Geologic Data

EXPLORATORY DRILLING, Phase 1 Stage 1
Santee Sioux Water Supply Feasibility Study

Solicitation. 06SQ600125
Santee, Nebraska
I. BACKGROUND

The Bureau of Reclamation (Reclamation) is conducting a Water Supply Feasibility Study for the Santee Sioux Nation. One of the water source options is to draw water from the Missouri River. Reclamation is considering installing a well in an alluvial layer that is hydraulically connected to the Missouri River.

II. Report Data

Three test holes existed along the Missouri River near Santee, NE prior to the Water Supply Feasibility Study (DH-1, DH-2 and TH-2). Their locations are shown on Figure 2. Data from these holes in included in the Design Data for Alternatives Screening, transmitted by letter on December 23, 2005.

Thiele Geotech Inc. of Omaha, NE was contracted to drill and sample three exploration holes in or near the alluvial deposits of the Missouri River at Santee, NE. The contractor successfully completed the first two holes (DH-3 and DH-4) in October 2006, but encountered material in the third hole (DH-5) which required drilling methods other than the specified wash-boring.

After reviewing the initial data, Reclamation decided to contract with Thiele Geotech to finish drilling hole DH-5 using hollow-stem augers and to drill test holes in two additional locations. After receiving Cultural & NEPA Clearance and with cooperative weather, Thiele Geotech remobilized in April, 2007 and completed DH-5 and drilled holes DH-6 and DH-7.

The drill logs, wash gradations, and photos are included in Tabs DH-3 through DH-7.
Figure 2: Exploratory Drilling Locations And Site Access
Santee Sioux Water Supply Feasibility Study

Legend

- Test Hole

Photo: 2003 FSA, Taken on 7-5-2003
DH-3
# Geologic Log of Drill Hole

**Feature:** Santee Water Supply  
**Project:** Spec. No. 065Q600125  
**State:** Nebraska

**Hole No.:** DH-3  
**Location:** Lat: 41° 17' 30"  
**Elev:** 1,322.0'  
**Ground Elevation:** 1,330.0'  
**Angle from Vertical:** 90°  
**Depth of Overburden:** 37.0'  
**Total Depth:** 38.5'  
**Bearing of Angle Hole:** Cast

**Depth or Elev. of Water Table:** Not Obtained  
**Hole Logged By:** Foreman

<table>
<thead>
<tr>
<th>Note</th>
<th>Type and Size of Hole</th>
<th>Recovery (%)</th>
<th>Core Recovery</th>
<th>Percolation Tests</th>
<th>Elevation</th>
<th>Depth</th>
<th>Core Loss</th>
<th>Core Recovery</th>
<th>Classification and Physical Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crazy Peak Site</td>
<td>3&quot;</td>
<td>S = Sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0-18' SANDY Silt, about 80% nonplastic fines and 20% very fine sand; grades sander with depth; saturated below 4'; paper-thin bedding with organic streaks; grayish-brown. (ML)</td>
</tr>
<tr>
<td>Purpose: Evaluate potential water supply source for Village of Santee</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>18-37' SHALEY CHALK, thinly bedded; lightly weathered; medium gray; can be cut with knife and crushed with high finger pressure.</td>
</tr>
<tr>
<td>Driller: Dave Mather of Thiel Geotech of Omaha NE</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>37-38.5 NIOBRARA FORMATION</td>
</tr>
<tr>
<td>Drill Rig:</td>
<td>CME-55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drill Method:</td>
<td>Set 22.5' of 34' ID Hollow stem auger as surface casing. Drive samples taken at 10' intervals beginning at 9.1' using SPT sampler. 140 lb. CME auto-hammer used to advance sampler. Hole advanced 22.5'-37.0' between drive samples with 3&quot; roller bit.</td>
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</tr>
<tr>
<td>Drill Fluid:</td>
<td>150 gallons of water with 1 pint of EZ-mud (antionic polymer).</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completion: Hole backfilled with cuttings. Top section contains mixture of bentonite. Coordinates by GPS; elev. from USGS Quad Sheet.</td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Explanation:**
- **Type of hole:** D = Diamond, H = Hoytellite, S = Shot, C = Churn
- **Hole sealed:** P = Packer, Cm = Cemented, Cs = Bottom of casing
- **Approximate size of hole (X-series):** \( \text{Ex} = \frac{1}{2} \text{ Ax} = 1 \frac{1}{2} \text{ Bx} = 2 \frac{1}{2} \text{ Nx} = 3 \)
- **Approximate size of core (X-series):** \( \text{Ex} = \frac{1}{16} \text{ Ax} = 1 \frac{1}{16} \text{ Bx} = 1 \frac{1}{16} \text{ Nx} = 2 \frac{1}{16} \)
- **Outside diameter of casing (X-series):** \( \text{Ex} = \frac{1}{16} \text{ Ax} = 1 \frac{1}{16} \text{ Bx} = 1 \frac{1}{16} \text{ Nx} = 2 \frac{1}{16} \)
- **Inside diameter of casing (X-series):** \( \text{Ex} = \frac{1}{16} \text{ Ax} = 1 \frac{1}{16} \text{ Bx} = 2 \frac{1}{16} \text{ Nx} = 3 \)
- **Angle Hole**
- **Vertical Hole**
**Grand Island Testing Laboratories**  
Division of Benjamin & Associates, Inc.  
SOIL-BITUMINOUS-CONCRETE TESTING  
SOIL INVESTIGATIONS  
ENVIRONMENTAL AUDITS  
TELEPHONE (308) 382-8463  
3550 WEST OLD HIGHWAY 30  
P.O. BOX 339  
GRAND ISLAND, NEBRASKA 68802  

**DATE:** November 8, 2006  
**NAME OF PROJECT:** Water Supply for the Village of Santee  
**LOCATION:** DH-3  
**TYPE OF TESTS:** WASH GRADATIONS FOR: Bureau of Reclamation-Nebraska/Kansas AO, 203 W. Second Street, Grand Island, NE 68801  

### MECHANICAL ANALYSIS OF MATERIAL

<table>
<thead>
<tr>
<th>SAMPLE DATE</th>
<th>SAMPLE NO.</th>
<th>PERCENT RETAINED:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1&quot;</td>
</tr>
<tr>
<td></td>
<td>S-2</td>
<td>W</td>
</tr>
<tr>
<td>28.5-30.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S-1</td>
<td>W</td>
</tr>
</tbody>
</table>
Photo 1 – Santee Sioux Water Supply Feasibility Study – Exploratory Drilling
Crazy Peak site. View looking from right bank of Missouri River looking downstream (east) towards drill site.
Photo by: R. Schieffer 10/30/2006 Solicitation No. 06SQ600125
Photo 2 – Santee Sioux Water Supply Feasibility Study – Exploratory Drilling
Crazy Peak site. Contractor finished with hole and is removing the hollow-stem auger set casing. (CME-55 rig)
Photo by: R. Schieffer 10/30/2006 Solicitation No. 06SQ600125
DHH-3
28.5-30.0
GEOLOGIC LOG OF DRILL HOLE

FEATURE: SanTEE Water Supply PROJECT, Spec No. 065Q600125
LOCATION: NE WAYNE, T33N R5W
COORDINATES: N 557,381 E 2,575,894 GROUND ELEVATION: 177.8 ANGLE FROM VERTICAL: 90°
TOTAL BEARNG OF ANGLE HOLE: 65.7 DEPTH OF OVERBURDEN: 64.7
DEPTH OR ELEV. OF WATER TABLE: Not Obtained

HOLE NO. DH-4

NOTES
On water table levels, water return, character of drilling etc.

Type of hole: D = Diamond, H = Haystellite, S = Shot, C = Churn
Hole sealed: P = Packer, Cm = Cemented, Ce = Bottom of casing
Approximate size of hole (X-series): \[ \frac{a}{x} + \frac{b}{x} + \frac{c}{x} = \frac{d}{x} \]
Approximate size of core (X-series): \[ \frac{a}{x} + \frac{b}{x} + \frac{c}{x} = \frac{d}{x} \]
Outside diameter of casing (X-series): \[ \frac{a}{x} + \frac{b}{x} + \frac{c}{x} = \frac{d}{x} \]
Inside diameter of casing (X-series): \[ \frac{a}{x} + \frac{b}{x} + \frac{c}{x} = \frac{d}{x} \]

DELTA SITE

Purpose:
Evaluate potential water supply source for Village of SanTEE

Driller:
Dave Mather of Thiele Geotech of Omaha NE

Drill Rig:
CMG55

Drill Method:
Set 22.5' of 3½" ID Hollowstem augers as surface casing.
Drive samples taken at 10' intervals beginning at 9.1' using SPT sampler.
140 lb. auto-hammer used to advance sampler. Hole advanced 22.5-65.0' with 3" roller bit between drive samples.

Drill Fluid:
200 gallons of water, 100 lbs of bentonite, and 1 quart of EZ-mud (antionic polymer).

Completion:
Backfilled hole with drill cuttings
Coordinates by GPS; elev. taken from USGS Quad Sheet.

Sampled for Testing:
0-20' SANDY SILT, about 65% no to low plasticity fines and 35% fine sand, becomes sandier with depth; saturated below 4'; scattered 0.1 to 0.2' interbeds of silty sand and lean clay; random 1/4" pieces of chalk; some rust staining; grayish brown. (ML)

20-40' POORLY GRADED SAND with SILT, about 90% fine sand and 10% non-plastic fines; scattered medium to coarse sand grains; maximum size coarse sand; saturated; gray. (SP-SM)

40-50' POORLY GRADED SAND, about 95% fine to medium sand; maximum size coarse sand; scattered layers of silt and wood at 42'; saturated; medium gray. (SP)

50-64.7' POORLY GRADED SAND, about 95% fine sand and 5% nonplastic fines; scattered 0.1' seams of medium sand, trace of coarse, and silt; maximum size coarse sand, grayish brown; saturated. (SP)

NIABRARA FORMATION

64.7-66.0' CHALK, lightly weathered; gray; separates into thin plates; can be cut with knife; requires high finger pressure to break fragments.

EXPLANATION

HOLE NO. DH-4
**WASH = W**
**DRY = D**

<table>
<thead>
<tr>
<th>SAMPLE DATE</th>
<th>SAMPLE NO.</th>
<th>1&quot;</th>
<th>3/4&quot;</th>
<th>1/2&quot;</th>
<th>3/8&quot;</th>
<th>4</th>
<th>8</th>
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<th>50</th>
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<th>100</th>
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<tbody>
<tr>
<td>23.0-24.5</td>
<td>W</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.3</td>
<td>0.8</td>
<td>0.9</td>
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<td>1.2</td>
<td>1.4</td>
<td>1.5</td>
<td>5.7</td>
<td>10.1</td>
<td>35.2</td>
<td>52.6</td>
<td>83.6</td>
</tr>
<tr>
<td>35.0-36.5</td>
<td>W</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1.0</td>
<td>4.2</td>
<td>75.3</td>
<td>85.9</td>
<td>97.1</td>
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<tr>
<td>45.0-46.0</td>
<td>W</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>4.5</td>
<td>5.6</td>
<td>7.6</td>
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<td>18.8</td>
<td>33.7</td>
<td>66.1</td>
<td>75.8</td>
<td>87.4</td>
<td>91.9</td>
<td>98.4</td>
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<td>55.0-56.5</td>
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<td>2.3</td>
<td>2.8</td>
<td>6.2</td>
<td>9.0</td>
<td>69.7</td>
<td>83.0</td>
<td>96.7</td>
</tr>
</tbody>
</table>
Photo 3 – Santee Sioux Water Supply Feasibility Study – Exploratory Drilling

Delta Site. Photo looking North-Northwest towards drill site. Site location is as far north as possible using a single axle drill rig. Notice cattails and swampy area directly behind the drill rig. (CME-55 rig)

Photo by: R. Schieffer 10/31/2006  Solicitation No. 06SQ600125
**GEOLOGIC LOG OF DRILL HOLE**

**FEATURE** Santee Water Supply  
**PROJECT** Spec. No. 06SD9600125  
**STATE** Nebraska  
**HOLE NO.** DH-5  
**LOCATION** 123456 Sec 1.3 T33N R55E  
**GROUND ELEVATION** 1218  
**ANGLE FROM VERTICAL** 90°

**BEGINNED** 4-10-06  
**FINISHED** 4-03-07  
**DEPTH OF OVERBURDEN** 46'  
**DEPTH** 47.0  
**BEARING OF ANGLE HOLE** Cast

**NOTES** Not Obtained  
**LOG** Hole Logged By Foreman

<table>
<thead>
<tr>
<th>Type of Hole</th>
<th>Core Recovery (%)</th>
<th>Percolation Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Core</td>
<td>Recovery</td>
</tr>
<tr>
<td></td>
<td>From</td>
<td>To</td>
</tr>
</tbody>
</table>

**Boat Ramp Site**

**Purpose:** Evaluate potential water supply source for Village of Santee.

**Driller:** Dave Mather of Thiele Geotech of Omaha NE

**Drill Rig:** CME-55

**Drill Method:**
- Set 22.5' of 34" ID hollow stem augers as surface casing.
- Drive samples taken at 10' intervals beginning at 22.5'
- Using SPT sampler.
- 140 lb. auto-hammer used to advance sampler. Hole advanced 22.5-46' with 3' roller bit between drive samples.

**Drill Fluid:** Water, bentonite, and EZ-mud (anionic polymer)

**Completion:** Backfilled with drill cuttings.

**Coordinates by GPS; elev. taken from USGS Quad Sheet.**

**Explanations**

- D = Diamond, H = Hydastellite, S = Shot, C = Churn
- P = Packer, Cm = Cemented, B = Bottom of casing
- Angle Hole
- Vertical Hole

<table>
<thead>
<tr>
<th>Type of Hole</th>
<th>Core Loss</th>
<th>Core Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hole sealed.</td>
<td>Approximate size of hole (X-series): (Ex = 1\frac{1}{4}''), (Ax = 1\frac{7}{8}''), (Bx = 2\frac{3}{8}''), (Nx = 3'')</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Outside diameter of casing (X-series): (Ex = 1\frac{1}{8}''), (Ax = 2\frac{1}{4}''), (Bx = 2\frac{7}{8}''), (Nx = 3'')</td>
</tr>
</tbody>
</table>

**NIOLARRA FORMATION**

46'-47.0' Chalk, weathered to clay-like indistinct layering, bands of gray and yellow; moldable with fingers.

**Off-Set Hole**

Off-set 10 feet west on 4-03-07: advanced hole to 43' with 34" ID hollow-stem augers, sampled at 43' and advanced augers to 45', advanced roller bit to 46', drive sample 46-47'. Hole backfilled with auger cuttings.
**MECHANICAL ANALYSIS OF MATERIAL**

<table>
<thead>
<tr>
<th>SAMPLE DATE</th>
<th>SAMPLE NO.</th>
<th>DRY</th>
<th>WASH</th>
<th>1&quot;</th>
<th>3/4&quot;</th>
<th>1/2&quot;</th>
<th>3/8&quot;</th>
<th>4</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>16</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>80</th>
<th>100</th>
<th>200</th>
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<tbody>
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<td>S-7 23.5-25.0</td>
<td>W</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
<td>0.9</td>
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<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>4.6</td>
<td>9.5</td>
<td>30.2</td>
<td>39.1</td>
<td>82.5</td>
<td></td>
</tr>
<tr>
<td>S-9 33.5-35.0</td>
<td>W</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1.9</td>
<td>4.6</td>
<td>83.7</td>
<td>89.1</td>
<td>96.5</td>
<td></td>
</tr>
<tr>
<td>S-8 43.5-45.0</td>
<td>W</td>
<td>0</td>
<td>15.1</td>
<td>21.7</td>
<td>30.4</td>
<td>41.5</td>
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<td>51.9</td>
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<td>63.1</td>
<td>78.7</td>
<td>83.4</td>
<td>91.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
- WASH = W
- DRY = D

**DATE:** November 8, 2006

**NAME OF PROJECT:** Water Supply for the Village of Santee DH-5

**LOCATION:**

**TYPE OF TESTS:** WASH GRADATIONS FOR: Bureau of Reclamation-Nebraska/Kansas AO, 203 W. Second Street, Grand Island, NE 68801
Photo 5 – Santee Sioux Water Supply Feasibility Study – Exploratory Drilling

Looking North across the Boat Ramp Site to the South Dakota Bluffs. The Car is the approximate location of the test hole location.

Photo by: R. Schieffer   5/2006   Solicitation No. 06SQ600125
**GEOLOGIC LOG OF DRILL HOLE**

**FEATURE**  Santee Water Supply  
**PROJECT Spec. No. 0638600125**  
**STATE**  Nebraska  
**HOLE NO.**  DH-6  
**LOCATION**  See Notes.  
**COORDINATES**  
**GROUND ELEVATION**  1238  
**DEPTH OF OVERBURDEN**  82.5'  
**TOTAL**  82.5'  
**BEARING OF ANGLE HOLE**  
**DEPTH OR ELEV. OF WATER TABLE**  Est 27'  
**FINISHED**  4-3-07  
**HOE LOGGED BY**  Cast  
**FOREMAN**  

### NOTES
- On water table levels, water return, character of drilling etc.

### RECOVERY
- **Type**  
- **Core Recovery (%)**  

### PERCOLATION TESTS
- **Type**  
- **Core Loss**  
- **Loss in (G.P.M.)**  
- **Length of Test (min)**  
- **Elevation**  

### CLASSIFICATION AND PHYSICAL CONDITION

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10'</td>
<td>SLT, about 90% no to low plasticity fines and 10% fine sand; moist; tight brown; topsoil 0-1.5&quot; (ML)</td>
</tr>
<tr>
<td>10-27'</td>
<td>LEAN CLAY, about 90% fines with medium plasticity and 10% fine sand; scattered lime nodules and chalk; fragments to 3/8&quot;; moist; brown with variations to brown-black; contains old soil horizons; minor rust streaking and lime spots. (CL)</td>
</tr>
<tr>
<td>27-56'</td>
<td>Alternating layers of SANDY SILT, SILTY SAND, and POORLY GRADED SAND, silts and silty sands predominate; layers are 0.3-0.8' thick; Sandy Silts are about 60% fines and 40% fine to coarse sand; silty sands are about 75% fine sand and 25% fines; poorly graded sands are about 90% fine to medium sand with trace of coarse sand and fine gravel; scattered fragments of chalk up to 3&quot;; shades of brown; saturated. (SM, ML, and SP)</td>
</tr>
<tr>
<td>55-70'</td>
<td>SILTY GRAVEL, about 60% fine to coarse sand and gravel with 40% nonplastic fines; max. size recovered 2&quot;, shades of brown, dark gray, and yellow; saturated. (GM)</td>
</tr>
<tr>
<td>70-82.5'</td>
<td>SILTY GRAVEL, about 85% fine to coarse sand and fine to coarse gravel and 15% fines; max. size recovered 2&quot;; dark gray; saturated.</td>
</tr>
<tr>
<td>82.5'</td>
<td>Bit refusal, a few chert shards recovered. Drilling action and shadings interrupted as bedrock surface - Niobrara Fm.</td>
</tr>
</tbody>
</table>

### EXPLANATION
- **Type of hole**: D = Diamond, H = Haystell, S = Shot, C = Churn
- **Hole sealed**: P = Packer, Cm = Cemented, Cs = Bottom of casing
- **Approximate size of hole (X-series)**: \( E_x = 1 \frac{1}{4} '' \), \( A_x = 1 \frac{3}{4} '' \), \( B_x = 2 \frac{1}{8} '' \), \( N_x = 3 '' \)
- **Approximate size of core (X-series)**: \( E_x = 1 \frac{1}{4} '' \), \( A_x = 1 \frac{3}{4} '' \), \( B_x = 1 \frac{3}{4} '' \), \( N_x = 2 \frac{1}{2} '' \)
- **Outside diameter of casing (X-series)**: \( E_x = 1 \frac{1}{4} '' \), \( A_x = 1 \frac{3}{4} '' \), \( B_x = 2 \frac{1}{8} '' \), \( N_x = 3 '' \)
- **Inside diameter of casing (X-series)**: \( E_x = 1 \frac{1}{4} '' \), \( A_x = 1 \frac{3}{4} '' \), \( B_x = 2 \frac{1}{8} '' \), \( N_x = 3 '' \)

**HOLE NO.** DH-6
**MECHANICAL ANALYSIS OF MATERIAL**

| SAMPLE DATE | SAMPLE NO. | WASH | DRY | 1" | 3/4" | 1/2" | 3/8" | 4   | 8   | 10  | 12  | 16  | 20  | 30  | 40  | 50  | 80  | 100 | 200 |
|-------------|------------|------|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| **S-7**     | **29.5-31.0** | **W** | **D** | 5.2 | 12.5 | 19.6 | 25.4 | 37.8 | 50.7 | 53.2 | 56.6 | 62.2 | 66.3 | 68.4 | 71.0 | 71.9 | 73.9 | 74.9 | 77.8 |
| **S-8**     | **34.5-35.0** | **W** | **D** | 0   | 2.2  | 4.9  | 5.6  | 8.7  | 11.5 | 12.0 | 12.8 | 15.7 | 23.5 | 60.5 | 92.9 | 94.5 | 96.2 | 96.6 | 97.4 |
| **S-9**     | **35.5-36.0** | **W** | **D** | 0   | 0   | 0   | 0.5  | 1.3  | 2.4  | 2.5  | 2.6  | 2.8  | 3.0  | 3.9  | 6.1  | 7.3  | 14.7 | 21.1 | 42.9 |
| **S-10**    | **45.0-46.0** | **W** | **D** | 13.8 | 13.8 | 22.0 | 28.4 | 42.3 | 58.3 | 60.2 | 62.3 | 65.5 | 67.6 | 69.2 | 72.9 | 75.5 | 80.8 | 82.5 | 86.5 |
| **S-11**    | **48.5-50.0** | **W** | **D** | 10.5 | 10.5 | 16.8 | 23.7 | 43.3 | 57.6 | 59.6 | 62.0 | 65.7 | 68.6 | 71.3 | 76.5 | 78.4 | 81.6 | 82.7 | 85.6 |
| **S-12**    | **54.5-56.0** | **W** | **D** | 12.0 | 13.1 | 19.4 | 24.8 | 38.0 | 55.1 | 56.8 | 60.4 | 64.8 | 69.9 | 77.0 | 84.9 | 86.7 | 89.0 | 89.6 | 91.3 |
| **S-13**    | **59.5-61.0** | **W** | **D** | 4.6  | 17.5 | 27.5 | 33.3 | 41.5 | 50.4 | 51.6 | 53.1 | 55.3 | 57.8 | 62.4 | 69.5 | 72.6 | 78.5 | 80.4 | 84.8 |
| **S-14**    | **64.5-66.0** | **W** | **D** | 35.3 | 39.8 | 46.5 | 51.8 | 62.1 | 71.3 | 72.9 | 74.7 | 77.2 | 79.8 | 83.0 | 86.0 | 87.2 | 89.2 | 90.0 | 92.3 |
| **S-15**    | **74.5-76.0** | **W** | **D** | 13.5 | 16.5 | 27.0 | 38.8 | 56.0 | 67.7 | 68.9 | 70.3 | 72.7 | 74.6 | 76.5 | 79.0 | 80.7 | 87.1 | 89.4 | 92.9 |
Photo 6 – Santee Sioux Water Supply Feasibility Study – Exploratory Drilling
Looking West at the Recreation Area Site. Notice the new walking trail to the right and the main East/West Road to the left.
Photo by: L. Cast  4/2007  Solicitation No. 06SQ600125
**GEOLOGIC LOG OF DRILL HOLE**

**FEATURE**
Santee Water Supply

**HOLE NO.**
DH-7

**LOCATION**
See Notes

**COORDINATES**

**GROUND ELEVATION**
1200

**TOTAL DEPTH OF OVERBURIEN**
57.0

**BEARING OF ANGLE HOLE**

**DEPTH OR ELEV. OF WATER TABLE**
29' Est.

**LOG CLASSIFICATION AND PHYSICAL CONDITION**

<table>
<thead>
<tr>
<th>DEPTH (FT)</th>
<th>CORE RECOVERY (%)</th>
<th>PERCOLATION TESTS</th>
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<tbody>
<tr>
<td>FROM</td>
<td>TO</td>
<td>(G.P.M.)</td>
</tr>
<tr>
<td>0-2</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>0-2</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2-17</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>2-17</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>17-25</td>
<td>50</td>
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</tr>
<tr>
<td>17-25</td>
<td>60</td>
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<tr>
<td>25-33</td>
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<tr>
<td>57.0</td>
<td>150</td>
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</table>

**EXPLANATION**

Type of hole
- D = Diamond, H = Haystellite, S = Shot, C = Churn
- Hole sealed
- P = Packer, Cm = Cemented, Cs = Bottom of casing

Approximate size of hole (X-series)
- Ex = \( \frac{1}{2} \), Ax = \( \frac{1}{4} \), Bx = \( \frac{1}{4} \), Nx = \( \frac{1}{4} \)

Approximate size of core (X-series)
- Ex = \( \frac{1}{2} \), Ax = \( \frac{1}{4} \), Bx = \( \frac{1}{4} \), Nx = \( \frac{1}{4} \)

Outside diameter of casing (X-series)
- Ex = \( \frac{1}{2} \), Ax = \( \frac{1}{4} \), Bx = \( \frac{1}{4} \), Nx = \( \frac{1}{4} \)

Inside diameter of casing (X-series)
- Ex = \( \frac{1}{2} \), Ax = \( \frac{1}{4} \), Bx = \( \frac{1}{4} \), Nx = \( \frac{1}{4} \)

**ELEVATION**

0-2: LEAN CLAY, Topsoil, about 95% fines with low plasticity; max. size noted medium sand; moist; black; some organic material. (CL)

2-17: LEAN CLAY, about 90% fines with low plasticity and 10% fine sand; scattered lime nodules to 1/8"; tan; dry-moist. (CL)

17-25: LEAN CLAY with layers of gravel, considerable drill chatter and short intervals of slow advancement; maximum size recovered 1/2".

25-33: POORLY GRADED GRAVEL with SILT, about 60% fine gravel with some coarse grains; 30% fine to coarse sand, and 10% nonplastic fines; max. size recovered 1.5"; grains are subrounded to rounded; saturated at 29'; dark brown; (GM)

33-37: POORLY GRADED SAND, about 95% fine to medium sand with some coarse sand and fine gravel and 5% nonplastic fines; max. size recovered 3/4"; particles are subrounded to rounded; saturated; tan with black specks. (SP)

37-54: POORLY GRADED GRAVEL with SILT, about 60% fine to coarse gravel, 30% fine to coarse sand, and 10% nonplastic fines; max. size recovered 1"; particles are subrounded to rounded; saturated; dark grayish brown.

54-57: SILTY SAND, about 85% fine to medium sand, predominately fine; trace of coarse sand and fine gravel, and 15% fines with no to low plasticity max. size recovered 1/2"; dark brown; saturated. (SM)

57.0 Bit refusal; drilling action interpreted as bedrock surface - Niobrara Formation.
## Water Supply for the Village of Santee DH-7

### Mechanical Analysis of Material

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>Sample No.</th>
<th>WASH = W</th>
<th>DRY = D</th>
<th>Percent Retained</th>
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<td>1&quot;</td>
<td>3/4&quot;</td>
<td>1/2&quot;</td>
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<tr>
<td>8-1 29.5-31.0</td>
<td>W</td>
<td>13.1</td>
<td>15.5</td>
<td>25.7</td>
</tr>
<tr>
<td>S-2 34.5-36.0</td>
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<td>4.4</td>
<td>6.0</td>
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<tr>
<td>S-4 44.5-46.0</td>
<td>W</td>
<td>15.4</td>
<td>16.9</td>
<td>28.0</td>
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<td>S-5 49.5-51.0</td>
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<td>16.3</td>
<td>18.0</td>
<td>22.3</td>
</tr>
<tr>
<td>S-6 54.5-56.0</td>
<td>W</td>
<td>0</td>
<td>3.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Photo 7 – Santee Sioux Water Supply Feasibility Study – Exploratory Drilling

Looking East at the Irrigation Well Site. The fenced-in area is a local storage unit.
Photo by: L. Cast  4/2007  Solicitation No. 06SQ600125