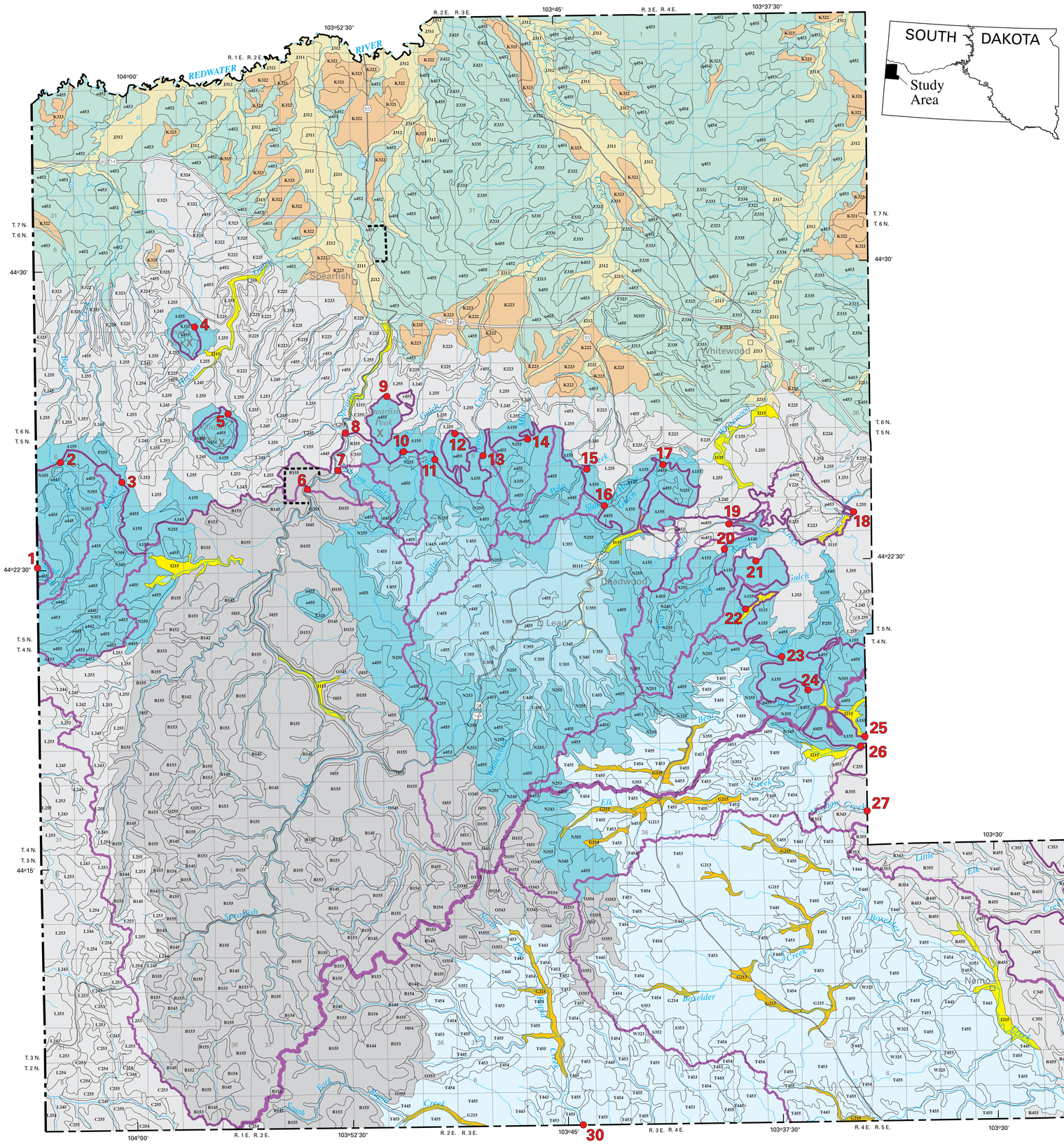
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
LAWRENCE COUNTY AND THE CITY OF SPEARFISH

WATER-RESOURCES INVESTIGATIONS REPORT 00-4103
Sensitivity of ground water to contamination —PLATE 1
Putnam, L.D., 2000, Sensitivity of Ground Water to Contamination in Lawrence County, South Dakota



EXPLANATION

Hydrogeologic Settings by Ground-Water Region (table 1)

Western Mountain Ranges Ground-Water Region

- Mountain Slopes-East (Ms-e)
- Mountain Slopes-North (Ms-n)
- Alluvial Mountain Valleys-East (Amv-e)
- Alluvial Mountain Valleys-North (Amv-n)

Nonglaciated Central Ground-Water Region

- Igneous Domes (Id)
- Limestone Plateau (Lp)
- Mountain Flanks (Mf)
- Alluvial Mountain Valleys (Amv)
- Alternating Sandstone, Limestone, and Shale-Thin Soil (Sls)
- Unconsolidated or Semi-Consolidated Deposits (Usd)
- River Alluvium without Overbank Deposits (Ra)

B324 **Sensitivity-unit code**

- B **Alphabetic character represents hydrogeologic unit (table 5)**
- 3 **First digit represents recharge-rate group (table 9)**
- 2 **Second digit represents depth-to-water group (tabel 11)**
- 4 **Third digit represents land-surface-slope group (table 12)**

Drainage basin boundary

Drainage subbasin boundary

Example area as discussed in text

18 Drainage area site--Number is site identification (table 13)

Hydrogeologic Unit—Alphabetic character in code

Hydro-geologic unit	Hydro-geologic setting	Geologic unit	Relative Sensitivity Ratings: Aquifer media	Unsaturated media	Hydraulic conductivity
A	Id	**Madison Limestone**—Limestone, more dolomitic with depth. Generally massive, karstic, and cavernous in upper part. **Englewood Formation**—Dolomitic limestone	10	10	8
B	Lp	**Madison Limestone**—Limestone, more dolomitic with depth. Generally massive, karstic, and cavernous in upper part. **Englewood Formation**—Dolomitic limestone	10	10	6
C	Mf	**Madison Limestone**—Limestone, more dolomitic with depth. Generally massive, karstic, and cavernous in upper part. **Englewood Formation**—Dolomitic limestone	10	10	6
D	Lp	**Madison Limestone**—Limestone, more dolomitic with depth. Generally massive, karstic, and cavernous in upper part. **Englewood Formation**—Dolomitic limestone	9	10	4
E	Mf	**Minnekahta Limestone**—Massive laminated crystalline limestone	8	9	4
F	Sls	**Minnekahta Limestone**—Massive laminated crystalline limestone	8	9	4
G	Amv-e	**Alluvium**—Clay, silt, sand, and gravel	7	9	10
H	Amv-n	**Alluvium**—Clay, silt, sand, and gravel	7	9	10
I	Amv	**Alluvium**—Clay, silt, sand, and gravel	7	8	10
J	Ra	**Alluvium**—Clay, silt, sand, and gravel	7	7	10
K	Usd	**Gravel deposits**—Clay, silt, sand, and gravel	7	5	6
L	Mf	**Minnelusa Formation**—Cross stratified sandstone, limestone, dolomite, and shale. Gypsum at top of formation. Lower part of formation is interbedded limestone and shale	7	5	4
M	Sls	**Minnelusa Formation**—Cross stratified sandstone, limestone, dolomite, and shale. Gypsum at top of formation. Lower part of formation is interbedded limestone and shale	7	5	2
N	Id	**Deadwood Formation**—Sandstone, shale, limestone, and local conglomerate at base	7	5	1
O	Lp	**Deadwood Formation**—Sandstone, shale, limestone, and local conglomerate at base	6	5	1
P	Id	**Minnelusa Formation**—Cross stratified sandstone, limestone, dolomite, and shale. Gypsum at top of formation. Lower part of formation is interbedded limestone and shale	5	5	1
Q	Lp	**Minnelusa Formation**—Cross stratified sandstone, limestone, dolomite, and shale. Gypsum at top of formation. Lower part of formation is interbedded limestone and shale	5	5	1
R	Mf	**Deadwood Formation**—Sandstone, shale, limestone, and local coglomerate at base	5	5	1
S	Ms-e	**Deadwood Formation**—Sandstone, shale, limestone, and local coglomerate at base	5	5	1
T	Ms-e	**Igneous and metamorphic rocks**—Schist, slate, quartzite, amphibolite, diorite, granite, and pegmatite	4	5	1
U	Ms-n	**Igneous and metamorphic rocks**—Schist, slate, quartzite, amphibolite, diorite, granite, and pegmatite	4	5	1
V	Mf	**Igneous and metamorphic rocks**—Schist, slate, quartzite, amphibolite, diorite, granite, and pegmatite	4	5	1
W	Ms-e	**Colluvium**—Talus and other debris associated with mass wasting	6	4	4
X	Id	**Colluvium**—Talus and other debris associated with mass wasting	6	4	4
Y	Mf	**Colluvium**—Talus and other debris associated with mass wasting	6	4	4
Z	Sls	**Inyan Kara Group (Fall River Formation** and **Lakota Formation)**—Sandstone and other clastic rocks	6	4	1
a	Id	**Tertiary intrusive igneous rocks**—Undifferentiated intrusive igneous rocks including rhyolite, latite, trachyte, and phonolite	4	4	1
b	Ms-e	**Tertiary intrusive igneous rocks**—Undifferentiated intrusive igneous rocks including rhyolite, latite, trachyte, and phonolite	4	4	1
c	Ms-n	**Tertiary intrusive igneous rocks**—Undifferentiated intrusive igneous rocks including rhyolite, latite, trachyte, and phonolite	4	4	1
d	Id	**Whitewood Formation**—Limestone and dolomite. **Winnipeg Formation**—Shale with interbedded siltstone	4	4	1
e	Mf	**Whitewood Formation**—Limestone and dolomite. **Winnipeg Formation**—Shale with interbedded siltstone	4	4	1
f	Lp	**Whitewood Formation**—Limestone and dolomite. **Winnipeg Formation**—Shale with interbedded siltstone	4	4	1

Hydrogeologic Unit—Alphabetic character in code (continued)

Hydro-geologic unit	Hydro-geologic setting	Geologic unit	Relative Sensitivity Ratings: Aquifer media	Unsaturated media	Hydraulic conductivity
g	Mf	**Whitewood Formation**—Limestone and dolomite. **Winnipeg Formation**—Shale with interbedded siltstone	4	4	1
h	Sls	**Morrison Formation, Unkpapa Sandstone, Sundance Formation, Gypsum Spring Formation**—Interbedded shale, sandstone, and gypsum	5	3	1
i	Ms-e	**White River Group**—Sandstone, claystone and siltstone with channel fillings and limestone lenses	3	3	1
j	Ms-n	**White River Group**—Sandstone, claystone and siltstone with channel fillings and limestone lenses	3	3	1
k	Id	**White River Group**—Sandstone, claystone and siltstone with channel fillings and limestone lenses	3	3	1
l	Lp	**White River Group**—Sandstone, claystone and siltstone with channel fillings and limestone lenses	3	3	1
m	Mf	**White River Group**—Sandstone, claystone and siltstone with channel fillings and limestone lenses	3	3	1
n	Sls	**White River Group**—Sandstone, claystone and siltstone with channel fillings and limestone lenses	3	3	1
o	Sls	**Spearfish Formation**—Silty shale interbedded with sandstone and siltstone and fine sandstone with gypsum in lower part	3	3	1
p	Mf	**Spearfish Formation**—Silty shale interbedded with sandstone and siltstone and fine sandstone with gypsum in lower part	3	3	1
q	Sls	**Belle Fourche Shale**—Shale, **Mowry Shale**—Shale, **Newcastle Sandstone**—Sandstone and siltstone, **Skull Creek Shale**—Shale with thin interbedded bentonite	2	2	1
r	Mf	**Opeche Shale**—Siltstone and sandy shale with local gypsum and anhydrite at top	2	2	1
s	Sls	**Opeche Shale**—Siltstone and sandy shale with local gypsum and anhydrite at top	2	2	1

Recharge rate—First digit in code

First digit	Recharge rate (inches per year)	Sensitivity rank
1	7 to less than 10	Highest
2	4 to less than 7	to
3	2 to less than 4	
4	0 to less than 2	lowest

Depth to water—Second digit in code

Second digit	Depth to water (feet)	Sensitivity rank
1	less than 20 (Comparison group)	Highest
2	less than 50 (Comparison group)	to
3	50 or greater than 50 (Comparison group)	lowest
4	highly variable (areas of fractured rock in stream valleys) (Comparison[1] group)	Highest to
5	highly variable (other areas) (Comparison[1] group)	lowest

[1] Areas with land-surface elevations less than 50 feet above stream bed elevations were delineated to make relative comparisons with areas greater than 50 feet above streambed elevations.

Land-surface slope—Third digit in code

Third digit	Land-surface slope (percent)	Sensitivity rank
1	0 to 2	Highest
2	greater than 2 to 6	
3	greater than 6 to 12	to
4	greater than 12 to 18	
5	greater than 18	lowest

Drainage areas upstream from potential streamflow-loss zones by drainage basin

[--, no data]

Site identification	Name	Approximate loss threshold (cubic feet per second)	Area (square miles)
	Sand Creek Basin		
1	Sand Creek tributaries	--	0.3
2	Bear Gulch	4	5.5
	Crow Creek Basin		
3	Beaver Creek	9	8.5
4	Crow Peak	--	0.5
	Spearfish Creek Basin		
5	Citadel Rock	--	1.1
6	Spearfish Creek (above power plant diversion)	23	142.1
7	Rubicon Gulch (Bridal Veil Falls)	21	1.4
8	Spearfish Creek (between diversion and [loss zone])	21	2.7
9	Spearfish Peak (Spearfish Creek tributaries)	--	1.1
	False Bottom Creek Basin		
10	Burno Gulch	--	2.5
11	False Bottom Creek	15	7.0
12	False Bottom Creek tributary	--	0.8
13	Tetro Creek	--	0.7
14	Miller Creek	--	2.7
15	Polo Creek	--	3.2
	Whitewood Creek Basin		
16	Slaughter House Gulch	--	0.4
17	Whitewood Creek	0	46.9
	Bear Butte Creek Basin		
18	Bear Butte tributaries (Boulder Park)	--	3.5
19	Boulder Creek	--	2.2
20	Two Bit Creek	--	6.8
21	Boulder Creek tributaries	--	1.2
22	Lost Gulch	--	1.5
23	Bear Butte Creek	12	15.9
24	Park Creek	--	3.2
	Elk Creek Basin		
25	Elk Creek (north tributary)	--	1.0
26	Elk Creek	19	22.3
27	Meadow Creek	--	1.9
28	Little Elk Creek	3	9.0
	Boxelder Creek Basin		
29	Boxelder Creek	50	90.1
	Rapid Creek Basin		
30	Rapid Creek tributaries	10	61.0

Planimetric base modified from U.S. Geological Survey digital data, 1:100,000: Belle Fourche, 1983; Rapid City, 1977
Universal Transverse Mercator projection
Zone 13
North American Horizontal Datum 1927

SCALE 1:100,000
1 0 1 2 3 4 5 6 MILES
1 0 1 2 3 4 5 6 KILOMETERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

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By
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2000