STATE OF SOUTH DAKOTA
Ralph Herseth, Governor

STATE GEOLOGICAL SURVEY
Allen F. Agnew, State Geologist

SPECIAL REPORT 1

WATER SUPPLY FOR THE CITY OF EUREKA

by
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UNION BUILDING
UNIVERSITY OF SOUTH DAKOTA
VERMILLION, SOUTH DAKOTA
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WATER SUPPLY FOR THE CITY OF EUREKA

SPECIAL REPORT 1

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ILLUSTRATIONS

ERRATA

Page 12. . . Second paragraph, line 11, "105 feet" not "39 feet".

Page 13. . . Under Test Hole 3, 74-79, " (small artesian flow at 74-76 ft.)" not "(small artesian flow)".

Page 14. . . Under right headings: "Depth (feet)" not "Depth" .

Page 14. . . Second paragraph, line 7, "diopside" not"diopide".

Page 14. . . Third paragraph, line 4, "diopside" not "siopside".

Page 15. . . Under 70 feet, line 6, "vitrain" not "vitrin".

Page 19. . . Well No. 7, Depth to water (feet), "6.OR" not "y.OR".

WATER SUPPLY FOR THE CITY OF EUREKA

INTRODUCTION

Purpose of Report

This report contains the results of a special investigation by the State Geological Survey in and around the City of Eureka (fig. 1), in order to ascertain the possible existence, adequacy and permanence of a shallow water supply for that city.

Water Problem

The present city well in Eureka was drilled in 1923 to a depth of about 2400 feet. The well produces water high in mineral content, and flows at a rate of 85 gallons per minute. Because of the extreme hardness and the excessive concentrations of calcium, magnesium and iron, the city established a water-treatment plant in 1946. However, because of high operating costs and inconvenience in maintaining the treatment plant, and because the city feels that naturally pure water would be more desirable than artificially purified water, the City Council is in favor of a shallow water supply similar in quality to that at the G. Mehlhoff farm, three miles southeast of Eureka (sec. 24, T. 126 N., R. 73 W.). Also, because the present well is 35 years old there is the factor of inadequate water supply from it in the future.

Previous Investigation

In the fall of 1953 R. E. Curtiss of the State Geological Survey conducted a three-day study of the shallow water potentialities in the same area as that covered by this report. Curtiss mapped the areal geology and made an inventory of farm wells in T. 126 N. He suggested an aquifer bounded on the west by Pfeiffer's spring (sec. 17), on the east by G. Mehlhoff's flowing well, on the north by Heib's flowing well in Eureka, on the south by Eisman's spring.

Present Investigation

Ten days were spent in the field early in September of 1958. Geophysicist Dan Lum and assistant Robert Benson, driller Richard Von Holdt and assistant Philip Lidel, and geological assistant Harold Wong helped the writer gather

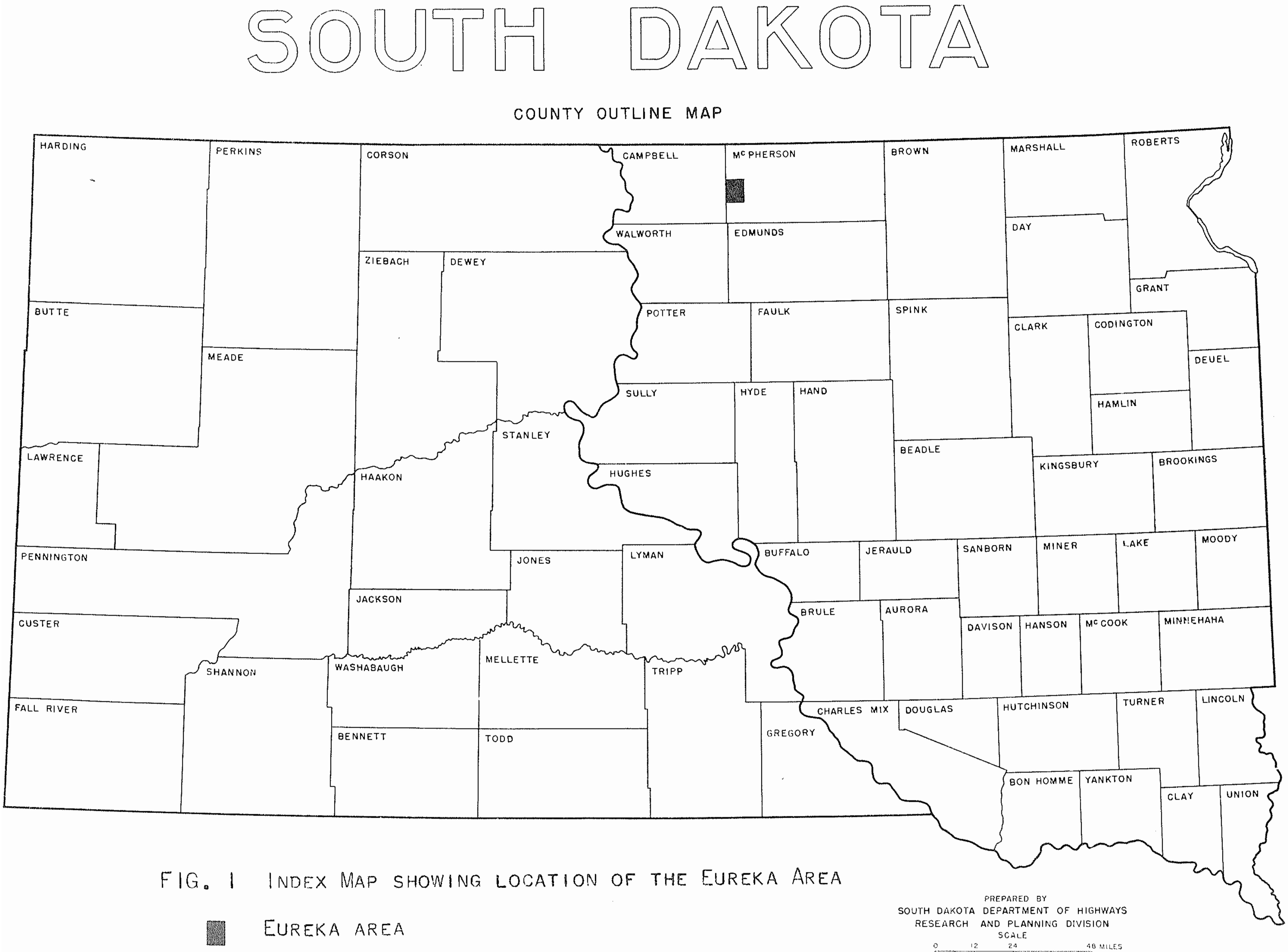

FIG. I INDEX MAP SHOWING LOCATION OF THE EUREKA AREA

EUREKA AREA

data pertinent to the problem. Reconnaissance geologic mapping was done on air photo index sheets. Electrical resistivity surveys were made to aid in the detection of a possible shallow ground water aquifer. A jeep-mounted auger drill was used to investigate the possible existence, areal extent and thickness of a shallow aquifer.

Nine test holes were drilled in the area with the hope of finding a sand and gravel reservoir which would supply sufficient water for Eureka's needs. The small number of test holes was necessitated because of two factors. First, owing to the lack of knowledge of the source of the flowing wells, there was a possibility of getting a "wild" well, which would need to be plugged with cement. (Despite precautions, two such holes were drilled and had to be plugged.) Thus, the expenditure of both time and money prohibited a more complete drilling program, although much information was gotten through the limited drilling program. Second, it was important to finish the work as rapidly as possible, because (1), the work was not part of the regularly scheduled Survey program for this period and unnecessary delay of the Eureka work would impede the completion of the Survey's summer field projects; and (2), the accomplishment of the work as rapidly and as completely as possible might eliminate the expenditure of additional funds both for the State and for the City of Eureka.

Acknowledgements

The work was performed under the supervision of Dr. A. F. Agnew, State Geologist. The writer wishes to thank Wayne McDaniel, Work Unit Conservationist of the Soil Conservation Service in Leola, for the use of the air photo index sheets. Also, he wishes to express his appreciation to the Eureka City Council and the residents in the vicinity of Eureka for their cooperation with the members of the field party during the gathering of the field data.

GENERAL GEOLOGY

Glacial ice advanced over Eastern South Dakota at least four times during the Pleistocene Epoch. The surface geology in the vicinity of Eureka is the result of the latest, or Wisconsin glaciation. As the ice sheet advanced southward, surface material was "plowed" up; some of this was pushed in front of the ice, some was dragged on the bottom, some was incorporated into the ice, and some was rafted along on top. All of the material was abraded, some being ground as fine as rock flour. Because the bedrock in Eastern South Dakota was chiefly shale, a large percentage of the glacially deposited material is of clay and silt size. The material carried by the ice was left at its front by the melting of the ice mass. The debris thus deposited is known as drift, and is divided into nonstratified (till) and stratified (outwash) material. The till consists principally of clay with all sizes of clastic detritus. The outwash is made up of washed sands and gravels with minor amounts of silt and clay, formed presumably by the washing of the finer constituents from the till. In the Eureka area the late Wisconsin till at the surface is underlain by early Wisconsin or pre-Wisconsin till, as shown by drill hole 3 (See Appendix A). Separating the tills in drill holes 3 and 8 is a fine sand ranging up to 10 feet thick, which presumably forms the "aquifer" from which the shallow artesian wells derive their flows.

Beneath the glacial drift lies the bedrock. It is not known with certainty which geologic formation makes up the bedrock at Eureka, but it is probably Pierre formation, based on surrounding exposures and test drillings (See Appendix C). Locally the Fox Hills formation overlies the Pierre to the west, and may also be present in the subsurface at Eureka.

HYDROLOGY

The occurrence of shallow ground water is controlled by several factors including porosity[1] and permeability[2], and the areal extent of the water-bearing material. The physical properties of the sediments are determined by laboratory analyses and the areal extent by field investigation.

In general, coarse-grained unconsolidated material is more permeable than fine-grained material. Porosity, however, depends more on grain shape than on grain size.

In the Eureka area the water-bearing formation, as already mentioned, is a fine sand. Figure 2 and Appendix B show the results of the laboratory analyses. As seen in the histograms (fig. 2 D, E), this sand is fine to medium in size. It is extremely well-sorted. Thus, this material has a high porosity because of its sorting, but a relatively low permeability because of its size. The significance of permeability is that in materials of low permeability the water can be withdrawn (discharged) much faster than it is replaced (recharged). Assuming that the recharge is accomplished entirely by precipitation (only 17.08 inches annually according to Figure 3), the discharge of wells in the Eureka area could easily exceed the recharge. This is especially true during dry years.

Permeability also influences the rate at which water can be removed from the aquifer. Water is discharged much more slowly from fine-grained sediments than from coarser-grained materials. This fact is evident at the G. Mehlhoff farm well where the rate of flow is about 37.5 gallons per minute. This well is reported to have been drilled into gravel. The remaining flowing wells in the area flow much less than Mehlhoff's because presumably these latter derive their supplies from the fine sand encountered in drill holes 3 and 8.

Water Table

The water table is the height to which water rises in the interstices of the unconsolidated deposits and bedrock. It has an irregular surface, corresponding roughly to the surface of the land. Thus its depth

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1. Porosity is the amount or percentage of pore space in a water-bearing material such as sand and gravel.
2. Permeability is the rate at which fluid can pass through the interconnected pore spaces of a material.

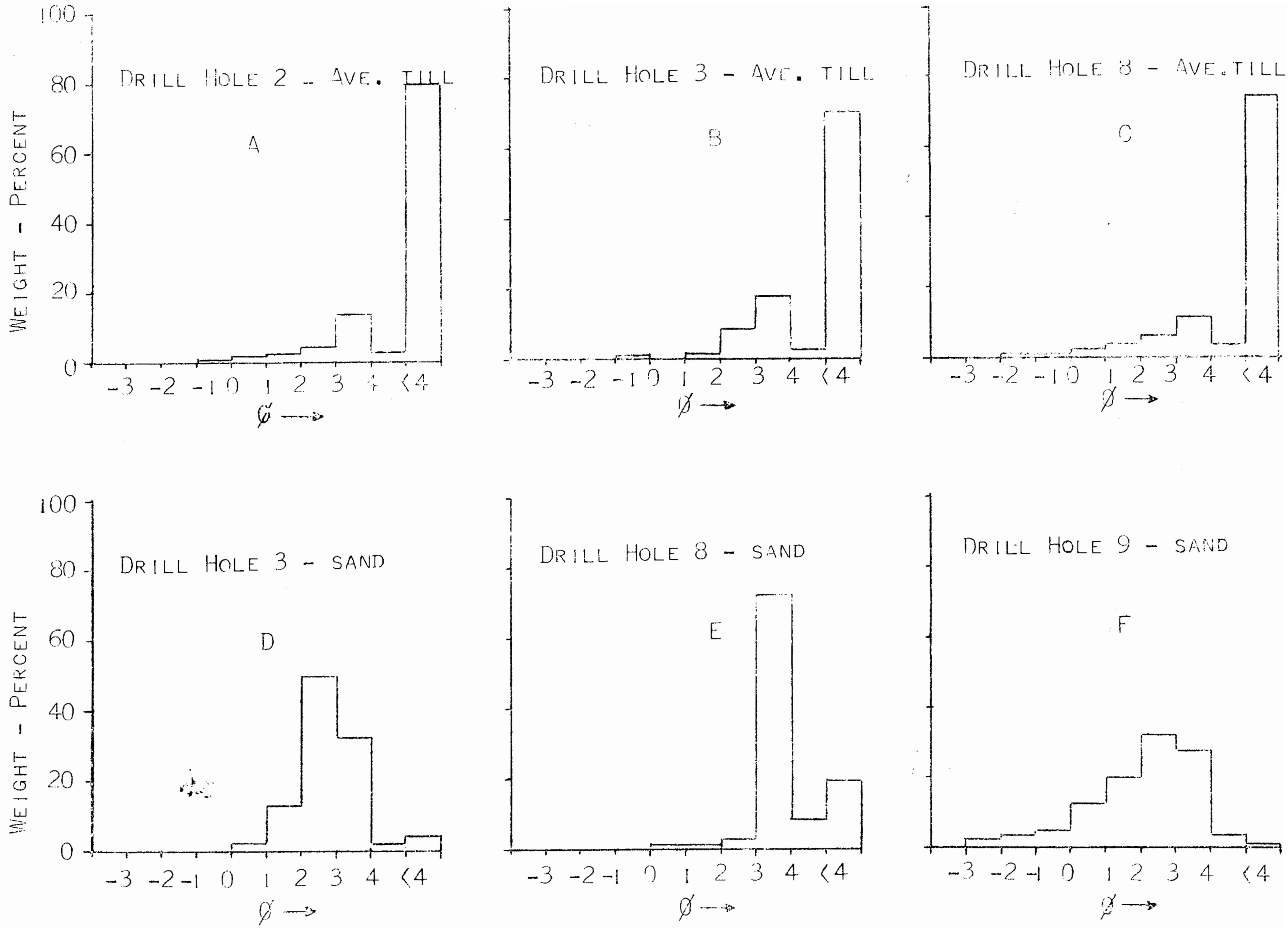


FIG. 2 HISTOGRAMS SHOWING SIZE DISTRIBUTION OF SAND IN DRILL HOLES 2,3,8,9

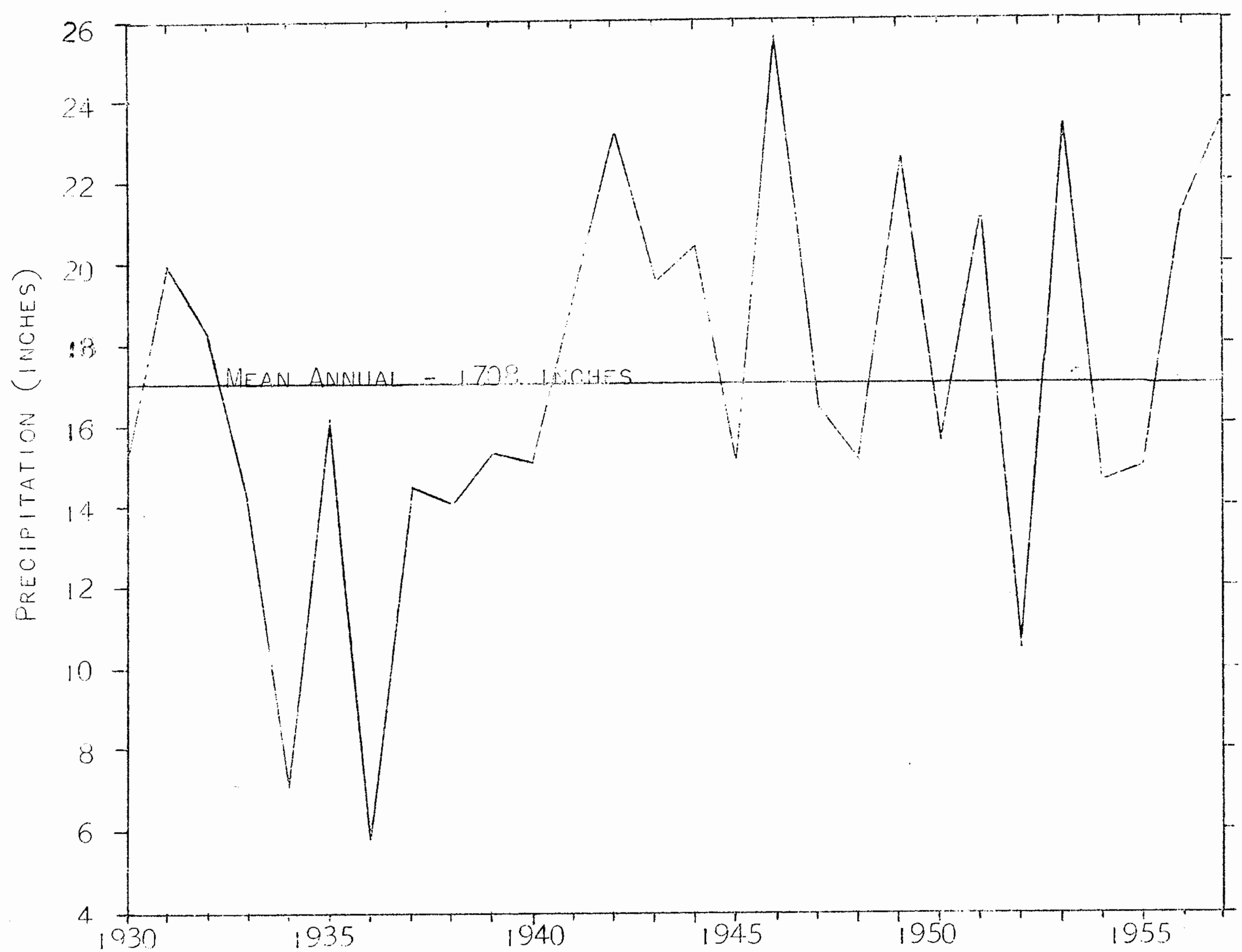


FIG. 3 MEAN ANNUAL PRECIPITATION AT EUREKA, 1930 TO 1957

Table 1.--Size Conversion Chart

Name	Wentworth's Limits (mm)	A.S.T.M. Screen Size	Phi Scale (Ø)
Pebble	32-64	1¼	-5
	16-32	5/8	-4
	8-16	5/16	-3
	4-8	#5	-2
Granule	2-4	10	-1
Very coarse sand	1-2	18	0
Coarse sand	½-1	35	+1
Medium sand	¼-½	60	+2
Fine sand	1/8-1/4	120	+3
Very fine sand	1/16-1/8	230	+4
Silt	1/32-1/16		+5
	1/64-1/32		+6
	1/128-1/64		+7
	1/256-1/128		+8
Clay	1/512-1/256		+9
	1/1024-1/512		+10

depends on the topography of the land. The map (Plate 1) shows by contours the water table surface in the Eureka area. In general the water table slopes from east to west, with a low area southwest of Eureka, and then apparently rises toward the west again. This probably indicates conformance to the topography or possibly indicates a source of pressure or "head" for the shallow artesian flows in the moraine (ridge of glacial drift) at Eureka. In general the flowing wells are confined to the area enclosed by lower contours. G. Mehlhoff's well is an exception to this possibly because of its proximity to the moraine east of the farm, or possibly because of the coarser material from which the water is derived.

Because the trend of the flowing wells cuts across the water table contour lines from northwest to southeast, reliable prediction for a location for a good flowing well cannot be made.

Recharge

When water is removed from an aquifer, water from some source must be added to replace it. In flowing wells the hydrostatic head or pressure in the aquifer forces in new water, replacing that which is removed.

Source

The supply of water available, then, depends also on the source. In the Eureka area the water for shallow artesian wells is possibly supplied in one of several ways: (1) It is derived from depth, seeping upward through permeable zones in the till; (2) it is confined to a buried outwash channel which gets its head in the moraine system at Eureka; (3) it percolates upward from a bedrock source through a fault zone (earth fissure). In the first and third cases the upward moving water charges the sand between the two tills and obtains pressure from underlying formations. In the second case, rainfall and runoff are the chief sources of water for the buried channel.

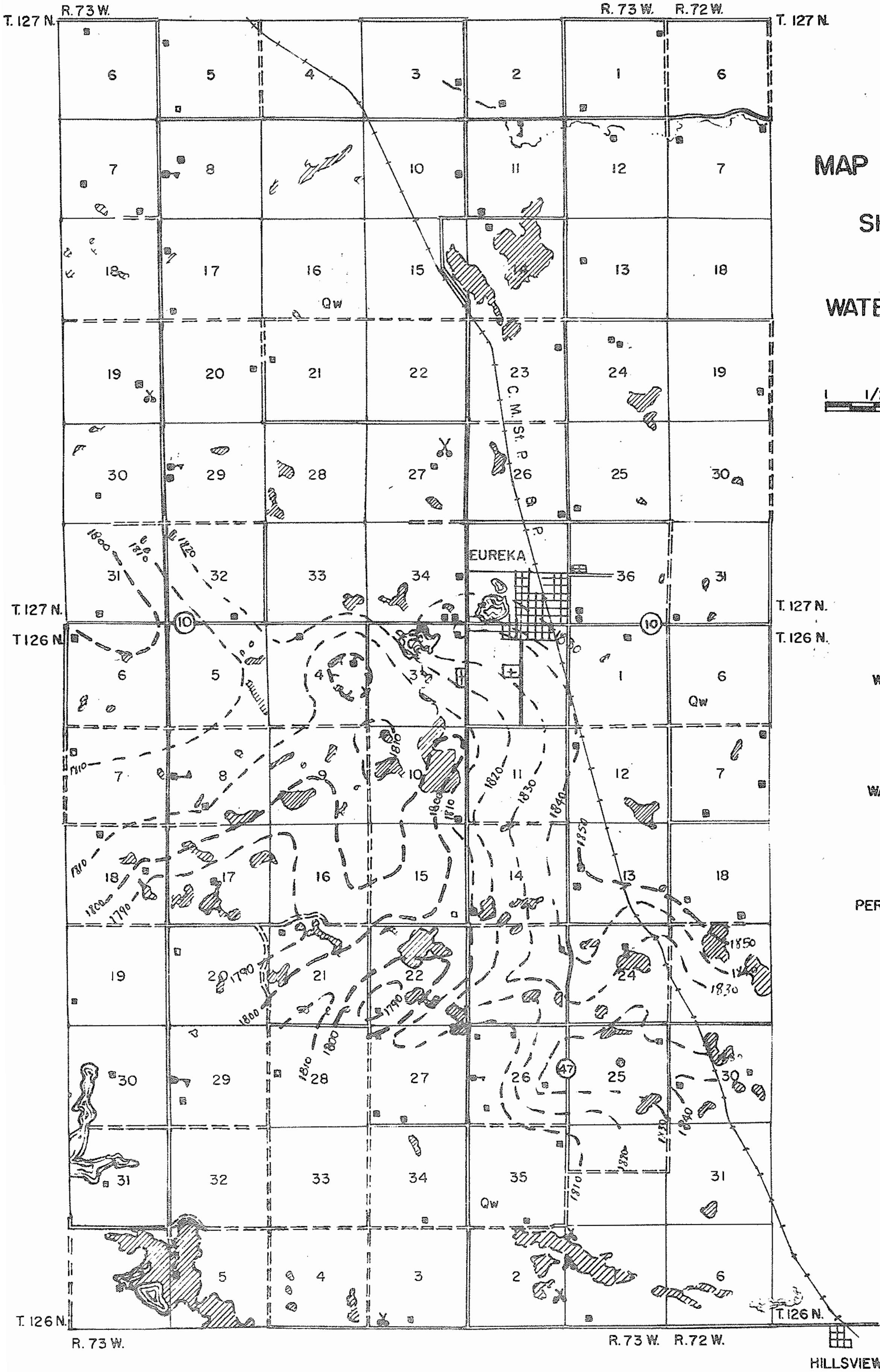
Adequacy and Permanence

If the source of water as in case two above is precipitation, the aquifer could easily be influenced adversely by long periods of drought, thus limiting the amount of water available for large scale use. If, however, the water has a subsurface source, the supply would be considered permanent under all climactic conditions and the amount of water recovered from any one well would depend on local conditions, such as porosity and permeability and extent.

MAP OF EUREKA AREA

SHOWING GEOLOGY AND WATER TABLE CONTOURS

FRED V. STEECE



1 1/2 0 1 2 Mi.

VERMILLION, SOUTH DAKOTA
SEPTEMBER, 1958

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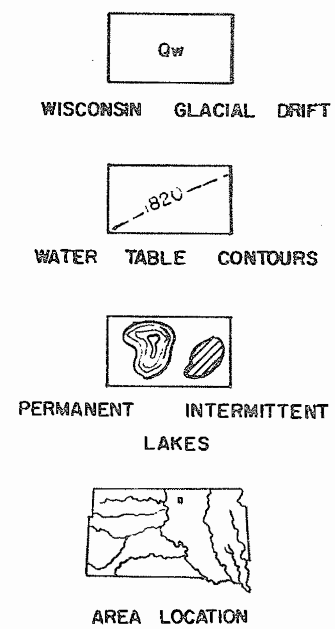


Quality of Water

Water in the form of rain and snow is relatively pure. As soon as it reaches the land it begins to react chemically with the material which it penetrates. The amount and kind of matter dissolved by the water depends on the nature of the material through which the water passes. For example, limestone is dissolved to produce calcium and carbonate (and bicarbonate) ions. Feldspar minerals give up sodium, potassium and aluminum ions and suspended silica particles. Iron and magnesium ions are derived from basic igneous rocks, which also produce alumina and silica. Minerals such as marcasite and pyrite (iron sulfide) and gypsum (calcium sulfate) produce acids which aid in the decomposition of other minerals. Similarly, when minerals containing chlorine and fluorine are dissolved, other acids are formed which react with other minerals, increasing the mineral matter in solution in the water.

In the Eureka area, waters analysed (see Table 2) show in all but one sample excessive concentrations of total solids (based on U. S. Bureau of Public Health standards, Table 3). Four samples are high in sulfate, four are above normal in iron, two exceed the standard in fluoride and iron and one is above normal in hardness. The Eureka city well water is objectionable because even after treatment it contains excessive concentrations of sulfate, fluoride and total solids. Analyses of water samples 3, 4, 5, 7 and 8, all located in the shallow artesian area south of Eureka, show only slightly higher total solids than the standard, except that samples 3 and 8 are higher in iron; samples 5, 7 and 8 in manganese; and sample 8 in sulfate.

It would, therefore, be desirable to obtain water like that found in the above wells (3, 4, 5, 7 and 8) for use by the City of Eureka.

Table 2.--Analyses of Waters from Eureka Area

Constituents (PPM) / Sample	Total Solids	Chloride Cl	Sulfate SO_4	Calcium Ca	Alkalinity PP	Alkalinity MO	Total Hardness	Nitrate NO_3	Sodium Na	Manganese Mn	Iron Fe	Fluoride F	Magnesium Mg
1. Eureka City Well-untreated	2268	63	1318	344	--	146	1272	0.5	144.0	none found	none found	3.2	--
2. Eureka City Well-treated	2260	60	1298	31	12	175	102	0.1	none	----	none found	3.6	6
3. Gotthilf Mehlhoff	698	16	211	58	13	334	183	0.2	124	none found	0.4	0.4	9
4. Dockter	582	11	157	57	3	305	201	0.2	89.0	0.3	trace	none	14
5. H. Mehlhoff	470	7	95	54	4	263	196	0.2	60.0	1.0	none	none	15
6. Hausauer	1078	25	372	51	3	439	196	0.5	260.0	none	none found	0.2	17
7. Spring, SE, SW sec. 9, T. 126 N., R. 73 W.	660	10	195	54	4	307	210	0.4	95.0	0.7	none	none found	18
8. Spring, C. NE sec. 10, T.126N., R. 73 W.	764	11	268	64	--	313	231	0.2	112.0	0.3	0.4	0.2	17
9. 58-1781	588	25	173	79	7	266	318	0.2	53.0	0.5	none found	none	29

Table 3.--United States Bureau of Public Health Service Standards for Drinking Water

Constituent	Standard Limits (PPM)
Copper (Cu)	3.0
Iron and Manganese (Fe and Mn together)	0.3
Magnesium (Mg)	125
Zinc (Zn)	15
Chloride (Cl)	250
Sulfate (SO_4)	250
Lead (Pb)	0.1
Fluoride (F)	1.5
Nitrate (NO_3)	10.0
Arsenic (As)	0.05
Selenium (Se)	0.05
Hexavalent Chromium (Cr)	0.05
Phenolic Compounds	0.001
Total Solids	500*

*Total solids may exceed 500 PPM to a maximum of 1000 PPM if the water having this concentration is the only water available.

GEOPHYSICAL INVESTIGATION

by

Daniel Lum

Introduction

After the geologic study of the Eureka shallow water supply was begun and it was learned that a buried outwash channel or fault zone might possibly be the source of an adequate artesian water supply, it was decided that an electrical resistivity survey might be valuable as an aid.

The Resistivity Method

The resistivity method depends primarily upon the contrasting electrical properties among different rock and soil types; under favorable conditions it is possible to determine either vertical or horizontal geologic differences that are buried in the sub-surface.

Resistivity measurements are made by determining the potential drop of an electric current flowing in the ground. Four electrodes are placed in the ground in a given configuration (Wenner Configuration); two electrodes are used to establish a known electric current flow in the ground and two electrodes are used to measure the apparent resistivity by the mathematical relation:

$$Pa = 2 \pi A \frac{v}{I}$$

where, Pa = apparent resistivity
a = distance between electrode
v = voltage
I = current

For practical purposes the observed apparent resistivity value is assumed to be governed by the subsurface material down to a depth equal to the electrode separation at the surface. Thus an electrode separation of 30 feet will measure 30 feet downward into the ground.

Field Procedure

In order to locate the possible shallow buried outwash channel or fault zone with a limited amount of time and personnel, a reconnaissance type of survey was made in the area just south of Eureka. This area was selected because (1) the city of Eureka wished to consider an artesian well site close to the city limits, and (2) it was thought that a buried outwash channel might trend northwestward from the flowing Mehlhoff well to just south of Eureka. Resistivity stations were established at ¼-mile intervals along four north-south traverses located on section roads; these traverses were thought to be nearly at right angles to the assumed trend of either geologic feature. A two-man crew thus was able to establish 33 resistivity stations, observing and recording the apparent resistivity for electrode separations of 50 and 100 feet (assumed depths of current penetration).

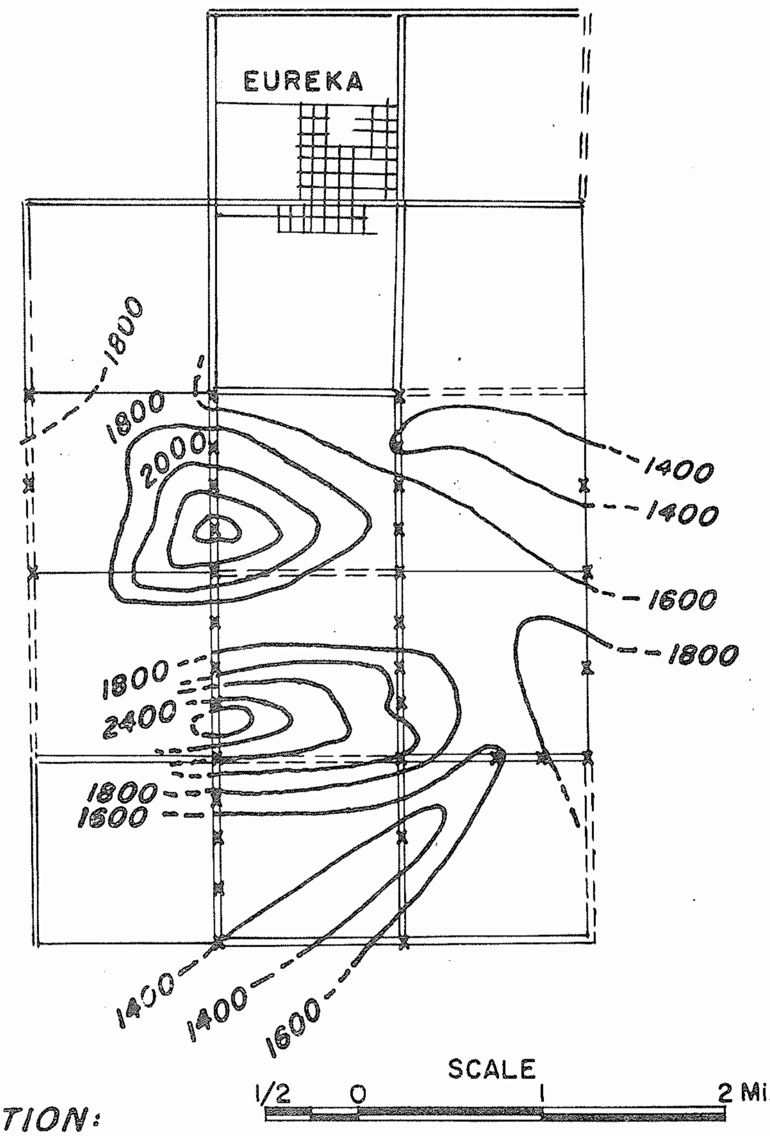
Interpretation and Results

The field data were plotted as resistivity profiles and as maps with contours of equal resistivity values. Such contour maps should outline either of the two geologic features being sought. The contour maps plotted for 50 and 100 foot depths of penetration were similar, and therefore only one map is included in this report. (See Figure 4).

The contour map shows no anomalous feature which definitely indicate either an outwash channel or a fault. Glacial till has a relatively low electrical resistivity as compared with sands and gravels, and a thick till above a buried outwash channel should cause the characteristic sand-gravel resistivity curve to be modified so that it is unrecognizable. Therefore it is concluded that the anomalous resistivity highs (fig. 4) are probably due to accumulations of gravel and boulders at the surface.

Conclusions

The resistivity data show no anomalous feature which might be interpreted as either an outwash channel or fault zone. Either the thick glacial drift (90 feet thick or more) masked detection by resistivity method, or no shallow channel or fault zone exists. No further conclusions can be drawn until an extensive drilling program over the area is made.



EXPLANATION:

in ohm - cm

x RESISTIVITY STATION

1800 CONTOUR SHOWING EQUAL RESISTIVITY FOR 100 FT ELECTRODE SEPARATION (ASSUMED DEPTH)

SURVEY BY DANIEL LUM geophysicist
ROBERT BENSON assistant

SEPTEMBER, 1958

FIG. 4. MAP SHOWING CONTOURS OF EQUAL RESISTIVITY VALUES

RECOMMENDATIONS AND CONCLUSIONS

Before any attempt is made by the City of Eureka to abandon the present city well, further investigation of the shallow water supplies should be undertaken. Several test wells should be drilled, and quantity and quality of the water should be determined by qualified personnel. The hydrostatic head should be determined in order to ascertain the amount of pumping apparatus which would be required to move the water from the wells to the city mains. Observations should be made during testing operations to determine the effect on nearby farm wells of removing large amounts of water from the aquifer.

In choosing a location for the test holes, the area of flowing wells south of town should be considered. The flowing well nearest the present city well is the Hieb well on the west side of town. Whether the aquifer is continuous from this well to the area of flowing wells south of town has not been determined. However, if the source of water in the Hieb well is from the subsurface, the area around the Hieb well could prove as satisfactory as the area to the south. Another possible site is in the NE¼ sec. 10, T. 126 N., R. 73 W., where the Survey's test hole 8 was drilled to a depth of 39 feet and a slow flow of water was developed. Another site would be near the G. Mehlhoff farm, although this is farther from town.

In order to supply the amount of water needed for the City of Eureka (about 250,000 gal. daily to be within the margin of safety) a field of several shallow wells may be necessary. The G. Mehlhoff well flows about 52,800 gal. per day ; thus, in order to insure the 250,000 gal. per day needed by the city, five such wells would be required. However, because no other well in the area has as great a flow as Mehlhoff's, a larger number of wells of less flow would be required to supply the city with adequate water.

Appendix A.--Logs of Geological Survey Drill Holes in Eureka Area

Test Hole 1
NWNW sec. 10, T. 126 N., R. 73 W.

0-4	Tan till
4-9	Grayish-brown till
9-24	Olive-brown till
24-29	Brown till
29-34	Brownish-gray till
34-39	Dark brown till
39-104	Dark gray till

Test Hole 2
NWSW sec. 10, T. 126 N., R. 73 W.

0-4	Tan till
4-14	Olive-green till
14-19	Olive-brown till
19-24	Dark gray till
24-29	Grayish-green till
29-69	Dark gray till
69-74	Fine to medium sand

Small artesian flow at 72-74 ft.

Test Hole 3
W¼ Corner sec. 10, T. 126N., R. 73 W.

0-4	Tan pebbly till
4-9	Olive-brown till
9-14	Brownish tan till
14-19	Brown till
19-24	Brownish-gray till
24-74	Dark gray till
74-79	Fine to medium sand (small artesian flow)
79-99	Brown till

Test Hole 4
SWSE sec. 21, T. 126N., R. 73 W.

0-4	Brownish-yellow till
4-14	Brown till
14-24	Olive-green till
24-94	Dark gray till

Water at 59 feet

Test Hole 5
SESE sec. 23, T. 126N., R. 73 W

0-9	Brownish-yellow till
9-19	Brown till
19-29	Olive-gray till
29-84	Dark gray till

Test Hole 6
SWSW sec. 2, T. 126 N., R. 73 W.

0-9	Olive-brown till
9-29	Brown till
29-99	Dark gray till

Small amount of water at 29 feet

Test Hole 7
Center sec. 10, T. 126N., R. 73 W.

0-4	Black silty top soil
4-14	Brown till
14-84	Dark gray till

Test Hole 8
SWNE sec. 10, T. 126 N., R. 73 W.

0-24	Brown till
29-34	Brownish-gray till
34-39	Fine sand (small artesian flow at 39 feet)
39-44	Coarse sand
44-49	Brown till

Test Hole 9
Near home of P.O. Kretschmar, City of Eureka

0-9	Tan till
4-29	Brown till
29-37	Coarse gravel

Appendix B.--Description of Select Drill Hole Samples of Eureka Area

Drill Hole #2	Depth
Clay, pale yellowish-brown (10 YR 6/2) very slightly silty, minute amounts of sand	5-19 (unwashed)
Sand, medium, subangular to rounded, quartz 60% batyriodial brownish-black (5 YR 2/1) iron-manganese concretions 25%, and 15% of minor constituents: milky quartz, rose quartz, feldspar, alabaster, amphibole, olivine, mica, calcite, chert, diopide and rock fragments	5-19 (washed)
Sand, medium to fine, subangular to rounded. Consisting of quartz 70%, iron-vitrain 15%, and 15% others: feldspar, siopside, calcite, chlorite, biotite, muscovite, amphibole, alabaster, olivine and rock fragments	19-24 (washed)
Clay, pale yellowish-brown (10 YR 6/2), slightly silty	24-29
Sand (#60 screen) subangular to rounded, quartz 60%, vitrain 10%, shale 15%, and 25% others: rose quartz, biotite, olivine, orthoclase, plagioclase, microcline, limonite, pyrite, gypsum, chlorite, chalk, chert, calcite rock fragments	29-34
Same	34-39
Same	39-44
Missing	44-54
Same	54-59
Same	64-69
	TOTAL DEPTH

Appendix B (Con'd)

Drill Hole #3 (#60 screen)

Till.. 0-74

(Sample off auger coming out of hole)
Sand, 60% rounded to subangular quartz, 5% light gray shale, 35% others: orthoclase, microcline, plagioclase, pyrite, chert, olivine, vitrin, chlorite, illite, biotite, gypsum, calcite, rose quartz, tourmaline, rock fragments............................70

Same..74

Same..89

Same..94

Same..99

TOTAL DEPTH

Drill Hole #8

Till. When washed: 65% rounded to subangular quartz, 15% light gray shale, 20% others: rose quartz, microcline, vitrain, limonite, orthoclase, olivine, biotite, amber, illite?, gypsum, calcite, chert, pyrite, chlorite, almandite?, amphibole...................................0-35?

Sand, same as above (seive #60).......................35

Sand, same (seive #120)...............................35

TOTAL DEPTH

Same. Nodosaria?.....................Bottom hole sample

Appendix C.--Formation Tops in Nearest Deep Wells to Eureka

Oil Hunters #1 Raetzman (About 1385)
Brown County, NE 33-125-65

0-200 Pierre

260-420 Niobrara

420-660 Carlile

660-700 Greenhorn

700 Graneros

1050-1080 Dakota

1145 Top Fuson

1230-1300 Sundance

1345-1400 "Millstone Grit" 1355? Red Beds

1400-1465 Maquoketa or Black River

1460 Limestone

1470-1500 Water bearing

1500-1522 Black River (T.D.)

Peppers #1 State
Walworth County, NE 36-123-76

0-140 Glacial till

140-170 Glacial till with Pierre clay

170-200 Pierre

960-1020 Niobrara

1065 Carlile

1490-1530 Greenhorn

1530 Graneros

Appendix C (Con'd)

1900-1960 Dakota

1960-1990 Fuson

1990-2100 Lakota

2160-2240 Sundance

2620-2740 Madison

3137-3330 Englewood

3330-3720 Limestone and dolomite

3720-3790 Black River

3840 Upper Cambrian

3920-3922 Precambrian ("granite")

Pray #1 Kranzler
Walworth County, NWNW 14-121-77

0-500 No cuttings

750-850 Pierre

850-940 Niobrara

940-1322 Carlile

1322-1350 Greenhorn

1350-1712 Graneros

1712-1860 Dakota

1860-1920 Fuson

1920-1935 Lakota

1935-2170 Sundance

2170 "Millstone Grit"

Appendix C (Con'd)

2310-2330 Minnelusa

2470-2480 Madison

3400-3500 Galena (Trenton)

3500-3610 Decorah

3615-3740 Black River

3740-3750 St. Peter

3751-3780 Upper Cambrian

3780-3808 Precambrian (granite)

Appendix D.--Well Records - Eureka Area

Well No.	Name (See Map for Location)	Depth of Well (ft)	Sea Level Elev. (ft)	Depth to Water (feet)	Elev. Water Table (feet)	Type of Well	Use of Water	(GPM) flow
1	NWNE 24, T. 126N., R. 73 W.; Gotthilf Mehlhoff	55R	1832.8	flowing	1832.8+	Dug	D-S	37.5
2	NWNW 12, T. 126, R. 73 Albert Stabler	65R	1874.0	35R	1839.0	Drilled	D-S	----
3	SWSW 18, 126, 72; Milbert Fauth	100R	1872.1	14.5M	1857.6	----	D-S	----
4	NENE 25, 126, 73; Abandoned	----	1840.1	11.0M	1829.1	----	N	----
5	NWSW 30, 126, 73; Arthur Neuharth	150R	1851.2	----	----	Dug	D-S	----
6	NENE 35, 126, 73; Rudolph Thurn	115R	1856.0	50.5M	1805.5	Bored	D-S	----
7	SWSW 22, 126, 73; Jacob Nehlich	16R	1788.9	6.0R	1782.9	Dug	D-S	----
8	NWNW 27, 126, 73; John Nehlich	80R	1812.4	6.0R	1806.4	Dug	D-S	----
9	SWSW 14, 126, 73; Hilmer Mehlhoff	10+R	1810.1 1813.1	Flowing	1810.1+ 1813.1+	Dug	D-S	2.0
10	SWNW 13, 126, 73; Harvey Mehlhoff	70R	1871.9	20R	1851.9	Dug	D-S	----
11	SESE 10, 126, 73; John Opp	33M	1820.9	4.5M	1816.4	Bored	D-S	----
12	NWNW 26, 126, 73; John Eismer	30R	1825.9	24R	1801.9	----	D-S	----
13	NENW 26, 126, 73; Edward Wanner	60R	1843.1	34M	1809.1	Drilled	D-S	----
14	SENE 23, 126, 73; David Dockter	10+R	1839.5	Flowing	1839.5+	----	D-S	0.3
15	NENW 18, 126, 73; Ottenbacher	120R	1826.5	15M	1811.5	Bored	D-S	----

Appendix D (Con'd)

Well No.	Name (See Map for Location)	Depth of Well (ft)	Sea Level Elev. (ft)	Depth to Water (ft)	Elev. Water Table (ft)	Type of Well	Use of Water	(GPM) flow
16	NWNW 6,126, 73; Norman Pfeiffer	63R	1825.2	43R	1782.2	Bored	D-S	----
17	NENE 3,126, 73; Albert Oster	32R	1857.0	15R	1842.0	----	D-S	----
18	SENE 4,126, 73;Milbert Warner	80R	1856.4	65M	1791.4	----	D-S	----
19	SESW 8,126, 73; Edwin Scherbenski	100R	1813.5	2.0R	1811.5	----	D-S	----
20	NESW 17,126, 73; Walter Pfeiffer	42R	1806.5	----	----	----	D-S	----
21	NWNW 21,126, 73; John Kuebler	40R	1793.0	13R	1780.0	----	D-S	----
22	SWNW 20,126, 73;Abandoned	12.5M	----	11M	----	----	N	----
23	NENW 4,126, 73; Fred Bucholz	86R	1870.2	50R	1820.2	----	D-S	----
24	NESE 26,126, 73; Adam Kessler	130R	1865.8	30R	1835.8	Drilled	D-S	----
25	NENW 6,127, 73; William Rohrbach	40R	----	----	----	Drilled	D-S	----
26	SENE 18,126, 73	----	1812.5	15	1797.5	----	D-S	----
27	NESE 3,127, 73; Arthur Hausauer	63R	----	Flowing	----	Drilled	D	50
28	NESE 10,127, 73;Arthur Strobel	165R	----	----	----	Drilled	D	----
29	NENW 14,127, 73;Alfred Fisher	17R	----	13	----	Dug	D	----
30a	SWSW 11,127, 73;Edward Fisher	----	----	Flowing	----	----	N	T
30b	SWSW 11,127, 73;Edward Fisher	22R	----	18R	----	Drilled	D	----

Appendix D (Con'd)

Well No.	Name (See Map for Location)	Depth of Well (ft)	Sea Level Elev. (ft)	Depth to Water (ft)	Elev. Water Table (ft)	Type of Well	Use of Water	(GPM) flow
31	SESW 2,127, 73;Edwin Dais	11R	----	9	----	Drilled	N	----
32	SESW 1,127, 73; Edward Hausauer	10R	----	5	----	Dug	D	----
33	NENW 12,127, 73; Paul Hausauer	12R	----	----	----	Drilled	D	----
34	NENE 1,127, 73; Bill Ritter	40	----	----	----	----	----	----
35	SWSW 33,128, 73;R.S.Isaak	90R	----	Flowing	----	Drilled	D-S	----
36	SENW 24,127, 73; Rev. ChristKiesz	28R	----	15R	----	Dug	D-S	----
37	NENE 23,127, 73;Fred Fisher	----	----	----	----	----	N	----
38	SESE 26,127, 73; Richard Schott	50R	----	12	----	----	D	----
39	C.NE 2,126, 73;Dierenfeldt	40R	----	20	----	----	D-S	----
40	C.NE 2,126, 73;Dierenfeldt	32R	----	20	----	----	D-S	----
41	SWSE 32, 127, 73; Phillip G. Wolf	106R	1842.8	26R	1816.8	Bored	S	----
42	SWSE 32,127, 73; Phillip G. Wolf	100R	----	V	----	Bored	D-M	----
43	SESW 31,127, 73;Clarence Rau	25R	1819.6	62	1757.6	Bored	S-D	----
44	NESW 30,127, 73; William Gill, Jr.	46R	----	33	----	Bored	D-S	----
45	NWSW 29,127, 73; Marvin Mutschler	35R	----	V	----	Bored	D-S	----

Appendix D (Con'd)

Well No.	Name (See Map for Location)	Depth of Well (ft)	Sea Level Elev. (ft)	Depth to Water (ft)	Elev. Water Table (ft)	Type of Well	Use of Water	(GPM) flow
46	SENE 34,127, 73; Arthur E. Bauer	70R	----	V	----	Bored	D-S	----
47	Mobil Station town; J.L. Ackerman	72R	----	8	----	Dug	D	----
48	NWSE 7,126, 72; William Fauth	58R	----	V	----	Drilled	D-S	----
49	SENE 20,127, 73;David Miller	14R	----	2.5	----	Dug	S	----
50	NESW 7,127, 73; Michael Wenzel	40R	----	20	----	Bored	D-S	----
51	SWNW 8,127, 73; Edward Schott	30R	----	25	----	Dug	D-S	----
52	SWNW 28,127, 73; Walter Haidle	15R	----	8	----	Bored	D-S	----

S-Stock
D-Domestic

R-Reported
M-Measured

B-Bored
N-None

T-Trickle
V-Variable