STATE OF SOUTH DAKOTA
Archie Gubbrud, Governor

STATE GEOLOGICAL SURVEY
Allen F. Agnew, State Geologist

SPECIAL REPORT 23

WATER SUPPLY FOR THE CITY OF LESTERVILLE, SOUTH DAKOTA

by
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Vermillion, South Dakota
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INTRODUCTION

Present Investigation

This report contains the results of a special investigation by the South Dakota State Geological Survey from July 23 to August 23, 1962, in and around the City of Lesterville, Yankton County, South Dakota (fig. 1), for the purpose of assisting the city in locating a future water supply. Lesterville now receives its water from a well which at present does not produce the quantity of water needed by the city. This well obtains its water from a glacial outwash at a depth of about 92 feet, and is located within the city limits (fig. 2).

A survey of the ground-water possibilities was made of a three square-mile area around the city and consisted of geologic mapping, the making of a well inventory, the drilling of 11 test holes and the taking of 15 water samples for analysis.

As a result of this investigation, an aquifer was found beneath the city at a depth of about 130-140 feet. The water is fairly good in quality, and the extent of the gravel is believed to be large enough to furnish a sufficient water supply for the city.

The field work and preparation of this report were performed under the supervision of Cleo M. Christensen, Staff Geologist. The aid of Robert Schoon, geologist-driller, assisted by Keith Munneke, who drilled seven test holes averaging 185 feet deep with the Survey's rotary drilling rig; and of Steve Pottratz and Richard Brown, who drilled four shallow test holes to an average depth of 47 feet with the Geological Survey's auger drill, is gratefully acknowledged.

The cooperation of the residents in and around the City of Lesterville, especially city officials C. H. Wood and Charles Hladky, is greatly appreciated. The writer also wishes to thank the State Chemical Laboratory in Vermillion for analyzing the water samples.

Location and Extent of Area

Lesterville is located in the northwestern part of Yankton County in southeastern South Dakota, and has a population of 173 (1960 census). The area is in the James Basin division of the Central Lowland physiographic province (fig. 1).

Climate

The climate is continental temperate with large daily fluctuations in temperature. The average daily temperature is 48.3 degrees F., and the average annual precipitation is 22.86 inches at the U. S. Weather Bureau Station in Menno, 14 miles to the north.

Topography and Drainage

The topography of the area is youthful glacial moraine--rolling hills and valleys with knobs and kettles.

The main drainage in the area is controlled by Beaver Creek (fig. 3) which flows in an easterly direction to the James River. Lesser intermittent streams flow into Beaver Creek, forming a trellis drainage pattern.

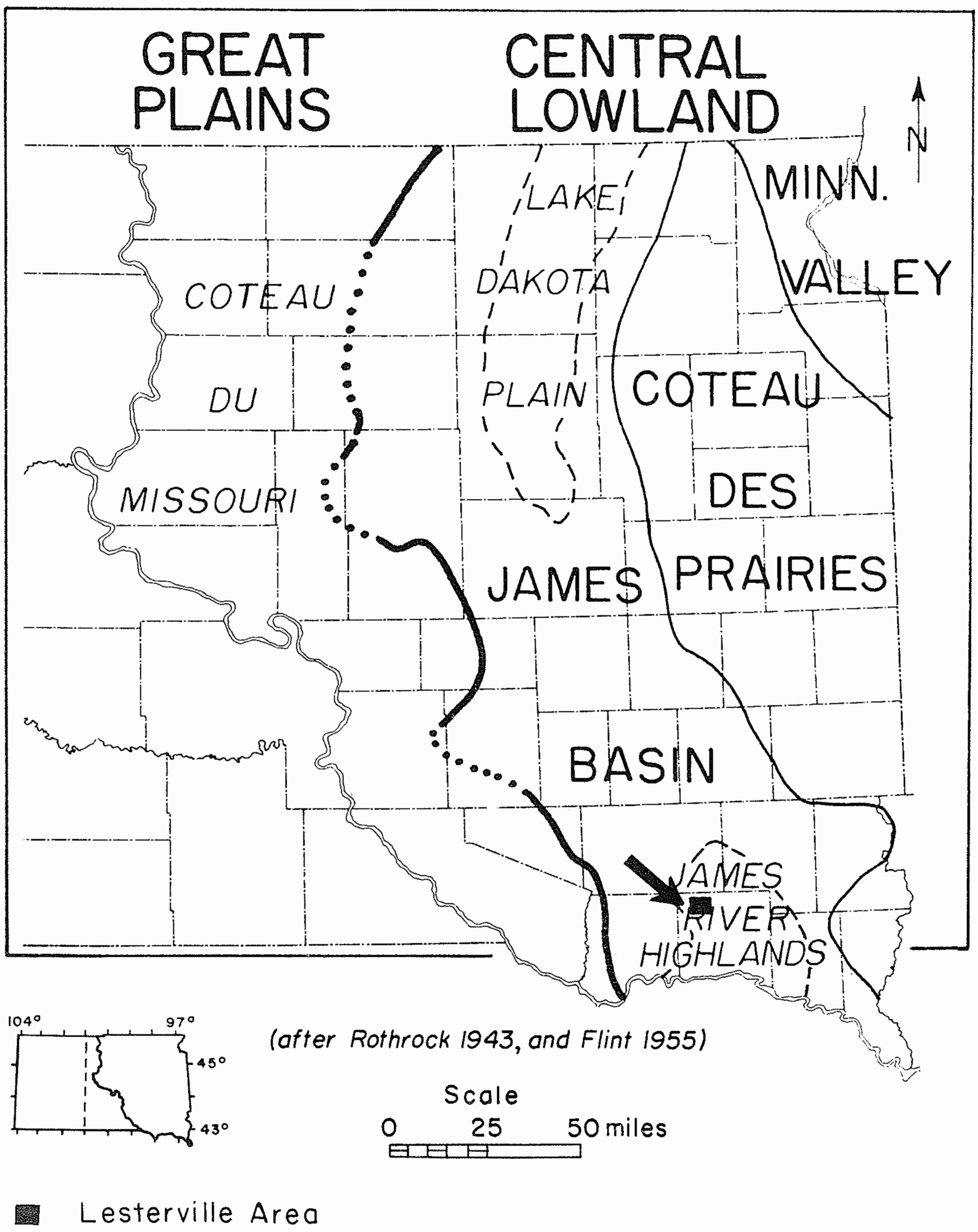

FIGURE I. MAJOR PHYSIOGRAPHIC DIVISIONS OF EASTERN SOUTH DAKOTA AND THE LOCATION OF THE LESTERVILLE AREA

FIGURE 2. DATA MAP OF LESTERVILLE AREA

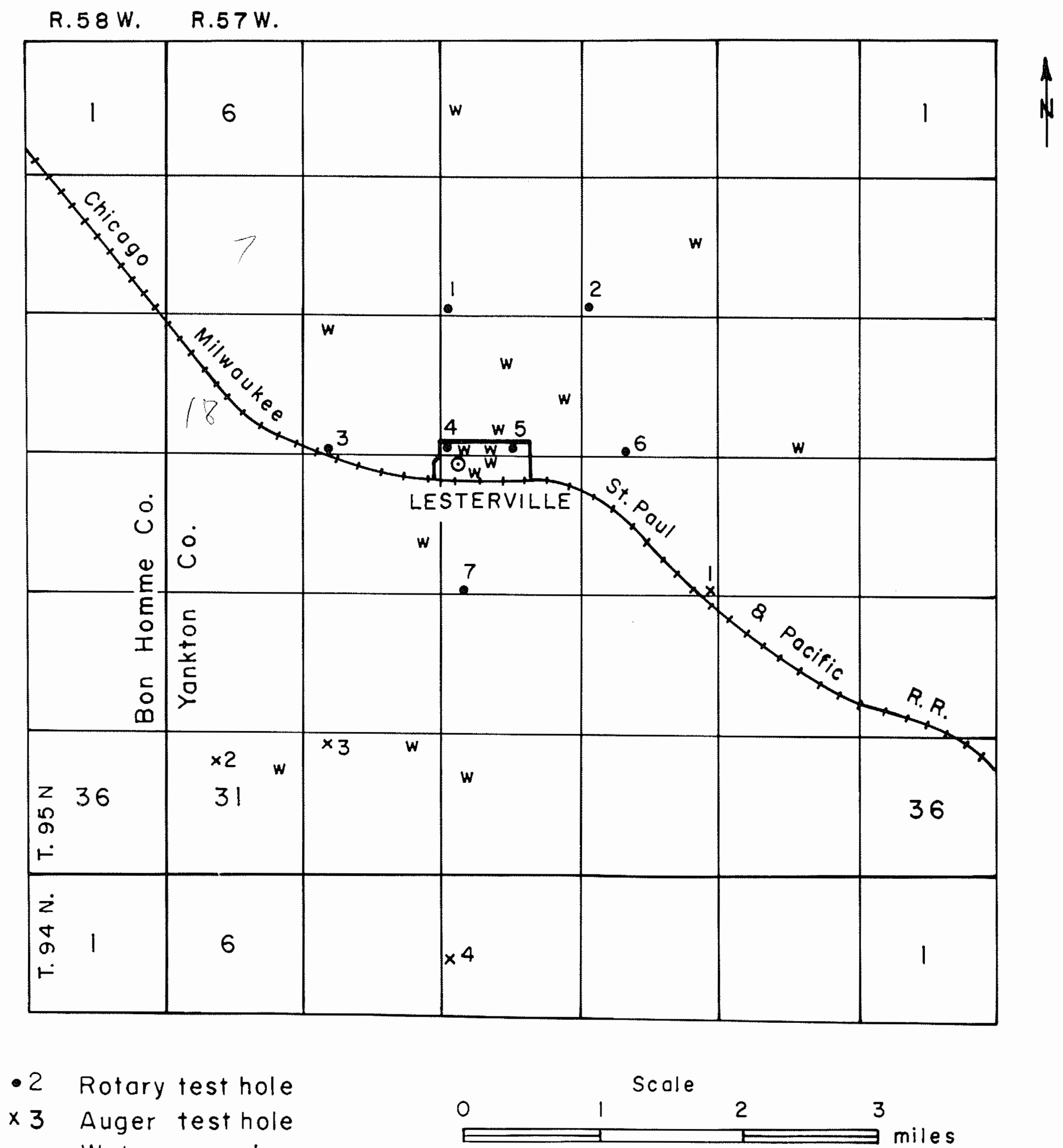

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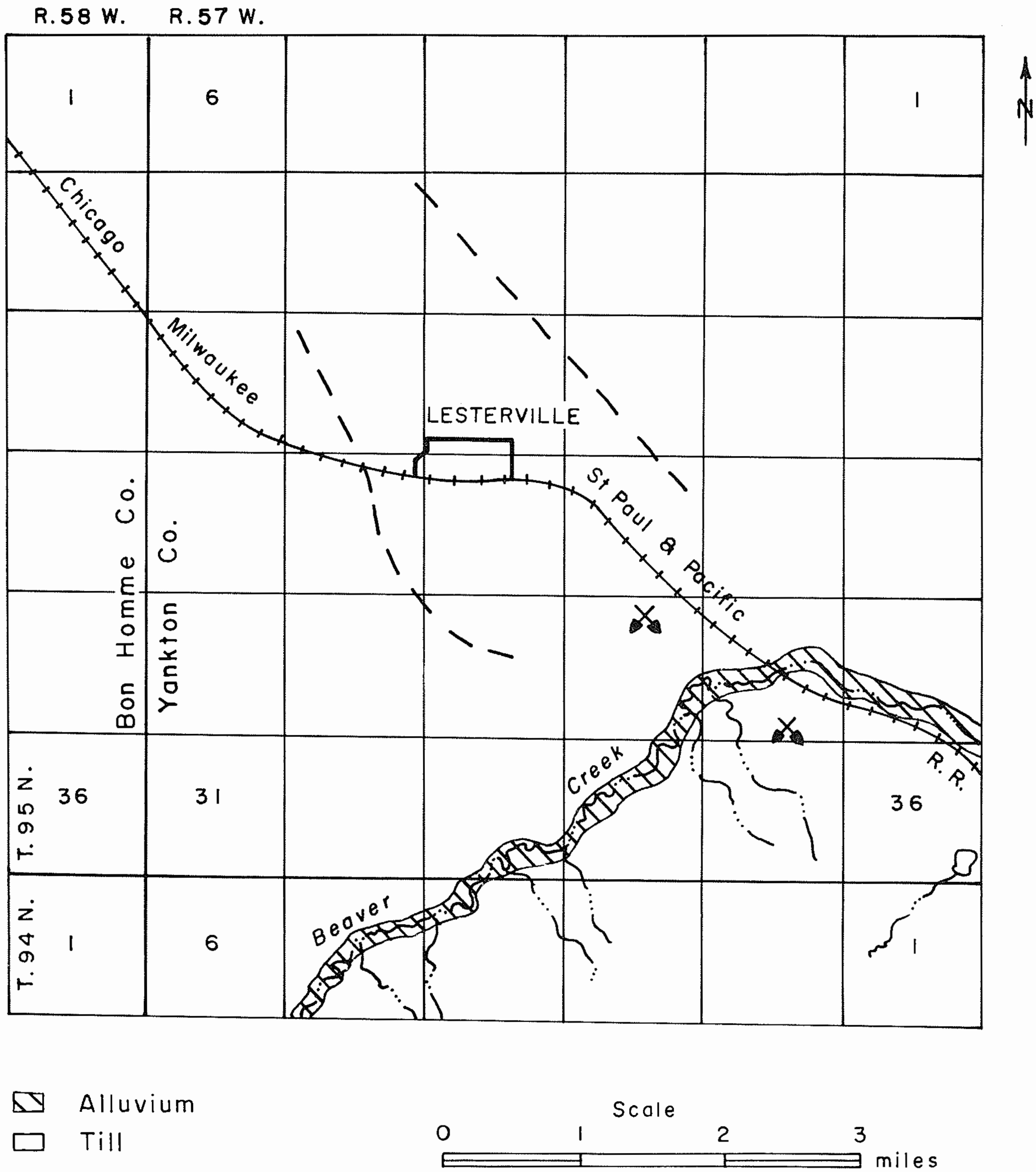
FIGURE 3. GENERALIZED GEOLOGIC MAP OF LESTERVILLE AREA



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GENERAL GEOLOGY

Surficial Deposits

The surficial deposits of the Lesterville area are mostly the result of continental ice sheets during the Pleistocene Epoch. These glacial deposits are collectively called drift and can be divided into till and outwash sediments.

Till consists of clay and silt-size particles mixed randomly with sand, pebbles, and boulders, and was deposited by the ice itself. Till covers most of the surface in the Lesterville area (fig. 3).

Outwash sediments consist chiefly of sand and pebbles with minor amounts of silt and clay. These sediments were deposited by meltwater streams from the wasting glaciers. The only surface outwash deposits found in the area are of very limited extent to the southeast of Lesterville (see gravel pits, fig. 3).

The only other surficial deposit in the area is alluvium which consists of silt and clay-size particles with minor amounts of sand. This alluvium was deposited by Recent streams. Small amounts of alluvium occur along Beaver Creek (fig. 3).

Subsurface Bedrock

Stratified sedimentary rocks of Cretaceous age lie beneath the surficial deposits in the Lesterville area, according to the log of the Rittershaus #1 Jamesville Colony Oil Test, six miles to the northeast. These deposits in descending order are the Niobrara, Carlile, Greenhorn, and Graneros Formations and the Dakota Group.

The Niobrara Marl consists of light- to medium blue-gray shale which contains numerous microscopic white calcareous specks. The Niobrara is 83 feet thick.

The Carlile Formation is medium- to dark-gray bentonitic shale with pyrite concretions and layers of brown siltstone. The Codell Member consists of interbedded sandstones in the upper part of this Carlile Formation. The Carlile is 143 feet thick.

The Greenhorn Formation consists of a hard layer of white- to cream-colored limestone containing numerous fossil fragments and is 55 feet thick. This limestone is overlain (and possibly underlain) by a layer of dark-gray shale containing numerous small white calcareous specks.

The Graneros Formation is hard light- to dark-gray siliceous shale which is 77 feet thick.

The Dakota Group consists of fine to coarse sandstone interbedded with gray shale. The sandstones of this formation supply water to a few wells in the area. These sandstones are 400 to 500 feet beneath the surface in the area; their waters are under artesian pressure, which causes the water to rise in the wells. The group has a total thickness of 354 feet.

The sediments of the Dakota Group are probably underlain by the Morrison Formation which is approximately 26 feet thick and is a non-marine sandy shale.

The Morrision is underlain by a Precambian diorite made up of coarse grained plagioclase, quartz, and an iron-manganese mineral, probably Augite.

OCCURRENCE OF GROUND WATER

Principles of Occurrence

Ground water may be defined as water contained in the voids or openings of rocks or sediments below the water table. Therefore, the water table marks the upper surface of the saturated zone of the water-bearing formations. The common belief that water occurs in "veins" which criss-cross the area in a disconnected maze is not true, as water occurs nearly everywhere below the surface. The existence of a water supply is controlled by the water table; this is not a static level, but fluctuates, and in a general way reflects the surface topography. The water table ranges from a few feet to many tens of feet below the surface.

The amount of water which is contained in the reservoir rock or aquifer is controlled by the porosity and permeability of the rock.

Porosity is a measure of the percentage of voids in a rock and is expressed in the ratio of pore space to the total volume of rock. Porosity is dependent on (1) the shape and arrangement of individual particles, (2) the degree of sorting of the particles, (3) the degree of cementation and compaction of the particles, and (4) the amount of material which has been removed by percolating ground water. Sands and gravels usually have porosities of 20-40 percent depending on the above conditions, whereas cemented sandstones have porosities of 15-25 percent. Sandstones have lower porosities owing to their higher degree of compaction and cementation.

Permeability is a measure of the rate at which a fluid will pass through a material. A material that has a high percentage of interconnected pores has a high permeability, whereas a material that has high porosity, but a low percentage of interconnected pores has low permeability. Therefore, it can be seen that porosity and permeability are not synonymous but nevertheless related.

Nearly all ground water is derived from precipitation. Rain or melting snow either percolates directly downward to the water table and becomes ground water, or drains off as surface water. Surface water either evaporates, escapes to the ocean by streams, or percolates downward to the ground-water table. In general, ground water moves laterally down the hydraulic gradient, and is said to be in transient storage.

Recharge is the addition of water to an aquifer and is accomplished in three ways: (1) by downward percolation of precipitation from the ground surface, (2) by downward percolation from surface bodies of water and (3) by lateral underflow of water in transient storage.

Discharge, or the removal of ground water from an aquifer, is accomplished in four main ways: (1) by evaporation and transpiration by plants, (2) by seepage upward or laterally into surface bodies of water, (3) by lateral underflow of water in transient storage, and (4) by pumping.

Ground Water in Glacial Deposits

Till does not yield water readily because of its unsorted nature and its low porosity and permeability. On the other hand, outwash is a favorable source of ground water.

Some surface outwash occurs to the southeast of Lesterville but it is above the water table.

A glacial outwash deposit covered by 115-125 feet of till occurs under the city (fig. 3). This deposit is called a buried outwash in this report; however, it is possible that it may be an old stream-channel deposit. Its origin and extent cannot be determined accurately unless additional information is gathered.

State Geological Survey Test Holes 1, 4, 5, and 6 penetrated this buried outwash (see Appendix A). These holes show the thickness to range from 9 feet (Test Hole 1) to 16 feet (Test Hole 5). This gravel is overlain and underlain by till.

The gravel in this aquifer is composed largely of limestone and shale pebbles.

Ground Water in Alluvium

The alluvium along Beaver Creek (fig. 3) contains a large quantity of ground water where it is below the water table, but because of its low permeability it will not yield water readily.

Ground Water in Bedrock

The Niobrara Marl commonly know as "chalk rock" is a known water-producer in some areas of the State. Its water is contained in joints and solution cavities along bedding planes in the formation. The Niobrara supplies water to numerous farm wells in the area; however, it is doubtful if it could supply enough water for the City of Lesterville.

The Dakota sandstones constitute a potential aquifer in the area; however, this aquifer contains water of poor quality.

Quality of Ground Water

Precipitated water is nearly pure before it reaches the ground; however, all ground water contains minerals which are obtained: (1) from the atmosphere, (2) from soil and underlying deposits as the water percolates downward to the water table, and (3) from deposits below the water table, in which the water is circulating. In general, the more minerals a water contains, the poorer its quality. The water in the Dakota sandstones is of poorer quality than that in the buried outwash deposits (Table 1).

Table 1 shows the chemical properties of various waters in the Lesterville area as compared to the standards established by the U. S. Department of Public Health.

Table 1--Chemical Analyses of Ground Water in the Lesterville Area
(for location see fig. 2 and following page)

Sample	Source	Parts Per Million											
		Calcium	Sodium	Chloride	Sulfate	Iron	Mag-nesium	Nitrate	Fluoride	Man-ganese	pH	Hard-ness $CaCO_3$	Total Solids
A		--	--	250	500*	0.3	--	10*	0.9-1.7**	0.05	--	--	1000
B	Dakota	268		68	632	5.0	5				7.4	690	2018
C	Dakota	317		104	777	7.0	52				7.1	900	2107
D	N***	123	130	17	432	6.6	44	2.0	0.6	trace	7.0	488	1058
E	Glacial	423	160	44	1918	0.1	262	38.5	0.4	trace	7.0	2132	3502
F	Glacial	244	100	5	682	7.3	68	0		0.4	7.2	888	1574
G	Glacial	162	46.2	52	410	2.2	109	.34	1.2	0	7.0	852	1276
H	Glacial	159	55	4	551	10.8	52	1.5	0.2	2.1	7.2	612	1180
I	Glacial	144	80	160	267	0.8	219	400	0.4	trace	7.1	1259	1932
J	Glacial	28	46	6	177	0.1	194	9.4	0.6	trace	7.3	868	1048
K	Glacial	123	12	8	205	5.3	39	0.6	0.2	trace	7.3	468	608
L	Glacial	634		264	1020	8.4	277				6.8	2640	4360
M	Glacial	357		20	486	40+	31				6.9	770	1790
N	Glacial	396		12	292	0.1	72				7.2	700	1510
O	Glacial	324		16	535	10+	20				6.9	730	1690
P	Glacial	104	12	29	197	2.0	43	2.0	0.2	0.0	7.8	440	706

* Modified for South Dakota by the South Dakota State Department of Health (written communication, February 5, 1962)

** Optimum

*** Niobrara

Locations of Water Samples

A U. S. Dept. of Public Health Drinking Water Standards (1961)

B Tom Pokorney (farm) SE$\frac{1}{4}$ sec. 16, T. 95 N., R. 57 W.

C George Mueller (farm) NW$\frac{1}{4}$ sec. 17, T. 95 N., R. 57 W.

D James Souhrada (farm) NE$\frac{1}{4}$ sec. 31, T. 95 N., R. 57 W.

E A. E. Souhrada (farm) NE$\frac{1}{4}$ sec. 32, T. 95 N., R. 57 W.

F Joe Chadley (farm) NE$\frac{1}{4}$ sec. 16, T. 95 N., R. 57 W.

G Test Hole #4 SW$\frac{1}{4}$ sec. 16, T. 95 N., R. 57 W.

H Frank Kocer (farm) NW$\frac{1}{4}$ sec. 4, T. 95 N., R. 57 W.

I Francis Kremer (farm) SW$\frac{1}{4}$ sec. 16, T. 95 N., R. 57 W.

J Well North of School SW$\frac{1}{4}$ sec. 16, T. 95 N., R. 57 W.

K School Well NW$\frac{1}{4}$ sec. 21, T. 95 N., R. 57 W.

L Ole Pedersen (farm) SE$\frac{1}{4}$ sec. 20, T. 95 N., R. 57 W.

M Joseph A. Zdenek (farm) NW$\frac{1}{4}$ sec. 33, T. 95 N., R. 57 W.

N Edwin Ripple (farm) NE$\frac{1}{4}$ sec. 10, T. 95 N., R. 57 W.

O Raymond C. Petrik (farm) SE$\frac{1}{4}$ sec. 14, T. 95 N., R. 57 W.

P City Well NW$\frac{1}{4}$ sec. 21, T. 95 N., R. 57 W.

The water taken from Test Hole 4 (G on Table 1) is within the set standards except from iron content and total solids. All of the samples except L were within the standard for chloride. The iron content of the water in the area is very high, and only samples E, J, and N were below that which is recommended. The water from the outwash is generally of better quality than the water from the Niobrara Chalk or Dakota sandstones.

CONCLUSIONS AND RECOMMENDATIONS

It is recommended that the City of Lesterville test for future water supplies in the buried outwash beneath the city at a depth of about 115-125 feet. In this area, as much as 15 feet of gravel was found (Test Hole 4). After a well site is chosen, a test well should be installed and test pumped. This test-pumping should be conducted by licensed engineers and should be run for a minimum of 72 hours. In this way the yield, drawdown, and recovery of the aquifer can be determined.

It is suggested that the city contract with a commercial drilling company licensed by the State of South Dakota to test-drill the areas recommended. The city officials should consult the State Water Resources Commission with regard to obtaining a water right and a permit to drill a city well, and the State Department of Health with regard to the biological and chemical suitability of the water. A consulting engineering firm licensed in the State of South Dakota should be hired to design the well and adjoining water system.

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Rothrock, E. P., 1943, A Geology of South Dakota, Ph. 1: The Surface: S. Dak. Geol. Survey Bull. 13, Pl. 2.

U. S. Public Health Service, 1961, Drinking Water Standards; Am. Water Works Assoc. Jour., v. 53, no. 8, p. 935-945.

APPENDIX A

Logs of Rotary Test Holes in the Lesterville Area
(for locations see figure 2)

Rotary Test Hole No. 1
Surface Elevation: 1388

0-60	clay, buff, sandy
60-125	clay, gray, sandy
125-134	gravel, pea to nut size, mostly shale and limestone pebbles
134-220	clay, gray, very silty, alluvium
1168 -220-230	Kc

Rotary Test Hole No. 2
Surface Elevation: 1377

0-35	clay, buff, sandy
35-175	clay, gray, sandy with few thin gravels
175-195	sand, fine to coarse
1182 195-215	Kc

Rotary Test Hole No. 3
Surface Elevation: 1370

0-22	clay, buff, sandy
22-43	clay, gray, sandy
43-75	sand, very fine with few clay stringers and coal horizons
75-155	clay, gray, sandy
155-160	sand, medium to gravelly
160-212	clay, gray, sandy
1158 -212-	sandstone, fine-grained, very friable

Rotary Test Hole No. 4
Surface Elevation: 1392

0-10	gravel, red, dry
10-25	clay, buff, sandy
25-30	clay, gray, sandy
30-35	sand, and pea-size gravel
35-115	clay, gray, sandy
115-130	gravel, pea to nut size, some sand
130-	clay, gray, sandy

Rotary Test Hole No. 5
Surface Elevation: 1389

0-20	clay, buff, sandy
20-42	clay, gray, sandy
42-65	clay, gray, sandy, with interbedded gravels
65-122	clay, gray, sandy
122-138	sand, and gravel, pea to nut size
138-190	clay, gray, sandy, pebbly
190-200	sand, fine to medium
1189 200-230	Kc Codell?

Rotary Test Hole No. 6
Surface Elevation: 1382

0-45	clay, buff, sandy
45-62	sand and gravel, dry
62-110	clay, gray, sandy
110-115	sand, medium-grained, with coal
115-125	gravel, very coarse

Rotary Test Hole No. 7
Surface Elevation: 1372

0-48	clay, buff, very sandy
48-103	sand, very fine, very clayey
103-128	sand, grit size, composed of shale granules
128-155	clay, gray, very sandy

APPENDIX B

Logs of Auger Test Holes in the Lesterville Area
(for location see figure 2)

Auger Test Hole No. 1
Surface Elevation: not measured

0-6	clay, brown, some pebbles
6-12	sand, dry, clayey
12-16	sand, saturated, clayey
16-34	clay, less sand
34-54	clay, blue

Auger Test Hole No. 2
Surface Elevation: not measured

0-4	clay, gray, silty
4-12	clay, brown, dry
12-34	clay, blue, saturated

Auger Test Hole No. 3
Surface Elevation: not measured

0-4	topsoil
4-19	clay, light brown, silty
19-24	clay, dark brown
24-43	clay, blue, dry
43-49	clay, blue, saturated

Auger Test Hole No. 4
Surface Elevation: not measured

0-14	clay, light brown, silty
14-22	clay, dark brown, sandy
22-34	clay, saturated, less sand
34-54	clay, blue

APPENDIX C

Table 2--Well Records in the Lesterville Area

Well location: Letters stand for quarter section, first number for section, second for township north, third for range west.
Type of well: D, drilled; B, bored
Water-bearing material: ss, sandstone
Use of water: S, stock; D, domestic

Well Location	Owner or Tenant	Type of Well	Depth of Well Below Land Surface (feet)	Geologic Source	Water Bearing Material	Use of Water
SE-1-95-58	Alvin Gall	D	236	Glacial	Sand	S&D
NE-12-95-58	Harold Hancock	D	643	Dakota	ss	S&D
SW-12-95-58	Richard Bauder	D	235	Niobrara	chalk	S&D
-13-95-58	Martin Kubal	D	640	Dakota	ss	S
NW-25-95-58	Joe Walloch	D	600+	Dakota	ss	S&D
NE-2-95-57	Reinhold Diede	D	212	Glacial	sand	S&D
SW-2-95-57	Marvin Sayler	D	188	Niobrara	chalk	S
-3-95-57	Richard Kost	D	211	Glacial	sand	S&D
SE-4-95-57	Walter Sayler	D Dug	272 15	 Glacial	 sand	 S
NW-4-95-57	Frank Kocer	D	195	Glacial	sand	S&D
NW-5-95-57	Eugene Auch	B	75	Glacial	sand	S&D
NE-6-95-57	Peter Orth	D	542	Dakota	ss	S
NE-7-95-57	Robert Gall	D	600+	Dakota	ss	S
NE-8-95-57	Ray Weber	D	200			
SE-8-95-57	Otto Peterson	D	220	Niobrara	chalk	S&D
SW-9-95-57	Frank Mudloff	D	525	Niobrara	chalk	S

Appendix C - Record of Wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well Below Land Surface (feet)	Geologic Source	Water Bearing Material	Use of Water
NW-9-95-57	Alvin E. Weber	D	105			
NE-10-95-57	S. J. Ripple	D	186	Glacial	sand	S&D
SW-11-95-57	Palmer Kreitzinger	D	200	Glacial	sand	S&D
NE-14-95-57	Henry Veirle	D	200+	Glacial	sand	
NW-14-95-57	Edwin VanOrny	D	180	Glacial	sand	S&D
SE-14-95-57	Raymond Petrik	D	180	Glacial	sand	
SW-15-95-57	Arthur Sills	B	47	Glacial	sand	S
NE-15-95-57	Frank Kulish	D	607	Dakota	ss	S&D
NE-16-95-57	Joe Chladek	D	120	Glacial	sand	S
SW-16-95-57	Francis Kremer	Dug	40	Glacial	sand	S
SW-16-95-57	John Scherschligt	Dug	40	Glacial	sand	
SE-16-95-57	Tom Pokorny	D	650	Dakota	ss	S&D
NW-17-95-57	George Mueller	D	565	Dakota	ss	S
NE-18-95-57	Edmund Kirscheman	D	210	Glacial	sand	
SE-18-95-57		D	550	Dakota	ss	
SW-18-95-57	Ruben Gall	D	576	Dakota	ss	S
NW-20-95-57	Gust J. Souhrada	B	50	Glacial	sand	S
SE-20-95-57	Ole Pedersen	D	95	Glacial	sand	S&D
NW-20-95-57	Stanley Borszich	D	240	Glacial	sand	S&D
NE-22-95-57	Maynard Hamburger	D	235	Niobrara	chalk	S
SW-22-95-57	Ole Pedersen	D	225	Niobrara	chalk	D

Appendix C - Record of Wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well Below Land Surface (feet)	Geologic Source	Water Bearing Material	Use of Water
NW-23-95-57	Gene Kolda	D	200	Glacial	sand	S&D
SW-23-95-57	Robert H. Pike	B	25	Glacial	sand	S&D
SW-25-95-57	Ed VanDryl	D	140	Glacial	sand	
NE-26-95-57	H. Barkl	D	178	Glacial	sand	
		Dug	15	Glacial	sand	S
SW-26-95-57	Edmund Burbridge	B	30			S
SW-27-95-57	Edwin Bloch	D	135	Glacial	sand	
		B	30	Till	clay	S
NE-27-95-57	Henry H. Kremer	B	98	Glacial	sand	
NW-27-95-57	George Vaith	D	250	Niobrara	chalk	D
NE-28-95-57	Emil Vitek	B	157	Niobrara	chalk	
SE-28-95-57	Xavier Blogh	D	230	Niobrara?	chalk?	
SW-29-95-57	John Lane	Dug	25			S
SE-30-95-57	M. Halva	D	200+			
NE-31-95-57	James Souhrada	D	180	Niobrara	chalk	S&D
NE-32-95-57	Albert Souhrada	B	50	Glacial	sand	
NW-32-95-57	F. A. Walloch	D	165	Niobrara	chalk	S
		Dug	45			S
NW-33-95-57	Jos. A. Zdenek	D	180	Glacial	gravel	
SW-33-95-57	G. Zdenek	D	182	Glacial	gravel	
NE-35-95-57	Joe Hejl	D	200			