EVALUATION OF THE BASAL AQUIFER IN THE VICINITY OF THE HANSON RURAL WATER SYSTEM WELLFIELD

by

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INTRODUCTION

During the summer of 1990, an investigation was conducted by the South Dakota Geological Survey for the Hanson Rural Water System and, the TM Rural Water District to analyze the basal outwash aquifer as a potential source of drinking water for the two systems. The results of that investigation are presented in Schulz (1991). The aquifer was found to have the potential to yield water to wells in quantities that could meet the systems' needs, but had inferior water quality compared to the Dolton aquifer from which both systems were obtaining their drinking water supplies.

At the request of Hanson Rural Water System, the South Dakota Geological Survey conducted an additional investigation of the basal outwash aquifer near the system's wellfield. The purpose of this investigation was to further delineate the basal outwash aquifer and to determine the water quality of the aquifer in an area closer to the rural water system's existing water treatment facilities. The results are presented in this report. The investigation was financed by the South Dakota Geological Survey and the Hanson Rural Water System.

Methods of Investigation

Field work began May 11, 1992, and continued through June 3, 1992. Ten test holes were drilled for this investigation using a forward mud rotary drill rig with a bit diameter of 5⅜ inches. Five of the test holes were completed as observation wells. In addition to the drilling, nine water samples were collected and analyzed for general water quality (fig. 1). The lithologic logs for the test holes and wells completed for this study are given in appendix A. Lithologic logs for the remainder of the test holes or wells used in this report remain on file at the South Dakota Geological Survey in Vermillion, South Dakota.

RESULTS OF INVESTIGATION

Geology

The geology of the study area can be divided into glacial deposits and bedrock. Table 1 shows the geologic unit or formation names, their relative ages, and provides a brief description of each unit known to be present in the study area. Three cross sections (figs. 2, 3, and 4) show the relative positions of the different units. Cross section locations are shown in figure 5.

Bedrock

Bedrock in the study area can be divided into two separate ages. These are (1) Cretaceous sediments, which include the Niobrara Formation, and the Sylt Rock Creek Formation and (2) Precambrian sediment, which is the Sioux Quartzite (table 1).

In the vicinity of the Hanson Rural Water System treatment plant, a bedrock high consisting of Sioux Quartzite is present (fig. 5). Approximately 1 mile east of the water treatment plant, a bedrock valley is present and is oriented in a northwest to southeast direction. The bedrock encountered along
the valley floor consists predominantly Sioux Quartzite with minor channel fillings of the Split Rock Creek Formation (figs. 2 and 4).

Glacial Deposits

The glacial deposits in the study area consist primarily of till and outwash. Till is the heterogeneous mixture of clay, silt, sand, gravel, and boulders in a predominantly fine grained matrix of clay and silt. Outwash consists mainly of sand and gravel with minor amounts of clay and silt. Two major outwash bodies have been recognized in the study area; one is informally known as the Dolton aquifer and the other has been termed the basal outwash aquifer. Although both of these outwash bodies were encountered in drilling for this project, only the basal outwash aquifer is discussed below.

Basal Outwash Aquifer

The sands and gravels which comprise the basal outwash aquifer have a variable thickness ranging from 38 feet to 10 feet. Overlying the basal outwash aquifer is unweathered till (figs. 2, 3, and 4). Bedrock is encountered immediately below the basal outwash aquifer.

Hydrology

Basal Outwash Aquifer

The basal outwash aquifer is under confined conditions as indicated by measured water levels in wells completed in this aquifer (table 2). As noted in Schulz (1991), the basal outwash aquifer lies in direct contact with bedrock units that have the potential to influence the water quality, direction of ground water flow, and the quantity of water available in the basal outwash aquifer. The saturated thickness in the study area ranges from 38 feet to 10 feet (fig. 6).

Water quality in the basal outwash aquifer is variable but does not violate any of the enforceable limits for drinking water standards set forth by the U.S. Environmental Protection Agency. However, water quality data from the nine observation wells sampled for this project show that the levels of total dissolved solids, iron, manganese, and sulfate exceed the secondary maximum contaminant levels set forth by the U.S. Environmental Protection Agency. These secondary drinking water standards are suggested limits and are not enforceable limits for public water supplies. Analytical results of the water samples collected for this study are presented in table 3.

Discussion and Conclusions

The basal outwash aquifer is a confined aquifer which generally lies within a bedrock valley traversing from the northwest to the southeast. The aquifer is in direct contact with bedrock units that have the potential to impact water quality, ground water flow direction, and quantity of water available. The water quality in the basal outwash aquifer does not violate any of the national interim primary
drinking water standards, although concentrations for total dissolved solids, iron, manganese, and sulfate exceed the secondary maximum contaminant levels.

The thickness of the basal outwash aquifer suggests a potential for development of a supplemental water source for the Hanson Rural Water System. Approximately 2 miles east of the Hanson Rural Water System treatment plant, the saturated thickness reaches 68 feet. This area could be further investigated by drilling a test well and conducting an aquifer test if the Hanson Rural Water System should decide to pursue development of the basal outwash aquifer.

POST-INVESTIGATION WATER USE

Because of a continuous decline of water levels and lower production of water from wells drilled into the Dolton aquifer, the Hanson Rural Water System joined the B-Y Rural Water System on March 15, 1996. The Hanson Rural Water System presently obtains the majority of its water from the B-Y Rural Water System with a small quantity being supplied by the Dolton aquifer.

REFERENCES

Figure 1. Locations of test holes and observation wells.
Figure 2. Geologic cross section A-A'.

Quaternary
- Qtw, weathered till
- Qtu, unweathered till
- Qow, undifferentiated outwash
- Qowd, outwash, Dolton aquifer
- Qowb, outwash, basal outwash aquifer

Cretaceous
- Ksrc, Split Rock Creek Formation

Pre cambrian
- pCs, Sioux Quartzite

50N-55W-23 CCCC
Well or test hole. Letters and numbers are the location. All logs are on file at the South Dakota Geological Survey. See figure 3 for cross section locations. See appendix A for location explanation.

Geologic contact. Dashed where approximate.

Static water level. Number represents the date measured; See table 2 for explanation of water level data.

Vertical exaggeration = 50x.
Figure 3. Geologic cross section B-B'.

South ←→ North

Quaternary:
- Qtw_ weathered till
- Qtu_ undifferentiated outwash
- Qow_ outwash, Bolton aquifer
- Qowb_ outwash, basal outwash aquifer

Precambrian:
- pCs_ Sioux Quartzite

Vendor: 55W-15 CCC

Well or test hole. Letters and numbers are the location. All logs are on file at the South Dakota Geological Survey. See Figure 5 for cross section locations. See Appendix A for location explanations.

Geologic contact. Dashed where approximate.

Elevation in feet above mean sea level.

Static water level. Number represents the date measured. See Table 2 for explanation of water level data.

Vertical exaggeration = 50x.
Figure 4. Geologic cross section C-C'.
- Test hole or observation well used to determine the bedrock surface elevation.

- Contour line representing equal points of elevation. The number represents the elevation in feet above mean sea level. Contour interval = 30 feet.

- Hanson Rural Water System treatment plant.

- A - A': Cross section location.

Figure 5. Cross section locations and configuration of the bedrock surface.
Figure 6. Saturated thickness of the basal outwash aquifer.

- Observation well used to determine the saturated thickness and sampled for water quality analysis. The number represents the thickness of saturated outwash in feet.

- Observation well used to determine the saturated thickness, but not sampled for water quality analysis. The number represents the thickness of saturated outwash in feet.

- Test hole used to determine the saturated thickness. The number represents the thickness of saturated outwash in feet.

- Approximate boundary of the basal outwash aquifer.

- Approximated areal extent of the basal outwash aquifer.

- Hanson Rural Water System treatment plant.
<table>
<thead>
<tr>
<th>Geologic Age</th>
<th>Geologic Unit or Formation Name</th>
<th>Designation Used on the Cross Sections</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Till</td>
<td>Qro or Qts</td>
<td>Heterogeneous mixture of clay, silt, sand, pebbles, and boulders.</td>
</tr>
<tr>
<td></td>
<td>Outwash</td>
<td>Qow, Qowd, or Qowb</td>
<td>Mixture of sand and gravel with minor amounts of silt and clay.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Niobrara Formation</td>
<td>Kn</td>
<td>Light to medium blue-gray marl and white to cream-colored calcareous, fensiliferous limestone; weathers white to dark yellowish-orange.</td>
</tr>
<tr>
<td></td>
<td>Split Rock Creek Formation</td>
<td>Krc</td>
<td>Dark-gray to black organic shale and silt, weakly calcareous.</td>
</tr>
<tr>
<td></td>
<td>Sioux Quartzite</td>
<td>pCx</td>
<td>Pink to red, extremely hard, fine to medium grained, well rounded quartz sand, silica cemented orthoquartzite; sometimes conglomeratic and jointed.</td>
</tr>
</tbody>
</table>

1 Modified from Christensen (1989)
<table>
<thead>
<tr>
<th>Well name</th>
<th>Location¹</th>
<th>Depth to water²</th>
<th>Water level elevation³</th>
<th>Date measured</th>
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<td>R3-90-23</td>
<td>101N-55W-25DADA</td>
<td>90.08</td>
<td>1349.42</td>
<td>6/2/92</td>
</tr>
<tr>
<td>R20-90-42</td>
<td>101N-55W-15CCCC</td>
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<td>1353.73</td>
<td>6/2/92</td>
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<tr>
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<td>96.92</td>
<td>1351.08</td>
<td>6/1/92</td>
</tr>
</tbody>
</table>

¹ See appendix A for explanation of location format.
² Depth to water measured in feet below casing top.
³ Water level elevations are in feet above mean sea level and are based on an estimation of land surface elevation from a topographic map (U.S. Geological Survey, 1964). Elevations are accurate to within plus or minus 5 feet.
## Table 3. Chemical analyses of water samples

<table>
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<tr>
<th>Legal location</th>
<th>Well name</th>
<th>Date collected</th>
<th>Well depth</th>
<th>Conductivity</th>
<th>Alkalinity</th>
<th>HCO₃⁻</th>
<th>Ca</th>
<th>Cl</th>
<th>F</th>
<th>Fe</th>
<th>K</th>
<th>Mg</th>
<th>Mn</th>
<th>Na</th>
<th>NO₂⁻ + NO₃⁻</th>
<th>SO₄²⁻</th>
<th>TDS</th>
<th>Hardness as CaCO₃</th>
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<td>1739</td>
<td>339</td>
<td>413</td>
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<td>12</td>
<td>62</td>
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<td>707</td>
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<td>305</td>
<td>1530</td>
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<td>6/3/92</td>
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<td>1550</td>
<td>338</td>
<td>412</td>
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<td>11.0</td>
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<td>0.18</td>
<td>12</td>
<td>49</td>
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<td>SW NW NW SE 23</td>
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<td>6/1/92</td>
<td>312</td>
<td>1600</td>
<td>339</td>
<td>413</td>
<td>176</td>
<td>12.0</td>
<td>0.41</td>
<td>0.10</td>
<td>11</td>
<td>49</td>
<td>1.85</td>
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<td>580</td>
<td>1280</td>
<td>641</td>
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<td>429</td>
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<td>522</td>
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<tr>
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<td>338</td>
<td>412</td>
<td>167</td>
<td>8.6</td>
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<td>&lt;0.05</td>
<td>11</td>
<td>49</td>
<td>1.36</td>
<td>79</td>
<td>&lt;0.04</td>
<td>440</td>
<td>1080</td>
<td>619</td>
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<td>6/3/92</td>
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<td>127</td>
<td>12.0</td>
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<td>&lt;0.03</td>
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<td>40</td>
<td>1.29</td>
<td>105</td>
<td>-0.04</td>
<td>364</td>
<td>920</td>
<td>482</td>
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</tbody>
</table>

* 1. Alkalinity = total alkalinity; HCO₃⁻ = bicarbonate; Ca = calcium; Cl = chloride; F = fluoride; Fe = iron; K = potassium; Mg = magnesium; Mn = manganese; Na = sodium; NO₂⁻ + NO₃⁻ = nitrite as nitrogen; SO₄²⁻ = sulfate; TDS = total dissolved solids; Hardness as CaCO₃ = calcium carbonate.

2. Well depth is presented to feet below casing top.

3. Numbers are presented in milligrams per liter.


APPENDIX A

Lithologic logs of test holes and observation wells completed by the South Dakota Geological Survey for this investigation

LEGAL LOCATION and LOCATION

The logs are listed by smallest township number, then the smallest range number, the smallest section number, and then by quarter section. NE = A; NW = B; SW = C; SE = D. A comparison of a LEGAL LOCATION and a LOCATION is as follows. A LEGAL LOCATION of NE NE NE SE sec. 21, T. 101 N., R. 55 W. is the same as a LOCATION of 101N-55W-21DAAA. In some locations, the smallest quarter section is followed by the number 1 or 2 which indicates that more than one log may exist for that particular location.

LATITUDE and LONGITUDE

The format is DD.MMSS where D is degrees, M is minutes, and S is seconds.

DRILLING COMPANY

SDGS is an abbreviation for South Dakota Geological Survey.

TOTAL DRILL HOLE DEPTH, SCREEN LENGTH, and TOTAL CASING AND SCREEN

The numbers are presented in feet.

CASING STICK-UP

The number is presented in feet above ground surface.

SCREEN TYPE and CASING TYPE

PVC is an abbreviation for polyvinyl chloride. MFG. is an abbreviation for manufactured and indicates a product that is commercially available. SLOT SIZE is the size, in inches, of the openings on the screen.

GROUND SURFACE ELEVATION

The number is presented in feet above mean sea level. T - the elevation was estimated using a 7.5 minute series topographic map.

CASING DIAMETER

The number is presented in inches.
County: MCCOOK
Legal Location: NE NE NE SE sec. 21, T. 101 N., R. 55 W.
Latitude: 43.208
Land Owner:
Project: RANSOM BURIED AQUIFER
Drilling Company: SDGS
Driller: G. JENSEN
Geologist: L. SCHULZ
Date Drilled: 05-20-1992
Ground Surface Elevation: 1448 T
Total Drill Hole Depth: 217
USGS Hydrological Unit Code: 10160011
Electric Log Information:
Spontaneous Potential:
Natural Gamma:
Samples:

0 - 17 Clay, brown, silty, sandy, pebbly; oxidized (till)
17 - 19 Clay, dark-brown, silty, sandy, pebbly; partly oxidized (till)
19 - 60 Clay, gray, silty, sandy, pebbly; unoxidized (till)
60 - 89 Sand, gray, medium to coarse, clean, mainly quartz and carbonates, much coal
89 - 147 Clay, gray, silty, sandy, pebbly; unoxidized (till)
147 - 178 Sand and gravel, brown fine to medium sand, medium gravel, mainy quartz and carbonates, some coal (Dolton outwash)
178 - 215 Silt, gray; some sand
215 - 217 Rock; very hard; could not penetrate. granite boulder. moved rig ahead and redrilled

County: MCCOOK
Legal Location: NE NE NE SE sec. 21, T. 101 N., R. 55 W.
Latitude: 43.208
Land Owner:
Project: RANSOM BURIED AQUIFER
Drilling Company: SDGS
Driller: G. JENSEN
Geologist: L. SCHULZ
Date Drilled: 05-20-1992
Ground Surface Elevation: 1448 T
‘Total Drill Hole Depth: 323.5
Water Rights Well:
Other Well Name:
Drain: JAMES
Management Unit: Screen Type: PVC, MFG., SLOT SIZE 0.020 IN.
Casing Type: PVC
Casing Top Elevation: 1451 T
Casing Stick-up: 3.00
Well Maintenance Date:
USGS Hydrological Unit Code: 10160011
Electric Log Information:
Spontaneous Potential:
Natural Gamma: X
Samples:

Location: 10N-55W-21DAAAA
Longitude: 97.2540
Driller’s Log:
Geologist’s Log: X
Drilling Method: ROTARY
Test Hole Number: R2-92-16
Single Point Resistivity:
Extra:

Location: 10N-55W-21DAAAA 1
Longitude: 97.2540
Driller’s Log:
Geologist’s Log: X
Drilling Method: ROTARY
Test Hole Number: R2-92-17
SDGS Well Name: R2-92-17
Aquifer:
Screen Length: 5.0
Casing Diameter: 2.0
Total Casing and Screen: 305.0
Single Point Resistivity: X
Every:
Well Information: Well screened from 305 to 390 feet below casing top. Filter pack from 302 to 270 feet below land surface. Bentonite grout from 270 feet to land surface. Next cement grout from 20 feet below land surface to ground level. 1 steel well protector installed.

0 - 19 Clay, brown, silty, sandy, pebbly, oxidized (ill)
19 - 60 Clay, gray, silty, sandy, pebbly, unoxidized (ill)
60 - 88 Clay, gray, very silty, sandy, pebbly, gravelly; unoxidized (ill)
88 - 147 Clay, gray, silty, sandy, pebbly; unoxidized (ill)
147 - 178 Sand and gravel, brown, fine to medium sand, medium gravel; mainly quartz and carbonates, some coal (Dolten outwash)
178 - 226 Silt, gray; some fine sand
226 - 257 Sand and gravel, gray, coarse sand; much drill chatter; clean
257 - 278 Clay, gray, silty, sandy, pebbly (ill)
278 - 302 Sand and gravel, gray to brown-gray, fine to medium sand, medium gravel; mainly quartz and carbonates, some coal
302 - 302.5 Quartzite, hard layer, could not penetrate, many pink ortho-quartzite chips received in cuttings (Sioux Quartzite)

County: MCCOOK
Legal Location: SE NE SE SE sec. 21, T. 101 N., R. 55 W.
Latitude: 43.3154
Land Owner: Project: HANSON BURIED AQUIFER
Drilling Company: SDGS
Driller: M. THOMPSON
Geologist: L. SCHULZ
Date Drilled: 05-26-1992
Ground Surface Elevation: 1446 T
Total Drill Hole Depth: 321
Water Rights Well:
Other Well Name:
Basin: JAMES
Screen Type: PVC, MFG., SLOT SIZE 0.020 IN.
Casing Type: PVC
Casing Top Elevation: 1449 T
Casing Stick-up: 200
Well Maintenance Date:
USGS Hydrological Unit Code: 10160011
Electric Log Information:
Spontaneous Potential:
Natural Gamma: X
Samples:
Well Information: Well has a 20 foot blanket added on the bottom. Screened interval from 301 to 296 feet below casing top. Filter pack from 321 to 273 feet below land surface. Bentonite grout from 273 feet to land surface. Next cement grout from 20 feet below ground level to land surface. 1 steel well protector installed.

0 - 1 Topsoil
1 - 17 Clay, brown, silty, sandy, pebbly; oxidized (ill)
17 - 150 Clay, gray, silty, sandy, pebbly, unoxidized (ill)

Location: 101N-55W-21DDAD
Longitude: 97.2540
Aquifer:
Screen Length: 5.0
Casing Diameter: 2.0
Total Casing and Screen: 323.0
Extra:
Single Point Resistivity: X
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<th>Depth</th>
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<tr>
<td>150 - 173</td>
<td>Sand and gravel, brown, fine to coarse sand, medium to coarse gravel; clean, mainly quartz and carbonates, many shale pebbles, some lignitic coal (Dolom outwash)</td>
</tr>
<tr>
<td>173 - 186</td>
<td>Silt, gray; some sand and clay</td>
</tr>
<tr>
<td>186 - 226</td>
<td>Clay, gray, silty, sandy, pebbly; oxidized (till)</td>
</tr>
<tr>
<td>226 - 229</td>
<td>Rocks; hard drilling</td>
</tr>
<tr>
<td>229 - 278</td>
<td>Clay, gray, silty, sandy, pebbly; oxidized (till)</td>
</tr>
<tr>
<td>278 - 314</td>
<td>Sand/gravel; poor return</td>
</tr>
<tr>
<td>314 - 315</td>
<td>Rocks</td>
</tr>
<tr>
<td>315 - 321</td>
<td>Quartzite, hard layers. Many pink ortho-quartzite chips received after rock bit was put on (Sioux Quartzite)</td>
</tr>
</tbody>
</table>

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**County:** MCCOOK  
**Location:** 101N-55W-22C6DC  
**Longitude:** 97.7506

**Land Owner:** Project: HANSON BURIED AQUIFER  
**Drilling Company:** SDGS  
**Geologist:** L. SCHULZ  
**Date Drilled:** 05-27-1992  
**Ground Surface Elevation:** 1451 T  
**Total Drill Hole Depth:** 400  
**USGS Hydrological Unit Code:** 10160011  
**Electric Log Information:**  
**Spontaneous Potential:** Single Point Resistivity: X  
**Natural Gamma:** X  
**Extra:**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
<td>Topsoil</td>
</tr>
<tr>
<td>1 - 17</td>
<td>Clay, brown, silty, sandy, pebbly; oxidized (till)</td>
</tr>
<tr>
<td>17 - 21</td>
<td>Clay, dark-brown, silty, sandy, pebbly; partly oxidized (till)</td>
</tr>
<tr>
<td>21 - 861</td>
<td>Clay, gray, silty, sandy, pebbly; unoxidized (till)</td>
</tr>
<tr>
<td>161 - 192</td>
<td>Sand and gravel, brown, medium sand, medium gravel; mainly quartz and carbonates, many shale pebbles, much lignitic coal (Dolom outwash)</td>
</tr>
<tr>
<td>192 - 248</td>
<td>Clay, gray, silty, sandy, pebbly; oxidized (till)</td>
</tr>
<tr>
<td>248 - 268</td>
<td>Sand, gray, fine-grained; much clay</td>
</tr>
<tr>
<td>268 - 275</td>
<td>Rocks</td>
</tr>
<tr>
<td>275 - 312</td>
<td>Clay, gray, silty, sandy, pebbly; some shale cuttings(?)</td>
</tr>
<tr>
<td>312 - 399</td>
<td>Shale and silt interbedded, black shale, dark-gray slate; silts are weakly calcareous (Split Rock Creek Formation)</td>
</tr>
<tr>
<td>399 - 400</td>
<td>Quartzite; hard layer. Could not penetrate, much white kaolinitic clay received in cuttings (Sioux Quartzite)</td>
</tr>
</tbody>
</table>

---

**County:** MCCOOK  
**Location:** 101N-55W-22DADD  
**Longitude:** 97.2428

**Land Owner:** Project: HANSON BURIED AQUIFER  
**Drilling Company:** SDGS  
**Geologist:** L. SCHULZ  
**Date Drilled:** 05-18-1992  
**Driller's Log:**addColumn  
**Geologist's Log:** X  
**Drilling Method:** ROTARY
Ground Surface Elevation: 1450 T
Total Drill Hole Depth: 358
Water Rights Well:
Other Well Name:
Basin: JAMES
Management Unit:
Screen Type: PVC, MFG. SLOT SIZE 0.020 IN.
Casing Type: PVC
Casing Top Elevation: 1452 T
Casing Stick-up: 2.00
Well Maintenance Date:
USGS Hydrological Unit Code: 10160011
Electric Log Information:
Spontaneous Potential:
Natural Gamma: X
Samples:

Well Information: Well has 20 foot blanket placed on the bottom. Screened interval is from 3/8 feet to 333 feet below casing top. Unable to place filter pack due to hole collapse. Bentonite grout from 163 feet to land surface. Next connect grout from 20 feet below land surface to ground level. 1 steel well protector.

0 - 28 Clay, brown, silty, sandy, pebbly; oxidized (till)
28 - 162 Clay, gray, silty, sandy, pebbly; unoxidized (till)
162 - 202 Sand and gravel, brown, fine to coarse sand, medium gravel, mainly quartz and carbonates, many shale pebbles (Delton outwash)
202 - 283 Clay, gray, very silty, sandy, pebbly; many rocks, unoxidized (till)
283 - 351 Sand and gravel, brown, fine sand, coarse gravel, mainly quartz and carbonates, some shale pebbles
351 - 358 Clay, dark-gray-black; grey (Split Rock Creek Formation)

County: MCCOOK
Legal Location: SW NW NW NW ss 23, T. 101 N., R. 55 W.
Latitude: 43.3229
Land Owner:
Project: HANSON BURIED AQUIFER
Drilling Company: SDGS
Driller: G. JENSEN
Geologist: L. SCHULZ
Date Drilled: 05-19-1992
Ground Surface Elevation: 1453 T
Total Drill Hole Depth: 310.5
Water Rights Well:
Other Well Name:
Basin: JAMES
Management Unit:
Screen Type: PVC, MFG. SLOT SIZE 0.020 IN.
Casing Type: PVC
Casing Top Elevation: 1455 T
Casing Stick-up: 2.00
Well Maintenance Date:
USGS Hydrological Unit Code: 10160011
Electric Log Information:

SDGS Well Name: R2-92-14
Test Hole Number: R2-92-14
Aquifer:
Screen Length: 5.0
Casing Diameter: 2.0
Total Casing and Screen: 360.0
Single Point Resistivity: X
Extra:
Location: 101N-55W-23BBBC
Longitude: 97.2423
Driller's Log:
Geologist's Log: X
Drilling Method: ROTARY
Test Hole Number: R2-92-15
SDGS Well Name: R2-92-15
Aquifer:
Screen Length: 10.0
Casing Diameter: 2.0
Total Casing and Screen: 312.0
Electric Log Information:
Spontaneous Potential: Extra
Natural Gamma: X
Sample:

Well Information: Well screened from 312 to 302 feet below casing top. Filter pack from 312 to 272 feet below casing top. Bentonite grout from 270 feet below land surface to ground level. Next cement grout placed from 20 feet below ground level to mud surface. I steel well protector installed.

0 - 17 Clay, brown, silty, sandy, pebbly; oxidized ( till)
17 - 23 Clay, dark-brown, silty, sandy, pebbly; partly oxidized (till)
23 - 174 Clay, gray, silty, sandy, pebbly; some small gravel strings throughout, unoxidized (till)
174 - 204 Sand and gravel, brown, fine to coarse sand, medium to coarse gravel, mainly quartz and carbonates, many lignite coal fragments (Delton outwash)
204 - 272 Clay, gray, very silty; some fine sand, calcareous
272 - 310 Sand and gravel, brown, coarse sand, medium to coarse gravel, mainly quartz and carbonates, some coal
310 - 310.5 Quartzite(?); hard layer, could not penetrate; no cuttings received, the elevation is consistent with the quartzite surface in this area (Sioux Quartzite)

County: MCCOOK
Legal Location: SW SW SW SW sec. 23, T. 101 N., R. 55 W.
Latitude: 43.3146
Longitude: 97.2424
Driller's Log:
Geologist's Log: X
Drilling Method: ROTARY
Test Hole Number: R2-92-11
SDGS Well Name: R2-92-11
Aquifer:
Screen Length: 10.0
Casing Diameter: 2.0
Total Casing and Screen: 333.0

Well Information: Well screened from 333 to 323 feet below casing top. Hole collapsed at 294 feet. No filter pack added. Bentonite grout from 294 feet to land surface. Cement grout from 20 feet below land surface to ground level. One steel well protector installed.

0 - 26 Clay, brown, silty, sandy, pebbly; oxidized (till)
26 - 196 Clay, gray, silty, sandy, pebbly; unoxidized (till)
196 - 238 Sand and gravel, brown, fine to coarse sand, fine gravel, mainly quartz and carbonates, many shale pebbles, some lignitic coal fragments (Delton outwash)
288  Clay, gray, silty, sandy, pebbly; becoming more silty with depth (till)
333  Sand and gravel, brown to gray-brown, medium sand, coarse gravel, mainly quartz and carbonates, some limy concretionary fragments in cuttings
334  Quartzite; hard, could not penetrate, many pink ortho-quartzite chips in cuttings (Sioux Quartzite)

County: MCCOOK
Legal Location: NE NW NW sec. 27, T. 101 N., R. 55 W.
Latitude: 43.3126
Land Owner:
Project: HANSON BURIED AQUIFER
Drilling Company: SDGS
Driller: G. JENSEN
Geologist: L. SCHULZ
Date Drilled: 05-13-1992
Ground Surface Elevation: 1439 T
Total Drill Hole Depth: 240

Electric Leg Information:
Spontaneous Potential: Single Point Resistivity: X Extra
Samples:
0 - 16  Clay, brown, silty, sandy, pebbly; oxidized (till)
16 - 152  Clay, gray, silty, sandy, pebbly; unoxidized (till)
152 - 181  Sand and gravel, brown, fine to coarse sand, medium to pea-size gravel; mainly quartz and carbonates; much coal (Dellton outwash)
181 - 222  Clay, gray, very silty; some fine sand
222 - 261  Clay, gray, silty, sandy, pebbly; many rocks, much wood in cuttings (till)
261 - 278  Clay and gravel, gray clay, brown gravel, silty; some sand (till)
278 - 286  Clay, gray, silty, sandy, pebbly, gravelly (till)
286 - 318  Clay and gravel, gravelly clay, brown gravel, silty; some sand (till)
318 - 356  Clay, gray, silty, sandy, gravelly (till)
356 - 370  Sand(?); poor return, this interval interpreted from electric log
370 - 404  Clay and silt interbedded, gray to black; silts are calcareous and organic (Split Rock Creek Formation)
404 - 424  Quartzite; much white kaolinite in cuttings, some soft pink clay; weathered (Sioux Quartzite)
424 - 425  Quartzite; hard, could not penetrate, many pink ortho-quartzite chips received in cuttings (Sioux Quartzite)

Location: 101N-55W-28BDDA
Longitude: 97.2717
<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 27</td>
<td>Clay, brown, silty, sandy, pebbly; oxidized (till)</td>
<td></td>
</tr>
<tr>
<td>27 - 144</td>
<td>Clay, gray, silty, sandy, pebbly; unoxidized (till)</td>
<td></td>
</tr>
<tr>
<td>144 - 165</td>
<td>Sand and gravel, brown, coarse sand, fine gravel, mainly quartz and carbonates (Dolton outwash)</td>
<td></td>
</tr>
<tr>
<td>165 - 193</td>
<td>Clay, gray, silty, sandy, pebbly; unoxidized (till)</td>
<td></td>
</tr>
<tr>
<td>193 - 236</td>
<td>Sand and gravel, brown, coarse sand, medium gravel, mainly quartz and carbonates</td>
<td></td>
</tr>
<tr>
<td>236 - 240</td>
<td>Quartzite, hard layer, could not penetrate, many pink ortho-quartzite chips received in cuttings (Sioux Quartzite)</td>
<td></td>
</tr>
</tbody>
</table>

County: MCCOOK  
Legal Location: NE NW NW NE sec. 29, T. 101 N., R. 55 W.  
Latitude: 43.3143  
Land Owner:  
Project: HANSON BURIED AQUIFER  
Drilling Company: SDGS  
Driller: G. JENSEN  
Geologist: L. SCHULZ  
Date Drilled: 05-13-1992  
Ground Surface Elevation: 1442 T  
Total Drill Hole Depth: 198  
USGS Hydrological Unit Code: 10160011  
Electric Log Information:  
Spontaneous Potential:  
Natural Gamma: X  
Samples:  
<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 21</td>
<td>Clay, brown, silty, sandy, pebbly; oxidized (till)</td>
<td></td>
</tr>
<tr>
<td>21 - 85</td>
<td>Clay, gray, silty, sandy, pebbly; unoxidized (till)</td>
<td></td>
</tr>
<tr>
<td>85 - 94</td>
<td>Sand, brown, fine-grained</td>
<td></td>
</tr>
<tr>
<td>94 - 141</td>
<td>Clay, gray, silty, sandy, pebbly; unoxidized (till)</td>
<td></td>
</tr>
<tr>
<td>141 - 193</td>
<td>Silt, clayey; some fine sand</td>
<td></td>
</tr>
<tr>
<td>193 - 198</td>
<td>Quartzite, hard layer, could not penetrate, many pink ortho-quartzite chips received in cuttings (Sioux Quartzite)</td>
<td></td>
</tr>
</tbody>
</table>

Location: 101N-55W-29ABBA  
Longitude: 97.2718  
Driller's Log:  
Geologist's Log: X  
Drilling Method: ROTARY  
Test Hole Number: R2-92-13  
Extra:  
Single Point Resistivity: X