year

Total loss ≈ 2205 acre feet per year

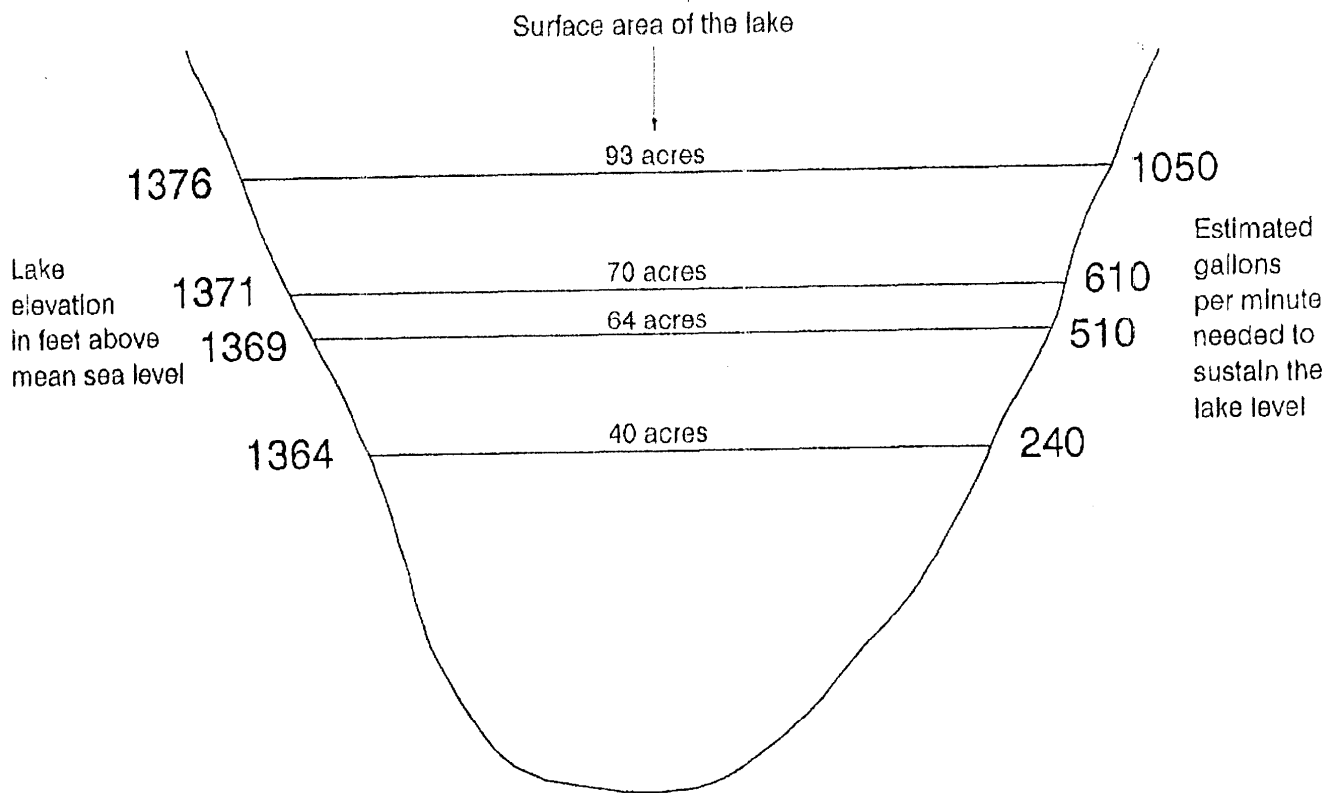
NET WATER BUDGET

(Gains) + (Losses) ≈ (90 acre feet) + (-2205 acre feet)

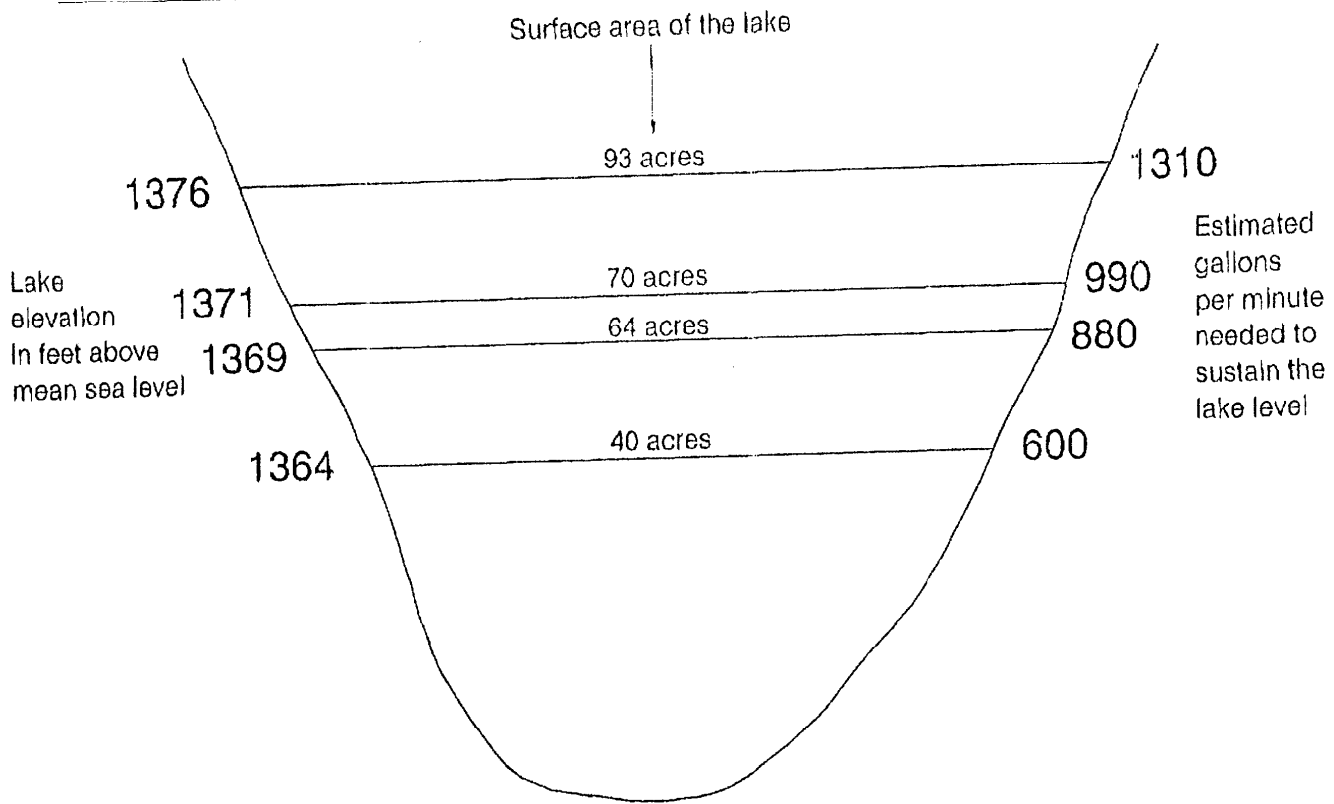
≈ -2115 acre feet per year

≈ -1311 gallons per minute

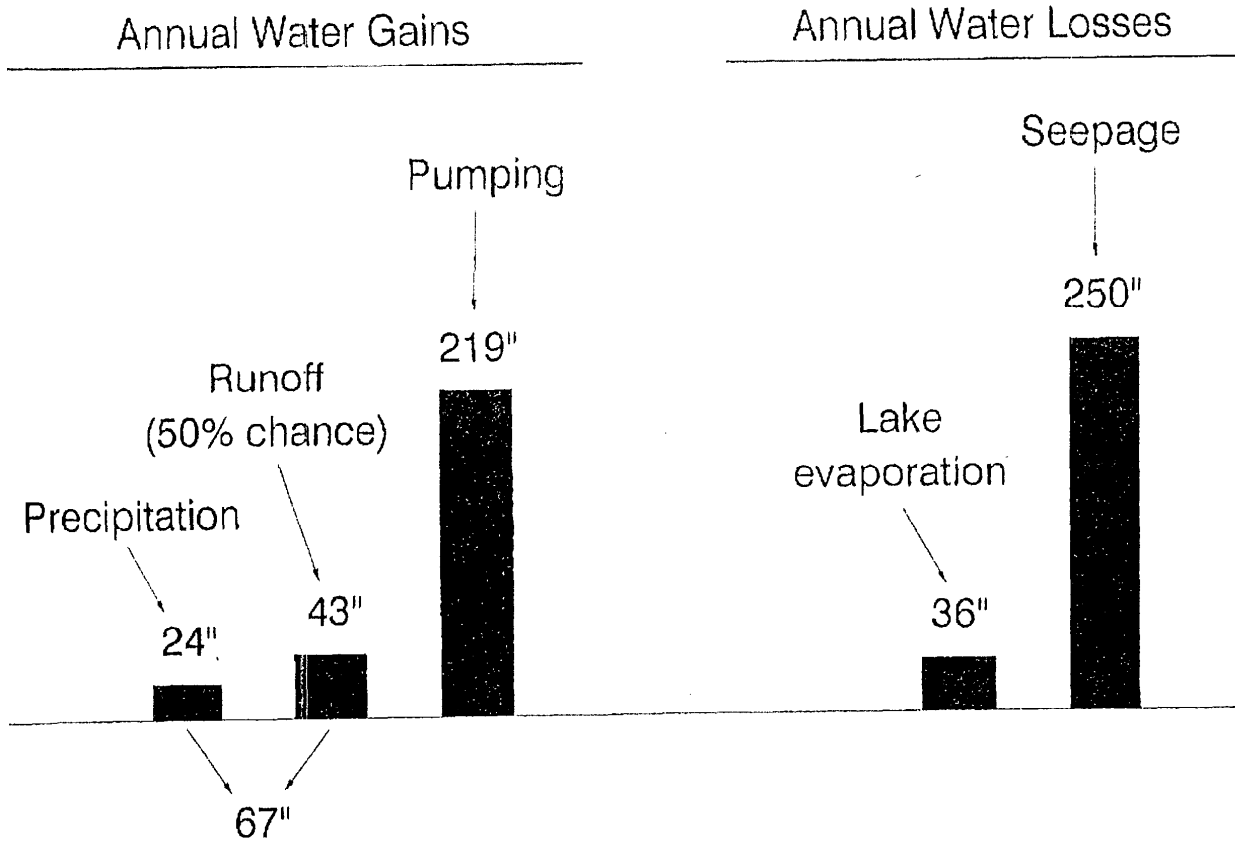
Lake elevation and size versus the supplementary inflow needed to sustain the lake level assuming "a 50 percent chance annual yield of surface runoff of approximately 332 acre-feet."

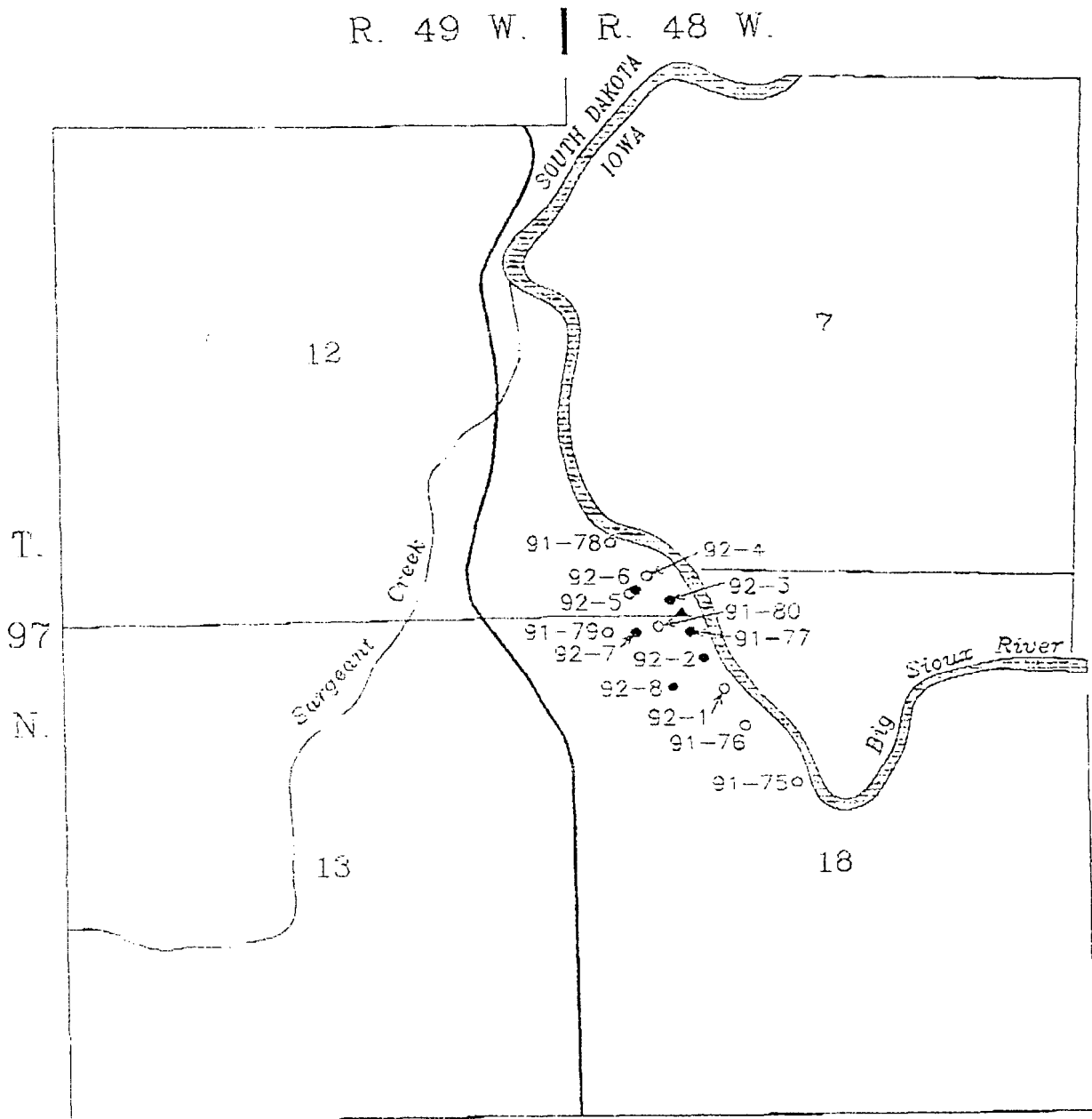


Lake elevation and size versus the supplementary inflow needed to sustain the lake level assuming no runoff into the lake and drought conditions (12 inches of rain per year).



Water-budget balance with a full lake



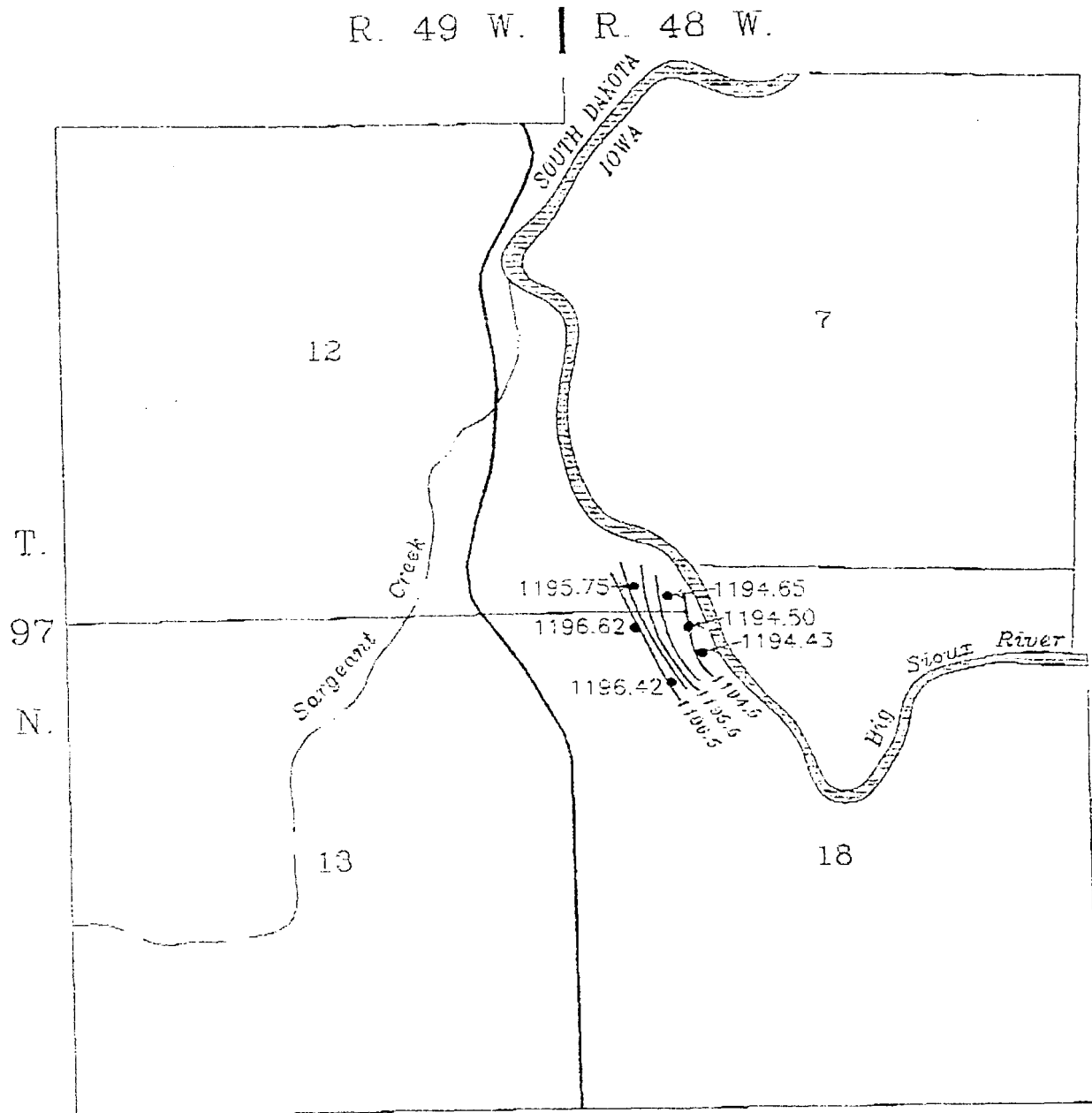


A horizontal scale bar with a vertical tick at the left end labeled '0' and a vertical tick at the right end labeled '1 Mile'. The bar is divided into four equal segments by three intermediate vertical ticks.

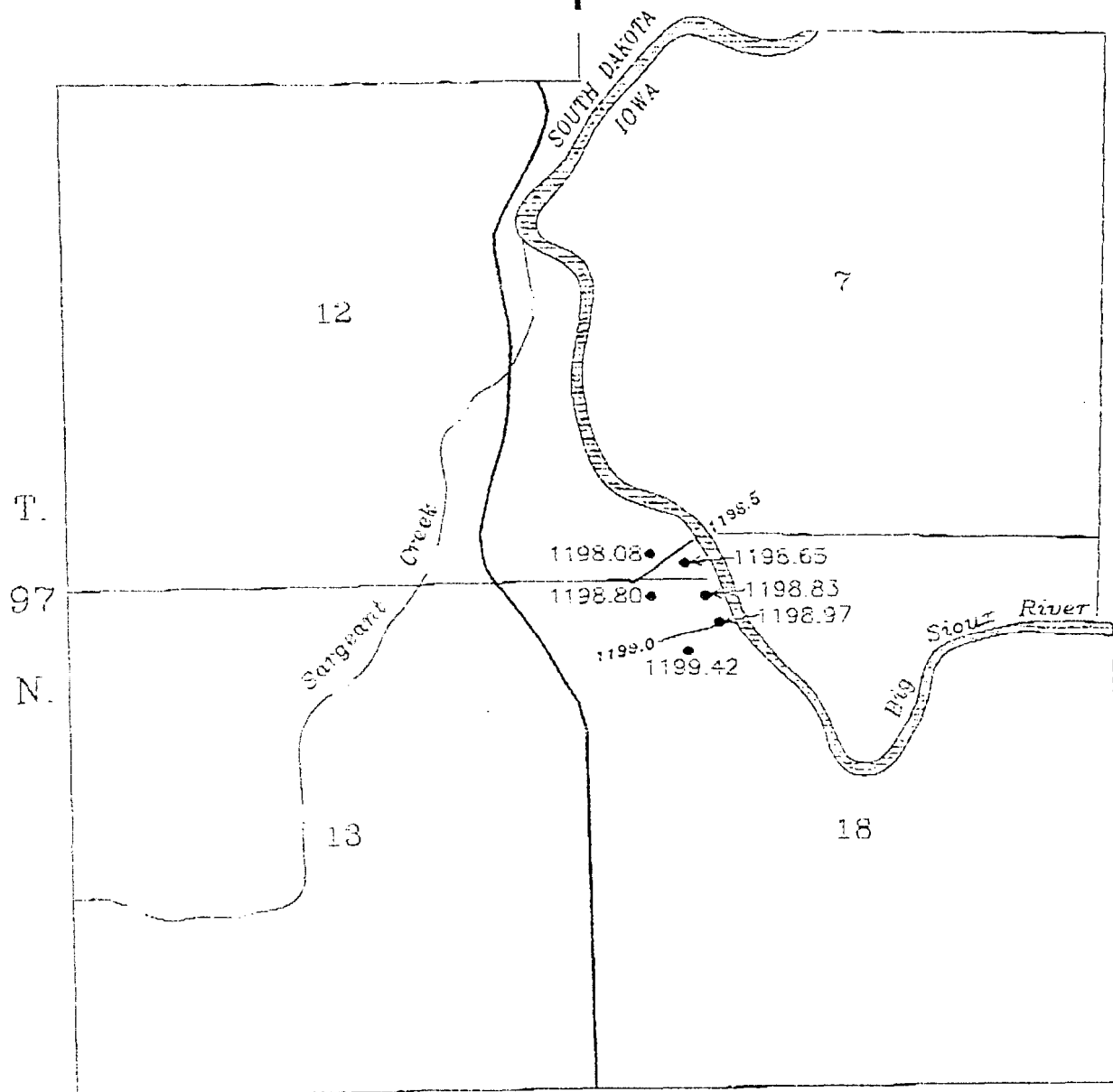


- ▲ Aquifer—test well
- Monitoring well
- Test hole

Locations of test holes and monitoring wells.



R. 49 W. | R. 48 W.



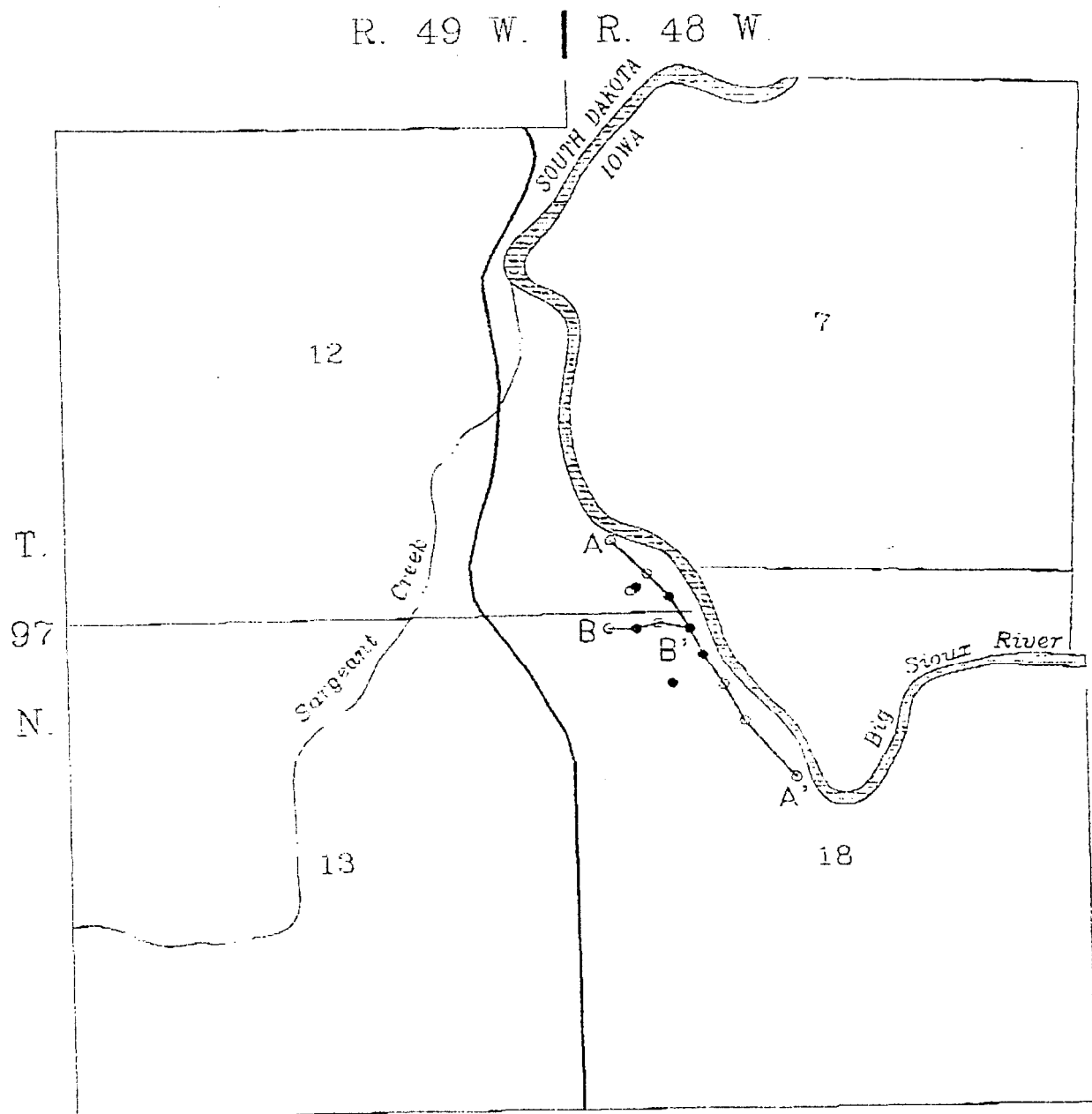
0 1 Mile



- Monitoring well

1199.0 — Line connecting points of equal water-table elevation.
Contour interval = 0.5 feet

Water-table elevations on 3/3/92.



0

1 Mile

• Monitoring well

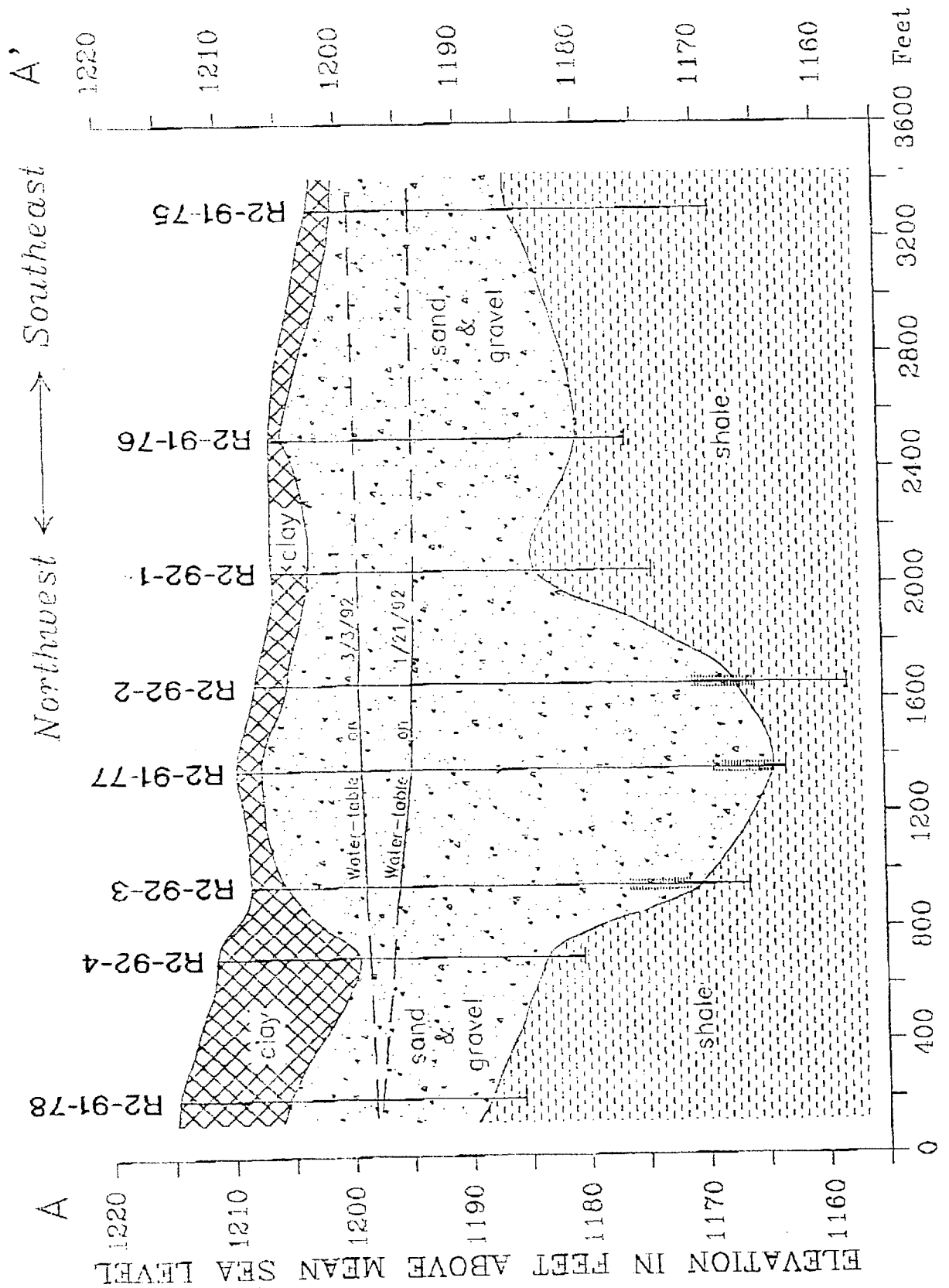
◦ Test hole

B ↔ B' Line of cross section.

Locations of cross sections.

Geologic Cross Section A - A'

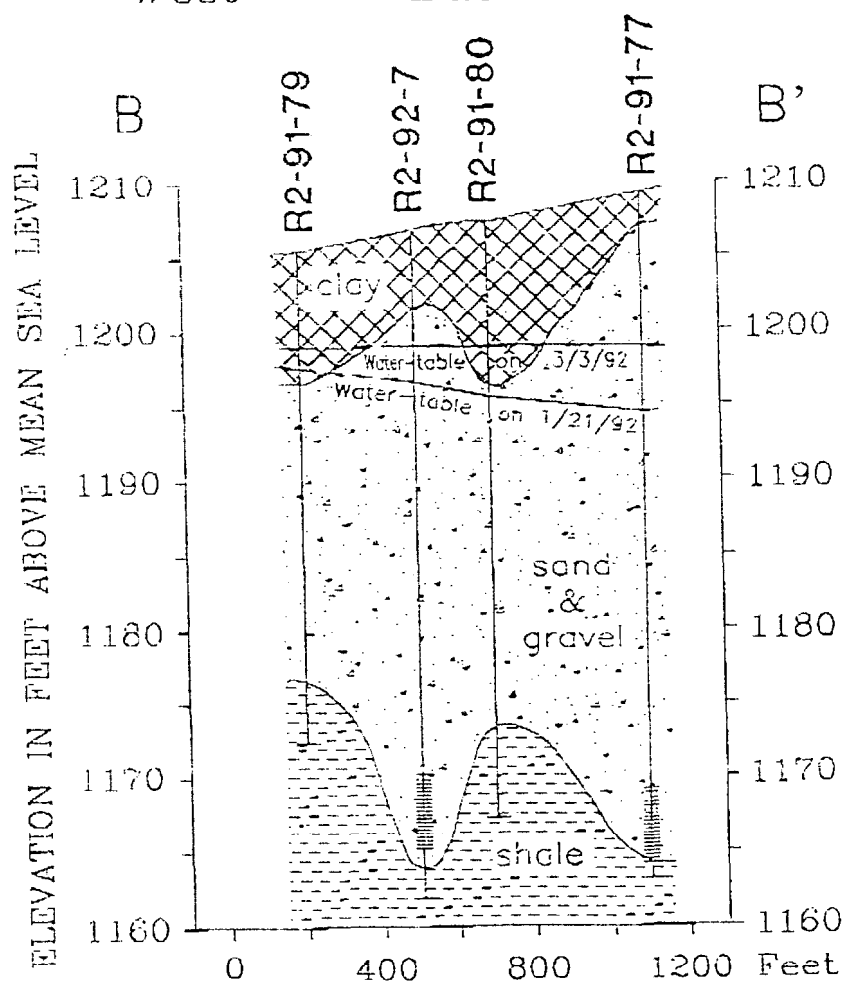
Vertical Exaggeration = 40x



Geologic Cross Section B - B'

Vertical Exaggeration = 40x

West $\longleftrightarrow$ East

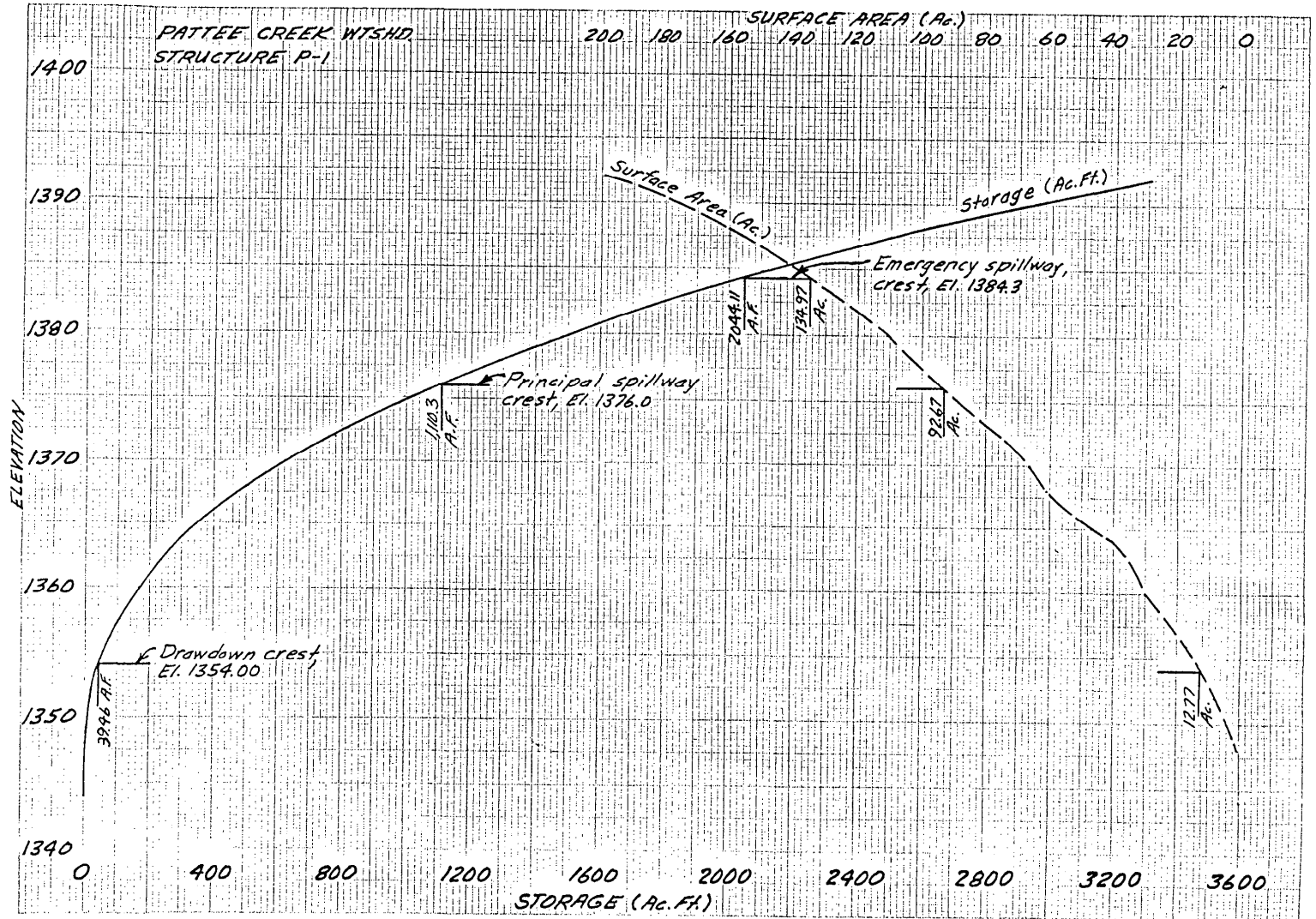


Lake Lakota (P-1)

INDEX IV

<u>Page No.</u>	<u>Item</u>
1	Stage storage curve
2	Computations on blanketing effects (4-13-81)
3	Computations on seepage at bridge (4-13-81)
4-5	Computations on seepage under dam (4-9-81)
6	Computations on surface flow (10-14-80)
7	Comparison of design SML report with perm. tested rates (4-13-81)
8-9	Computations on stage vs loss (8-27-79)
10	Computations on stage vs pool loss (8-28-79)
11	Computation on seepage loss (9-23-80)

PATTEE CREEK WTSHD.
STRUCTURE P-1



STATE S. Dak. PROJECT P-1 Deficiency Investigation
DATE 4/13/81
SUBJECT blanketing effects

$$Q = K I A, \text{ estimated } K = 0.0005 \text{ to } 0.15$$

$$\text{assume } A = 800' \times 1000' = 800000, \text{ ft.}^2$$

$$I = \frac{1'}{1'} = 1$$

$$Q = (0.0005)(1)(800000) = 400 \frac{\text{ft}^3}{\text{day}} = .06 \frac{\text{ac. ft.}}{\text{week}}$$

$$Q = (0.15)(1)(800000) = 120000. \frac{\text{ft}^3}{\text{day}} = 19.28 \frac{\text{ac. ft.}}{\text{week}}$$

These calculations assume blanket leakage only in the first 1000 feet upstream from the dam.

The calculations show that due to the extensive opportunity for recharge (large blanket area over the aquifer) blanketing would not solve the problem unless it was very extensive and very effective. Only a portion of the seepage is likely to be stopped by blanketing.

STATE

S. Dak.

PROJECT

P1 Deficiency Investigation

BY

D. Hale 4/13/81

TOPIC

Seepage at bridge (surface)

surface flow measured October 14, 1980
was 3.9 acre-feet per week.

continuing on down valley, $I = 0.00385$
for a flow of 0.88 acre feet/week
assuming similar sand cross section

$$0.88 + 3.9 = 4.8 \text{ acre feet flow}$$

other seepage would be via lower sand

S. Dak. P-1 Deficiency Investigation
Hale 4/9/81
Seepage Under Dam

$$Q = K I A$$

$$A = (2.65'')^2 (5000) = 13250 \text{ sq. ft. medium size SP}$$

- Note - other large layers of sand lie just below this SP material and also carry water. Flows will actually be higher than calculated.

$$I = \frac{H}{L} = \frac{20}{880} = 0.0227$$

- Note - I is indicated for example by comparing hole 23 water levels with water levels in hole 35.

$$K = 100 \text{ to } 200$$

$$Q_{K100} = K I A = 100 (0.0227) (13250) = 30,077.5 \frac{\text{ft}^3}{\text{day}}$$

$$Q_{K200} = 60155.$$

$\therefore Q$ thru this layer amounts to 5 to 10 ac.ft./wk

Lake losses at full pool amount to 8 to 10 acre feet per week via seepage. Most of this seepage may be passing under the dam.

STATE

S. Dak. P-1 Deficiency Investigation
 Hale 4/9/81
 seepage under dam

- seepage measure in 1969 (1st deficiency) =
 171 gallons per minute

$$(171 \cancel{\text{gal}}/\text{min}) (60 \frac{\text{min}}{\text{hr.}}) (24 \frac{\text{hr.}}{\text{day}}) (7 \frac{\text{day}}{\text{wk.}}) \left(\frac{1}{7.481} \frac{\text{ft}^3}{\text{gal}} \right) \left(\frac{1}{43560} \frac{\text{ac.}}{\text{ft}^2} \right) \\ = 5.3 \text{ ac. ft./week}$$

- Pumping into pool from 1000 ft. downstream

$$(6 \text{ ac. ft./week}) \left(\frac{1}{60(24)(7)} \frac{\text{week}}{\text{min.}} \right) (7.481 \frac{\text{gal.}}{\text{ft}^3}) (43560 \frac{\text{ft}^2}{\text{ac.}}) \\ = 194. \text{ gal./min. against 36 ft. lift.}$$

S. Dak. P-1 Deficiency Investigation
D. Hale Oct. 14, 1980
Measurement of surface Flow

Surface seepage flow was measured on Oct. 14, 1980 just downstream from the road located 1000' downstream from P-1 dam. The entrance and throat sections of a 9 inch steel Parshall flume was used to measure the flow. The flow was measured by Dwight Hale, design engineer.

Flow depth was measured to be 0.21 feet deep in the 9 inch wide throat section. Using table 9-14 of SCS National Engineering Handbook Section 15, Chapter 9,
 $Q = 0.28 \text{ cfs}$

$$0.28 \frac{\text{ft}^3}{\text{sec}} \left(\frac{3600 \text{ sec}}{\text{hr}} \right) \left(\frac{24 \text{ hr}}{\text{day}} \right) \left(\frac{7 \text{ day}}{\text{week}} \right) \left(\frac{1}{43560} \frac{\text{ac}}{\text{ft}^2} \right) =$$

$$= 3.9 \text{ acre feet/week}$$

STATION 5, Dak. P-1 deficiency investigation

D. Hale 4/13/81
comparison of Design SML report with
perm. tested rates1/24/61 SML report indicates $K = 0.0005 \text{ ft/day}$
for blanket materials.

$$Q = (0.0005)(1/4)(800)(1000) = 400 \frac{\text{ft}^3}{\text{day}} = 0.06 \frac{\text{ac. ft.}}{\text{wk.}}$$

SML also indicated an average $K = 0.1 \text{ ft/day}$
as conservative for these surface soilsand giving a maximum loss of
20 cubic feet per day per foot of dam.A total loss of 5120 cubic feet per day
was calculated. $5120 \frac{\text{ft}^3}{\text{day}} = 0.82 \frac{\text{A.F.}}{\text{wk}}$ 4/2/80 Permeability testing showed $K = 5 \text{ ft/day}$
for blanket, $Q = (5)(1)(800000) = 4000000 \frac{\text{ft}^3}{\text{day}}$
 $= 643 \frac{\text{ac. ft.}}{\text{wk.}}$ Upper sand and gravel layer under
dam gave $K = 100 \text{ to } 200 \text{ ft/day}$
for a flow of 5 to 10 acre ft/week.Actual in-place permeability tests are
needed for this type of structure

STATE

S. Dak.

FEDERAL

Pattee Creek Watershed

D. Hale 8/27/79

Sta. P-1

Stage VS loss

SHEET 1 OF 3

Losses at high pool stages

- July 22, 1969 pool El. 1375.1, 1030 A.Ft.
Aug. 18, 1969 pool El. 1373.7, 865 A
165 A in 27 days = 6.11 A/day (hot summer evaporati)
- Aug. 15, 1978 pool El. 1375.7, 1095 A
Oct. 18, 1978 pool El. 1373.5, 900 A
evaporation (85 ac.) (0.5 ft.) = 42.5 A
(1095 - 900 - 42.5) (0.5) = 76.25 A in
76.25 A in 64 days = 1.19 A/day

Losses at middle pool stages

- Dec. 7, 1969, pool El. 1370.5, 675 A
Feb. 6, 1970, pool El. 1369.3, 580 A
evaporation (68 acres) (0.35 ft.) = 23.8 A
(95 - 23.8) / 61 = 1.17 A/day
- Aug. 21, 1970, pool El. 1371.6, 750 A
Sept. 21, 1970, pool El. 1370.5, 673 A
evaporation (68 acres) (0.178 ft.) = 12.46
(77 - 12.46) / 31 = 2.08 A/day
- Dec. 1, 1978, pool El. 1370.8, 700 A
Jan. 9, 1979 pool El. 1370.3, 650 A
evap. (70) (2.24) = 15.68, (50 - 15.68) / 39 = 0.88 A/day

Lake Lakota (P-1)

INDEX VI

<u>Page No.</u>	<u>Item</u>
1	Water budget analysis used for design
2	Water budget analysis for present situation
3	Water budget analysis for 25% seepage reduction
4	Water budget analysis for 50% seepage reduction

(full) pool 1110 A.C.F.

copied by Hale 4/13/81

(Full pool El. 1376)

Present Situation

Water Budget Analysis, P-1. Deficiency
Design adjusted for 8 Ac.Ft. per wk seepage
at full pool (1110 Ac.Ft.) D. Hale 4/14/81

YEAR	Runoff Ac. Ft.	Water Surface El., Ft.	Water Surface Area, Ac.	Evap. Ac. Ft. (1.21 Ft.)	Seepage Ac. Ft.	Discharge Ac. Ft.	Storage Dec. 31 Ac. Ft.	W.S. El. Dec. 31 Ft.
1948	—							
1949	731	1371.4	72	87	329	—	315	1364.1
1950	470	1372.3	75	91	346	—	348	1365.0
1951	2279	1376.	93	113	416	1517	581	1370.8
1952	2489	1376	93	113	416	1960	581	1370.8
1953	2403	1376	93	113	416	1874	581	1370.8
1954	1201	1376	93	113	416	672	581	1370.8
1955	241	1372.6	77	93	352	—	377	1365.5
1956	114	1367.7	60	73	259	—	159	1359.7
1957	279	1366.8	57	69	242	—	127	1361.8
1958	39	1359.9	30	36	112	—	18	1356.2
1959	422	1366.8	57	69	242	—	129	1361.8
1960	1927	1376	93	113	416	946	581	1370.8
1961	716	1376	93	113	416	187	581	1370.8
1962	2977	1376	93	113	416	2448	581	1370.8
1963	147	1371.5	72	87	331	—	310	1364.2
1964	76	1365.8	71.5	86	223	—	77	1355.8
1965	1408	1376	93	113	416	375	581	1370.8
1966	839	1376	93	113	416	310	581	1370.8
1967	887	1376	93	113	416	358	581	1370.8
1968	85	1370.6	69	83	314	—	269	1363.
1969	2764	1376	93	113	416	1923.	581	1370.8
(full pool El. 1376)								

25% Seepage reduction

Water Budget Analysis, P-1 Deficiency

Design adjusted for 6 Ac. Ft. per wk. seepage
at full pool (1110 Ac. Ft.)

D. Hale 4/14/81

YEAR	Runoff Ac. Ft.	Water Surface El., Ft.	Water Surface Area, Ac.	Evap. Ac. Ft. (1.21 Ft.)	Seepage Ac. Ft.	Discharge Ac. Ft.	Storage Dec. 31 Ac. Ft.	W. S. El. Dec. 31 Ft.
1948	—							
1949	731	1371.4	72	87	247	—	397	1366.
1950	470	1373.4	81	98	275	—	494	1367.9
1951	2279	1376	93	113	312	1663	685	1370.9
1952	2489	1376	93	113	312	2064	685	1370.9
1953	2403	1376	93	113	312	1978	685	1370.9
1954	1201	1376	93	113	312	776	685	1370.9
1955	241	1374	84	102	284	—	540	1386
1956	114	1370.4	68	82	233	—	339	1364.7
1957	279	1369.7	66	80	223	—	315	1364.2
1958	39	1365	46	56	156	—	152	1359.2
1959	422	1365.5	49	59	163	—	352	1365
1960	1927	1376	93	113	312	1169	685	1370.9
1961	716	1376	93	113	312	291	685	1370.9
1962	2977	1376	93	113	312	2552	685	1370.9
1963	147	1372.8	78.5	95	267	—	470	1367.5
1964	76	1368.7	63	76	208	—	262	1362.8
1965	1408	1376	93	113	312	560	685	1370.9
1966	839	1376	93	113	312	414	685	1370.9
1967	887	1376	93	113	312	462	685	1370.9
1968	85	1372	74	90	255	—	425	1366.5
1969	2764	1376	93	113	312	2079	685	1370.9
(full pool El. 1376)								

50% seepage reduction

Water Budget Analysis, P-1 Deficiency

Design adjusted for 4 Ac. Ft. per wk seepage
at full pool (1110 Ac. Ft.)

D. Hale 4/14/81

YEAR	Runoff Ac. Ft.	Water Surface El., Ft.	Water Surface Area, Ac.	Evap. Ac. Ft. (1.2 Ft.)	seepage Ac. Ft.	Discharge Ac. Ft.	Storage Dec. 31 Ac. Ft.	W.S. El. Dec. 31 Ft.
1948	—							
1949	731	1371.4	72	87	164	—	480	1367.5
1950	470	1374.3	85	103	192	—	655	1370.4
1951	2279	1376.	93	113	208	1824	789	1372.3
1952	2489	1376	93	113	208	2168	789	1372.3
1953	2403	1376	93	113	208	2082	789	1372.3
1954	1201	1376	93	113	208	880	789	1372.3
1955	241	1375.2	90	109	200	—	721	1371.4
1956	114	1372.9	78.5	95	179	—	561	1368.9
1957	279	1373	79	96	180	—	564	1369
1958	39	1369.5	86.2	104	147	—	352	1365
1959	422	1372.1	74.2	90	171	—	513	1368.1
1960	1927	1376	93	113	208	1330	789	1372.3
1961	716	1376	93	113	208	395	789	1372.3
1962	2977	1376	93	113	208	2656	789	1372.3
1963	147	1374.1	84.2	102	190	—	644	1370.2
1964	76	1371.3	71.4	86	164	—	470	1367.4
1965	1408	1376	93	113	208	768	789	1372.3
1966	839	1376	93	113	208	518	789	1372.3
1967	887	1376	93	113	208	566	789	1372.3
1968	85	1373.4	81	98	183	—	593	1369.5
1969	2764	1376	93	113	208	2247	789	1372.3
(full pool El. 1376)								