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Regional Analysis of Rural Domestic Well-water Quality -- Missouri River Lowlands

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Rural Domestic Well-water Quality in the *Missouri River Lowlands*

Groundwater Region 3 from *Domestic Water-well Quality in Rural Nebraska*
(A data-analysis report for the Nebraska Department of Health compiled by D. C. Gosselin and others, 1996)

Geology and Hydrogeology

Groundwater Region 3 occupies the lowlands of the Missouri River valley (Figure 1). The principal aquifer is composed primarily of Quaternary river-deposited (alluvial) sand and gravel beneath the floodplain of the Missouri River. These deposits are generally less than 100 feet thick and consist primarily of fine- to medium-grained sand and fine-grained gravel interlayered with lesser amounts of silt and clay. In some areas, deposits associated with glacial activity occur beneath the more recent river deposits; these mostly consist of clay-rich glacial till and fine- to coarse-grained sediments washed out of glaciers and/or alluvium. The glacier-related deposits occur mostly in ancient valleys (paleovalleys) that cut into bedrock under the Missouri River valley. (Geologic cross sections for Region 3 are available at the Conservation and Survey Division; Figure 1.)

Depth to water is usually less than 50 feet. Saturated thickness of the principal aquifer is less than 100 feet (Table 1). In the South Sioux City area, the Dakota Group is present beneath the alluvial and glacial deposits. In this area, the Dakota Group sandstone is used as another source of groundwater. South of Sioux City, the base of the aquifer consists of limestone and shale of Pennsylvanian age. Upstream from Sioux City, the base of the principal aquifer conforms to the surface of the Cretaceous rocks, which include the Greenhorn-Graneros, Carlile and Niobrara formations, as well as the Dakota Group.

Results*

Well Characteristics

Characteristics of the wells sampled during the 1994-1995 study are summarized in Table GW3.1. The average year of installation for the six wells was 1965; installation ranged from 1954 to 1979. For the five wells where information was available, all the wells were drilled. One has steel casing, three have plastic casing, and one has concrete casing. All the wells are less than 100 feet; they have an average depth of 80 feet, which reflects the shallow depths to groundwater. Regarding the wells for which information is available, three had a diameter of 4 inches, one was 6 inches, and the concrete-cased well had a diameter of 24 inches. On average, 1.8 individuals used each well. Nitrate fertilizers and pesticides were used at five of the six locations.

Nitrates

Nitrate data for wells sampled during the 1994-1995 study are summarized in Table GW3.1. Their locations are shown in Figure GW3.1. Two of the wells had concentrations above the detection limit, 0.6 and 27.9 parts per million (ppm) nitrate-nitrogen. In the 1985-1989 study, these same wells had nitrate-nitrogen values of 135 ppm and 26.3 ppm, respectively.

There are too few samples to reach any conclusions based on statistical evidence; however, a couple of simple observations can be made. The wells that have nitrate concentrations above the detection limit have casings that end in pits, which are subject to flooding. These two wells also have distances to cropland of less than 100 feet.

Pesticides

There were no pesticides detected in any of the six wells sampled (Figure GW3.2).

Bacteria

Coliform-bacteria data for the six wells sampled during the 1994-1995 study are summarized in Table GW3.1 and Figure GW3.3. In the well that had coliform bacteria, there were 29 colonies per 100 ml sample. As with nitrate occurrences, its well casing was completed in a well pit.

**** Where associations, relationships, increases or decreases are discussed, our analyses have determined that they are statistically significant. If the relationship between contaminant concentrations and various factors are not discussed, they have not been demonstrated to be statistically significant.***

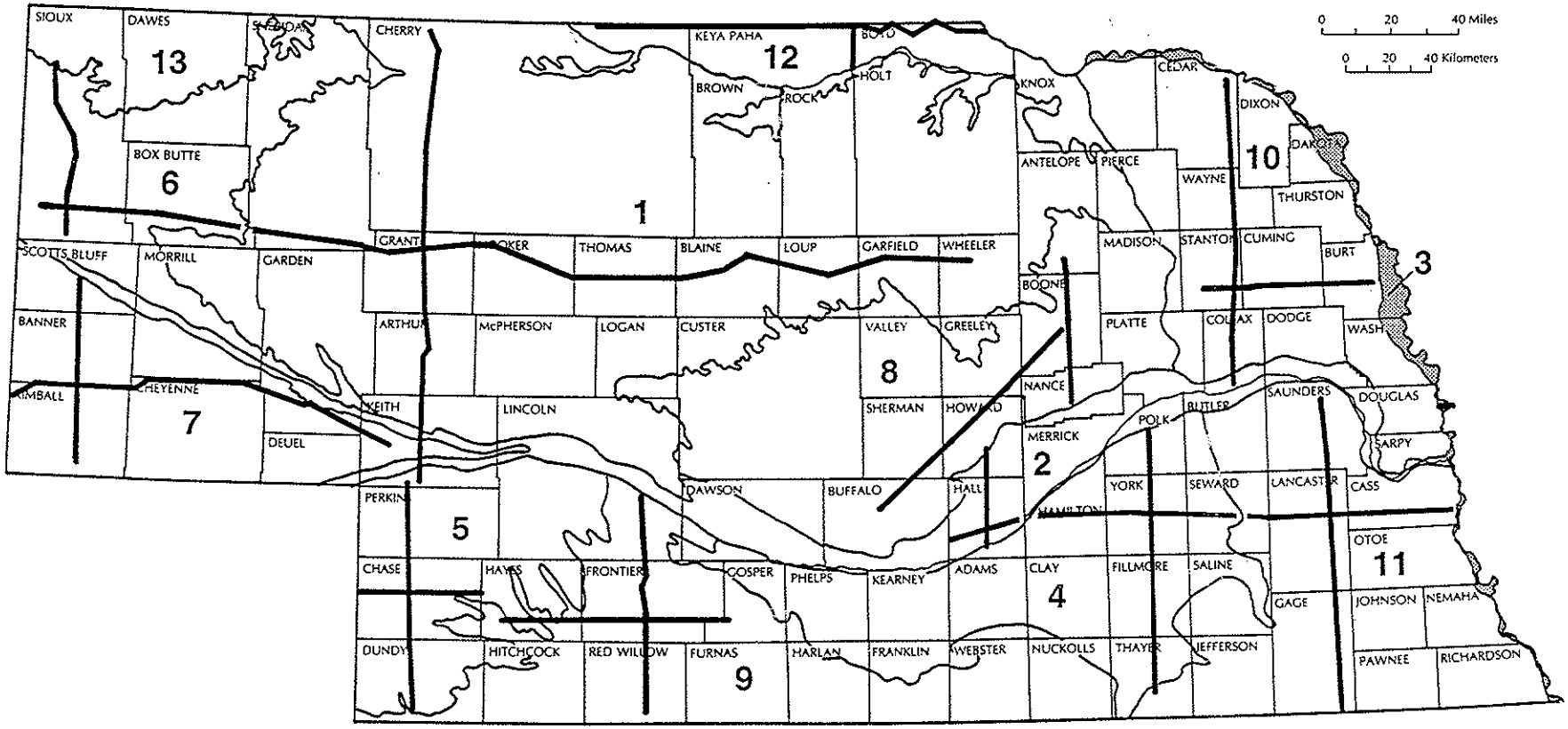

Fig. 1—*Locations of geologic cross sections* **(Region 3 in gray)**

Water-bearing Properties of Major Rock Units in Nebraska

From *The Groundwater Atlas of Nebraska* — Conservation and Survey Division, University of Nebraska-Lincoln

Era	Period	Epoch	Millions of years	Group or Formation	Lithology	Water-bearing Properties
Cenozoic	Quaternary	Holocene	0.01		Sand, silt, gravel and clay	Principal groundwater reservoir; Ogallala is absent in east and northwest. Arikaree is present primarily in west.
		Pleistocene	~2.0			
		Pliocene	5		Sand, gravel and silt	
		Miocene	24	Ogallala	Sand, sandstone, siltstone and some gravel	
		Oligocene		Arikaree	Sandstone and siltstone	
				White River	Siltstone, sandstone and clay in lower part	Secondary aquifer in west; water may be highly mineralized.
		Eocene	37	Rocks of this age are not identified in Nebraska.		
		Paleocene	58			
Mesozoic	Cretaceous	Late Cretaceous	67	Lance	Sandstone and siltstone	Generally not an aquifer; yields water to few wells in west.
				Fox Hills		
				Pierre	Shale and some sandstone in west	Generally not an aquifer; sandstones in west yield highly mineralized water to few industrial wells.
				Niobrara	Shaly chalk and limestone	Secondary aquifer where fractured and at shallow depths, primarily in east.
				Carlile	Shale; in some areas contains sandstones in upper part	Generally not an aquifer; sandstones yield water to few wells in northeast.
				Greenhorn-Graneros	Limestone and shale	Generally not an aquifer, yields water to few wells in east.
		Early Cretaceous	98	Dakota	Sandstone and shale	Secondary aquifer, primarily in east; water may be highly mineralized.
	Jurassic		144		Siltstone and some sandstone	Not an aquifer
	Triassic		208		Siltstone	Not an aquifer
Paleozoic	Permian		245		Limestone, dolomites, shales and sandstone.	Some sandstone, limestone and dolomites are secondary aquifers in east. Water may be highly mineralized.
	Pennsylvanian		286			
	Mississippian		320			
	Devonian		360			
	Silurian		408			
	Ordovician		438			
	Cambrian		505			
Precambrian			570			

Table 1—Hydrostratigraphic chart (showing water-bearing rock units) of Nebraska
Time divisions are not to scale.

Table GW3.1. Summary of Domestic Well Characteristics and Water Quality Data (1994-95)

Well characteristics

	Number of wells	Mean	Minimum	Maximum	Standard deviation
Well Installation Date					
All	5	1965	1954	1972	7
<1940	0				
1940-1969	1				
1960-1979	4				
1980-present	0				
Well Depth (feet)					
All	5	79.4	45	100	25
<50	1				
50-99	2				
100-199	2				
>200	0				
Well Diameter (inches)					
All	5	8.4	4	24	8.8
<2	0				
2-3	0				
4-5	3				
6-7	1				
>8	1				
Number of Well Users	5	2.2	1	5	1.6
Distance to Contaminant Source (feet):					
cesspool	1	160	160	160	-
septic	6	202	100	500	149
waste lagoon	-	-	-	-	-
barnyard	4	295	30	700	292
pasture land	3	750	350	1200	427
cropland	5	130	50	230	67
Well Type:					
drilled	5				
driven	0				
dug	0				
other	0				
Casing Material:					
steel	1				
plastic	3				
concrete	1				
brick	0				
tile	0				
other	0				
Sanitary Seal:					
yes	2				
no	1				
Casing in Pit:					
yes	3				
no	2				
Nitrate Used:					
yes	5				
no	1				
Pesticide Used:					
yes	5				
no	1				

Water Quality Data

	Number of wells	Mean	Median	Minimum	Maximum	Standard deviation	Detections
Nitrate as Nitrogen (ppm NO3-N)							
1994-1995	6	4.8	0.1	0.1	27.9	11.3	
Bacteria (colonies per 100 ml)							
1994-1995	6			0	29		1
Pesticides (ppb)							
1994-1995	6			0	0		0

Nebraska Department of Health
Rural Domestic Well Water Quality Study: 1994-1995
Nitrate Sampling Locations - Region #3

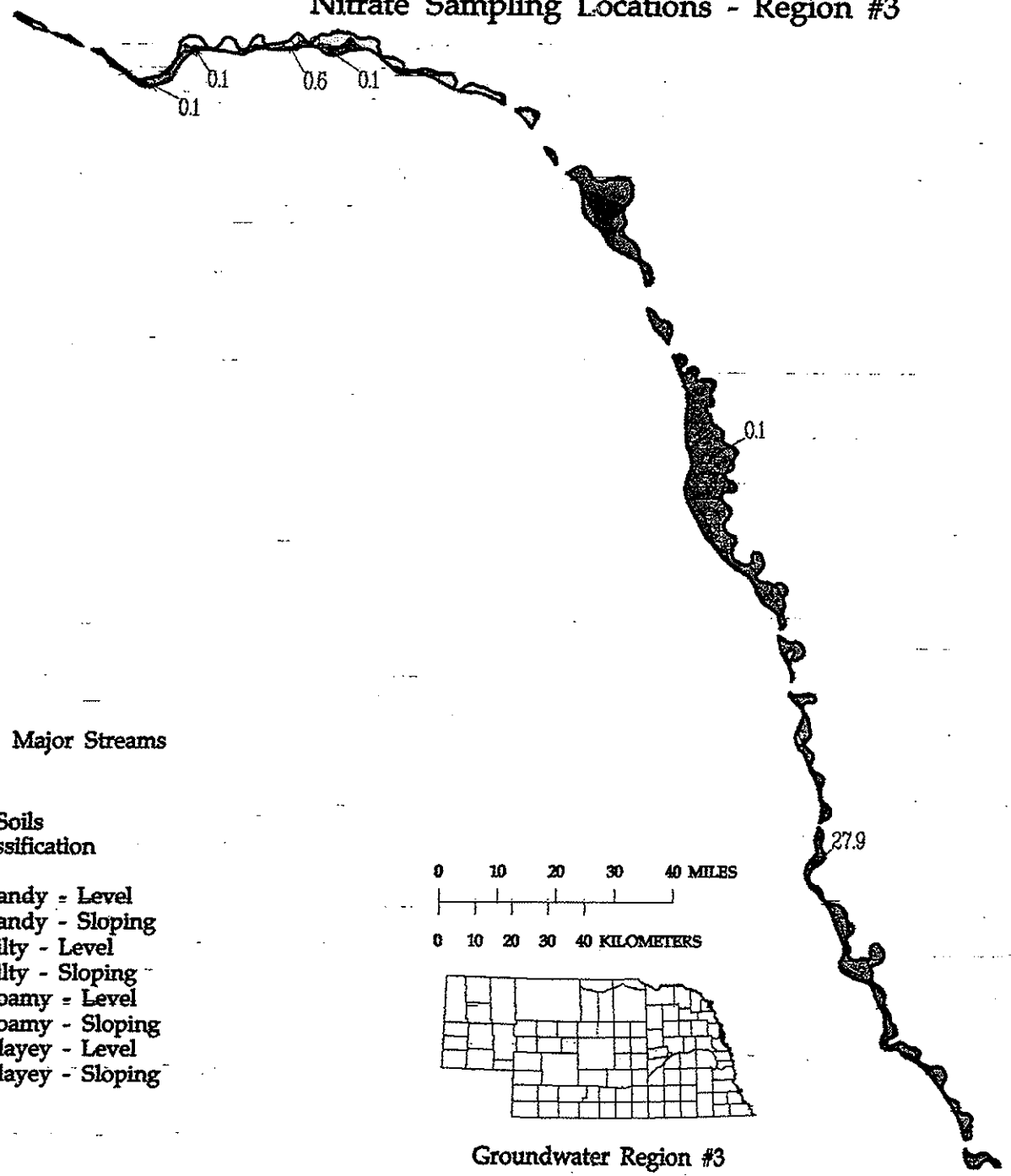

Figure GW3.1

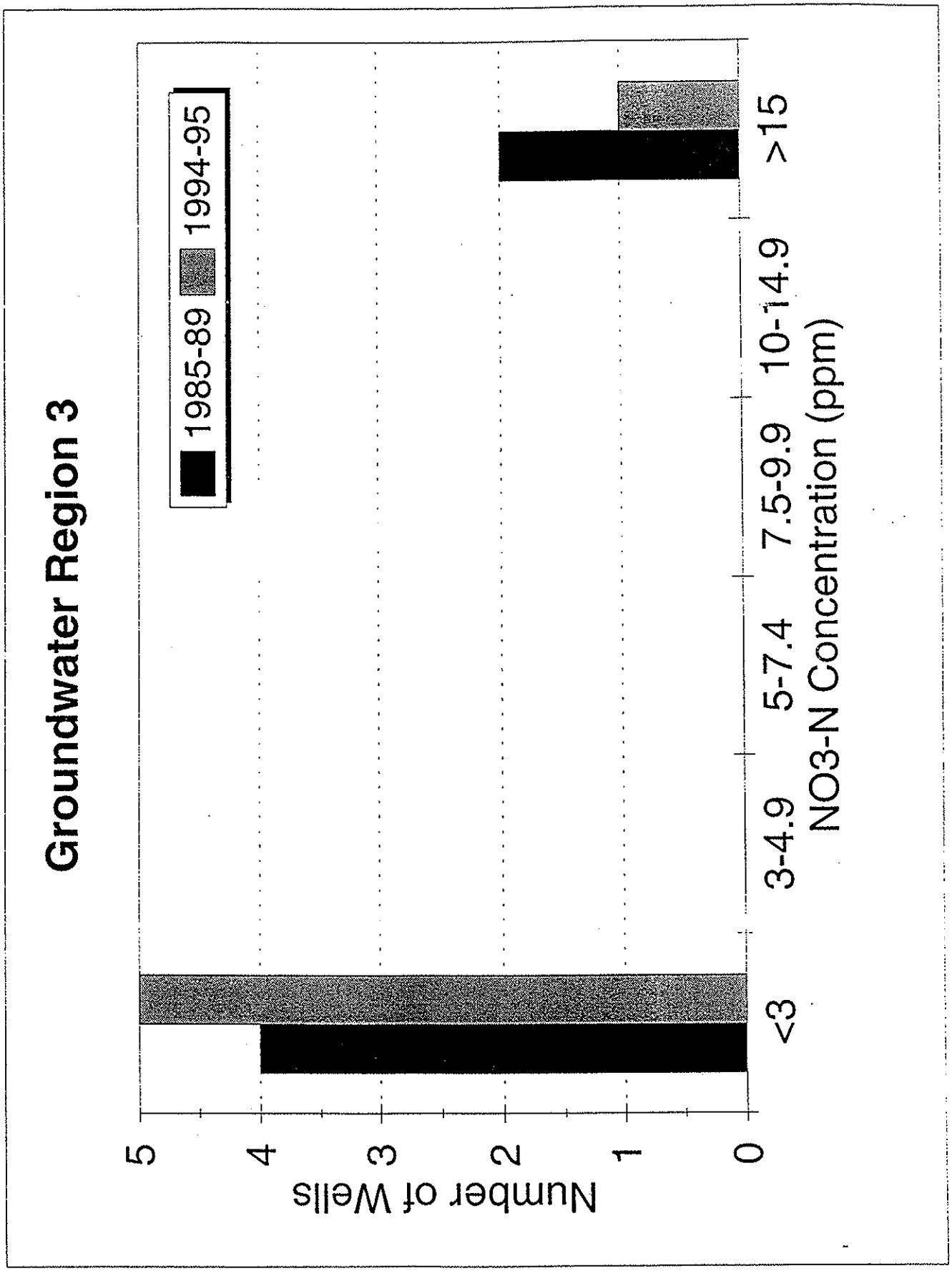
Groundwater Region 3
1985-89
1994-95
Number of Wells
0
1
2
3
4
5
<3
3-4.9
5-7.4
7.5-9.9
10-14.9
>15
NO3-N Concentration (ppm)

Figure GW3.2

Nebraska Department of Health
Rural Domestic Well Water Quality Study: 1994-1995
Pesticide Sampling Locations - Region #3

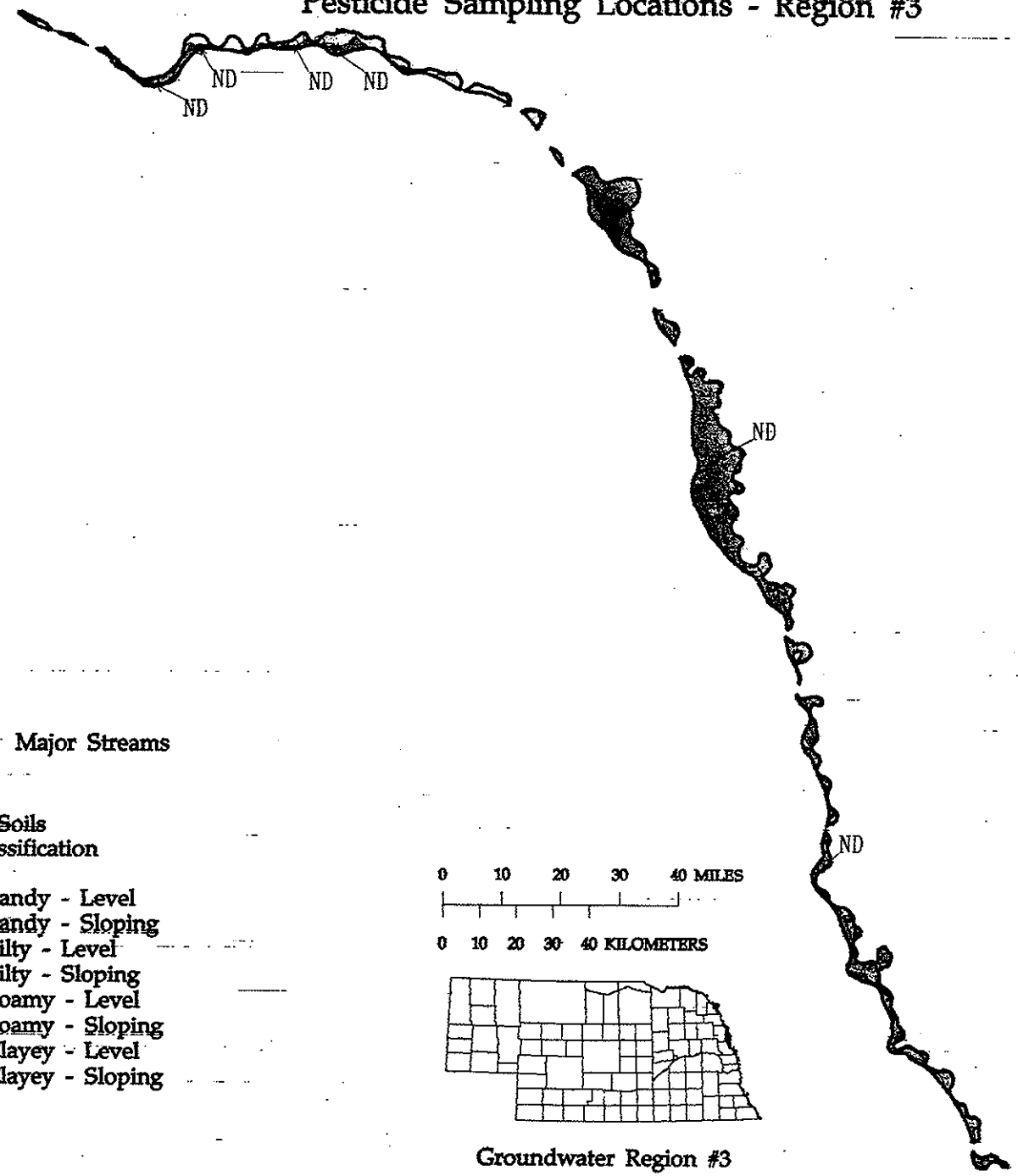

Figure GW3.3

Nebraska Department of Health
Rural Domestic Well Water Quality Study: 1994-1995
Bacteria Sampling Locations - Region #3

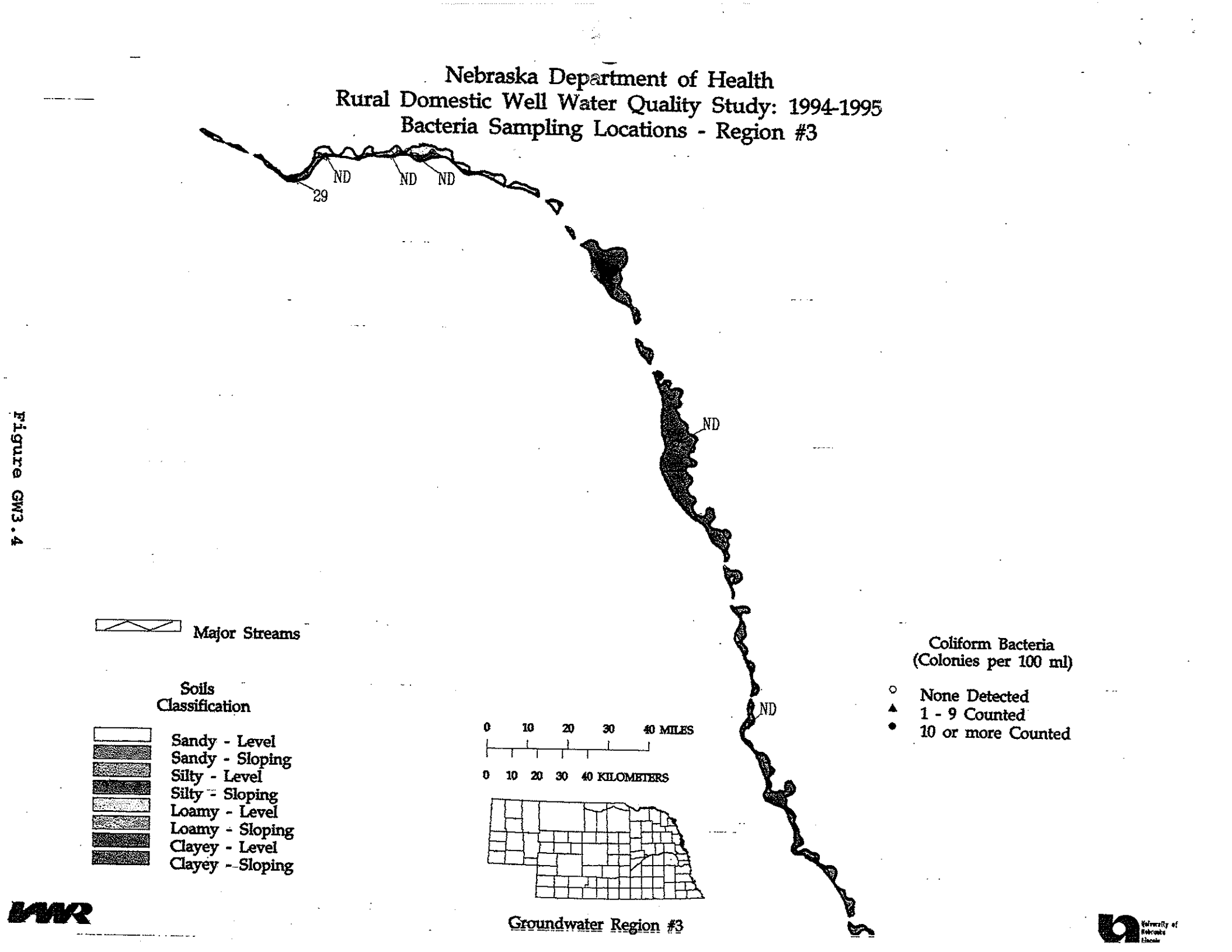

Figure GW3.4

Discussion

Although only six domestic wells were sampled in this region, it appears that wells ending in a pit that are near cropland are susceptible to contamination.

References

Burchett, R.R., 1965, Correlation of Formations Drilled in Test Holes for Interstate 480 Bridge between Omaha, Nebraska and Council Bluffs, Iowa: Nebraska Geological Survey Paper 17, University of Nebraska. Conservation and Survey Division, 30 p.