STATE OF SOUTH DAKOTA
Archie Gubbrud, Governor

STATE GEOLOGICAL SURVEY
Duncan J. McGregor, State Geologist

SPECIAL REPORT 29

# GROUND WATER SUPPLY FOR THE CITY OF LANGFORD, SOUTH DAKOTA

by
Allan Wood and Lynn Hedges

Science Center
University of South Dakota
Vermillion, South Dakota
1964

# CONTENTS

# ILLUSTRATIONS



## TABLE



## APPENDIXES

# INTRODUCTION

## Present Investigation

This report contains the results of a special investigation by the South Dakota Geological Survey from July 15 to July 26, 1963, for the purpose of locating future water supplies for the city of Langford, Marshall County, South Dakota (fig. 1). The city now receives its water from an artesian well at a depth of 1,000 feet. The well, drilled in 1947, can be pumped at about 40 gallons per minute, which is inadequate during the summer months when water consumption is at a maximum. The water obtained from this well is high in mineral content. Consequently, in the fall of 1962, the State Geological Survey was requested to conduct a ground water survey in and around the city.

This survey consisted of mapping the areal geology, drilling 42 shallow test holes, making a well inventory, and collecting and analyzing eight water samples.

Thirty-nine of the shallow test holes were drilled with the State Geological Survey's jeep-mounted auger drill, and the remaining three test holes were drilled with the Survey's truck-mounted hydraulic auger drill.

The field work and preparation of this report were performed under the supervision of Lynn S. Hedges, ground water geologist. The assistance of drillers Harry Haywood, Lynn Huenemann, Keith Munneke, and John Cassens is gratefully acknowledged. Nathaniel Lufkin of the Survey staff made partial chemical analyses of water samples collected during the study.

The cooperation of the residents in and around the city of Langford is greatly appreciated. The writer also wishes to thank the State Chemical Laboratory in Vermillion for analyzing water samples.

## Location and Extent of Area

The city of Langford is located in Marshall County, South Dakota (fig. 1), and has a population of 397 (1960 census). The area studied spans the James Basin section and the Lake Dakota Plain section of the Central Lowland physiographic province (fig. 1).

## Climate

The climate is continental temperate with large daily and seasonal fluctuations. The average daily temperature is 43.5 degrees F., and the average annual precipitation is 18.36 inches at the U. S. Weather Station in Britton, 17 miles to the northeast.

## Topography and Drainage

The topography of the Langford area is nearly flat to typical youthful glacial moraine--rolling hills and valleys with knobs and kettles.

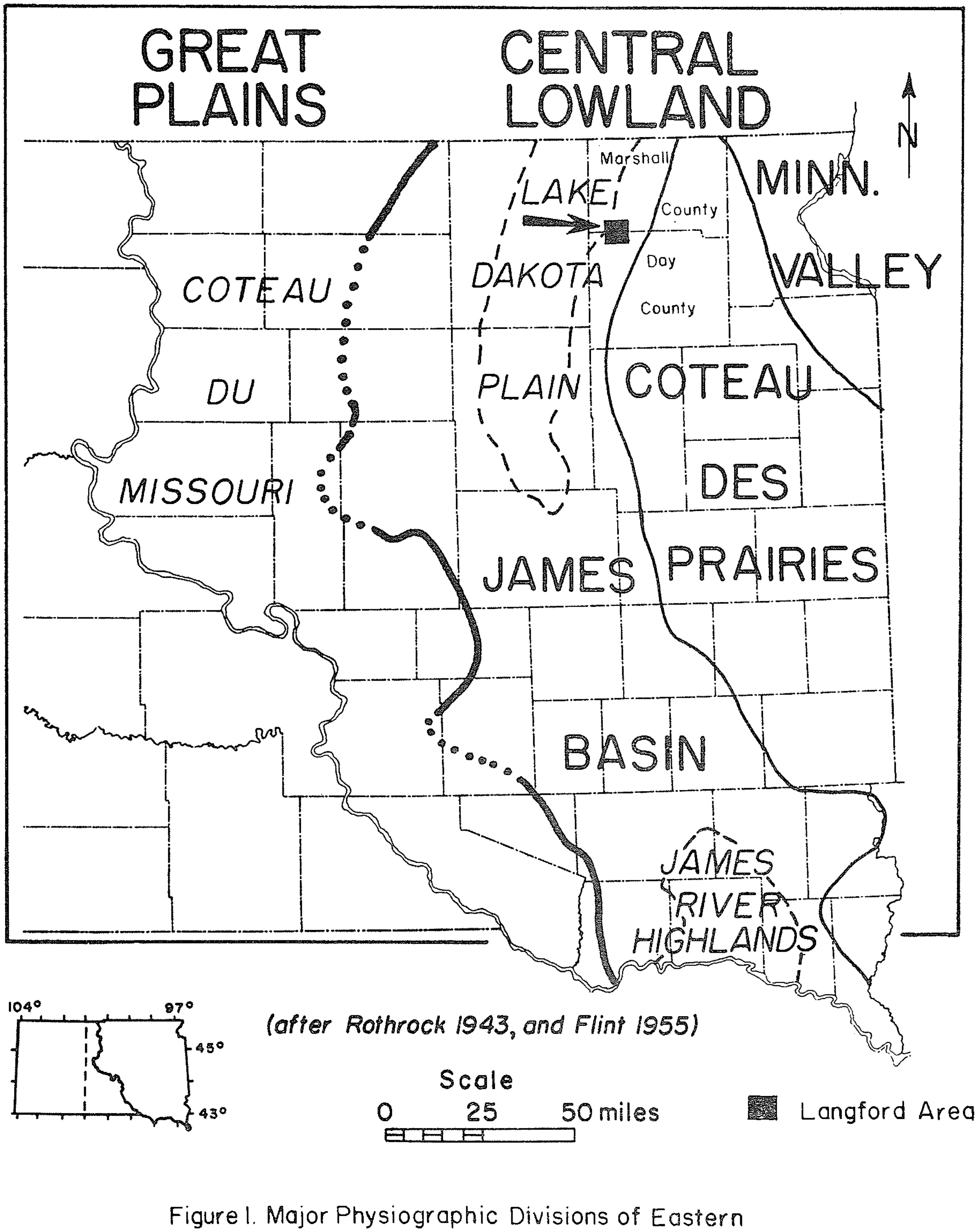



Figure I. Major Physiographic Divisions of Eastern South Dakota and the Location of the Langford Area.

To the east the land surface rises abruptly and is dissected by youthful V-shaped valleys with broad, flat-topped, intervening east-west ridges. At Langford and to the west, the topography is gently rolling to nearly flat, where the till merges into the sediments from glacial Lake Dakota (fig. 2).

The drainage in the area is to the west and is locally controlled by the escarpment of the Coteau des Prairies. The streams are intermittent and they ultimately drain westward into the James River.

## GENERAL GEOLOGY

### Surficial Deposits

The surficial deposits of the Langford area are mostly the result of glaciation during the Pleistocene Epoch. These glacial deposits are collectively termed drift and can be divided into till, outwash, and lake sediments.

Till consists of clay- and silt-size particles mixed randomly with sand, pebbles and boulders, and was deposited by the ice itself. The major surficial deposit in the Langford area is till and slightly reworked till (fig. 2). Where the till joins the lake sediments, the till may be partly or wholly covered with windblown material derived from the lake sediments.

Outwash sediments consist chiefly of sand and gravel with minor amounts of silt and clay, and were deposited by meltwater streams. No surficial outwash deposits were found in the Langford area; however, a buried outwash covered with as much as 24 feet of till is present just north of Langford (fig. 2).

The lake sediments consist of clay, silt, and fine- to medium-grained sand, and were deposited in the lake by the meltwater from the wasting glacier.

Alluvium consists of silt- and clay-size particles with minor amounts of sand, deposited by recent streams since the retreat of the glaciers. Alluvium occurs along the small intermittent streams in the area (fig. 2).

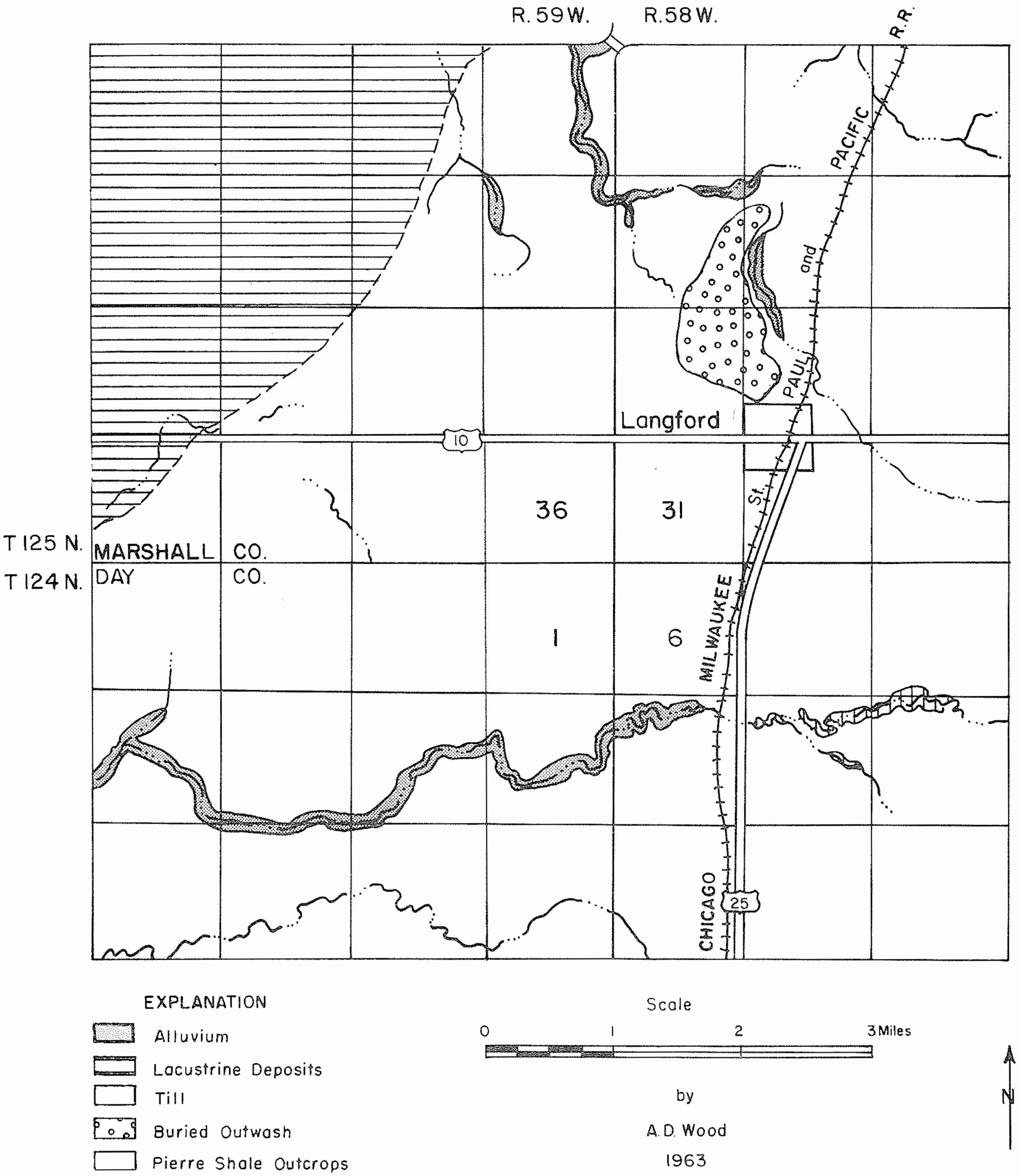
### Exposed Bedrock

The Pierre Formation, which is the only bedrock exposed in the Langford area, crops out along many of the streams east and south of Langford. The Pierre Formation consists of light-gray to dark-gray fissile shale containing iron concretions.

### Subsurface Bedrock

Stratified sedimentary rocks of Cretaceous age lie beneath the surficial deposits in the Langford area. The deposits in descending order are the Pierre, Niobrara, Carlile, Greenhorn, and Graneros Formations, and the Dakota Group.

Figure 2. Generalized Geologic Map of Langford Area.




Drafted by D. W. Johnson

Figure 3 is a contour map showing the configuration of the surface of the Pierre Shale as it would appear if all glacial deposits were removed. This map shows that the surface of the shale slopes gradually downward to the west and appears to have a narrow, shallow valley cut into its surface north of Langford.

The Pierre Formation in the subsurface is light to very dark bluish-gray, bentonitic sandy shale, and is characterized by ironstone and lime concretions. The thickness of the Pierre in this particular area is unknown, but probably is variable and in general thickens to the west. This formation crops out in nearly every valley in the far eastern portion of the area.

The Niobrara Formation, in the subsurface, consists of bluish-gray clay marl with a high percentage of organic calcium carbonate, and is sometimes highly fractured.

The Carlile Formation consists of medium- to dark-gray bentonitic shale.

The Greenhorn Limestone is a white, dense, and sometimes fractured limestone.

The Graneros Shale is a light- to dark-gray shale.

The Dakota Group consists chiefly of fine to coarse, light-colored, water-bearing sandstones intercalated with gray shales.

## OCCURRENCE OF GROUND WATER

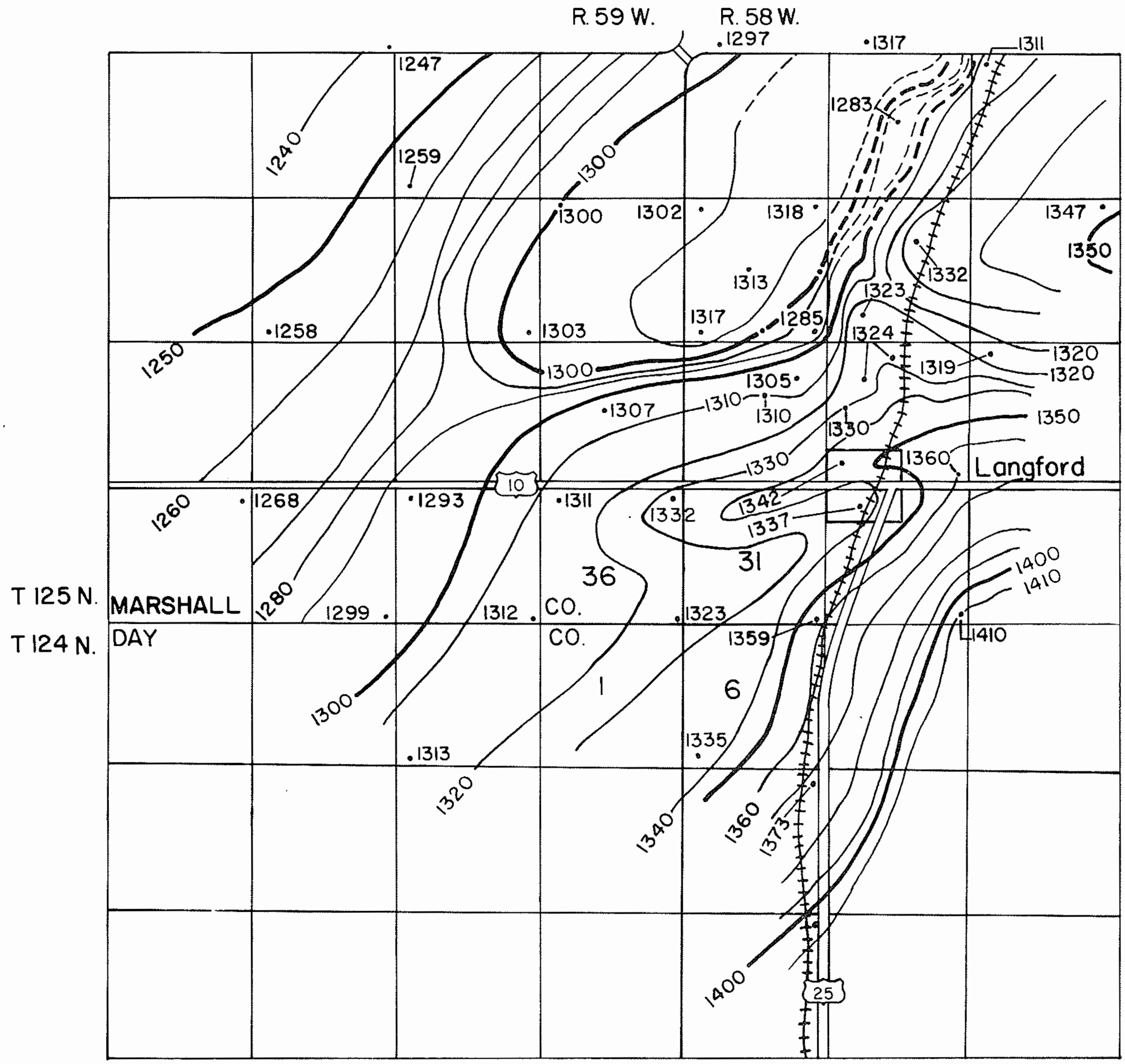
### Principles of Occurrence

Ground water may be defined as water contained in the voids or openings of rock or sediments below the water table. Therefore, the water table marks the upper surface of the saturated zone of the water-bearing formation. 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 can range from a few feet to many tens of feet below the surface; in the Langford area it is 8-35 feet below the surface.

The amount of water that is contained in the reservoir rock or aquifer is controlled by the porosity and permeability of the rock. Porosity is a measure of the number of voids in a rock and is expressed in the ratio of pore space to the total volume of rock.

Porosity is dependent upon (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 that has been removed by percolating ground water. Sands and gravels usually have porosities that range from 20-40 percent, depending upon 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.

Figure 3. Map showing configuration of Buried Surface of Pierre Shale in Langford Area.




EXPLANATION

Contour Interval 10 feet.

Scale

0 1 2 3 Miles

N

by

A.D. Wood

1963

Drafted by D.W. Johnson

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 likewise has a high permeability, whereas a material that is high in porosity but in which the pores are not connected will have low permeability. Therefore, it can be seen that porosity and permeability are not synonymous, but are 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 as springs, (3) by lateral underflow of water in transient storage, and (4) by pumping of wells.

## Ground Water in Alluvium

Alluvium is present along many of the small intermittent streams and is associated with many of the small ponds in the area. This alluvium often contains large amounts of water where it is below the water table, but because of its low permeability it does not yield water readily.

## Ground Water in Glacial Deposits

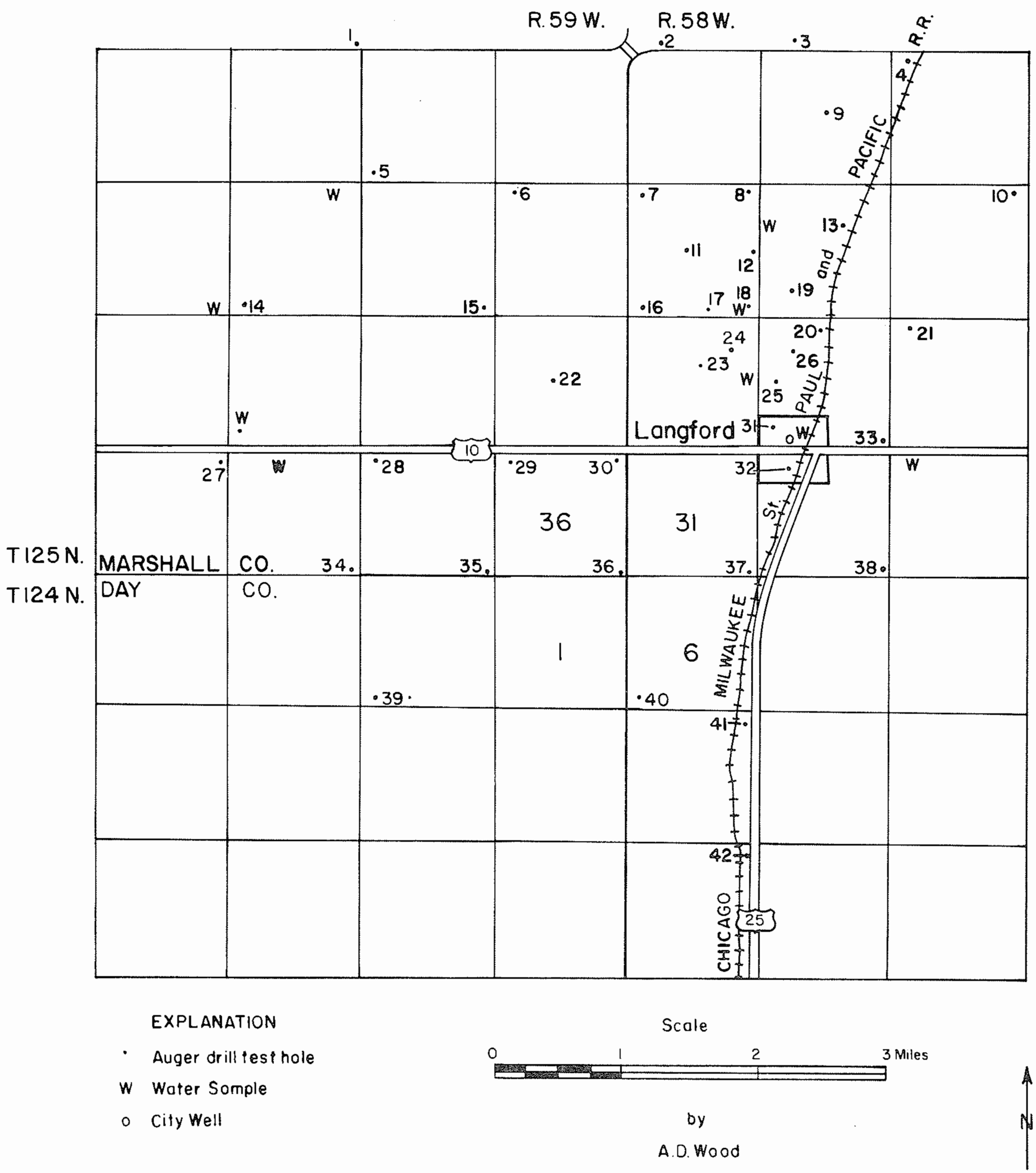
Till does not yield water readily because of its highly unsorted nature and low porosity and permeability. In this area, the glacial Lake Dakota sediments, if they contain enough sand, will yield small quantities of water.

State Geological Survey Test Holes 1, 5, and 14 penetrated the lake deposits (Appendix A). These test holes show the lake deposits are as much as 49 feet thick. The lake deposits are very silty and clayey, and probably would not supply a sufficient quantity of water for the city.

A possible glacial outwash deposit covered by alluvium and till occurs just north of Langford (fig. 2). This deposit is called a buried outwash for the purpose of this report; however, it is possible that it may be a buried lake or deltaic deposit.

State Geological Survey Test Holes 12, 17, 18, 23, 24, and 25 drilled through this deposit. The buried deposit consists of a dark-gray, fine- to medium-grained sand which is moderately to well sorted, and contains some incorporated silt and clay. This sand deposit overlies the Pierre Formation, and is overlain by 20-30 feet of till and alluvium.

Figure 4. Data Map of Langford Area.




Drafted by D.W. Johnson

## Ground Water in Bedrock

Both the Pierre Formation and the Dakota Group supply water to wells in the Langford area.

The Pierre Formation, because of its low permeability, would not supply sufficient amounts of water for the city, but it does, however, supply small domestic needs.

The sandstones of the Dakota Group are the only other bedrock from which water is readily obtained in the Langford area, and are the present supply of water for the city of Langford. These sandstones are at a depth of 950-1,150 feet, and their waters are under artesian pressure.

Recharge of the Dakota sandstones in South Dakota comes from the Rocky Mountains or Black Hills, where they crop out at a much higher elevation than in the Langford area. The overlying Cretaceous shales provide the impervious material that confines the water to the sandstones.

## 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 it can be said that the more minerals a water contains, the poorer its quality.

The water in the Pierre Formation and Dakota sandstones is generally of a poorer quality than that in the buried outwash deposits.

Table 1 shows the chemical properties of various waters in the Langford area, as compared with the present city water and with the standards for drinking water established by the U. S. Department of Public Health. It can be seen that the present city well exceeds the Public Health standards in sulfates, iron, fluoride, and total solids. The high excess of sulfates, fluoride, and total solids is particularly noteworthy.

Samples H, I, and J are from the Lake Dakota sediments and are highly variable in quality, depending on local conditions. The water ranges from good in Sample I, to very poor in Sample H. There is very little possibility of the town obtaining a water supply from this source.

Samples F and G are from the buried outwash shown on Figure 2. Sample F is high in sulfates, iron, manganese, and total solids; however, the sulfate, iron, and total solids content is still less than the present city supply. Sample G is high in total solids and no test was run for manganese. Factors the city should consider concerning the quality of the water from the buried outwash are the low fluoride content and the possible high manganese content.

The only undesirable quality of the water from the buried outwash, as compared to the city's present supply, is the hardness content. Although this is an undesirable quality as to soap consumption, it is not harmful for drinking, as indicated by the absence of maximum limits imposed by the Public Health standards.

Table 1.--Chemical Analyses of Water Samples from the Langford Area

Geologic Source: D, Dakota Sandstone; LD, Lake Dakota; BO, Buried Outwash

| | Parts Per Million | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | Source | Calcium | Sodium | Magne-sium | Chloride | Sulfate | Iron | Manga-nese | Nitrate | Fluoride | pH | Hardness $CaCO_3$ | Total Solids |
| A | | --- | --- | 50 | 250 | 500* | 0.3 | 0.05 | 10.0* | 0.9-1.7** | --- | --- | 1000* |
| B | D | 13 | 865 | 4 | 223 | 1225 | 1.6 | 0.0 | 1.5 | 8.0 | 8.5 | 51 | 2601 |
| C | D | 254 | | -149 | 220 | 875 | 9.0 | | | | 8.0 | 40 | 3775 |
| D | D | 620 | | -250 | 232 | 2515 | None | | | | | 2550 | 6425 |
| E | Till? | 395 | | 132 | 36 | 242 | Trace | | | | 7.2 | 460 | 1160 |
| F | BO | 229 | 145 | 94 | 6 | 994 | 0.5 | 1.6 | | 0.6 | | 958 | 2106 |
| G | BO | 466 | | 151 | 24 | 438 | None | | | | | 510 | 1618 |
| H | LD | 507 | | -2 | 640 | 1312 | 1.0 | | | | | 1260 | 5420 |
| I | LD | 90 | | -4 | 12 | 20 | None | | | | | 240 | 541 |
| J | LD | 195 | 430 | 154 | 37 | 1612 | | 0.4 | 13.0 | 0.4 | | 1121 | 3086 |

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

** Optimum

Samples F and J were analyzed by the State Chemical Laboratory, Vermillion. Sample B was taken from South Dakota Public Water Supply Data, 1961. All other samples were analyzed by field kit.

## Locations of Water Samples

A. U. S. Department of Public Health Drinking Water Standards (1961)
B. Langford City Water
C. Kenneth Jones, SENE$\frac{1}{4}$ sec. 30, T. 125 N., R. 58 W.
D. Dale Carson, NENW$\frac{1}{4}$ sec. 34, T. 125 N., R. 59 W.
E. Norris Goreham, NWNW$\frac{1}{4}$ sec. 33, T. 125 N., R. 58 W.
F. State Geological Test Hole No. 18, SESE sec. 19, T. 125 N., R. 58 W.
G. Cliff Lesher, SWNW$\frac{1}{4}$ sec. 20, T. 125 N., R. 58 W.
H. Harry Stolemerk, NWNE$\frac{1}{4}$ sec. 22, T. 125 N., R. 59 W.
I. Raymond Anderson, SESE$\frac{1}{4}$ sec. 21, T. 125 N., R. 59 W.
J. Gilbert Gavret, NWSW$\frac{1}{4}$ sec. 27, T. 125 N., R. 59 W.

## CONCLUSIONS AND RECOMMENDATIONS

It is recommended that the city of Langford test for future water supplies in the buried outwash indicated in Figure 2.

The buried outwash lies mostly in a narrow bedrock channel (fig. 3). This would indicate a rather limited recharge area for the aquifer. Test Holes 17 and 18 showed up to 28 and 30 feet of saturated sand, respectively, while Test Hole 12 showed only 17 feet of saturated sand. This shows how rapidly the outwash deposit thins towards the margin; again, suggesting a restricted recharge area.

The buried outwash is a fine- to medium-grained sand containing silt and clay, and therefore is expected to be only moderately permeable and capable of a limited yield.

The quality of water in the buried outwash does not meet all Public Health Standards, as indicated in Table 1. However, the water is generally of better quality than the present city supply.

If the city, on the basis of the conclusions determined in this report, decides to test for future water supplies in the buried outwash, it should contact a commercial drilling company to drill several additional test holes in the area to determine the most suitable location for a well. A pump test supervised by competent engineers should be run for a minimum of 72 hours to determine the yield, drawdown, and recovery. The results of the pump test would indicate whether a low-yield well could be sustained for a long period of time.

The only other ground water possibility for the city of Langford would be further development of the present water supply from the Dakota sandstones.

The city officials should consult the State Water Resources Commission with regard to obtaining a water right and a permit to drill the 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 South Dakota should be hired to design the wells and water lines, providing the quantity of water in the outwash is sufficient to at least supplement that obtained in Langford.

## REFERENCES CITED

Flint, R. F., 1955, Pleistocene Geology of Eastern South Dakota: U. S. Geol. Survey Prof. Paper 262, fig. 1.

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

South Dakota Public Water Supply Data, 1961, Division of Sanitary Engineering, South Dakota Department of Health, 31 p.

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 State Geological Survey Auger Test Holes in the Langford Area

(for location see Figure 4)

Test Hole No. 1
Elevation: 1,300 feet
Depth to water: 13 feet

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-9 | silt, yellow |
| 9-14 | clay, grayish-yellow |
| 14-44 | sand, fine to medium, containing some clay and silt |
| 44-54 | Pierre Shale, weathered |

* * * * *

Test Hole No. 2
Elevation: 1,315 feet
Depth to water: dry hole

| | |
|---|---|
| 0-3 | topsoil, black |
| 3-9 | silt, light brown |
| 9-14 | clay, brown, shale fragments |
| 14-19 | Pierre Shale, bentonite layer at 18' |

* * * * *

Test Hole No. 3
Elevation: 1,329 feet
Depth to water: dry hole

| | |
|---|---|
| 0-11 | silt, yellow |
| 11-12 | Pierre Shale |

* * * * *

Test Hole No. 4
Elevation: 1,342 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-9 | sand, brown, fine grained, clayey, silty |
| 9-14 | clay, buff, silty |

(continued on next page)

Test Hole No. 4--continued

| | |
|---|---|
| 14-24 | clay, dark gray, silty |
| 24-31 | Pierre Shale, weathered |

* * * * *

Test Hole No. 5
Elevation: 1,299 feet
Depth to water: 23 feet

| | |
|---|---|
| 0-9 | clay, gray to buff |
| 9-19 | silt, buff, clayey |
| 19-40 | sand, buff to gray, fine grained, silty |
| 40-44 | Pierre Shale |

* * * * *

Test Hole No. 6
Elevation: 1,311 feet
Depth to water: dry hole

| | |
|---|---|
| 0-1 | topsoil, black |
| 1-4 | clay, brown, pebbly |
| 4-11 | silt, brown, clayey, moist |
| 11-14 | Pierre Shale |

* * * * *

Test Hole No. 7
Elevation: 1,325 feet
Depth to water: 16 feet

| | |
|---|---|
| 0-4 | topsoil, dark brown |
| 4-9 | silt, dark brown, sandy |
| 9-23 | clay, brown, silty |
| 23-24 | Pierre Shale |

* * * * *

Test Hole No. 8
Elevation: 1,336 feet
Depth to water: dry hole

| | |
|---|---|
| 8-18 | clay, dark brown, silty |
| 18-19 | Pierre Shale |

* * * * *

Test Hole No. 9
Elevation: 1,300 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | topsoil, black, grades to gray silt |
| 4-17 | clay, buff to brown, pebbly, with incorporated shale |
| 17-19 | Pierre Shale |

* * * * *

Test Hole No. 10
Elevation: 1,366 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | silt, dark brown, sandy |
| 4-18 | silt, brown, sandy |
| 18-19 | Pierre Shale |

* * * * *

Test Hole No. 11
Elevation: 1,340 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | topsoil, black, dry |
| 4-19 | silt, brown, powdery |
| 19-26 | clay, brown, incorporated shale fragments |
| 26-27 | Pierre Shale |

* * * * *

Test Hole No. 12
Elevation: 1,345 feet
Depth to water: 22 feet

| | |
|---|---|
| 0-2 | topsoil, black |
| 2-19 | clay, brown |
| 19-29 | sand, brown, fine grained, saturated |
| 29-39 | sand, gray, fine to medium grained |
| 39-44 | Pierre Shale |

* * * * *

Test Hole No. 13
Elevation: 1,350 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | silt, yellow, pebbly |
| 4-18 | clay, yellow, sandy, incorporated shale fragments |
| 18-19 | Pierre Shale |

* * * * *

Test Hole No. 14
Elevation: 1,308 feet
Depth to water: 29 feet

| | |
|---|---|
| 0-4 | topsoil, black, and gray silt |
| 4-14 | silt, buff, sandy |
| 14-49 | sand, gray, fine |
| 49-50 | Pierre Shale |

* * * * *

Test Hole No. 15
Elevation: 1,322 feet
Depth to water: dry hole

| | |
|---|---|
| 0-1.5 | topsoil, black |
| 1.5-4 | clay, yellow to brown |
| 4-14 | silt, brown, clayey |
| 14-23 | clay, gray, with incorporated shale fragments |
| 23-24 | Pierre Shale |

* * * * *

Test Hole No. 16
Elevation: 1,336 feet
Depth to water: dry hole

| | |
|---|---|
| 0-1 | topsoil, black |
| 1-9 | silt, brown, clayey |
| 9-18 | clay, gray, with incorporated shale fragments |
| 18-19 | Pierre Shale |

* * * * *

Test Hole No. 17
Elevation: 1,343 feet
Depth to water: 11 feet

| | |
|---|---|
| 0-1 | topsoil, black |
| 1-9 | clay, dark brown, pebbly |
| 9-29 | sand, buff, fine grained |
| 29-39 | sand, gray, silty |
| 39-44 | Pierre Shale |

* * * * *

Test Hole No. 18
Elevation: 1,350 feet
Depth to water: 8 feet
(continued on next page)

Test Hole No. 18--continued

| | |
|---|---|
| 0-14 | clay, brown, silty, sandy, saturated at 8 feet |
| 14-19 | clay, brown, pebbly |
| 19-24 | clay, gray, grading to fine silty sand |
| 24-64 | sand, brown to gray, grading to medium grained, abundant small wood particles |
| 64-86 | Pierre Shale |

* * * * *

Test Hole No. 19
Elevation: 1,350 feet
Depth to water: not measured

| | |
|---|---|
| 0-3 | topsoil, black |
| 3-4 | clay, yellow |
| 4-9 | clay, yellowish-brown |
| 9-27 | clay, dark brown, pebbly, sandy |
| 27-39 | Pierre Shale |

* * * * *

Test Hole No. 20
Elevation: 1,356 feet
Depth to water: 19 feet

| | |
|---|---|
| 0-1.5 | topsoil, black |
| 1.5-4 | clay, buff, pebbly |
| 4-9 | clay, gray, few pebbles |
| 9-14 | clay, black |
| 14-24 | clay, buff, sandy |
| 24-32 | clay, dark gray |
| 32-34 | Pierre Shale |

* * * * *

Test Hole No. 21
Elevation: 1,358 feet
Depth to water: 9 feet

| | |
|---|---|
| 0-2 | topsoil, black |
| 2-4 | clay, brown |
| 4-9 | clay, rusty, brown, sandy |
| 9-14 | no cuttings |
| 14-19 | clay, brown |
| 19-24 | no cuttings |
| 24-29 | clay, dark gray to black |
| 29-59 | Pierre Shale |

* * * * *

Test Hole No. 22
Elevation: 1,336 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-14 | clay, buff, silty |
| 14-34 | clay, gray, silty, incorporated shale |
| 34-39 | Pierre Shale |

* * * * *

Test Hole No. 23
Elevation: 1,351 feet
Depth to water: 14 feet

| | |
|---|---|
| 0-4 | clay, gray, powdered |
| 4-9 | clay, brown, pebbly, dry |
| 9-14 | silt, brown, sandy, pebbly |
| 14-19 | clay, brown, sandy |
| 19-24 | silt, brown |
| 24-29 | sand, gray, very clayey |
| 29-34 | no cuttings |
| 34-39 | Pierre Shale |

* * * * *

Test Hole No. 24
Elevation: 1,350 feet
Depth to water: not measured

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-9 | clay, black, hard, dry |
| 9-14 | clay, brown, hard, weathered |
| 14-24 | silt, brown, pebbly |
| 24-39 | sand, brown, fine to medium, clayey |
| 39-44 | Pierre Shale |

* * * * *

Test Hole No. 25
Elevation: 1,356 feet
Depth to water: 17 feet

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-16 | clay, black to brown to buff, sandy, silty |
| 16-21 | sand, gray, pebbly, clayey |
| 21-24 | clay, brown, and weathered shale |
| 24-29 | Pierre Shale |

* * * * *

Test Hole No. 26
Elevation: 1,350 feet
Depth to water: 9 feet

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-9 | clay, black, pebbly |
| 9-24 | clay, yellow, sandy and silty |
| 24-25 | clay, dark gray, pebbly, silty |
| 25-26 | Pierre Shale |

* * * * *

Test Hole No. 27
Elevation: 1,308 feet
Depth to water: 17 feet

| | |
|---|---|
| 0-4 | clay, dark brown, silty |
| 4-9 | clay, varved?, gray to yellow, 1/8 inch thick laminations |
| 9-24 | silt, brown, sandy |
| 24-40 | clay, gray, silty |
| 40-44 | Pierre Shale |

* * * * *

Test Hole No. 28
Elevation: 1,317 feet
Depth to water: 14 feet

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-14 | sand, buff, fine grained, clayey |
| 14-19 | clay, brown, pebbly |
| 19-24 | Pierre Shale and bentonite |

* * * * *

Test Hole No. 29
Elevation: 1,335 feet
Depth to water: dry hole

| | |
|---|---|
| 0-2 | topsoil, black |
| 2-9 | silt, yellow |
| 9-19 | clay, dark brown, silty, pebbly |
| 19-34 | Pierre Shale and bentonite |

* * * * *

Test Hole No. 30
Elevation: 1,346 feet
Depth to water: dry hole
(continued on next page)

Test Hole No. 30--continued

| | |
|---|---|
| 0-2 | topsoil, black |
| 2-4 | clay, dark brown |
| 4-13 | silt, brown, sandy |
| 13-14 | Pierre Shale |

* * * * *

Test Hole No. 31
Elevation: 1,365 feet
Depth to water: dry hole

| | |
|---|---|
| 0-2 | topsoil, black |
| 2-9 | clay, dark brown, pebbly |
| 9-14 | sand, brown, fine grained, clayey |
| 14-22 | clay, dark gray, pebbly |
| 22-23 | Pierre Shale |

* * * * *

Test Hole No. 32
Elevation: 1,371 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-19 | clay, dark brown to yellow |
| 19-29 | clay, gray, silty, incorporated shale fragments |
| 29-34 | Pierre Shale |

* * * * *

Test Hole No. 33
Elevation: 1,384 feet
Depth to water: dry hole

| | |
|---|---|
| 0-9 | clay, brown |
| 9-14 | clay, yellow |
| 14-24 | clay, brown, pebbly |
| 24-29 | Pierre Shale |

* * * * *

Test Hole No. 34
Elevation: 1,328 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | clay, gray, silty |
| 4-19 | clay, buff to brown, pebbly |
| 19-24 | clay, brown to gray, silty |
| 24-29 | Pierre Shale |

* * * * *

Test Hole No. 35
Elevation: 1,341 feet
Depth to water: dry hole

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-14 | clay, dark buff |
| 14-34 | Pierre Shale and bentonite |

* * * * *

Test Hole No. 36
Elevation: 1,356 feet
Depth to water: 14 feet

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-24 | clay, dark to light brown, silty |
| 24-34 | Pierre Shale |

* * * * *

Test Hole No. 37
Elevation: 1,375 feet
Depth to water: dry hole

| | |
|---|---|
| 0-2 | topsoil, black |
| 2-16 | clay, dark brown, pebbly, incorporated shale fragments |
| 16-19 | Pierre Shale |

* * * * *

Test Hole No. 38
Elevation: 1,422 feet
Depth to water: dry hole

| | |
|---|---|
| 0-2 | topsoil, black |
| 2-12 | clay, brown to dark brown, sandy |
| 12-14 | Pierre Shale |

* * * * *

Test Hole No. 39
Elevation: 1,332 feet
Depth to water: dry hole

| | |
|---|---|
| 0-9 | clay, gray to brown, silty |
| 9-16 | clay, brown |
| 16-19 | Pierre Shale |

* * * * *

Test Hole No. 40
Elevation: 1,364 feet
Depth to water: 18 feet

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-17 | clay, dark brown to buff, silty |
| 17-27 | sand, buff, very fine, clayey |
| 27-29 | Pierre Shale |

* * * * *

Test Hole No. 41
Elevation: 1,389 feet
Depth to water: 12 feet

| | |
|---|---|
| 0-4 | topsoil, black |
| 4-15 | clay, black, sandy, silty |
| 15-16 | Pierre Shale |

* * * * *

Test Hole No. 42
Elevation: 1,421 feet
Depth to water: dry hole

| | |
|---|---|
| 0-2 | topsoil, black |
| 2-4 | clay, light tan |
| 4-12 | clay, dark brown, pebbly, shale fragments |
| 12-13 | Pierre Shale |

* * * * *

## APPENDIX B

Table 2.--Records of Wells in the Langford Area

Well location: Letters stand for quarter section, first number for section, second for township north, third for range west.
Type of well: Du, dug; D, drilled; B, bored
Geologic source: G, glacial; P, Pierre; D, Dakota
Character of material: O, outwash; SL, sand lens; SS, sandstone; LS, lacustrine sand; SH, shale
Use of water: D, domestic; S, stock

| Well Location | Owner or Tenant | Type of Well | Depth of Well (feet) | Geologic Source | Character of Material | Use of Water |
|---|---|---|---|---|---|---|
| SE1-124-58 | Gotfried Anderson | D | 125 | P | SH | S,D |
| NE3-124-58 | A. Kishner | D | | D | SS | S,D |
| SW5-124-58 | Bill Reints | D | 1000 | D | SS | S,D |
| NW9-124-58 | J. L. Martin | D | 100 | P | SH | S,D |
| SW9-124-58 | Charles Olson | D | 138 | P | SH | S,D |
| SE10-124-58 | Richard Olson | D | 154 | P | SH | S,D |
| NW12-124-58 | Joe Olson | D | 112 | P | SH | S,D |
| NE17-124-58 | L. Dwight | D | 130 | P | SH | S,D |
| NE17-124-58 | L. Dwight | | 17 | G | SL | S |
| SE1-124-59 | Merle Olson | Du | 12 | G | SL | S,D |
| SW2-124-59 | Merle Olson | D | | D | SS | S,D |
| NE5-124-59 | Merton Heing | D | | D | SS | S,D |
| SE9-124-59 | Allan Anderson | D | | D | SS | S,D |
| SW11-124-59 | M. Wegeritner | D | | D | SS | S,D |
| NE13-124-59 | George Sneins | D | 1000 | D | SS | S,D |
| NE16-124-59 | George Olson | D | 960 | D | SS | S,D |

Appendix B-Records of Wells--continued

| Well Location | Owner or Tenant | Type of Well | Depth of Well (feet) | Geologic Source | Character of Material | Use of Water |
|---|---|---|---|---|---|---|
| NW21-124-59 | Ole Olson | Du | 19+12 | G | SL | S,D |
| SE7-125-58 | Newton Jones | D | 1000+ | D | SS | S,D |
| NE8-125-58 | Neal Peterson | D | 1010 | D | SS | S,D |
| NE8-125-58 | C. Peterson | D | 1010 | D | SS | S,D |
| SW9-125-58 | C. Swearingen | D | 1100 | D | SS | S,D |
| NW10-125-58 | Arden Peterson | D | 32 | P | SH | S,D |
| NW11-125-58 | Olif West | D | 1185 | D | SS | S,D |
| SW13-125-58 | Herb Plantun | D | 120 | P | SH | S,D |
| SW14-125-58 | Ken Foote | D | 110? | P | SH | S,D |
| SW14-125-58 | Ken Foote | Du | 30 | P | SH | S |
| NW15-125-58 | Emil Thole | D | 970 | D | SS | S,D |
| NW20-125-58 | Ken Jones | D | 1075 | D | SS | S,D |
| NW20-125-58 | Ken Jones | D | 35 | G | SL | S |
| SW20-125-58 | Cliff Lesher | D | 975 | D | SS | D |
| SW20-125-58 | Cliff Lesher | D | 36 | G | O | S |
| SE23-125-58 | Omer Lamberton | D | 143 | P | SH | S,D |
| SE23-125-58 | Harold Franzen | D | 120 | P | SH | S,D |
| SW25-125-58 | Herb Plantun | D | 100 | P | SH | S,D |
| SW25-125-58 | Ralph Ogren | D | 180 | P | SH | S,D |
| NW29-125-58 | Clayton Osness | D | 19 | G | O | D |
| NE30-125-58 | Ken Jones | D | 1150 | D | SS | S,D |

Appendix B-Records of Wells--continued

| Well Location | Owner or Tenant | Type of Well | Depth of Well (feet) | Geologic Source | Character of Material | Use of Water |
|---|---|---|---|---|---|---|
| NE32-125-58 | Albert Schmidt | B | 25 | P? | SH? | D |
| NW33-125-58 | Norris Goreham | B | 20 | P | SH | S,D |
| SE33-125-58 | James Reints | D | 100 | P | SH | S,D |
| NW34-125-58 | Ernest Ogren | D | 125 | P | SH | S,D |
| SE34-125-58 | Robert Healy | D | 125 | P | SH | S,D |
| SE34-125-58 | Robert Healy | D | 100 | P | SH | S,D |
| NE35-125-58 | J. E. Marr | D | 102 | P | SH | D |
| NW36-125-58 | A. C. Carlson | D | 225 | P | SH | S,D |
| NW2-125-59 | Lyle Goreham | D | 1000? | D | SS | S,D |
| SW3-125-59 | Raymond Hartberg | D | 1000- | D | SS | S,D |
| SE7-125-59 | Paul Ferden | D | 1000+ | D | SS | S,D |
| NE10-125-59 | Dale Quist | D | 900 | D | SS | S,D |
| NW10-125-59 | | D | | D | SS | S,D |
| NW11-125-59 | Bill Wigdahl | D | 1000 | D | SS | S,D |
| NE13-125-59 | Roy Jerde | D | 1000+ | D | SS | S,D |
| SE13-125-59 | Roy Jones | D | 1025 | D | SS | S,D |
| NW15-125-59 | J. Lamberton | D | 1000 | D | SS | S,D |
| SE21-125-59 | Ray Anderson | D | 28-32 | G | SL | S,D |
| NE22-125-59 | Harry Stolsmerk | D | 40 | G | LS | S,D |
| SE22-125-59 | Marvin Nelson | D | 850 | D | SS | S,D |
| SE23-125-59 | R. Herman | D | 1000+ | D | SS | S,D |

Appendix B-Records of Wells--continued

| Well Location | Owner or Tenant | Type of Well | Depth of Well (feet) | Geologic Source | Character of Material | Use of Water |
|---|---|---|---|---|---|---|
| SW24-125-59 | Jesse West | D | 907 | D | SS | S,D |
| NW26-125-59 | Martin Nelson | D | 1000- | D | SS | S,D |
| SW27-125-59 | Gilbert Garrett | B | 24 | G | LS | S,D |
| NW28-125-59 | Ernest Olson | D | 1000- | D | SS | S,D |
| NW29-125-59 | Clayton Osness | D | 15 | G | O | S,D |
| NW34-125-59 | Dale Carson | D | 1000 | D | SS | S,D |
| NE25-125-59 | A. Osness | D | 970 | D | SS | S,D |
| NE35-125-59 | A. Kishner | D | | | | S,D |
| NE35-125-59 | A. Kishner | Du | 16 | P | SH | S |