U.S. Department of the Interior
U.S. Geological Survey

HYDROGEOLOGIC AND WATER-QUALITY DATA, UPPER SIOUX INDIAN COMMUNITY, SOUTHWESTERN MINNESOTA, 1994-96

By Michael L. Strobel and Lisa M. Pottenger

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In cooperation with the Upper Sioux Indian Community

Mounds View, Minnesota
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CONVERSION FACTORS AND UNITS OF CONCENTRATION

Multiply	By	To obtain
foot (ft)	0.3048	meter
acre	4.047×10^{-3}	square kilometer
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
degree Fahrenheit (°F)	(°F-32)/1.8	degree Celsius (°C)

Concentrations of chemical constituents in water samples are given in milligrams per liter (mg/L) and in micrograms per liter (µg/L). Milligrams per liter is a unit that expresses the concentration of a chemical constituent in solution as the mass (milligrams) of the constituent per unit volume (liter) of water. One milligram per liter is equal to 1,000 micrograms per liter.

DEFINITION OF TERMS

Alkalinity. Capacity for neutralizing acid and commonly reported as an equivalent amount of calcium carbonate ($CaCO_3$). This property is attributed to dissolved species of carbon dioxide if the pH of the water is less than 9.5.

Aquifer. A geological formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Bacteria. Microscopic unicellular organisms, typically spherical, rodlike, or spiral and threadlike in shape, often clumped into colonies. Some bacteria cause disease, while others perform an essential role in nature in the recycling of materials; for example, by decomposing organic matter into a form available for reuse by plants.

Dissolved. The material in a representative water sample that passes through a 0.45-µm (micrometer) membrane filter. Determinations of "dissolved" constituents are made on subsamples of the filtrate.

Dissolved-solids concentration. Determined either analytically by the "residue-on-evaporation" method, or mathematically by totaling the concentrations of individual constituents reported in a comprehensive chemical analysis. During the analytical determination of dissolved solids, the bicarbonate (generally a major dissolved component of water) is converted to carbonate. Therefore, in the mathematical calculation of dissolved-solids concentration, the bicarbonate value, in milligrams per liter, is multiplied by 0.492 to reflect the change.

Fecal coliform bacteria. Bacteria that are present in the intestines or feces of warm-blooded animals. They are often used as indicators of the sanitary quality of water. In the laboratory they are defined as all organisms that produce blue colonies within 24 hours when incubated at 44.5°C ± 0.2°C on M-FC medium (nutrient medium for bacterial growth). Their concentrations are expressed as number of colonies per 100 mL (milliliter) of sample.

Fecal streptococcal bacteria. Bacteria that are present in the intestines of warm-blooded animals. Their presence in water is considered to verify fecal pollution. They are characterized as Gram-positive, *cocci* bacteria, which are capable of growth in brain-heart infusion broth. In the laboratory they are defined as all organisms that produce red or pink colonies within 48 hours at 35°C ± 1.0°C on KF-streptococcus medium (nutrient medium for bacterial growth). Their concentrations are expressed as number of colonies per 100 mL of sample.

Hardness. A physical-chemical characteristic of water that is commonly recognized by the increased quantity of soap required to produce lather. It is attributable to the presence of alkaline earths (principally calcium and magnesium) and is expressed as equivalent calcium carbonate ($CaCO_3$).

Parameter code. A 5-digit number used in the U.S. Geological Survey computerized data system, WATSTORE, to uniquely identify a specific constituent. The codes used in WATSTORE are the same as those used in the U.S. Environmental Protection Agency data system, STORET. The U.S. Environmental Protection Agency assigns and approves all requests for new codes. Parameter codes are presented in table 4.

Particle-size classification (texture). The classification used in this report agrees with recommendations made by the American Geophysical Union Subcommittee on Sediment Terminology. The classification is (size is in millimeters):

Classification	Size (mm)	Method of analysis
Clay	0.00024 - 0.004	Sedimentation
Silt	0.004 - 0.062	Sedimentation
Sand	0.062 - 2.0	Sedimentation of sieve
Gravel	2.0 - 64.0	Sieve

The particle-size distribution given in this report is not necessarily representative of all particles in the geologic unit. Most organic matter is removed and the sample is subjected to mechanical and chemical dispersion before analysis.

Percent composition. A unit for expressing the ratio of a particular part of a sample or population to the total sample or population in terms of types, numbers, mass, or volume.

Pesticides. Chemical compounds used to control undesirable organisms. Major categories of pesticides include insecticides, miticides, fungicides, herbicides, and rodenticides.

pH. A measure of the acidity (or alkalinity) of a solution; it is equal to the negative logarithm of the concentration of hydrogen ions in the solution. A pH of 7.0 indicates a neutral solution; a pH value lower than 7.0 indicates an acid solution; and a pH value greater than 7.0 indicates an alkaline solution.

Sea level. Refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Specific conductance. A measure of the ability of water to conduct an electrical current. It is expressed in microsiemens per centimeter (µS/cm) at 25°C. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved-solids content of the water. Commonly, the concentration of dissolved solids (in milligrams per liter) is about 65 percent of the specific conductance (in microsiemens). This relation is not constant, and may vary in the same source with changes in the composition of the water.

Total. The total amount of a given constituent in a representative sample, regardless of the constituent's physical or chemical form. This term is used only when the analytical procedure assures measurement of at least 95 percent of the constituent present in both the dissolved and suspended phases of the sample. A knowledge of the expected form of the constituent in the sample, as well as the analytical methodology used, is required to judge when the results should be reported as "total."

Hydrogeologic and Water-Quality Data, Upper Sioux Indian Community, Southwestern Minnesota, 1994-96

By Michael L. Strobel and Lisa M. Pottenger

Abstract

This report presents data on hydrogeology and water quality at the Upper Sioux Indian Community, located along the Minnesota River in southwestern Minnesota. Data were collected during 1994-96 by the U.S. Geological Survey in cooperation with the Upper Sioux Indian Community. The data will serve as a reference to monitor potential changes in hydrogeologic and water-quality conditions at the Community. The data include: (1) river stage in Hazel Creek; (2) a geologic log at a test hole near the Community; (3) texture analysis of selected samples from auger cuttings at the test hole; (4) specific conductance, pH, temperature, dissolved oxygen, and hardness measurements in water samples collected from 16 ground-water sites and 5 surface-water sites; (5) cation, anion, and trace-metal concentrations in water samples from 16 ground-water sites and 5 surface-water sites; (6) fecal coliform and fecal streptococcal bacteria colony counts in water samples from 9 ground-water sites; (7) nutrient concentrations in water samples from 16 ground-water sites and 5 surface-water sites; and (8) pesticide concentrations in water samples from 6 ground-water sites.

INTRODUCTION

The Upper Sioux Indian Community (hereinafter referred to as the Community) encompasses an area of 912 acres, is located in southwestern Minnesota, and lies within the Minnesota River valley and the adjacent upland area south of the river (fig. 1). The population of the Community is 200. The primary economic activities at the Community are tourism, gaming, and agriculture. The casino is a major user of water resources in the area.

The primary source of water for the Community is ground water. The Community wells are open to either the confined bedrock aquifer or shallow glacial aquifers. The Community concern regarding future water demand, assessment of the shallow ground-water and surface-water sources, and water-quality conditions prompted this investigation. Surface-water, geologic, and water-quality data were collected and analyzed for the Upper Sioux Indian Community during 1994-96 by the U.S. Geological Survey (USGS) in cooperation with the Upper Sioux Indian Community.

Purpose and Scope

The purpose of this report is to list hydrogeologic and water-quality data collected from 1994-96 at the Upper Sioux Indian Community. Data include: (1) river stage in Hazel Creek; (2) a geologic log at a test hole near the Community; (3) texture analysis of selected samples from auger cuttings at the test hole; (4) specific conductance, pH, temperature, dissolved oxygen, and hardness measurements in water samples collected from 16 ground-water sites and 5 surface-water sites; (5) cation, anion, and trace-metal concentrations in water samples from 16 ground-water sites and 5 surface-water sites; (6) fecal coliform and fecal streptococcal bacteria colony counts in water samples from 9 ground-water sites; (7) nutrient concentrations in water samples from 16 ground-water sites and 5 surface-water sites; and (8) pesticide concentrations in water samples from 6 ground-water sites.

Location and Description of Study Area

The study area covers about 4 mi^2 (fig. 1). The Community, which is within the study area, is located partially on the southern high bluff and partially within the wide valley of the Minnesota River. The area within the Minnesota River valley is flood plain characterized by woodlands, wetlands, and cultivated lands. The upland area consists of grasslands, cultivated land, wetlands, and residential areas. The escarpment separating these two areas is steep and has a vertical elevation change of over 170 ft. The area surrounding the Minnesota River valley mainly is used for agricultural production.

Within the study area, the topography changes from slightly rolling hills and glacial drift plain in the uplands to

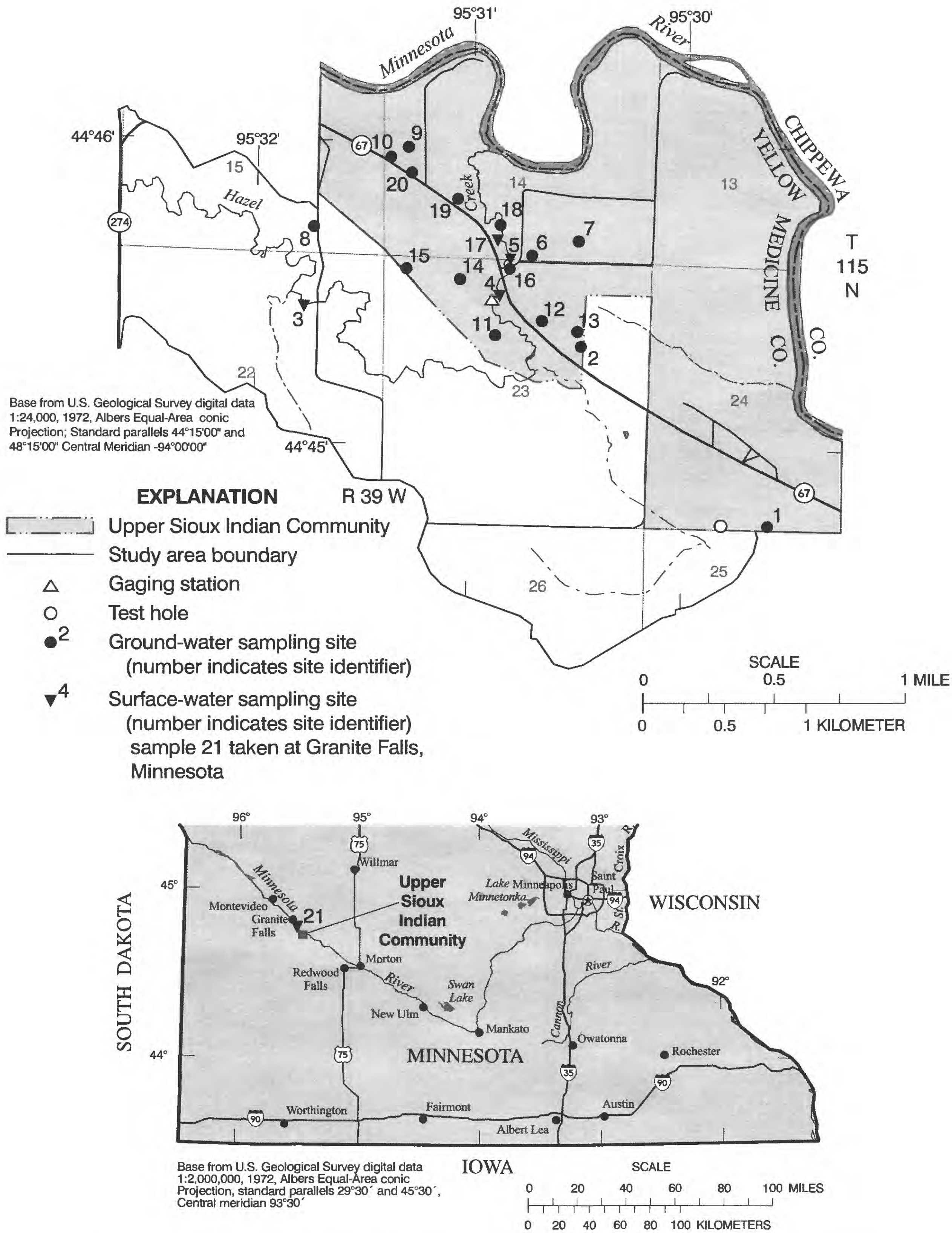

Figure 1. Location of study area and sampling sites at the Upper Sioux Indian Community, southwestern Minnesota, 1994-96.

relatively flat topography in the river valley. As much as 180 ft of glacial drift overlies Precambrian and Cretaceous bedrock in the uplands. The bedrock is exposed along the escarpment that forms the southern edge of the Minnesota River valley. Within the valley, alluvial deposits, as much as 50 ft thick, overlie Precambrian bedrock. Numerous shallow lakes and wetlands formed on the hummocky surface of the glacial drift in the uplands. Along the escarpment, ground-water discharge from glacial and bedrock aquifers provides flow to springs, which drain to the Minnesota River.

Methods of Investigation

Stage measurements in Hazel Creek (station number 444529095305101) were measured using a staff gage installed in 1994 (table 1). The measurements were taken daily during November 1994 through October 1995, except when the Creek was frozen.

A test hole was drilled in the southeastern part of the study area to 180 ft on May 19, 1995 (fig. 1). The geologic log for the test hole is listed in table 2. Selected samples collected during the test drilling were analyzed for texture (table 3) by the University of North Dakota in Grand Forks.

Water samples were collected from streams and ground water during 1995-96 and analyzed for cations, anions, trace metals, nutrients, and pesticides at the USGS National Water Quality Laboratory in Arvada, Colorado (table 4, on floppy disk located on the back cover of this report). Water samples were collected, treated, and stored in accordance with procedures described by Fishman and Friedman (1989). Water samples from streams were collected below the surface near the center of the stream. Water samples from wells were collected using a peristaltic pump or the *in-situ* pump after a minimum of three well volumes of water was purged. Field measurements of specific conductance, pH, temperature, and dissolved oxygen were made with portable, multiparameter meters calibrated at the start of each sampling day. Fecal coliform and fecal streptococcal bacteria in water samples were measured at the USGS laboratory in Mounds View, Minnesota. The samples were incubated in a nutrient medium for bacteria growth and concentrations expressed in number of colonies per 100 milliliter of sample.

Water-quality analyses are listed in table 4 on the 3-1/2 in. floppy disk located on the back cover of this report. Constituents that were present at a concentration less than the reporting limit are reported as < (less than).

Two blank and two replicate samples were collected and analyzed for cations and anions, trace metals, and nutrients to verify quality assurance of the analytical results reported by the USGS National Water Quality Laboratory. The blank and replicate samples were subjected to the same processing, handling, and equipment as sample water. The quality-assurance analyses indicated that samples were not cross-contaminated by equipment between visits to sample sites and that analytical results for water samples reported by the USGS National Water Quality Laboratory were reproducible to within 5 percent.

REFERENCE CITED

Fishman, M.J., and Friedman, L.C., 1989, Methods for the determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

Table 1. Stage measurements in Hazel Creek (station number 444529095305101), Upper Sioux Indian Community, southwestern Minnesota, 1994-95

[Datum on staff gage is at 883.10 feet above sea level. Measurements are in feet above datum. mm/dd/yy, month, date, year]

Date (mm/dd/yy)	Time	Stage	Date (mm/dd/yy)	Time	Stage	Date (mm/dd/yy)	Time	Stage
11/17/94	1410	0.20	3/17/95	1400	0.96	4/18/95	1700	2.50
12/06/94	1410	0.52	3/18/95	1200	0.88	4/19/95	1300	2.58
12/07/94	1445	0.54	3/19/95	1600	0.80	4/20/95	1500	2.66
12/08/94	1400	0.60	3/20/95	1830	0.80	4/21/95	1300	2.92
12/09/94	1445	0.64	3/21/95	1600	0.76	4/22/95	1600	2.82
12/10/94	1640	Frozen	3/22/95	0900	0.72	4/23/95	1500	2.56
12/11/94	0830	Frozen	3/23/95	1100	0.70	4/24/95	1600	2.38
12/12/94	0830	Frozen	3/24/95	1400	1.64	4/25/95	1200	2.16
12/13/94	0830	Frozen	3/25/95	1030	1.20	4/26/95	1700	2.08
12/14/94	0830	Frozen	3/26/95	1100	1.16	4/27/95	1400	2.04
12/15/94	0830	Frozen	3/27/95	0930	2.60	4/28/95	1600	1.98
12/16/94	0830	Frozen	3/28/95	1230	2.30	4/29/95	1000	1.90
12/17/94	0830	Frozen	3/29/95	1730	1.96	4/30/95	1200	1.84
12/18/94	0830	Frozen	3/30/95	1600	1.72	5/01/95	1400	1.80
12/19/94	0830	Frozen	3/31/95	0930	1.58	5/02/95	1600	1.76
12/20/94	0830	Frozen	4/01/95	1600	1.44	5/03/95	1400	1.68
12/21/94	0830	Frozen	4/02/95	1600	1.36	5/04/95	1300	1.62
12/22/94	0830	Frozen	4/03/95	1200	1.24	5/05/95	1100	1.56
12/23/94	0830	Frozen	4/04/95	1300	1.10	5/06/95	1000	1.60
12/24/94	0830	Frozen	4/05/95	1200	1.14	5/07/95	0800	1.62
12/25/94	0830	Frozen	4/06/95	1530	1.12	5/08/95	1000	1.66
12/26/94	0830	Frozen	4/07/95	1400	1.08	5/09/95	1400	1.78
12/27/94	0830	Frozen	4/08/95	1400	1.10	5/10/95	0900	1.84
12/28/94	0830	Frozen	4/09/95	1600	1.14	5/11/95	1300	2.02
12/29/94	0830	Frozen	4/10/95	1300	1.24	5/12/95	1500	2.10
12/30/94	0830	Frozen	4/11/95	1900	1.36	5/13/95	1600	2.08
12/31/94	0830	Frozen	4/12/95	1500	1.66	5/14/95	0800	2.04
3/12/95	1400	3.14	4/13/95	1300	1.96	5/15/95	1000	2.00
3/13/95	1400	2.86	4/14/95	1600	2.62	5/16/95	1200	1.96
3/14/95	1000	2.08	4/15/95	1400	2.66	5/17/95	1400	1.92
3/15/95	1800	1.86	4/16/95	1600	2.62	5/18/95	1600	1.86
3/16/95	1200	1.10	4/17/95	1300	2.58	5/19/95	1000	1.80

Table 1. Stage measurements in Hazel Creek (station number 444529095305101), Upper Sioux Indian Community, southwestern Minnesota, 1994-95—Continued

[Datum on staff gage is at 883.10 feet above sea level. Measurements are in feet above datum. mm/dd/yy, month, date, year]

Date (mm/dd/yy)	Time	Stage	Date (mm/dd/yy)	Time	Stage	Date (mm/dd/yy)	Time	Stage
5/20/95	0800	1.76	6/24/95	1600	1.62	8/22/95	1000	0.92
5/21/95	1400	1.60	7/21/95	0630	2.08	8/23/95	1300	0.88
5/22/95	1600	1.48	7/22/95	1200	1.96	8/24/95	1400	0.90
5/23/95	1000	1.36	7/23/95	1500	1.90	8/25/95	0900	0.94
5/24/95	0800	1.30	7/24/95	2000	1.84	8/26/95	1600	0.98
5/25/95	0900	1.26	7/25/95	1600	1.76	8/27/95	1300	1.06
5/26/95	1200	1.18	7/26/95	1830	1.64	8/28/95	1500	1.02
5/27/95	1300	1.30	7/27/95	1100	1.66	8/29/95	1000	0.98
5/28/95	0900	1.56	7/28/95	1800	1.54	8/30/95	1200	0.92
5/29/95	1700	1.70	7/29/95	1330	1.46	8/31/95	1330	0.96
5/30/95	1500	1.86	7/30/95	1000	1.40	9/01/95	1600	0.88
6/01/95	1000	1.92	7/31/95	1900	1.36	9/02/95	1800	0.86
6/02/95	1400	2.02	8/01/95	1600	1.32	9/03/95	1000	0.80
6/03/95	0900	2.08	8/02/95	1000	1.28	9/04/95	1300	0.84
6/04/95	1000	2.10	8/03/95	1800	1.20	9/05/95	1600	0.80
6/05/95	1200	2.04	8/04/95	1600	1.26	9/06/95	1730	0.78
6/06/95	1300	1.96	8/05/95	2030	1.34	9/07/95	1000	0.80
6/07/95	1400	1.90	8/06/95	1900	1.26	9/08/95	1400	0.76
6/08/95	1600	1.86	8/07/95	1800	1.18	9/09/95	1600	0.74
6/10/95	0900	1.80	8/08/95	1600	1.10	9/10/95	0900	0.70
6/11/95	1200	1.78	8/09/95	1900	1.02	9/11/95	1100	0.78
6/12/95	1600	1.70	8/10/95	1600	0.94	9/12/95	1200	0.82
6/13/95	1000	1.66	8/11/95	2000	0.86	9/13/95	1400	0.86
6/14/95	1100	1.80	8/12/95	1900	0.82	9/14/95	0900	0.80
6/15/95	1300	1.88	8/13/95	1300	0.88	9/15/95	1100	0.84
6/16/95	1600	2.00	8/14/95	2000	1.04	9/16/95	1000	0.90
6/17/95	1800	2.12	8/15/95	1300	1.06	9/17/95	1400	0.94
6/18/95	1200	2.06	8/16/95	1600	1.02	9/18/95	1600	0.92
6/19/95	1600	2.04	8/17/95	1000	1.08	9/19/95	1100	0.92
6/20/95	1200	1.98	8/18/95	1730	1.12	9/20/95	1500	0.88
6/21/95	1300	1.96	8/19/95	1500	1.08	9/21/95	1700	0.84
6/22/95	1000	1.84	8/20/95	1800	1.00	9/22/95	0900	0.80
6/23/95	0900	1.76	8/21/95	1200	0.96	9/23/95	1300	0.86

Table 1. Stage measurements in Hazel Creek (station number 444529095305101), Upper Sioux Indian Community, southwestern Minnesota, 1994-95—Continued

[Datum on staff gage is at 883.10 feet above sea level. Measurements are in feet above datum. mm/dd/yy, month, date, year]

Date (mm/dd/yy)	Time	Stage	Date (mm/dd/yy)	Time	Stage	Date (mm/dd/yy)	Time	Stage
9/24/95	1100	0.90	10/01/95	0900	2.84	10/08/95	1300	2.48
9/25/95	1600	0.96	10/02/95	1100	2.88	10/09/95	1700	2.26
9/26/95	1300	0.92	10/03/95	1300	2.92	10/10/95	0900	2.18
9/27/95	1500	0.86	10/04/95	1600	2.86	10/11/95	1600	2.12
9/28/95	0800	0.88	10/05/95	0900	2.80	10/12/95	1000	2.08
9/29/95	1000	0.92	10/06/95	1400	2.74			
9/30/95	0600	0.96	10/07/95	1500	2.66			

Table 2. Geologic log of test hole drilled at the Upper Sioux Indian Community, southwestern Minnesota, May 19, 1995

Description	Depth below land-surface datum (feet)
Soil, black	0-2
Clay, yellow/tan	2-18
Clay, gray/brown, some sand and gravel	18-25
Cobble	25-26
Clay, chocolate brown	26-29
Clay, gray, moist, some sand and gravel	29-35
Clay, yellow, moist	35-45
Clay, yellow, some sand and gravel	45-63
Clay, brown	63-75
Till, gray	75-90
Sand and gravel, coarse to pebbly, brown/gray	90-100
Sand and gravel, medium to pebbly, clean, rounded	100-105
Sand, gray, fine to coarse, trace gravel	105-110
Clay, gray, some sand decreasing in abundance downward	110-130
Clay, gray-black, and regolith	130-140
Clay, gray-black, with lignite	140-145
Siltstone, light gray, sandy	145-150
Sandstone, gray, decomposed, fine to very coarse	150-160
Shale, light gray, some fine sand	160-165
Sandstone, light gray, fine, with gray and red clay	165-177
Regolith, green/blue clay	177-180

Table 3. Texture analysis from drill cuttings sampled at the Upper Sioux Indian Community, southwestern Minnesota, 1995

Depth of sampled interval (feet below land surface)	Percent gravel	Percent sand	Percent silt	Percent clay
17-18	5.6	5.2	71.7	17.5
18-25	3.2	33.8	43.2	19.9
26-29	5.0	38.5	31.0	25.4
30-35	0.2	12.3	54.4	33.1
50-55	1.9	32.4	31.5	34.2
63-65	0.1	4.0	65.1	30.8
80-85	1.6	19.4	37.0	41.9
85-90	5.0	38.5	23.2	33.3
90-95	33.1	59.8	2.7	4.4
95-100	47.0	45.8	3.9	3.3
100-105	31.2	66.8	0.9	1.1
105-110	11.8	85.8	0.2	2.2
110-115	14.7	21.8	39.2	24.3
120-125	0.6	4.2	40.2	55.0

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