Mike
Nov '81

SECTION 208 - WATER QUALITY STUDY AREAS

SOIL EROSION AND SEDIMENT YIELD STUDY

IN

LAKE KAMPESKA WATERSHED

CODINGTON, GRANT AND DAY COUNTIES, SOUTH DAKOTA

SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
HURON, SOUTH DAKOTA

ASSISTED BY
SOUTH DAKOTA DEPARTMENT OF WATER AND NATURAL RESOURCES
PIERRE, SOUTH DAKOTA

February 1981

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Introduction

Intense use of our natural resources over the years has caused a general deterioration of our environment. Some of our air, soil, and water resources have become polluted. Increased public awareness of this situation helped to bring about the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). Section 208 of P.L. 92-500 addresses water pollution problems as it calls for management practices "...(to) be developed and implemented to assure adequate control of sources of pollutants in each state."

The South Dakota Department of water and Natural Resources has responsibility for formulating a section 208 water quality management plan for South Dakota. The watershed was one of six selected in 1980 for study to facilitate formulation of the plan. (See Figure 1.)

It is generally thought that sediment and nutrients are the principal pollutants in South Dakota lakes and streams. 1/, 2/, 3/

This report outlines more detailed information on soil erosion, sediment sources and quantities, management practices to control sediment, and costs for those practices. This information was developed by the Soil Conservation Service (SCS) for the South Dakota Department of Water and Natural Resources.

1/ Mathew, F.L., "Water Pollution in South Dakota, Part I: Natural Water Quality and Pollution Sources," 1970, South Dakota Water Resources Institute, South Dakota State University, Brookings, South Dakota, 34 pages.

2/ "Development Components of the South Dakota Water Plan, Volume II-B" 1977, Division of Resources Management, South Dakota Department of Water and Natural Resources, Pierre, South Dakota.

3/ "A plan for the Classification-Preservation-Restoration of Lakes in Northeastern South Dakota" 1977, State Lakes Preservation Committee, State of South Dakota and the Old West Regional Commission, Pierre, South Dakota.

Summary

This study has determined relative percentages of erosion and sediment yield from cropland, grassland, gullies, streambanks, and other sources. The Universal Soil Loss Equation and direct volume methods were used to estimate gross erosion which was multiplied by estimated sediment delivery ratios developed by watershed shape analysis 1/ to obtain estimated sediment yields.

Sediment was determined to be a pollutant in the Lake Kampeska Water Quality Study Area (WQSA). Best management practices (BMP's) for this state section 208 water quality management plan thus became those management practices that reduced sediment yield.

A review of the Technical Guide for South Dakota (available at offices of the Soil Conservation Service) indicated soil and water conservation practices (management practices) that are potential BMP's. The relationships between runoff, sediment yield, and management practices, were outlined and, coupled with views of SCS district conservationists, a number of BMP's were selected for the WQSA. Costs for BMP's were generally abstrated from the SCS Cost-Return Handbook.

No quantification of reductions in sediment yield due to application of BMP's was attempted. The reasons for this are twofold:
1. The technical data base was inadequate.
2. The potential combinations of BMP's were too great.

Definition and Outline of Study Methods

Erosion

Sheet erosion occurs as water flows overland and moves layers of soil particles loosened by raindrop impact. Rill erosion is movement of soil particles as overland flow concentrates into small channels, or rills, 2 to 12 inches deep. Soil particles are loosened in rills by shear force exerted on the bottom and banks of the rill by the channelized water. Bank sloughing, or miniature landslides, occur as the bottom and lower banks are eroded.

The Universal Soil Loss Equation (USLE), 2/, 3/ was used to estimate sheet and rill erosion in the WQSA's. SCS personnel familiar with each WQSA derived the data needed for the USLE from their field experience, Section III of the South Dakota Technical Guide and detailed soils maps.

1/ "Sediment yield was Gross Erosion in Minnesota" by O.M. Finkelson, Geologist, SCS, St. Paul, Minnesota 1978.

2/ Wischmeir, W.H., and Smith, D.D., "Prediction Rainfall Erosion Looses, A Guide to Conservation Planning", Agricultural Handbook, No. 537, December 1978, Science & Education Administration.

3/ "Estimating Soil Loss Resulting from Water and Wind Erosion in South Dakota," June 1977, South Dakota Technical Guide III-1, USDA, SCS, Huron, South Dakota.

Sheet and rill erosion from construction sites, roads and roadbanks was estimated using a direct volume method (multiplying the area of erosion by an estimated rate of erosion and the volume weight of the eroding soil. 1/ Sample areas were observed in each WQSA and county highway maps were used to expand the sample data.

Gully and streambank erosion is soil moved by water flowing in channels that are greater than 12 inches deep. The mechanisms of loosening and moving soil particles are the same as in rill erosion except for the larger scale. Lake shore erosion occurs as wave action loosens and moves soil particles. The direct volume method was used to estimate gully, streambank, and lake shore erosion. The effects of ice were also considered in the erosion rate. Sample areas were observed in each WQSA and aerial photographs were used to expand the sample data.

Sediment Yield

Sediment yield is the amount of soil removed from a drainage basin. 2/, 3/ It is measured (or estimated) at a point or at a stream channel cross section and only represents a fraction of the total soil eroded in the basin above that point.

In this study, gross erosion was estimated and then multiplied by an estimated sediment delivery ratio to obtain sediment yield. This ratio is expressed as a percent and represents the amount of soil removed from a watershed (sediment) divided by the amount of soil moved in the watershed (erosion). It is thus inversely proportional to the amount of deposition occurring between points of erosion and the point where sediment yield is measured.

Many factors affect sediment yield - watershed size, shape, hydrology, channel density, land use, vegetative cover, geology and topography, soil structure, texture, and permeability. The interaction between all of these factors was subjectively analyzed after a delivery ratio was selected from a drainage area versus delivery ratio curve. This analysis resulted in raising or lowering the curve ratio and the adjusted ratio was used to estimate sediment yield from all sources of sheet and rill erosion. Much higher ratios were used to estimate sediment yield from gully, streambank, and lakeshore erosion.

1/ Method is outlined in the "Erosion and Sediment Inventory Handbook," USDA-SCS, Syracuse, New York (1972) and in "Guide to Sedimentation Investigations," Technical Guide 12, South Technical Service Center, USDA-SCS, Fort Worth, Texas (1976).

2/ "Sedimentation," 1975 National Engineering Handbook, Section 3, USDA, SCS, Washington, D.C.

3/ "Predicting Sediment Yields," in "Proceedings of the National Symposium on Soil Erosion and Sedimentation by Water," 1977, American Society of Agricultural Engineers, Publication 4-77, St. Joseph, Michigan.

Best Management Practices

The Environmental Protection Agency (EPA) has defined best management practices, as published in the Federal Register, as follows:

> "The term, best management practices (BMP), means a practice, or combination of practices, that is determined by a State (or designated areawide planning agency) after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals (40 CFR Part 130)."

Thus best management practices in section 208 water quality management plans are primarily those management practices that are believed to have a beneficial impact on water quality. 1/ Since sediment yield affects water quality adversely in these study areas, management practices that reduce sediment yield will be BMP's. Best management practices were selected from Section III of the South Dakota Technical Guide and costs were taken from the SCS Cost-Return Handbook.

Narrative Comments

The Soil Conservation Service completed a study of the Lake Kampeska Watershed. The purpose of this study was to identify the water erosion and sedimentation problems relative to Lake Kampeska. The watershed was divided into four subwatersheds. (See Watershed Map)

This study brings out the kinds and amounts of erosion and sedimentation including the location, extent, and whether or not each tributary significantly contributes sediment into Lake Kampeska.

Table 1 shows the present "Land Uses and Estimated Acres Needing Treatment" of the Lake Kampeska Watershed Area. Figures are given for each tributary and a total for watershed. Lake Kampeska Watershed contains 192,328 acres. Figures are given for the following uses: cropland, grassland (both tame and native included), woodland, farmsteads, and urban, and non-sediment contributing areas. Estimated acres are listed for acres adequately treated, and acres needing treatment with recommended Best Management Practices (conservation practices) which will contribute to water quality improvement as well as erosion control on the land in the watershed area.

1/ "Environmental Impact of Land Use on Water Quality, Final Report on the Black Creek Project (Summary," 1977, U.S. Environmental Protection Agency 905/9-77-007-A, Great Lakes National Program Office, Chicago, Illinois.

Narrative Comments (cont.)

Table 2 - "Soil Erosion and Sediment Yield Estimates" lists erosion and sediment yield information. The figures are given by tributaries. They are further broken down by land use, sheet and rill erosion, and other erosion and sediment yields. A final total column shows estimated total tons of sediment per year for the watershed.

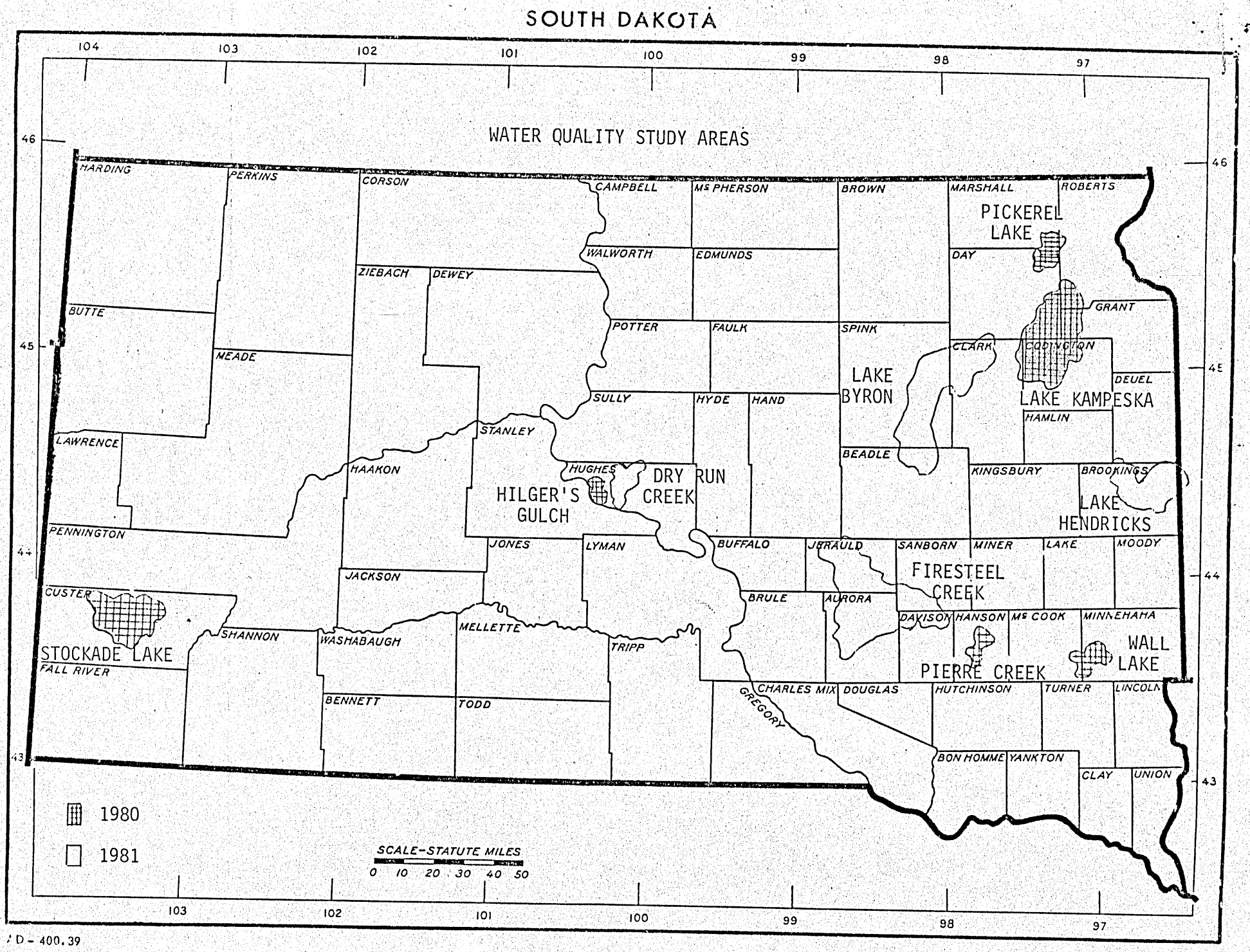
The Big Sioux and Gravel Creek Watersheds deposit sediment into Lake Kampeska only during flood stages of runoff. A large diversion, just below the overflow point for the lake on the Big Sioux River, regulates the water which runs from the river into the lake or vice versa, depending on climatic conditions. As a result, most of the sediment from these two watersheds bipasses the lake.

No figures were developed showing the extent of soil losses from erosion by wind. It was felt that an estimate of 1 to 1½ tons per acre per year could be used if this information is needed.

Table 3 - "Estimates of Best Management Practices (Conservation Practices and Measures) needed for Land Adequately Treated, Including Costs" shows the major land treatment needed in this watershed area. The table also shows estimated amounts and probable costs to get the land in this watershed "adequately treated". It must be kept in mind, that these are "Estimates" only, and that specific practices, and accurate amounts together with precise costs can only be obtained in a planning process with the owners and operators of each tract of land, based on their decisions on how each field is to be used and treated. This study does not show this sort of detailed information.

This study contains a "Shoreline Erosion and Sediment Contributing Area Map". Table 4 lists the amounts of sediment produced from each of the segments shown on the map. The total tons of sediment per year in Table 4 corresponds to the total tons of sediment yield from the lakeshore column in Table 2.

FIGURE 1



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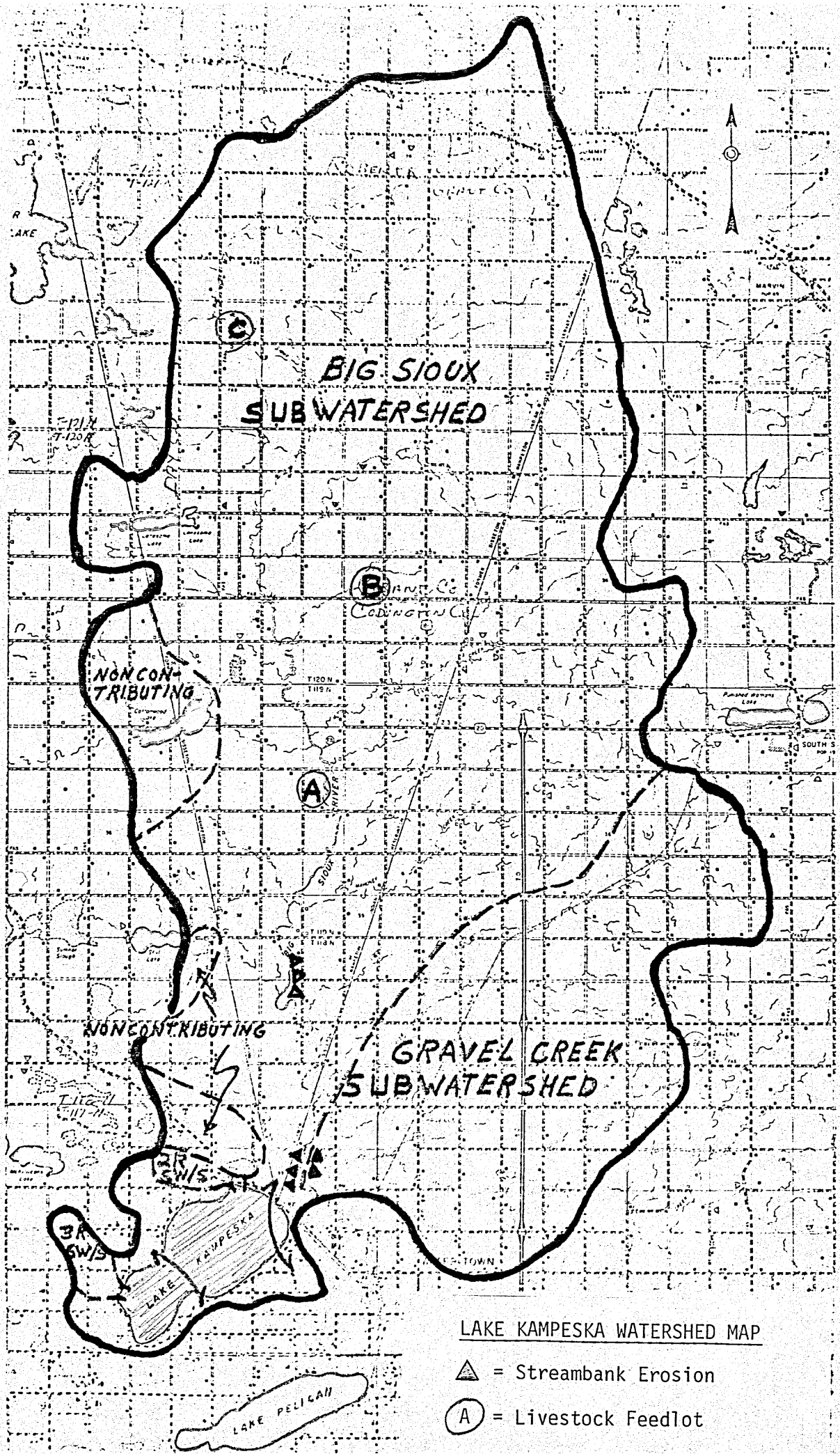


LAKE KAMPESKA WATERSHED MAP

△ = Streambank Erosion

(A) = Livestock Feedlot

TABLE 1

LAND USE AND ESTIMATED ACRES NEEDING TREATMENT
LAKE KAMPESKA WATERSHED AREA

WQSA or SUBWATERSHEDS	LAND USE (Acres) and TREATMENT (Acres and Percent)											
	CROPLAND		GRASSLAND		WOODLAND		FARMSTEAD AND URBAN		NON SEDIMENT CONTRIBUTING[1]		TOTAL	
	AC	%	AC	%	AC	%	AC	%	AC	%	AC	%
Big Sioux Subwatershed	111,017	100	27,785	100	-	-	4,669	100	1,511	100	144,982	100
Adequately Treated	38,856	35	8,335	30	-	-	3,502	75	1,360	90	52,053	36
Needs Treatment	72,161	65	19,450	70	-	-	1,167	25	151	10	92,929	64
Gravel Creek Subwatershed	31,944	100	12,261	100	-	-	705	100	16	100	44,926	100
Adequately Treated	11,180	35	3,678	30	-	-	529	75	14	90	15,401	34
Needs Treatment	20,764	65	8,583	70	-	-	176	25	2	10	29,525	66
2R Subwatershed	545	100	145	100	-	-	34	100	16	100	740	100
Adequately Treated	191	35	44	30	-	-	26	75	14	90	275	37
Needs Treatment	354	65	101	70	-	-	8	25	2	10	465	63
3R Subwatershed	1,329	100	276	100	-	-	10	100	65	100	1,680	100
Adequately Treated	465	35	83	30	-	-	8	75	58	90	614	37
Needs Treatment	864	65	193	70	-	-	2	25	7	10	1.066	63
TOTAL FOR WATERSHED	144,835	100	40,467	100	-	-	5,418	-	1,608	100	192,328	100
Adequately Treated	50,692	35	12,140	30	-	-	4,065	75	1,446	90	68,343	36
Needs Treatment	94,143	65	28,327	70	-	-	1,353	25	162	10	123,985	64

1/ Generally, water, marsh and sloughs

TABLE 2

SOIL EROSION AND SEDIMENT YIELD
LAKE KAMPESKA WATERSHED AREA

WQSA or Subwatershed		Cropland	Grassland	Sub Total	Channels	Lake shore	Construction [1]	Sub Total	Total	Acre Feet Per Yr. [2]	Percent [3]
Big Sioux Subwatershed	Erosion Tons/Yr.	254,110	3,858	257,968		1,261		1,261	259,229		
	Sed. Yield [4] Tons/Yr.	847	13	860		1,261		1,261	2,121	1.62	0.003
Gravel Creek Subwatershed	Erosion Tons/Yr.	88,179	1,758	89,937					89,937		
	Sed. Yield [4] Tons/Yr.	292	6	298					298	.23	-
2R Subwatershed	Erosion Tons/Yr.	1,228	54	1,282					1,282		
	Sed. Yield [4] Tons/Yr.	344	15	359					359	.27	.001
3R Subwatershed	Erosion Tons/Yr.	5,199	222	5,310					5,310		
	Sed. Yield [4] Tons/Yr.	1,247	27	1,274					1,274	.98	.002
Total	Erosion Tons/Yr.	348,716	5,781	354,497		1,261		1,261	355,758		
	Sed. Yield [4] Tons/Yr.	2,730	61	2,791		1,261		1,261	4,052	3.10	.006

1/ Not estimated, but has high potential. Planned developments should include a sediment control plan for before, during, and after construction.

2/ Tons converted to acre feet. Sediment in lake volume computed at 60 pounds per cubic foot due to submerged sediment.

3/ Annual sediment yield expressed as a percent of total lake volume. Lake volume of Lake Kampeska is 52,941 acre feet.

4/ Sediment deposited in Lake Kampeska.

TABLE 3 BEST MANAGEMENT PRACTICES (Conservation Practices and Measures) 1/ 2/ 3/

LAKE KAMPESKA WATERSHED AREA

Conservation Practices	Unit	Unit 4/ Cost	Big Sioux		Gravel Creek		R-2		R-3		Total Watershed	
			Amount Needed	Cost	Amount Needed	Cost	Amount Needed	Cost	Amount Needed	Cost	Amount Needed	Cost
		(Dollars)		(Dollars		(Dollars)		(Dollars)		(Dollars)		(Dollars)
Cropland - 144,835 Acres												
Conservation Cropping System	acre	-	111,017	-	31,944	-	545	-	1,329	-	144,835	-
Conservation Tillage System	acre	5	111,017	555,085	31,944	159,720	545	2,725	1,329	6,645	144,835	724,175
Grass and Legumes in Rotation	acre	18	5,550	99,900	1,600	28,800	30	540	65	1,170	7,245	130,410
Wind Stripcropping	acre	4	6,130	24,520	1,765	7,060	30	120	75	300	8,000	32,000
Grass Waterways	acre	500	38	19,000	10	50	1	100	1	225	5,000	25,000
Cover & Green Manure Crop	acre	5	3,835	19,175	1,100	5,500	20	100	45	225	5,000	25,000
Waste Utilization	acre	3	4,600	13,800	1,325	3,975	20	60	55	165	6,000	18,000
Minimize Fall Tillage	acre	-	11,500	-	3,300	-	60	-	140	-	15,000	-
Timing Fertilizer Application	acre	-	19,160	-	5,515	-	95	-	230	-	25,000	-
Minimize Pesticide Use	acre	-	7,665	-	2,200	-	40	-	95	-	10,000	-
Contour Stripcropping	acre	6	3,835	23,010	1,100	6,600	20	120	45	270	5,000	30,000
Terraces	mile	2,112	33	69,696	15	31,680	1	2,112	1	2,112	50	105,600
Grassland - 40,467 Acres												
Proper Grazing Use	acre	-	16,670	-	7,357	-	87	-	166	-	24,280	-
Pasture and Hayland Planting	acre	20	6,860	137,200	3,030	60,600	40	800	70	1,400	10,000	200,000
Deferred Grazing	acre	-	8,335	-	3,675	-	45	-	80	-	12,135	-
Planned Grazing Systems	acre	-	19,450	-	8,580	-	100	-	190	-	28,320	-
Livestock Water Stations	No	1,000	14	14,000	6	6,000	0	0	0	0	20	20,000
Critical Area Planting	acre	1,000	3	3,000	5	5,000	1	1,000	1	1,000	10	10,000
Pasture and Hayland Management	acre	-	11,115	-	4,900	-	60	-	110	-	16,185	-
Waste Management Systems	No	20,000	5	100,000	1	20,000	0	-	0	-	6	120,000
Wildlife Upland Habitat	acre	4	65	260	30	120	0	-	5	20	100	400
Farmstead, Urban & Other, 5,418 acres												
Sediment Control Measures 5/	acre	2,000	129	258,000	19	38,000	1	2,000	1	2,000	150	300,000
TOTALS - Total acres - 192,328 acres 6/				1,336,646		378,055		10,077		15,807		1,740,585
												$9.05 Average per acre

1/ Needed to get "Land Adequately Treated."
2/ Refer to Soil Conservation Service Technical Guide for South Dakota 1981.
3/ On site investigation and planning are necessary to determine kinds, locations, sizes, extent & costs of practices (BMP's).
4/ Refer to Soil Conservation Service Cost-Return Handbook for South Dakota 1981.
5/ Examples of measures are: cover and green manure crop, filter strips, lined and grassed waterways, diversions, mulching, sediment basins, streambank protection, and critical area planting.
6/ Includes 1,608 acres of non-sediment contributing area.

LAKE KAMPESKA

WATER QUALITY STUDY AREA

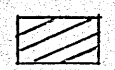
SOIL MAPS AND INDEXES TO MAP SHEETS

ESTIMATED SOIL LOSSES

SHEET AND RILL EROSION

CODINGTON, DAY, GRANT,

AND ROBERTS COUNTIES

 WHERE CULTIVATED > 5 TONS/AC/YR

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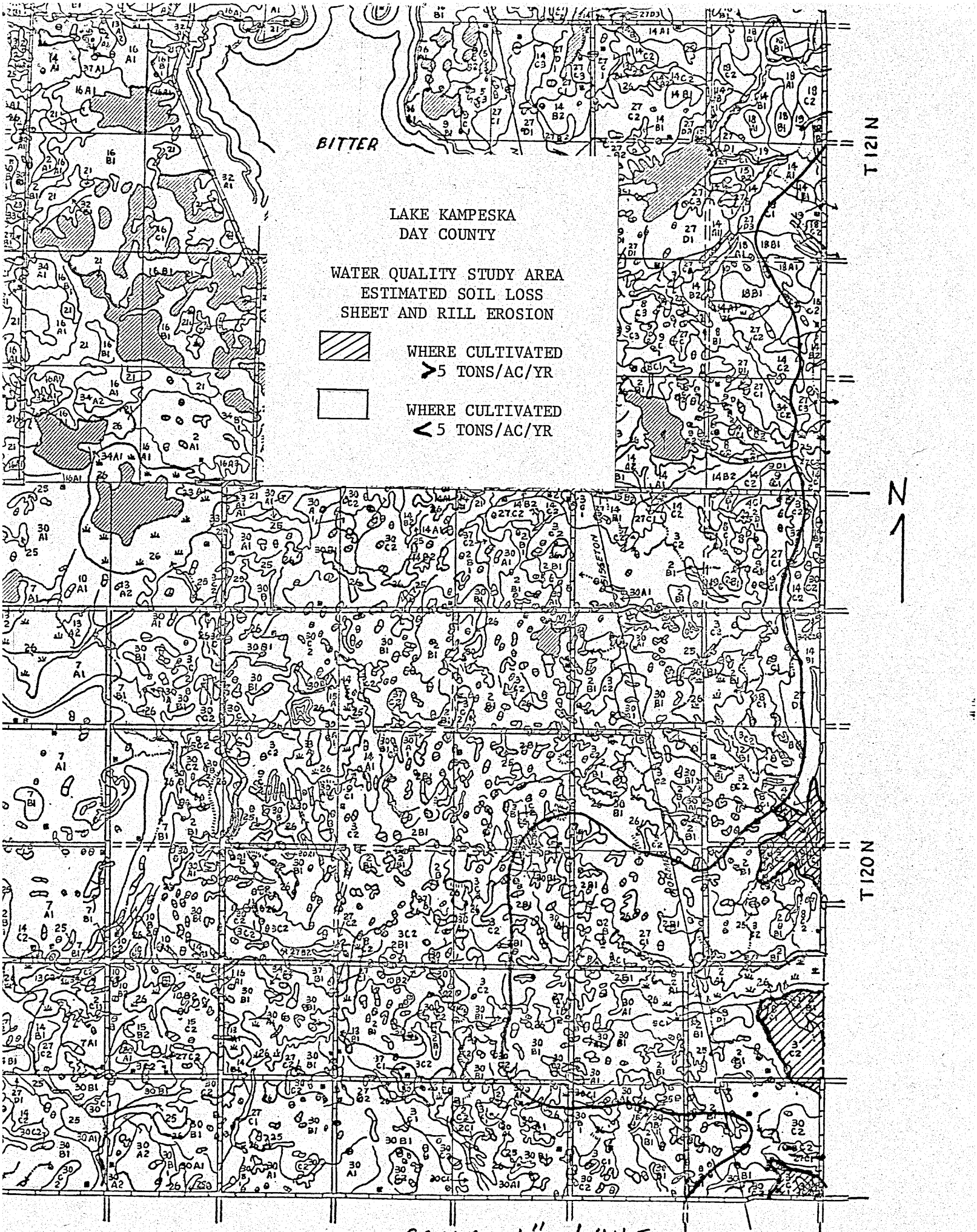
REFER TO SOIL SURVEYS FOR MORE INFORMATION ABOUT THE SOILS.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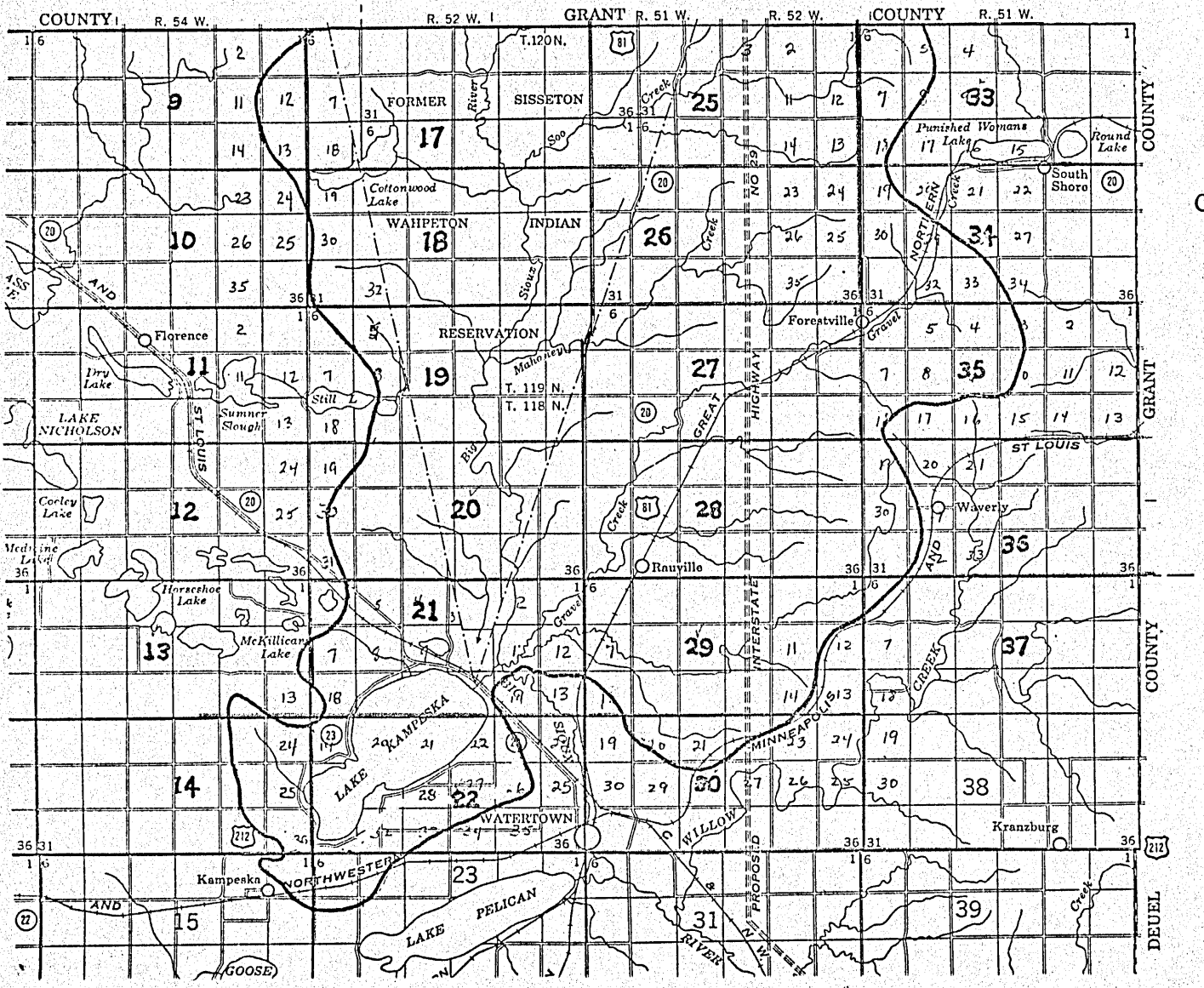

INDEX TO MAP SHEETS

CODINGTON COUNTY, SOUTH DAKOTA

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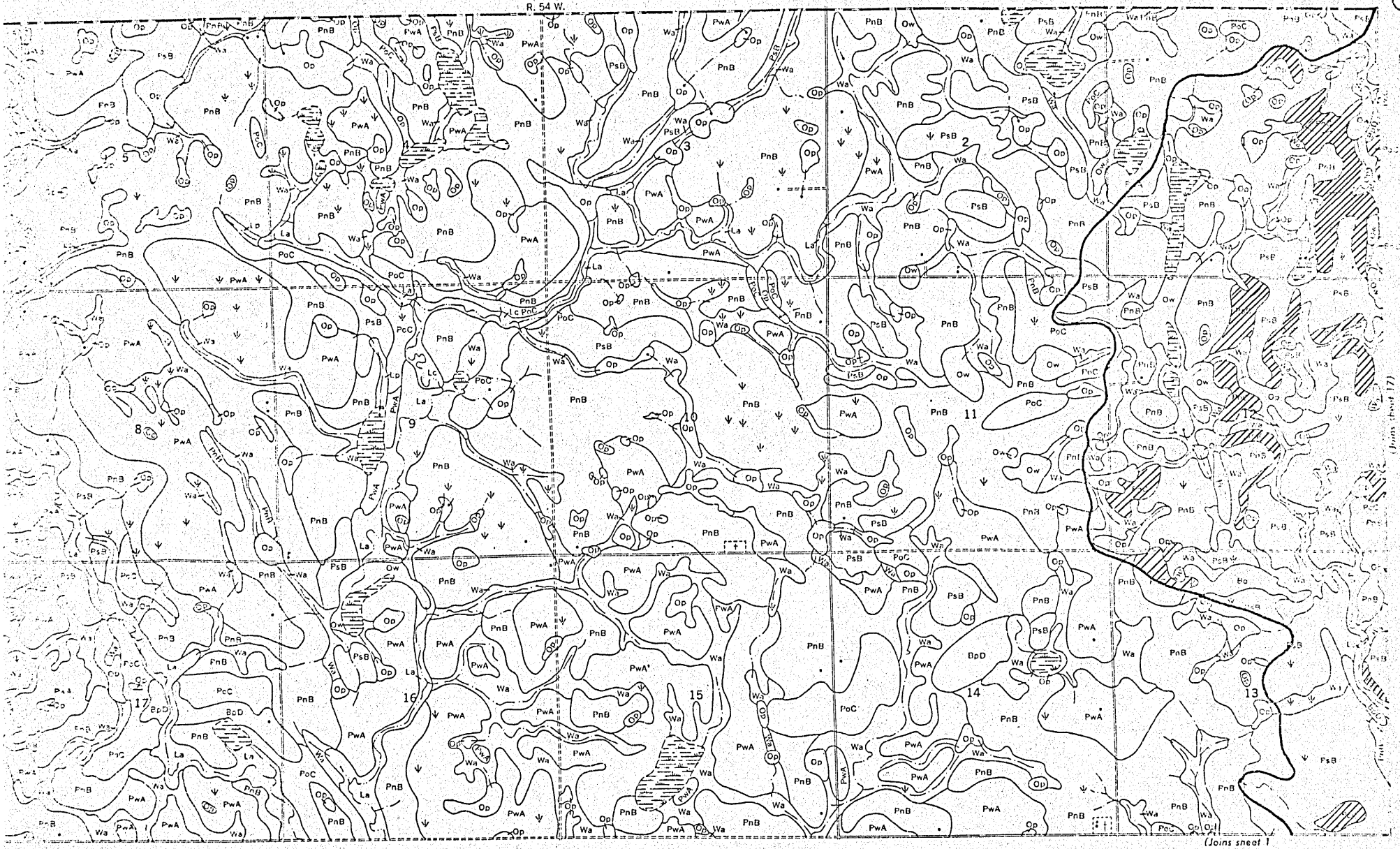
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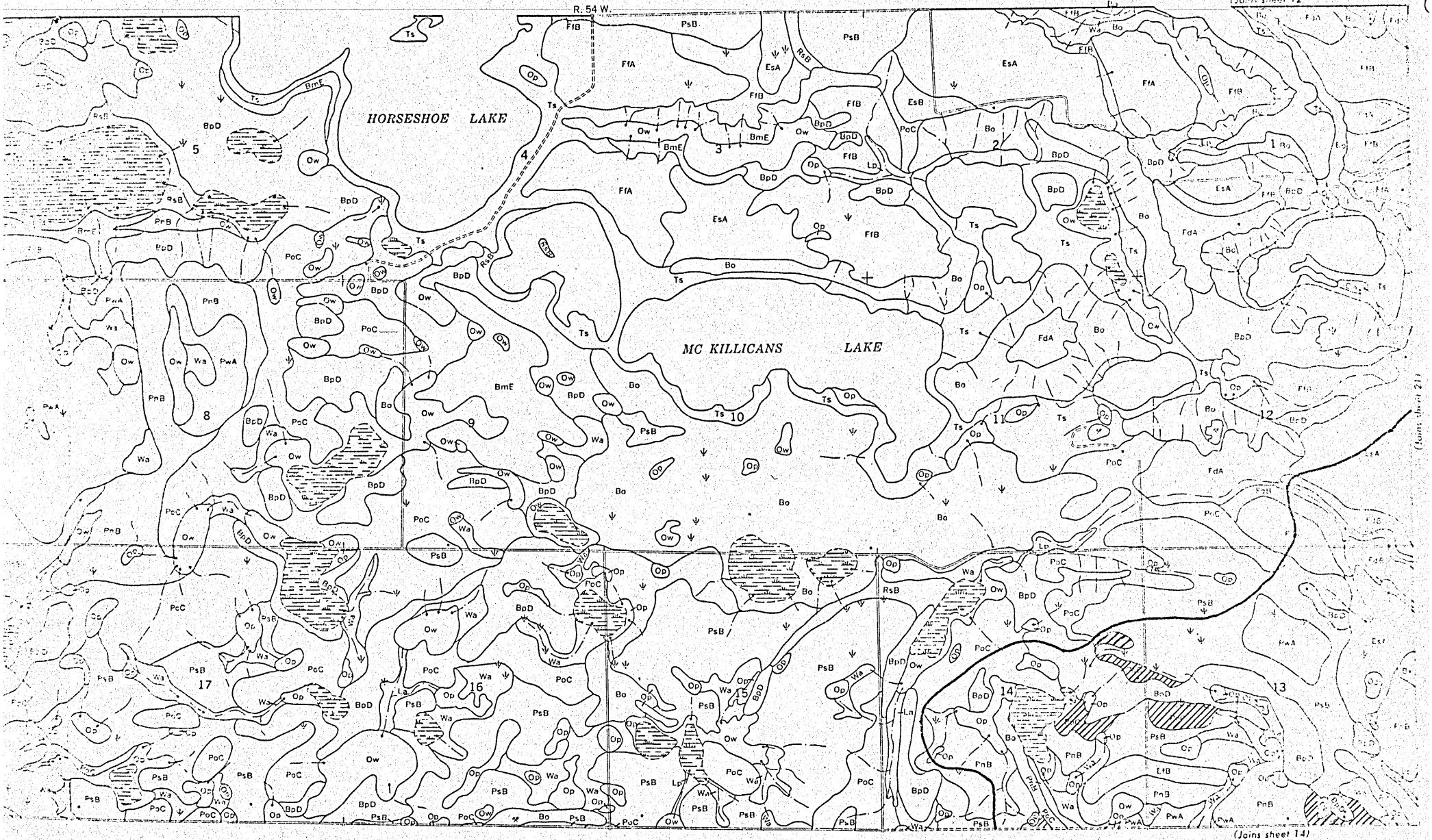

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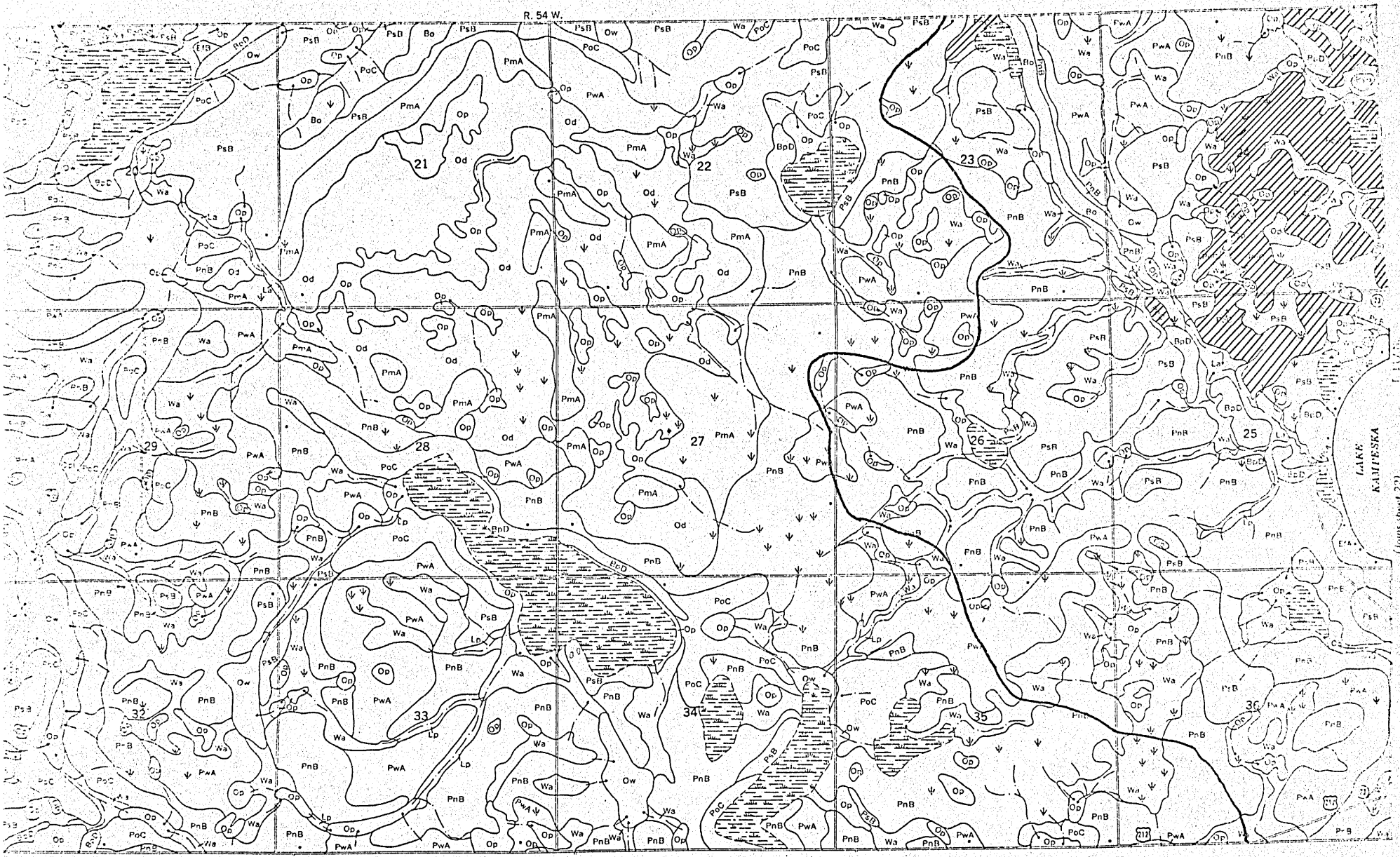

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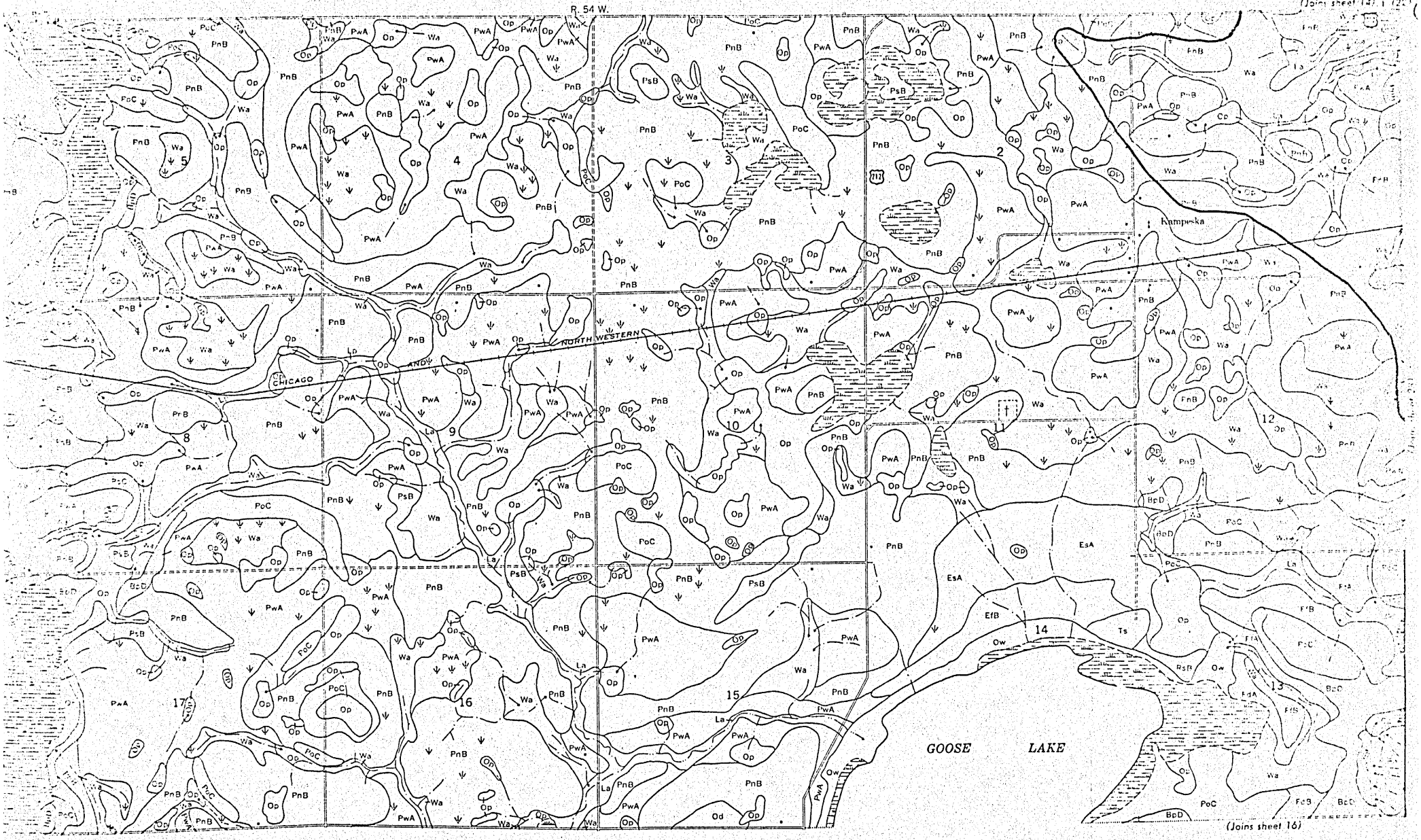

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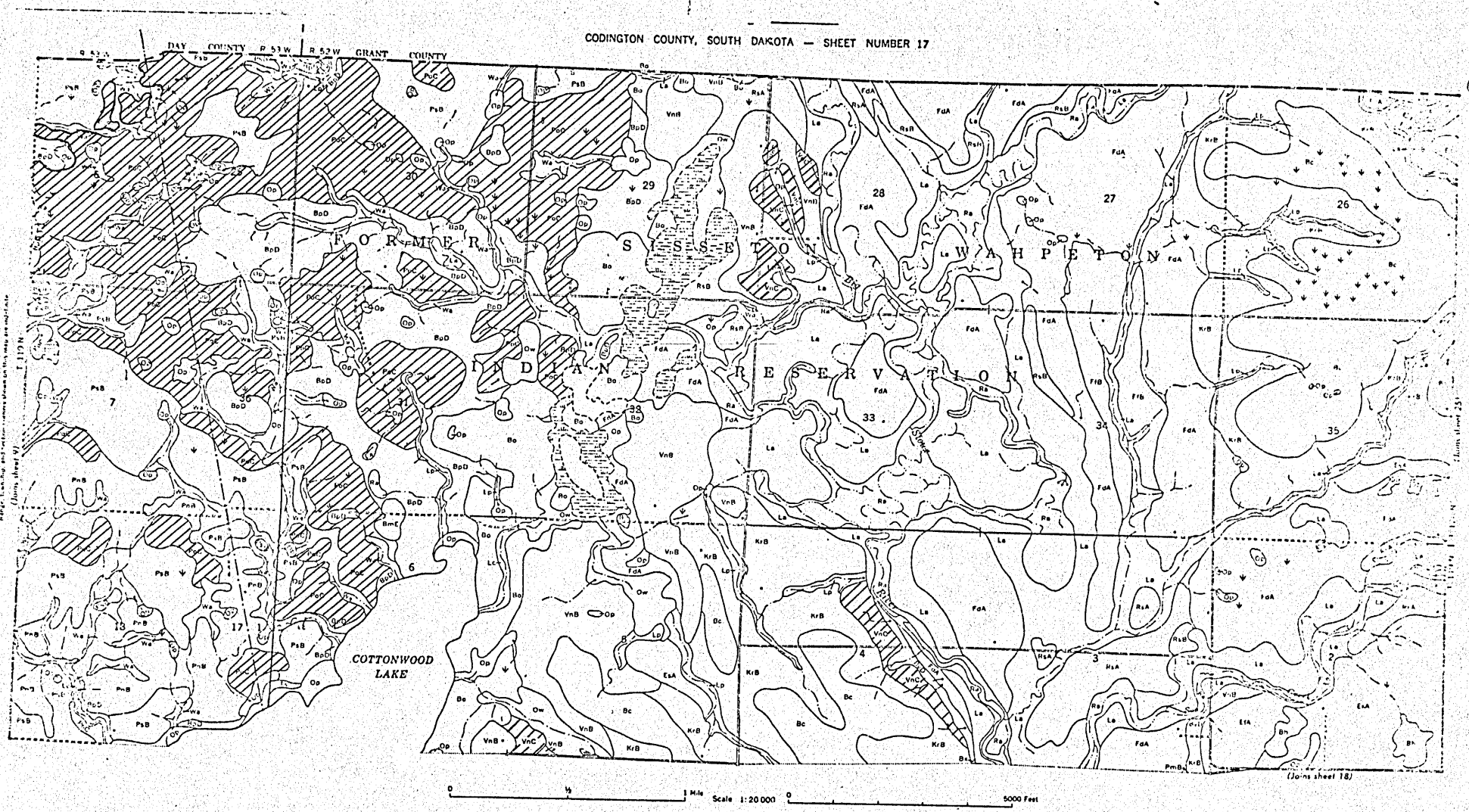

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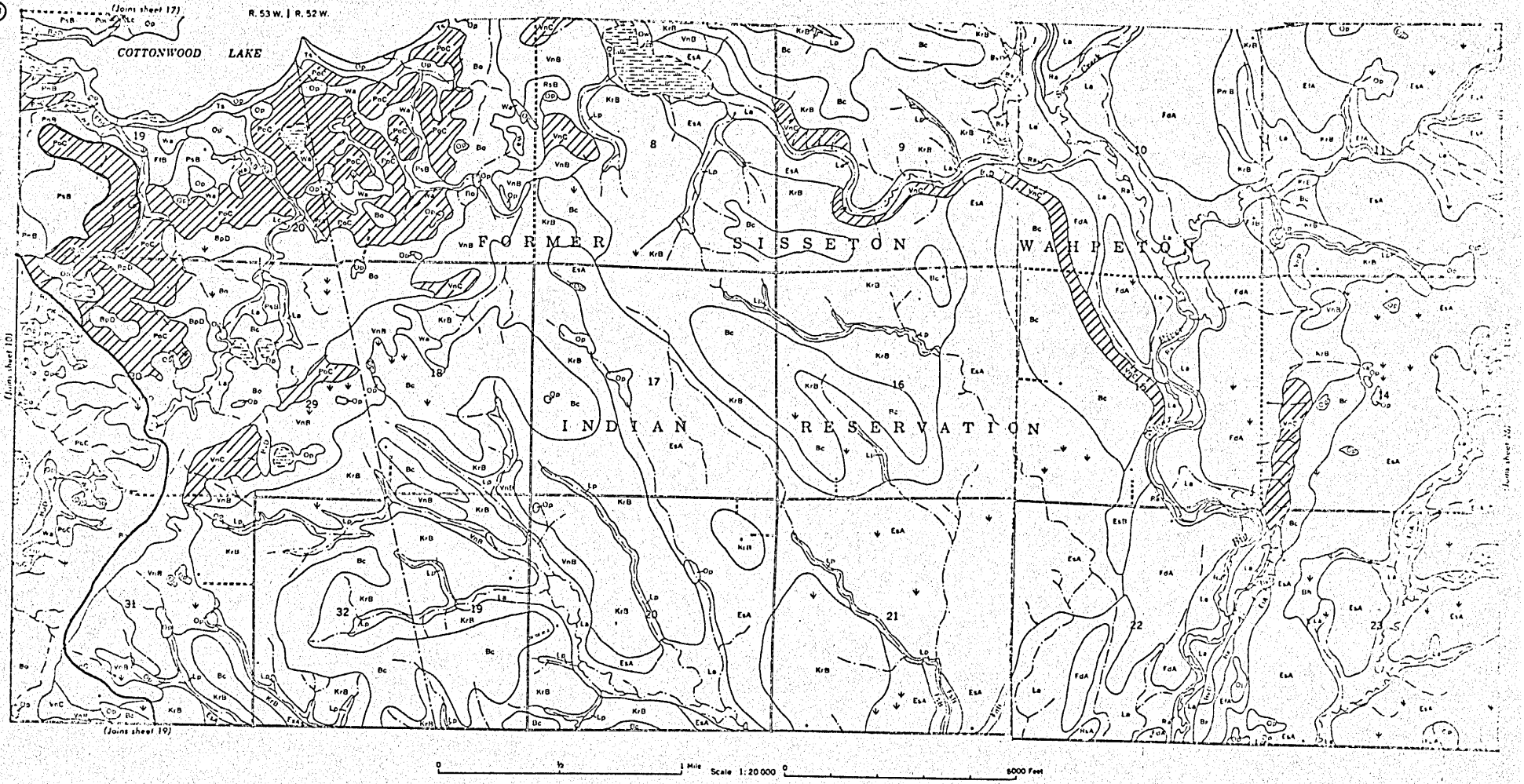

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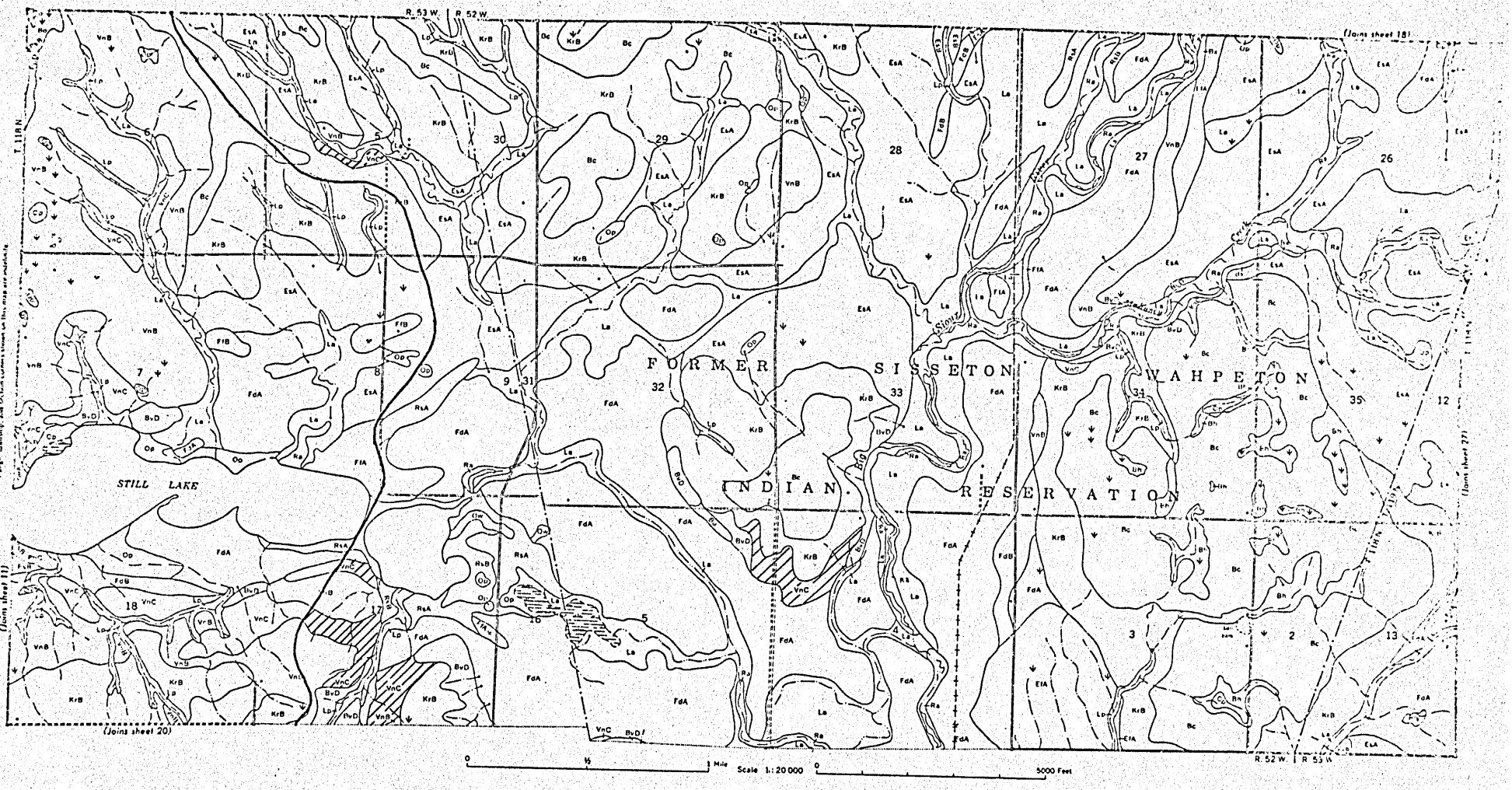

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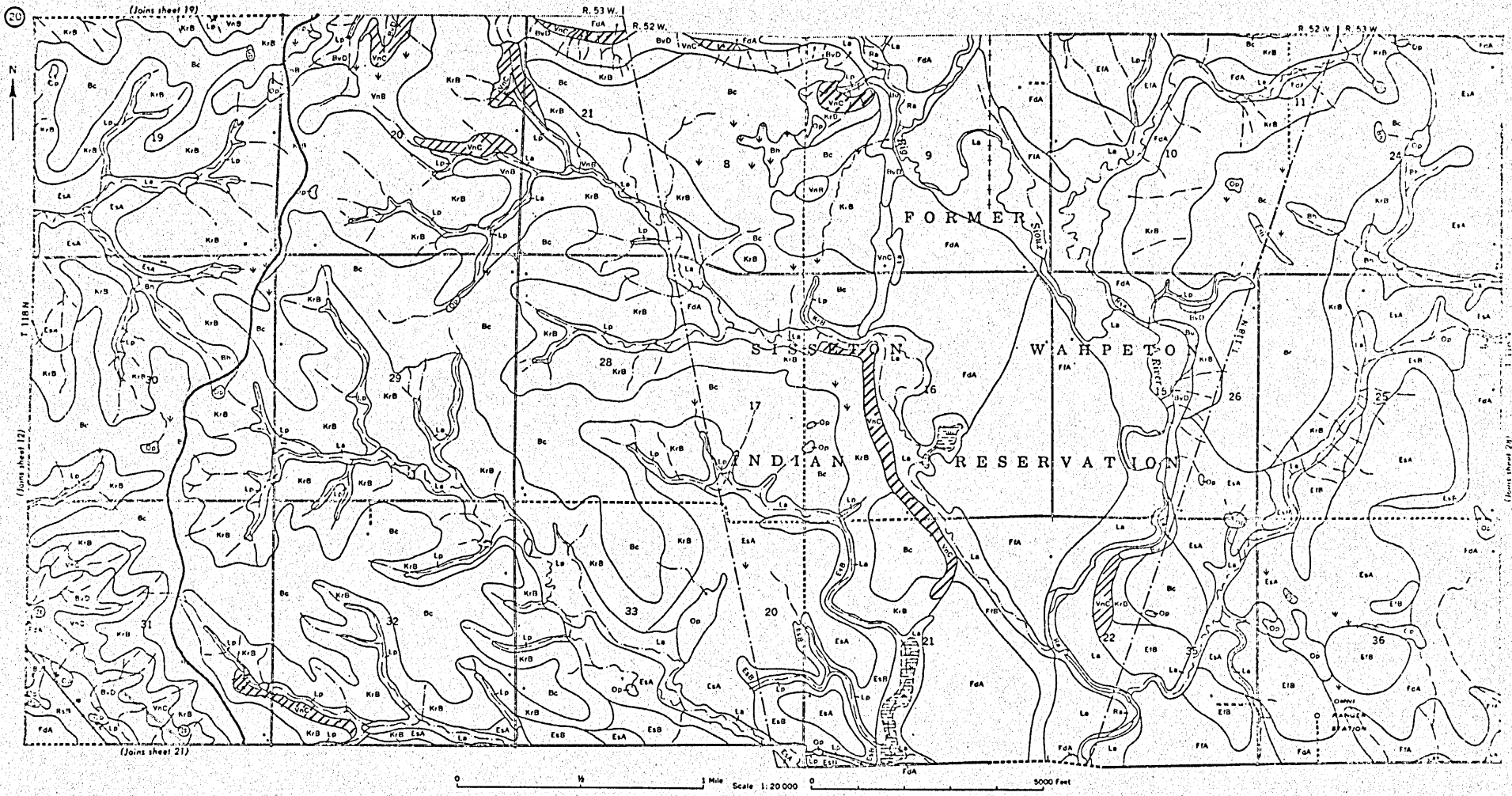

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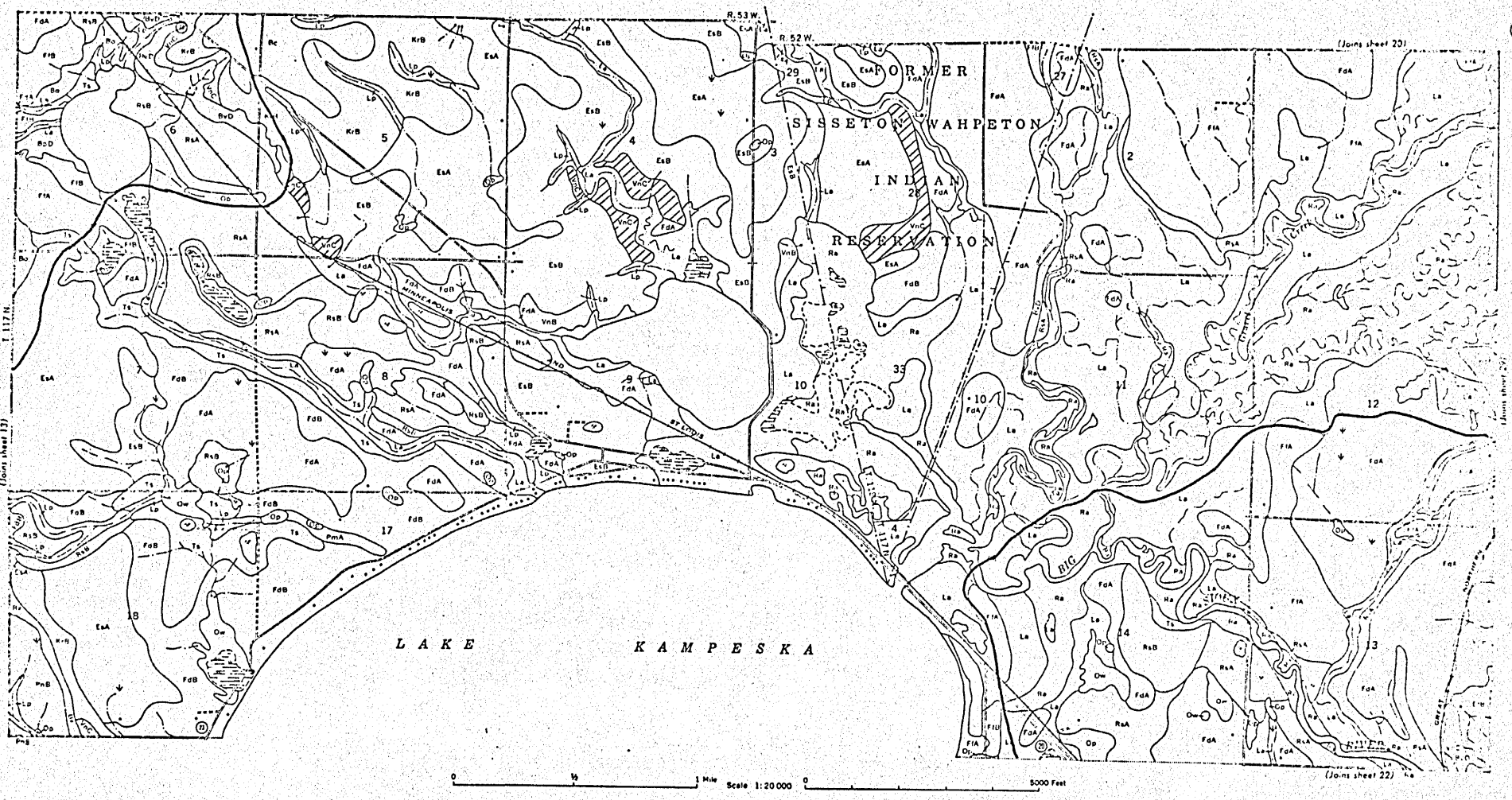

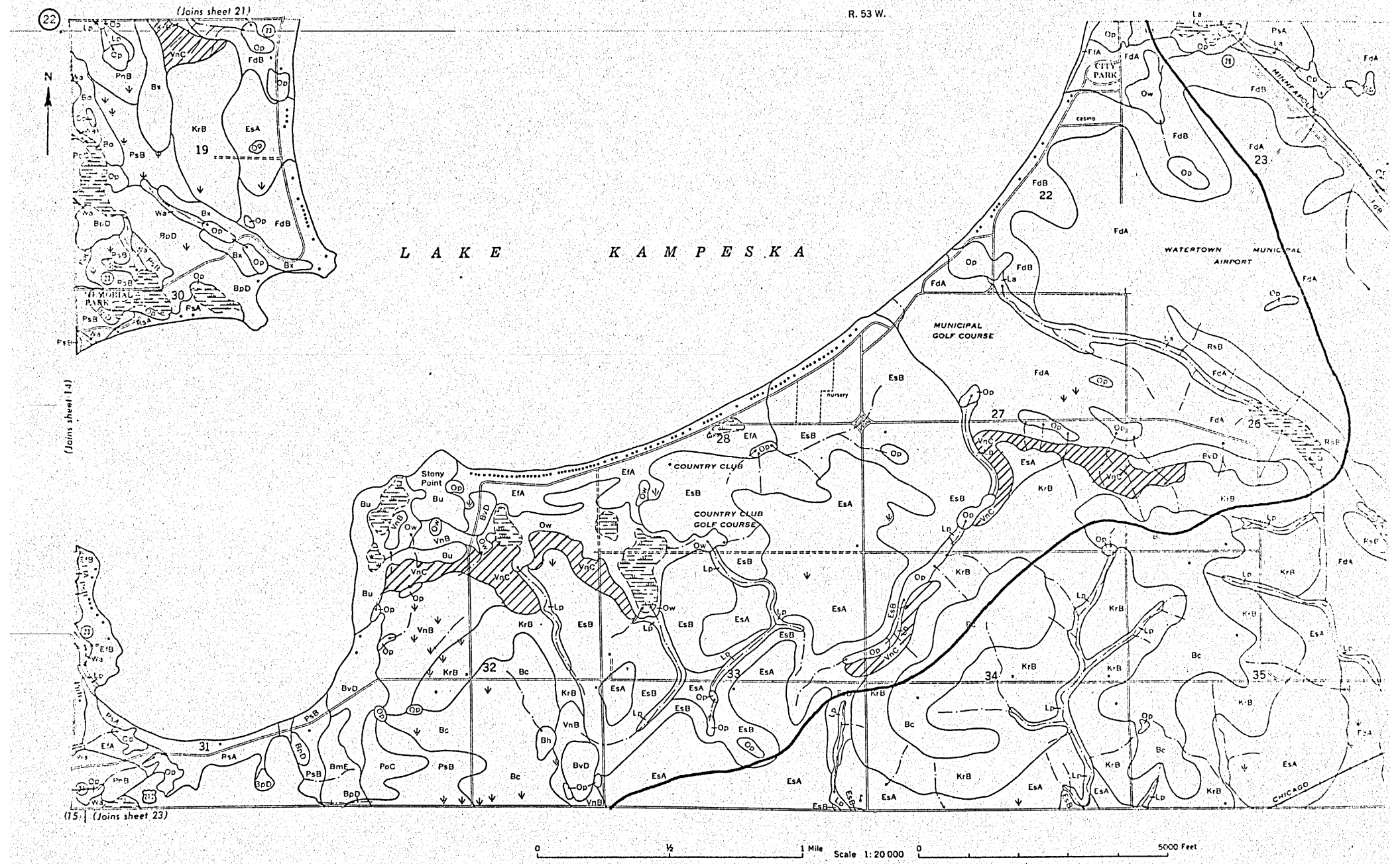
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R. 53 W.
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LAKE KAMPESKA
CITY PARK
MEMORIAL PARK
MUNICIPAL GOLF COURSE
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COUNTRY CLUB GOLF COURSE
WATERTOWN MUNICIPAL AIRPORT
MINNEAPOLIS
CHICAGO
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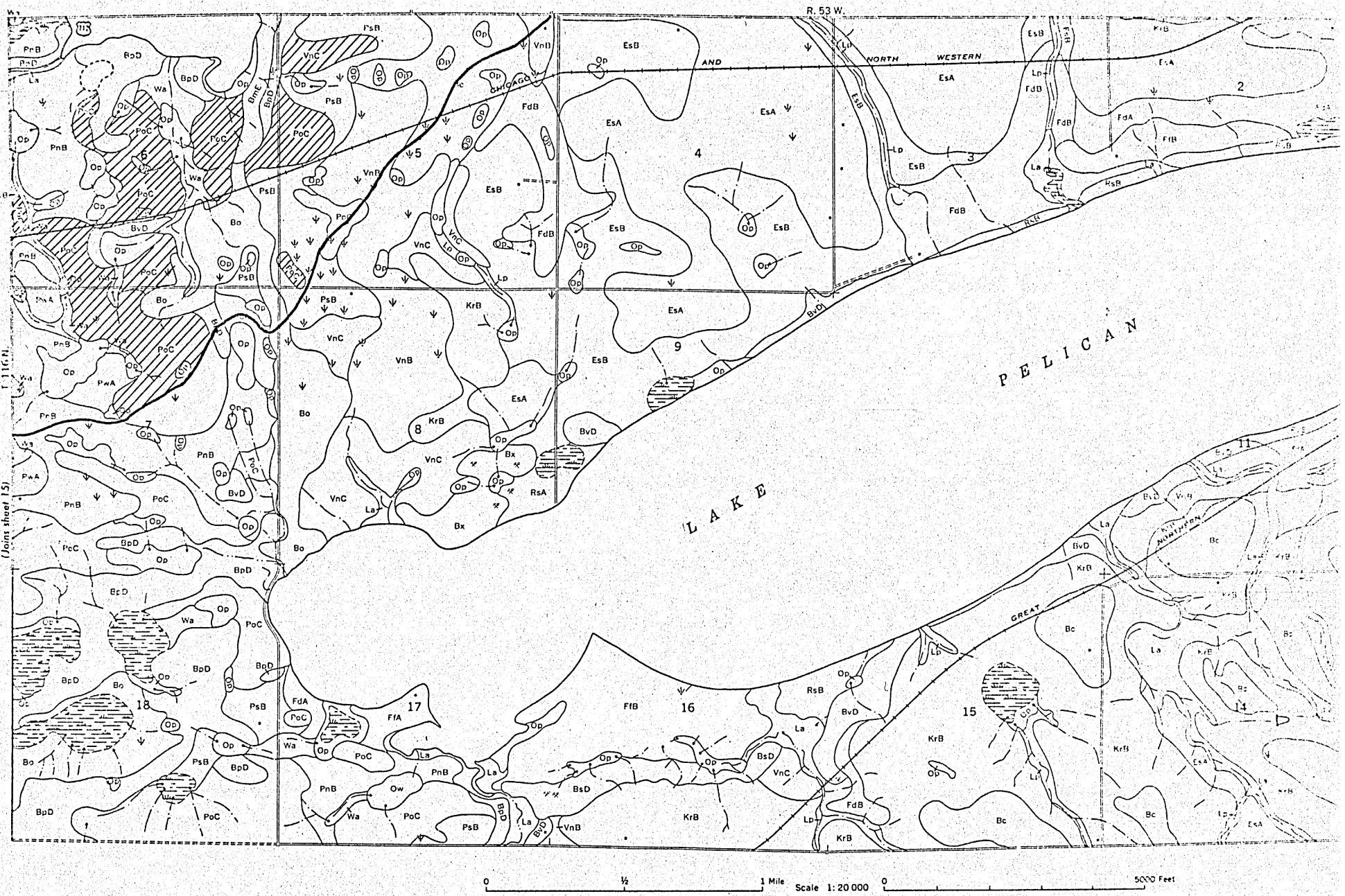
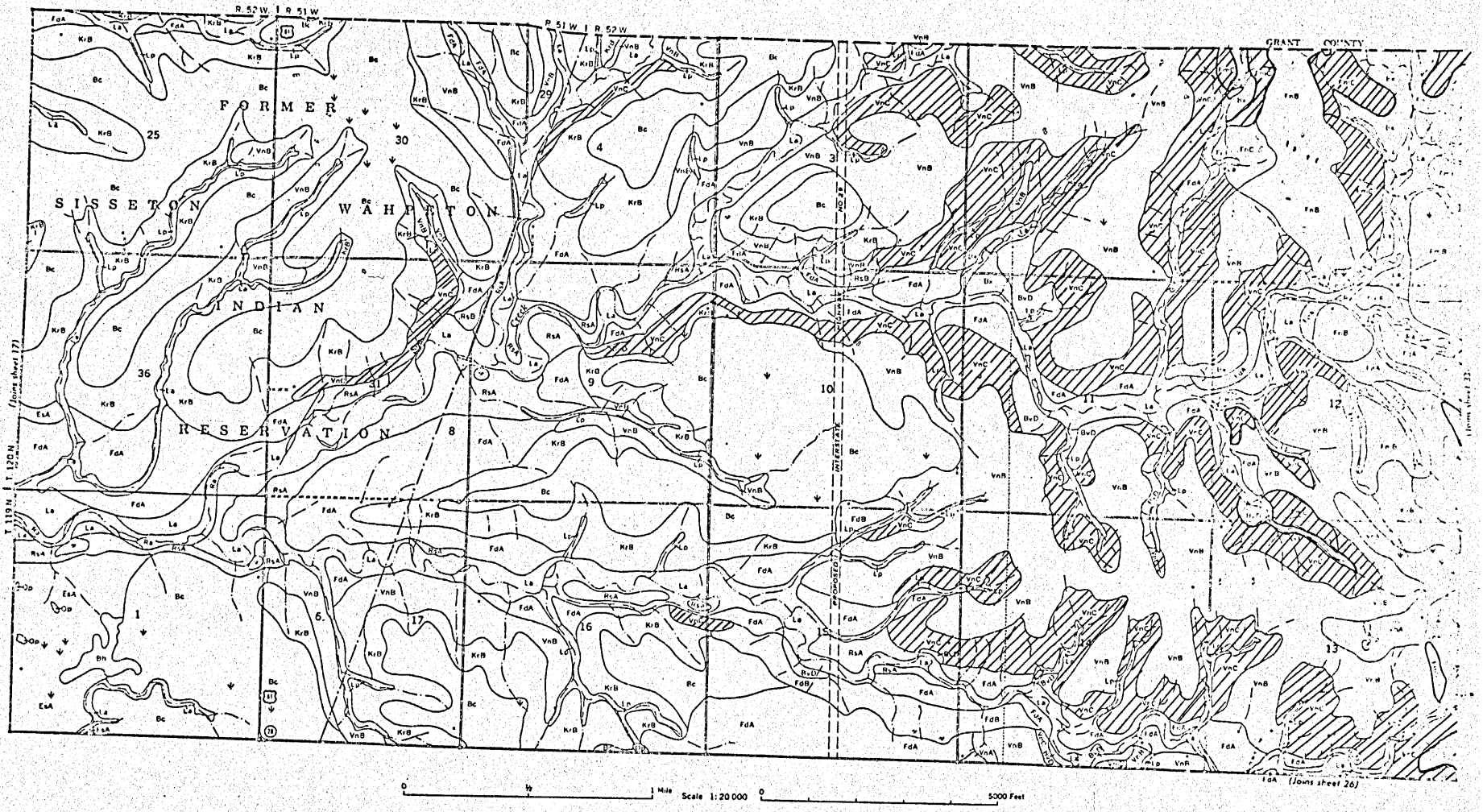
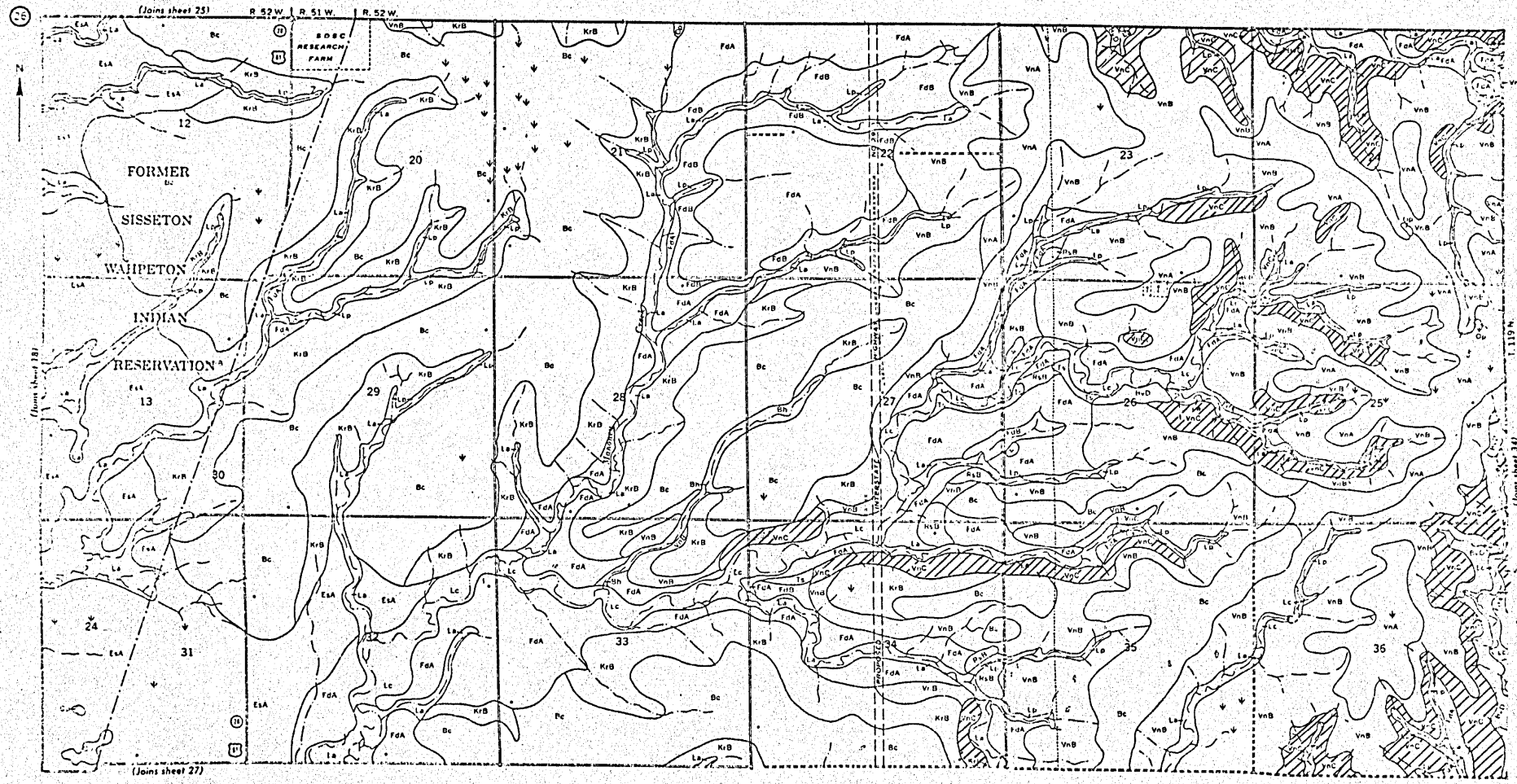
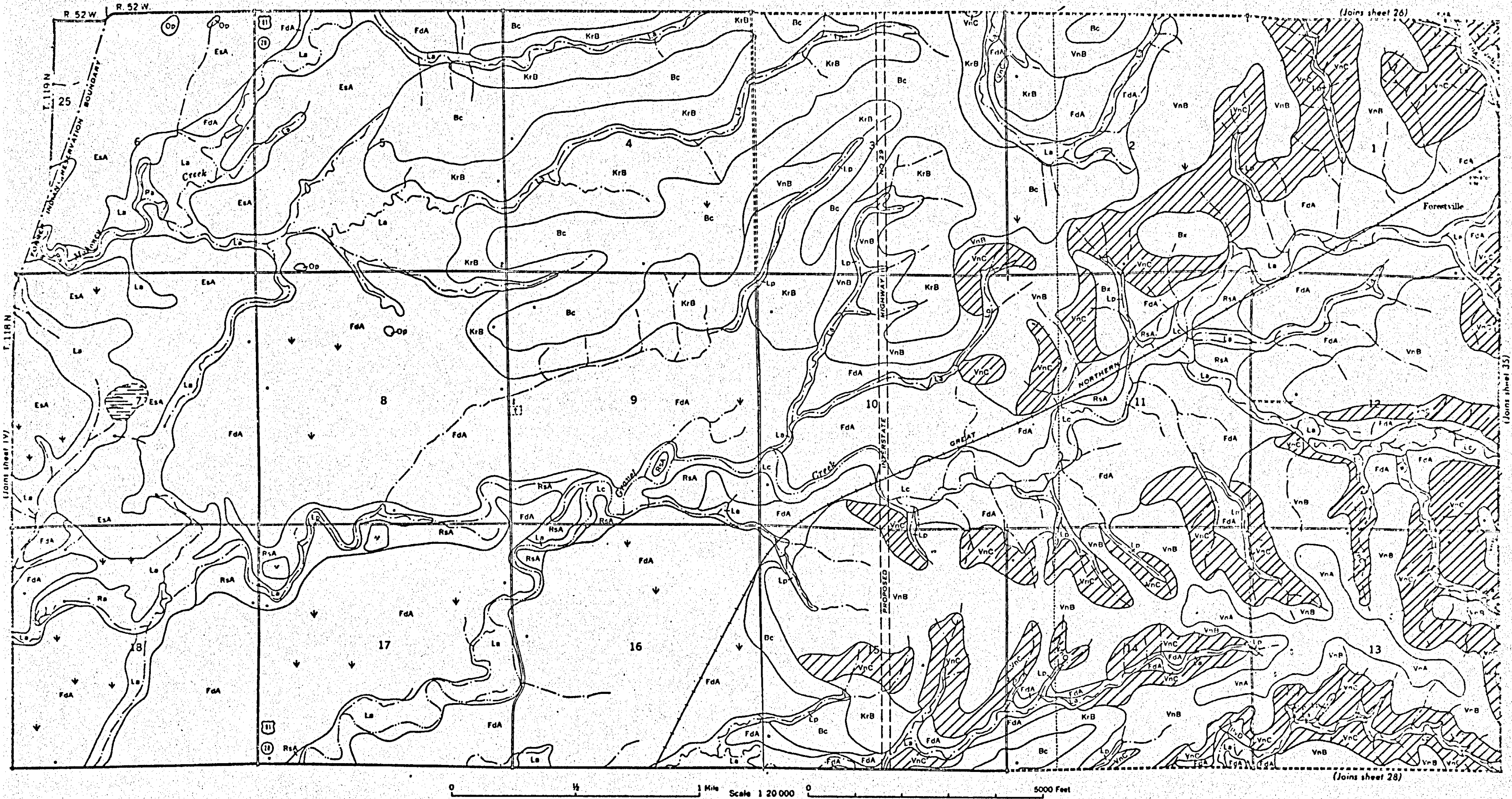


CODINGTON COUNTY, SOUTH DAKOTA — SHEET NUMBER 25

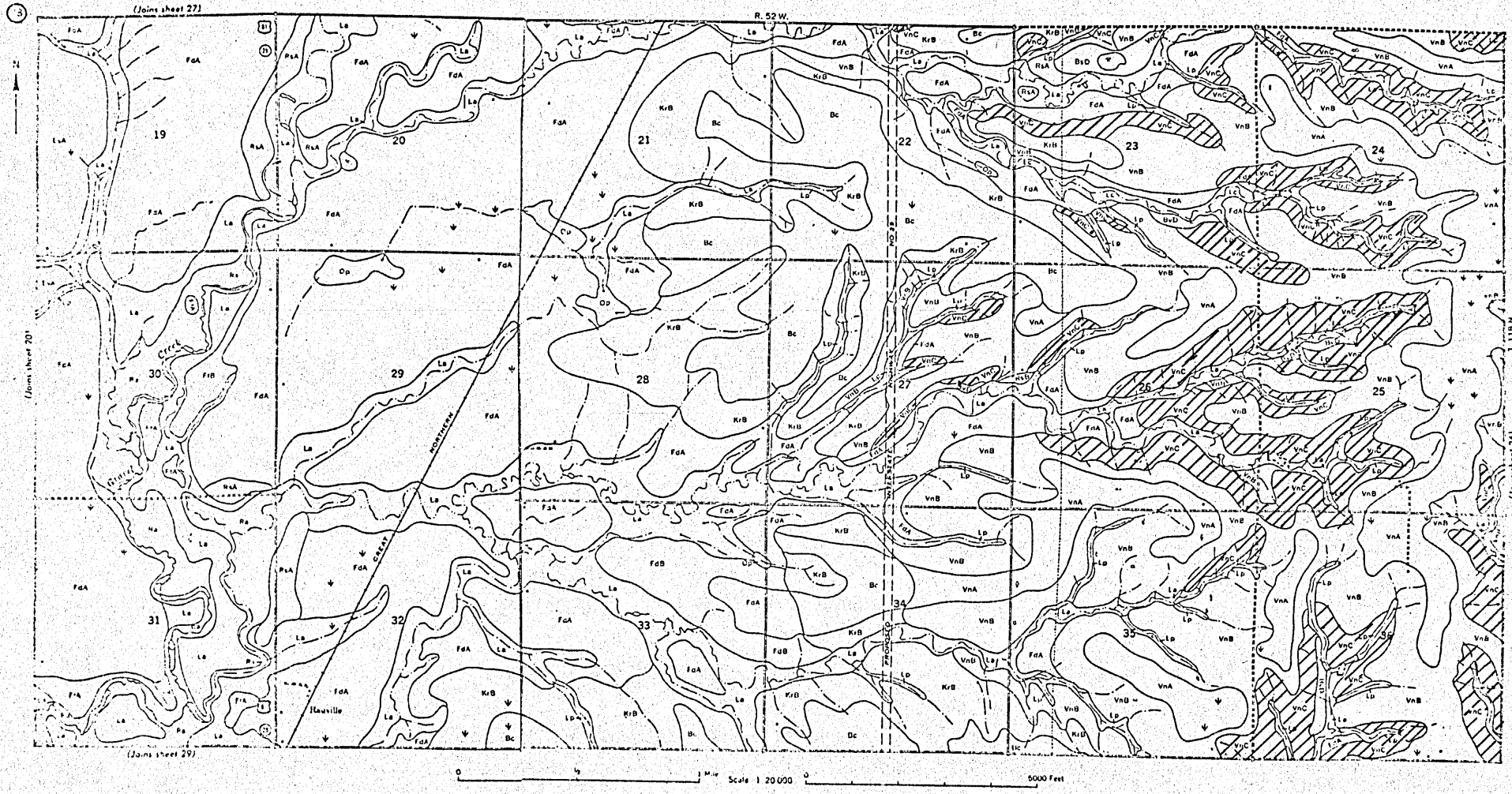


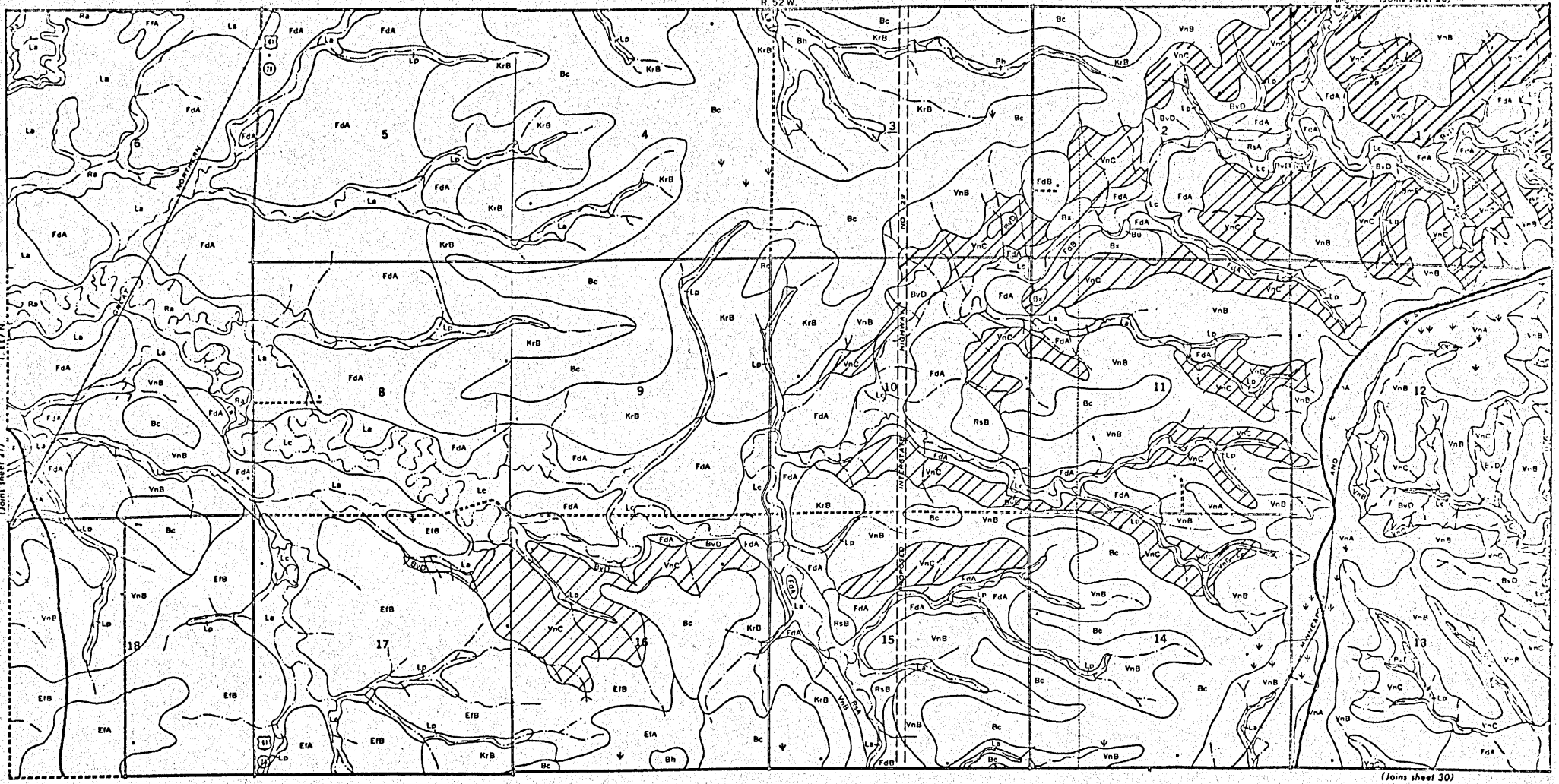
CODINGTON COUNTY, SOUTH DAKOTA — SHEET NUMBER 26



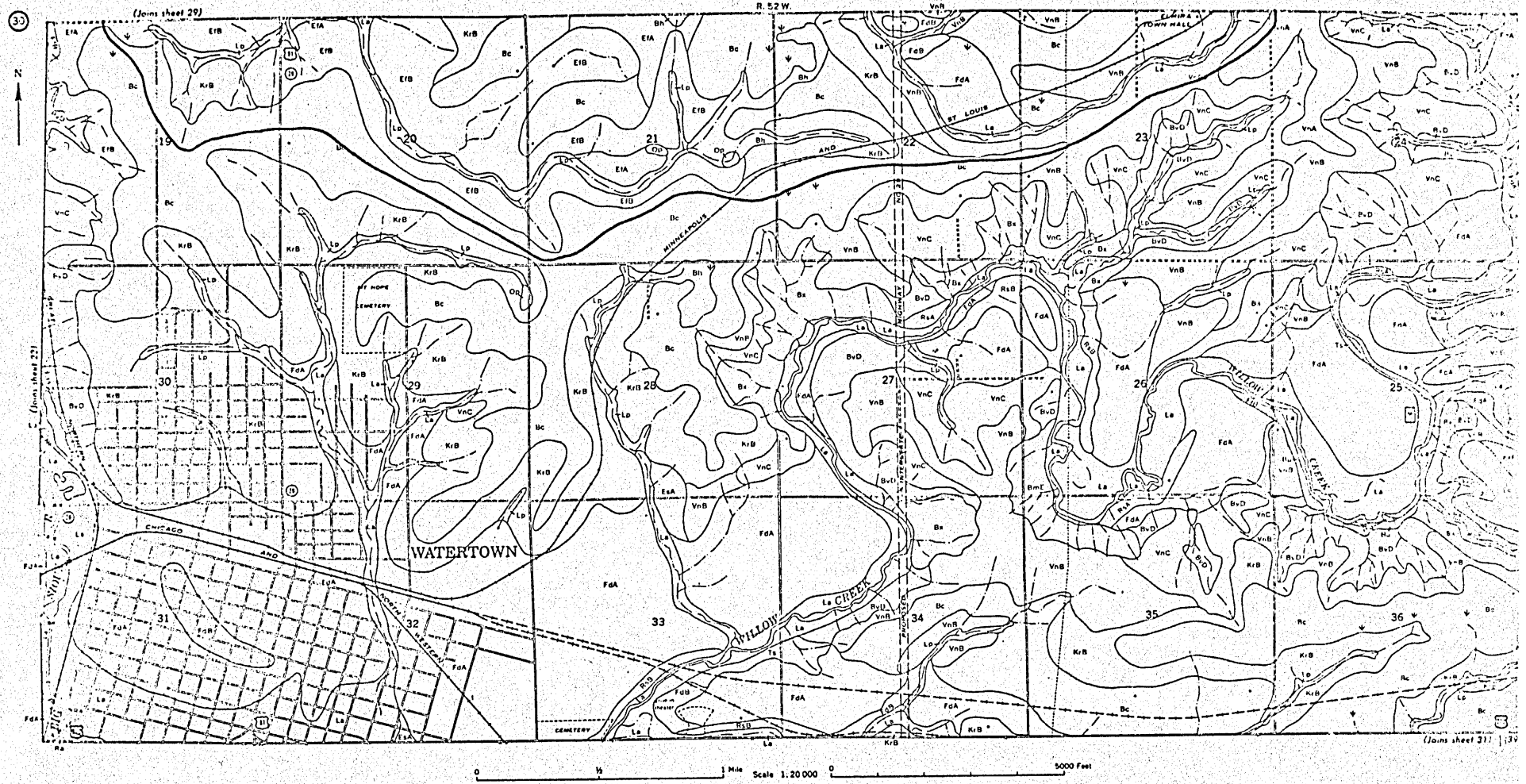

(Joins sheet 26)
(Joins sheet 35)
(Joins sheet 28)
(Joins sheet IV)
R. 52 W.
T. 119 N.
T. 118 N.
SISSETON INDIAN RESERVATION BOUNDARY
Gravel Creek
Creek
PROPOSED INTERSTATE HIGHWAY NO. 29
GREAT NORTHERN
Forestville
0
½
1 Mile
Scale 1:20 000
0
5000 Feet
N

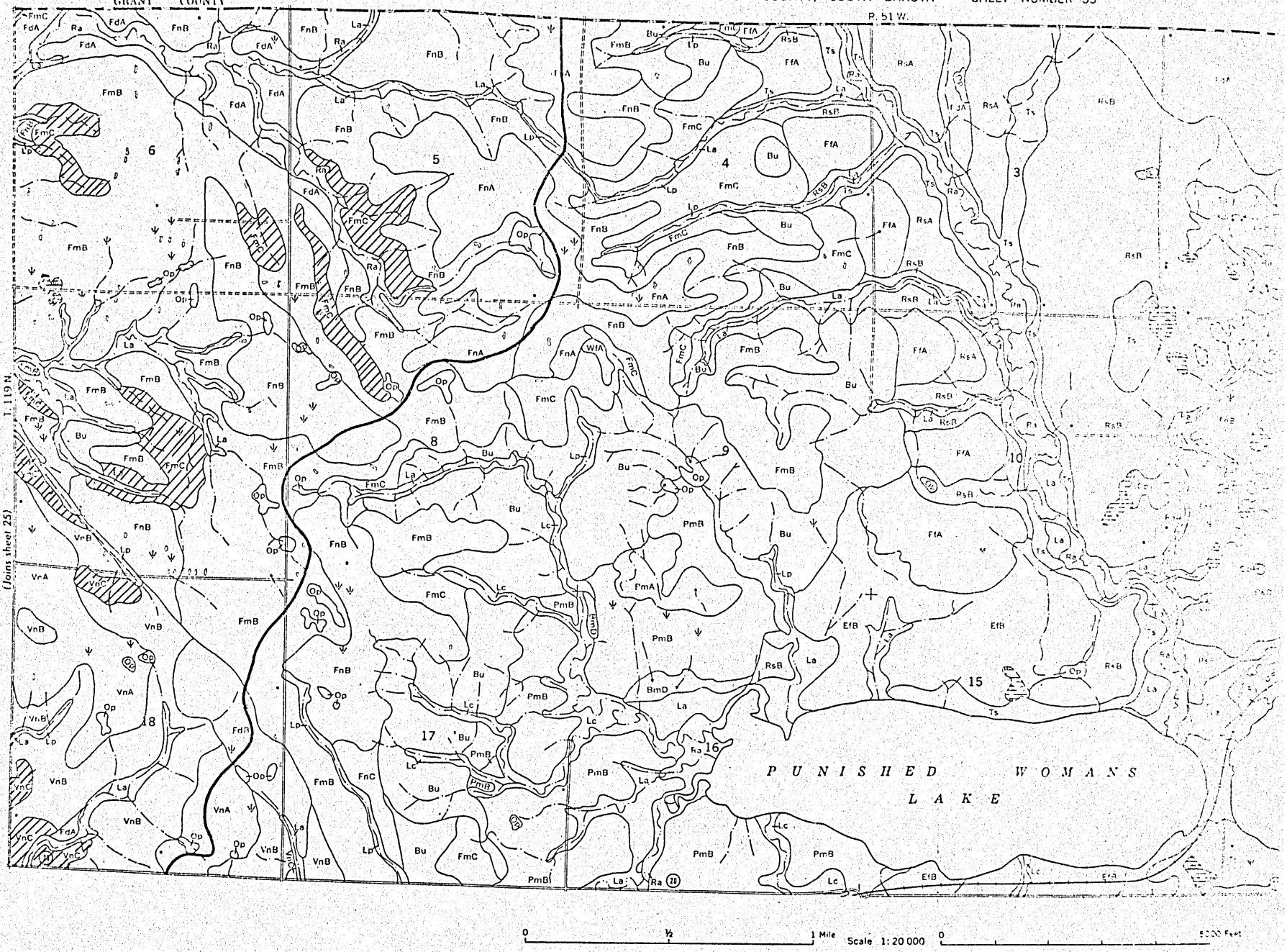
CODINGTON COUNTY, SOUTH DAKOTA — SHEET NUMBER 28




R. 52 W.
(Joins sheet 28)
(Joins sheet 31)
(Joins sheet 30)
T. 117 N.
NORTHERN
CHICAGO
NO. 81
INTERSTATE
MINNEAPOLIS
Ra
FfA
La
FdA
Lp
KrB
Bc
Bh
VnB
VnC
BvD
Bx
FdB
RsA
RsB
Lc
EfB
EfA
VnA
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0
½
1 Mile
Scale 1:20000
0
5000 Feet

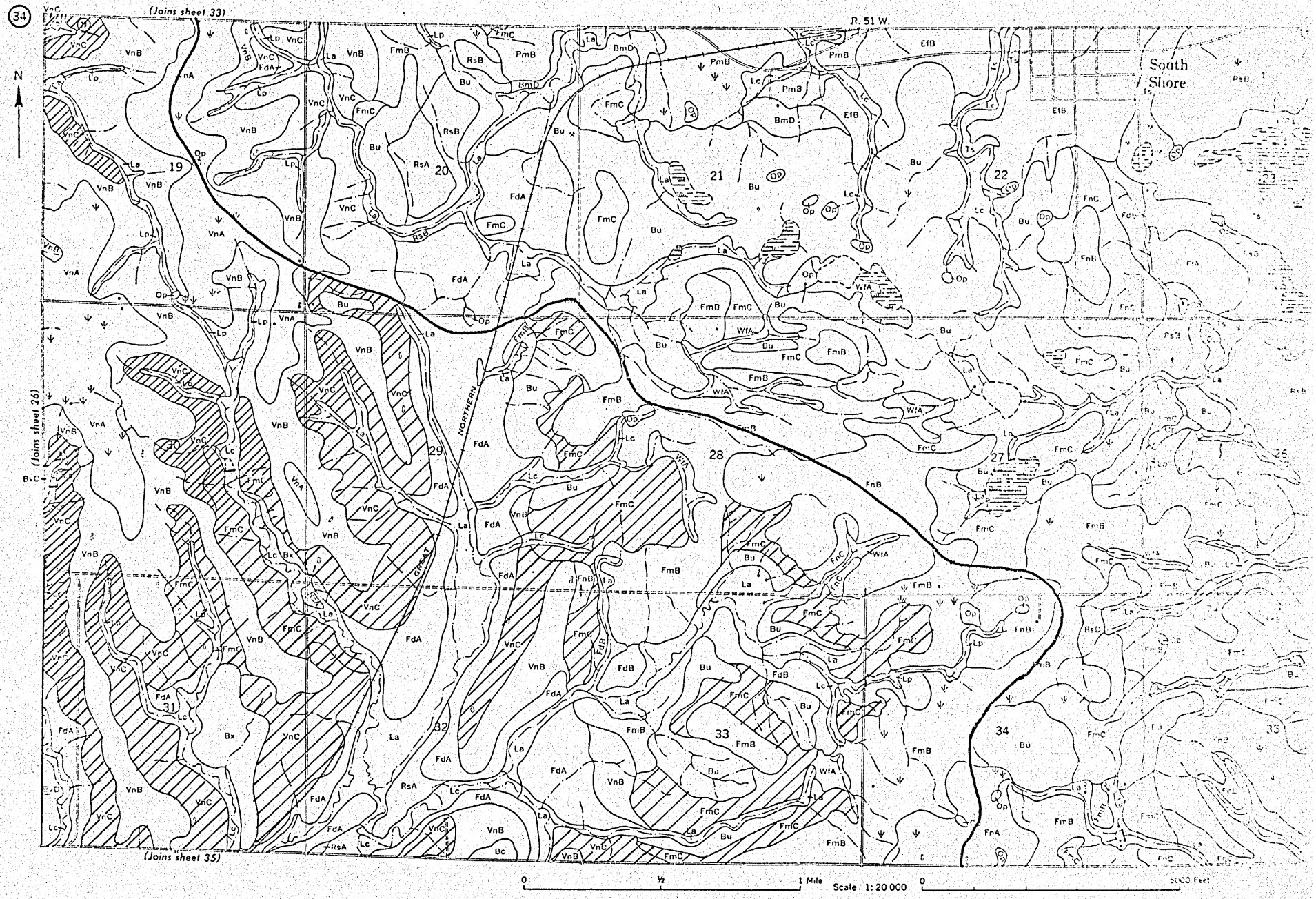
CODINGTON COUNTY, SOUTH DAKOTA — SHEET NUMBER 30

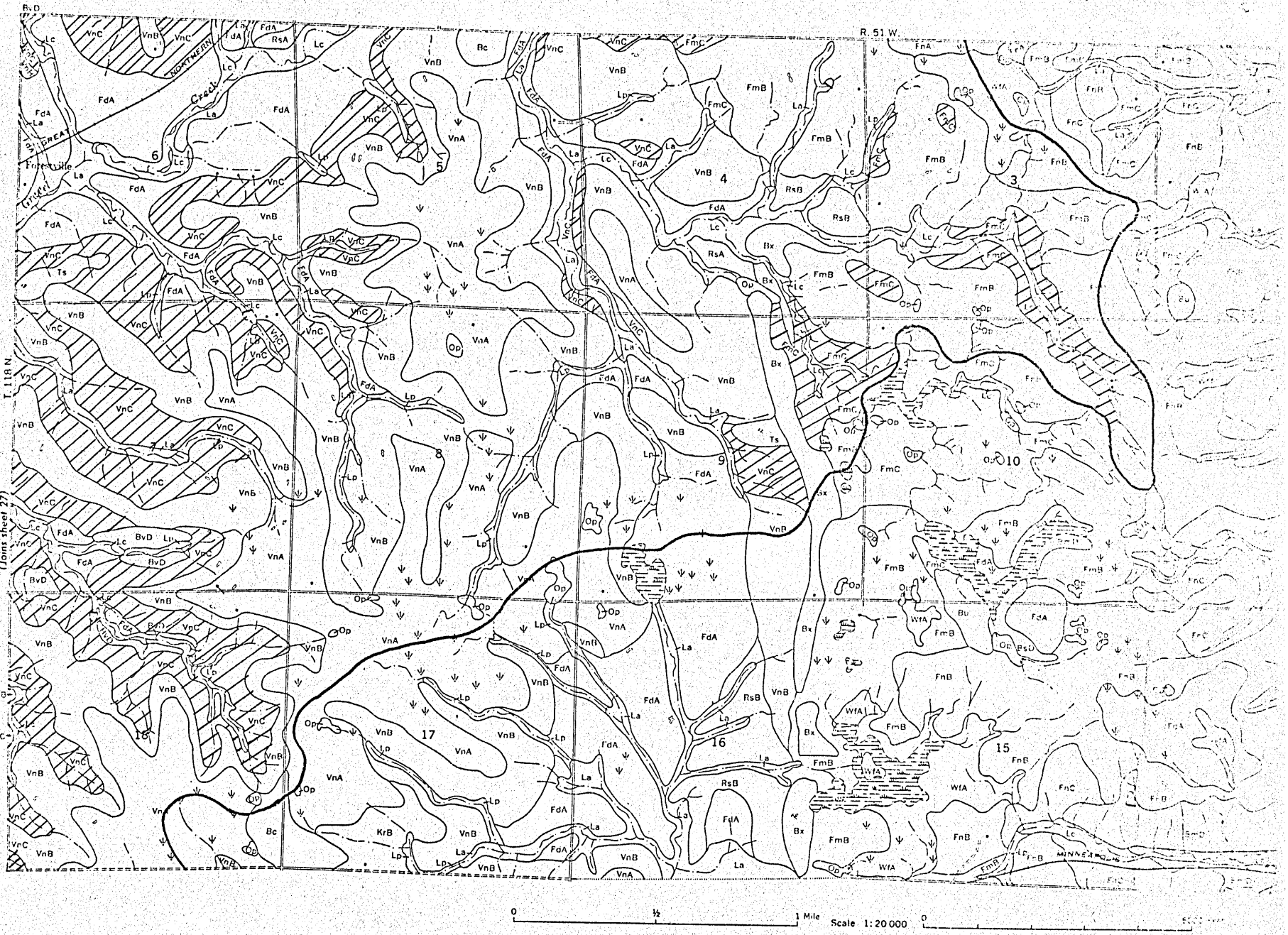




This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the South Dakota Agricultural Experiment Station.

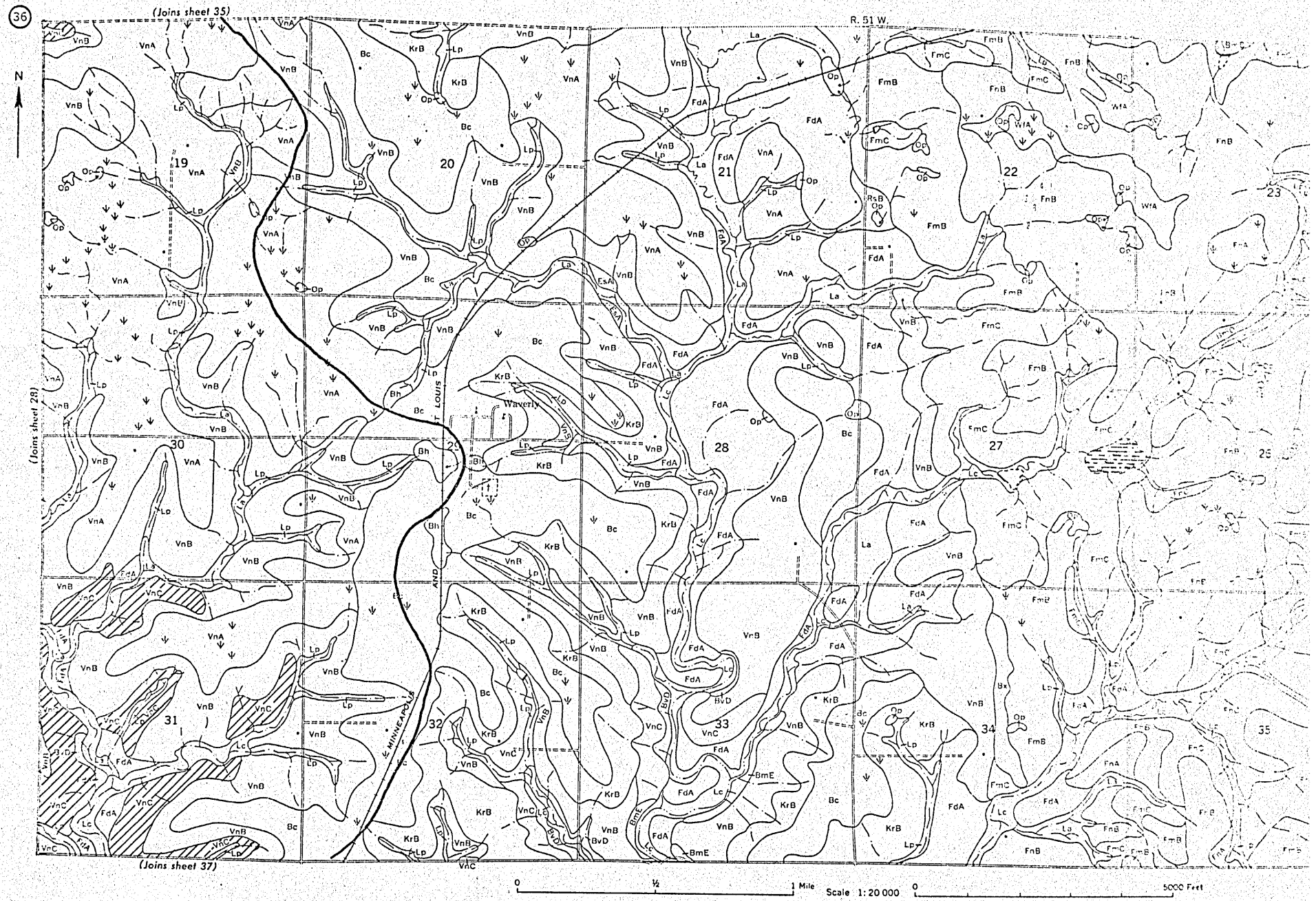
Range, township, and section corners shown on this map are intermittent.

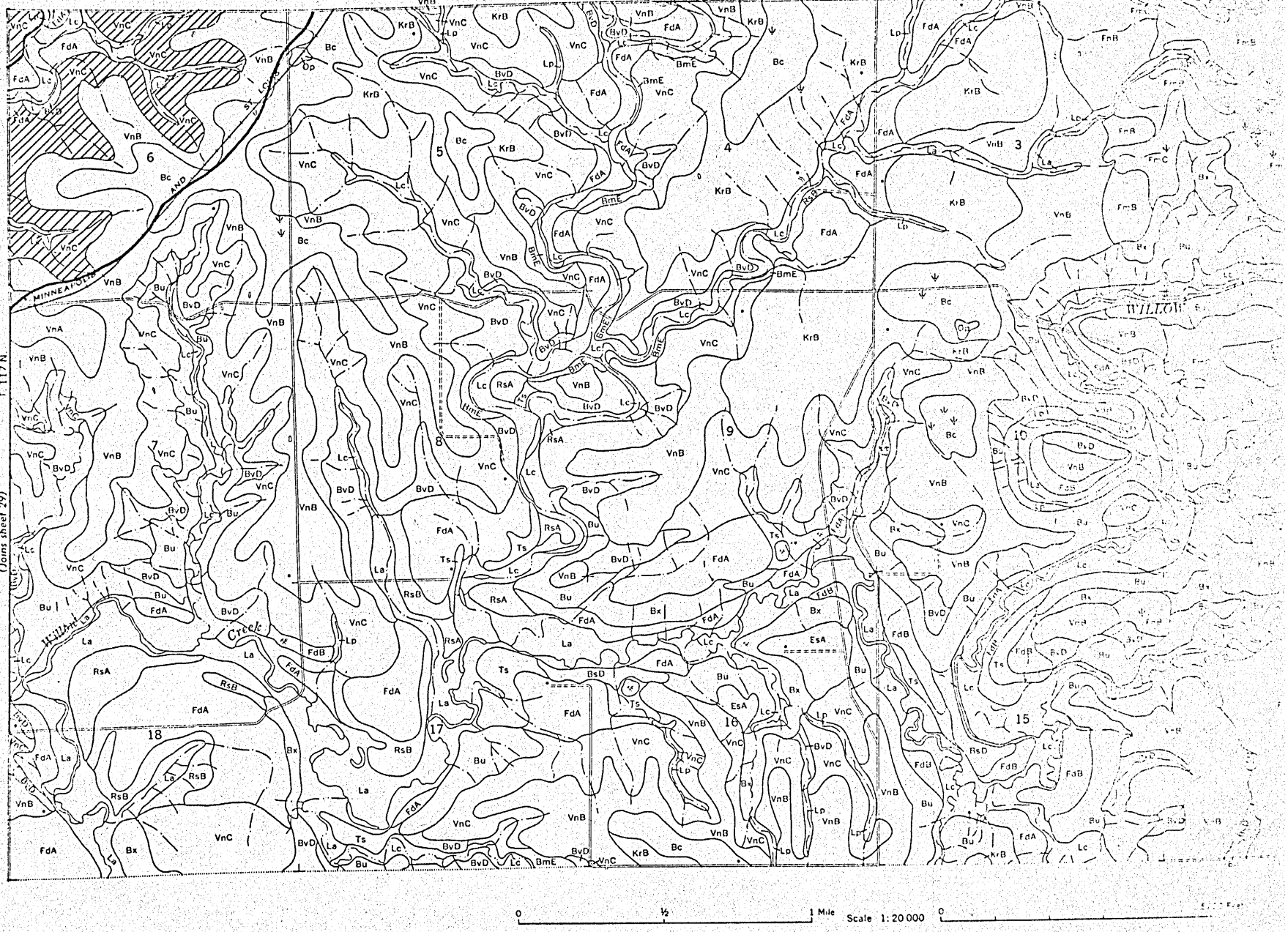

34
(Joins sheet 33)
R. 51 W.
South Shore
N
(Joins sheet 26)
(Joins sheet 35)
NORTHERN
GREAT
0 ½ 1 Mile
Scale 1:20 000
0 5000 Feet



This map is one of a set compiled on the basis of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the South Dakota Agricultural Experiment Station

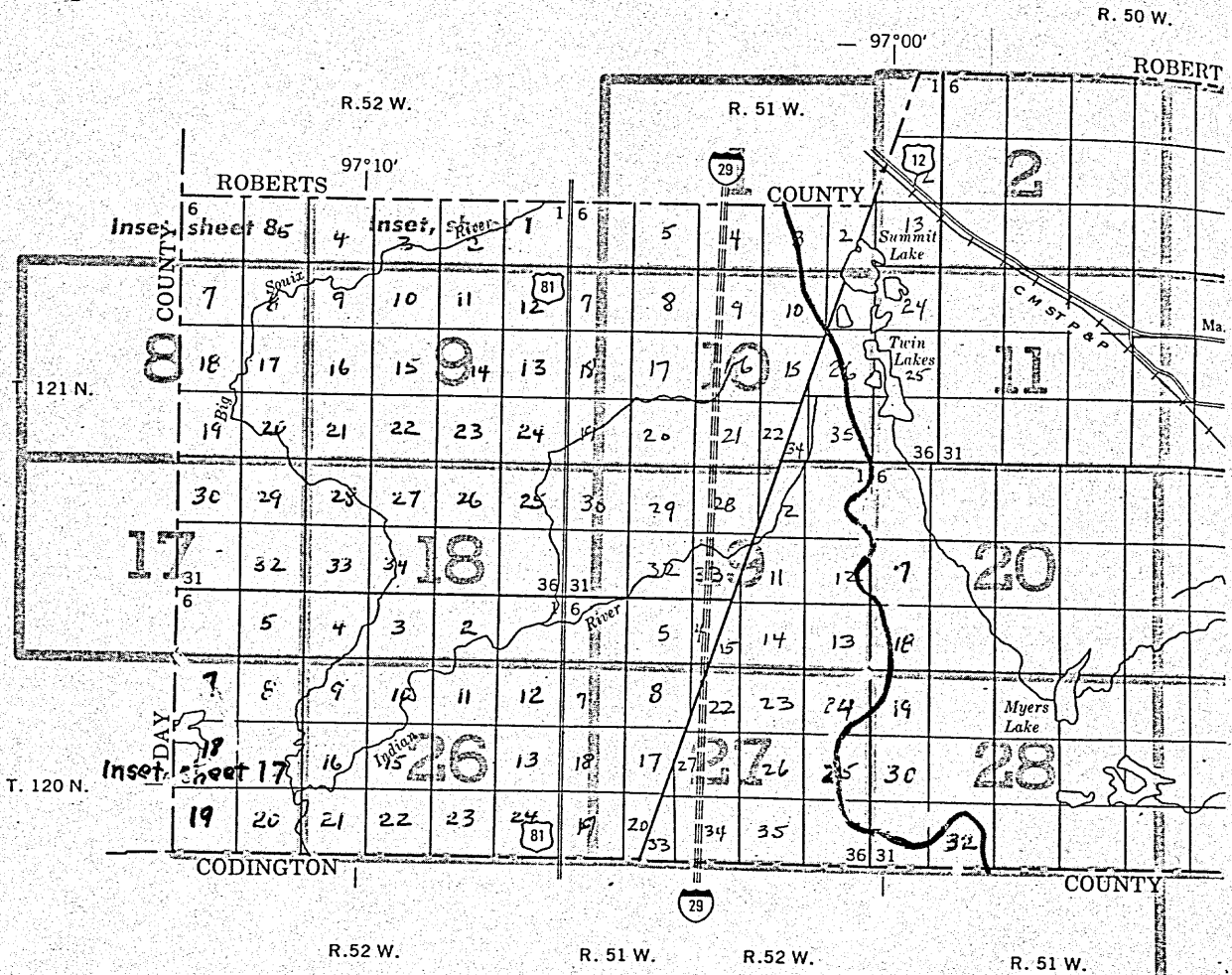
Range, township, and section corners shown on this map are unofficial.


36
(Joins sheet 35)
R. 51 W.
N
(Joins sheet 28)
(Joins sheet 37)
Waverly
ST LOUIS AND MINNEAPOLIS
19
20
21
22
23
30
29
28
27
25
31
32
33
34
35
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet



This map is one of a set compiled as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the South Dakota Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

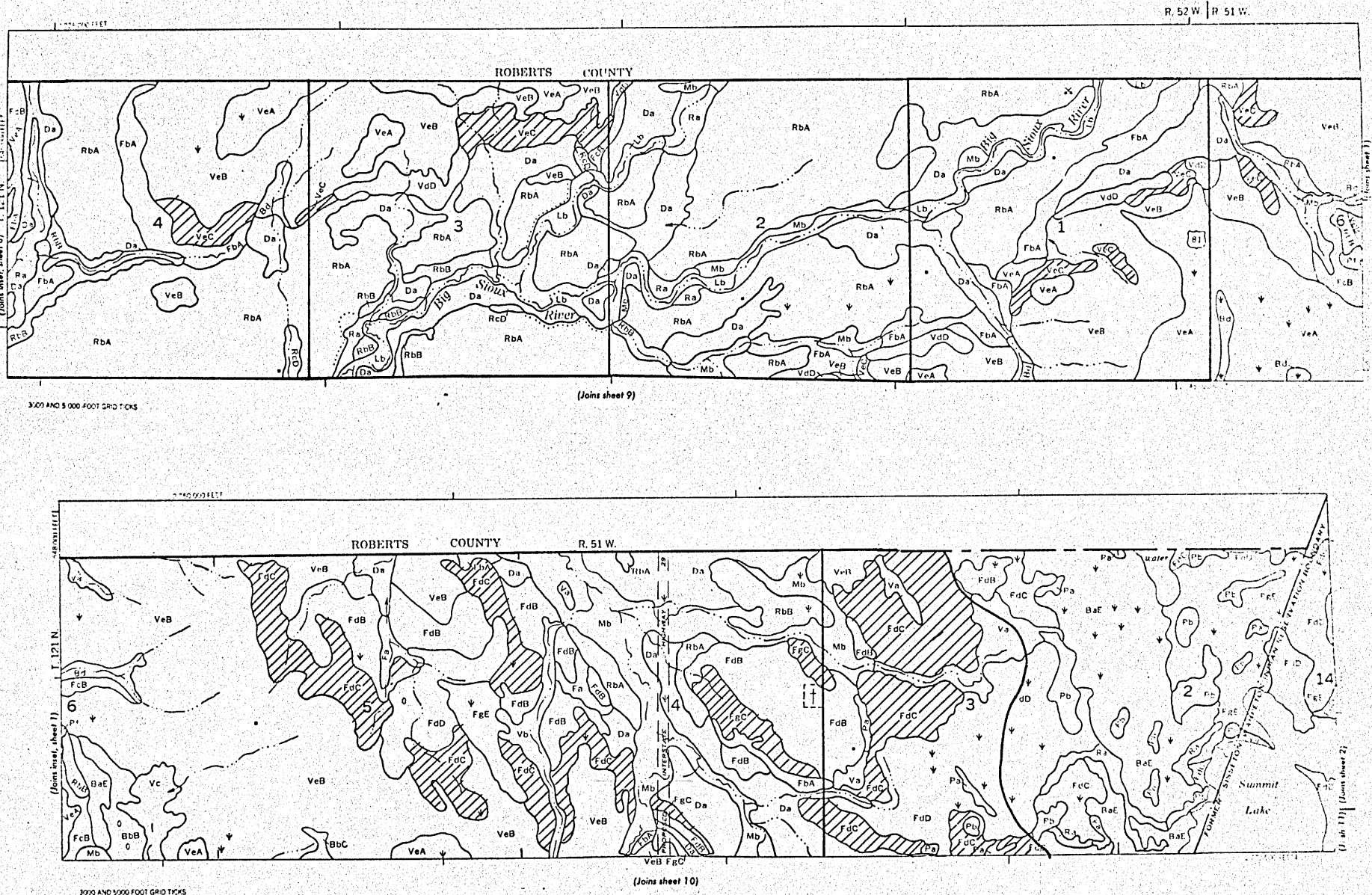


INDEX TO MAP SHEETS

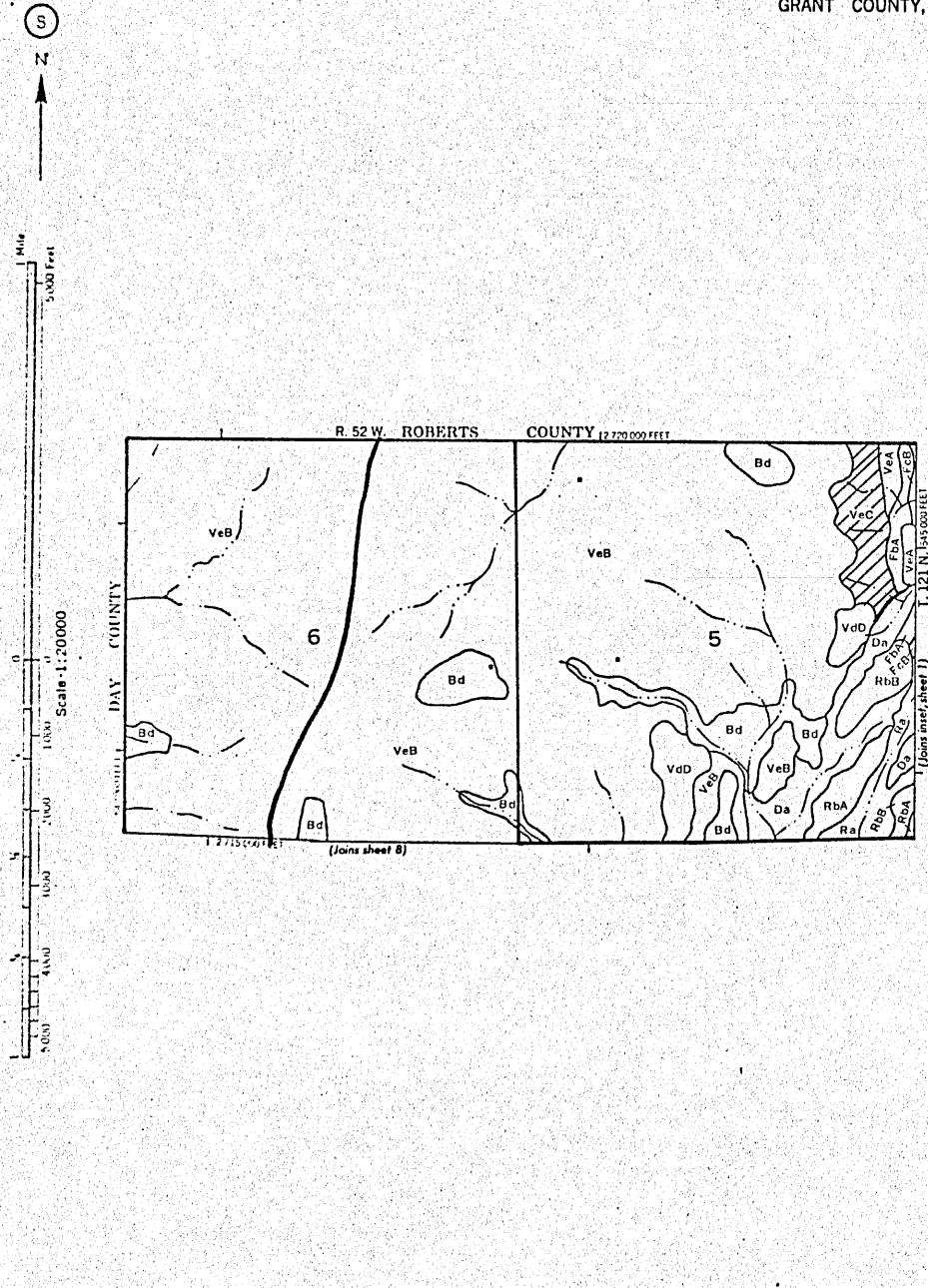
GRANT COUNTY, SOUTH DAKOTA

Scale 1:190,080

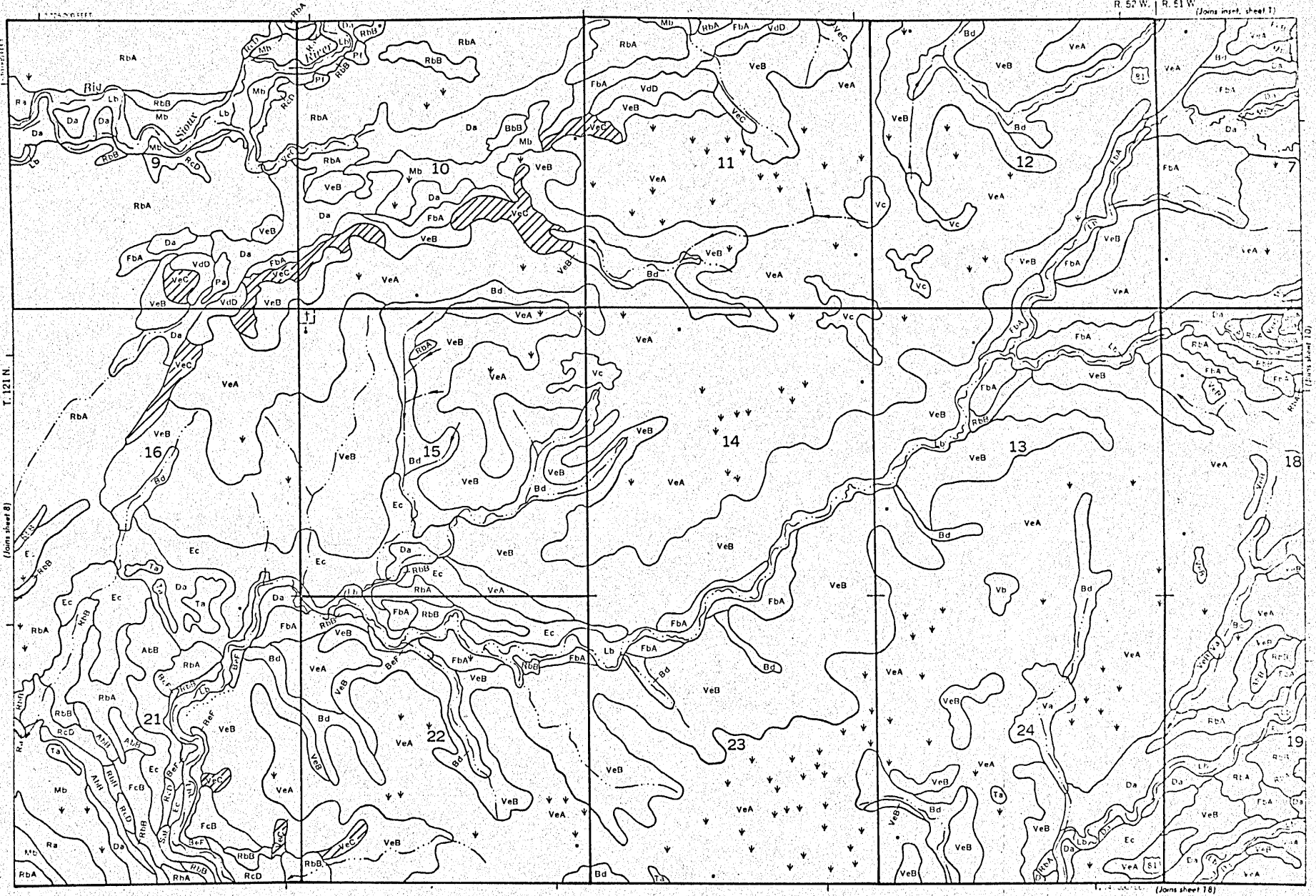
1 0 1 2 3 4 Miles


R. 52 W.
R. 51 W.
ROBERTS COUNTY
T. 121 N.
Big Sioux River
Lake Summit
(Joins sheet 9)
(Joins sheet 10)
(Joins inset, sheet 8)
(Joins sheet 2)
3000 AND 5 000-FOOT GRID TICKS
3000 AND 5000 FOOT GRID TICKS

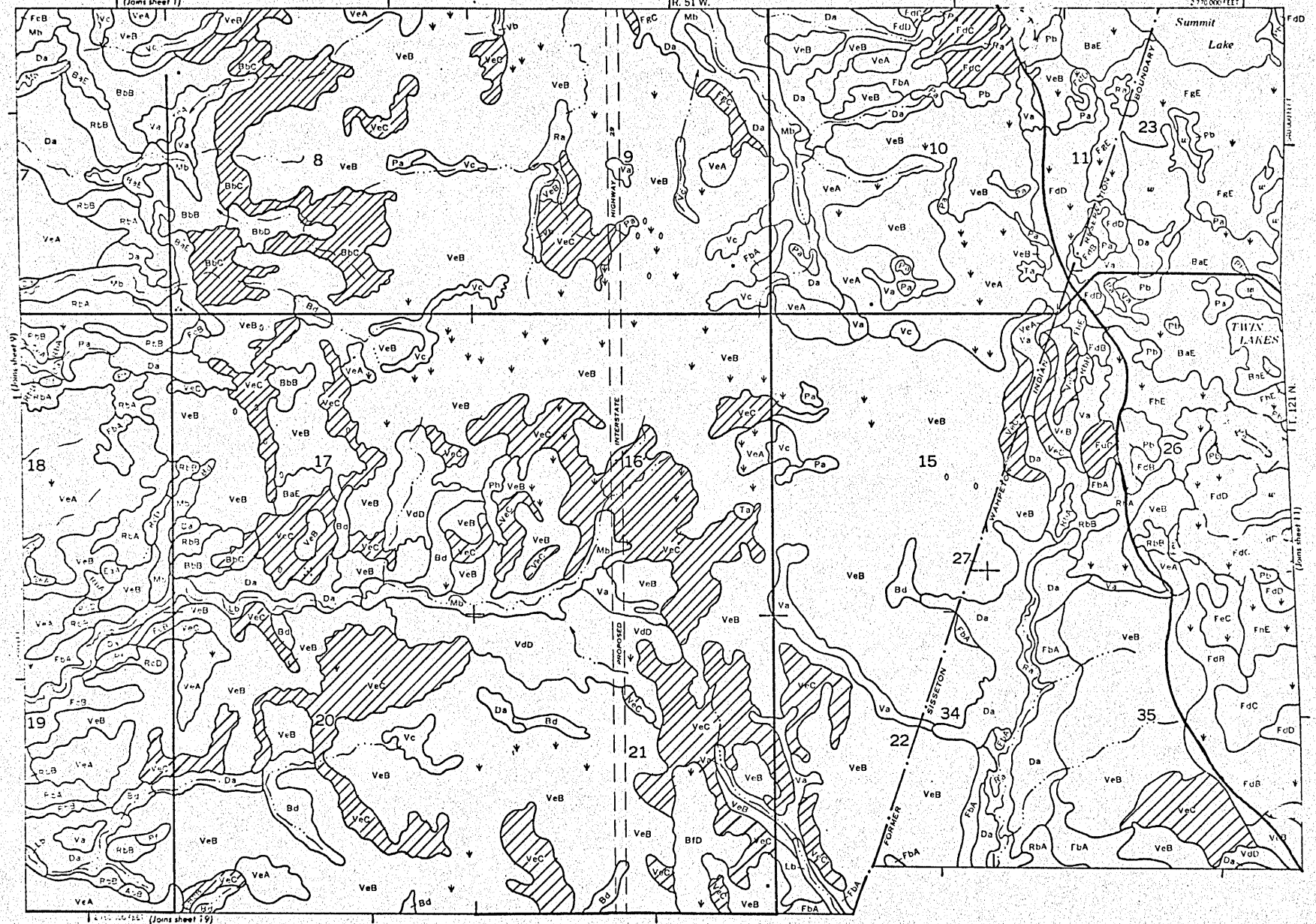
GRANT COUNTY, SOUTH DAKOTA — SHEET NUMBER 8

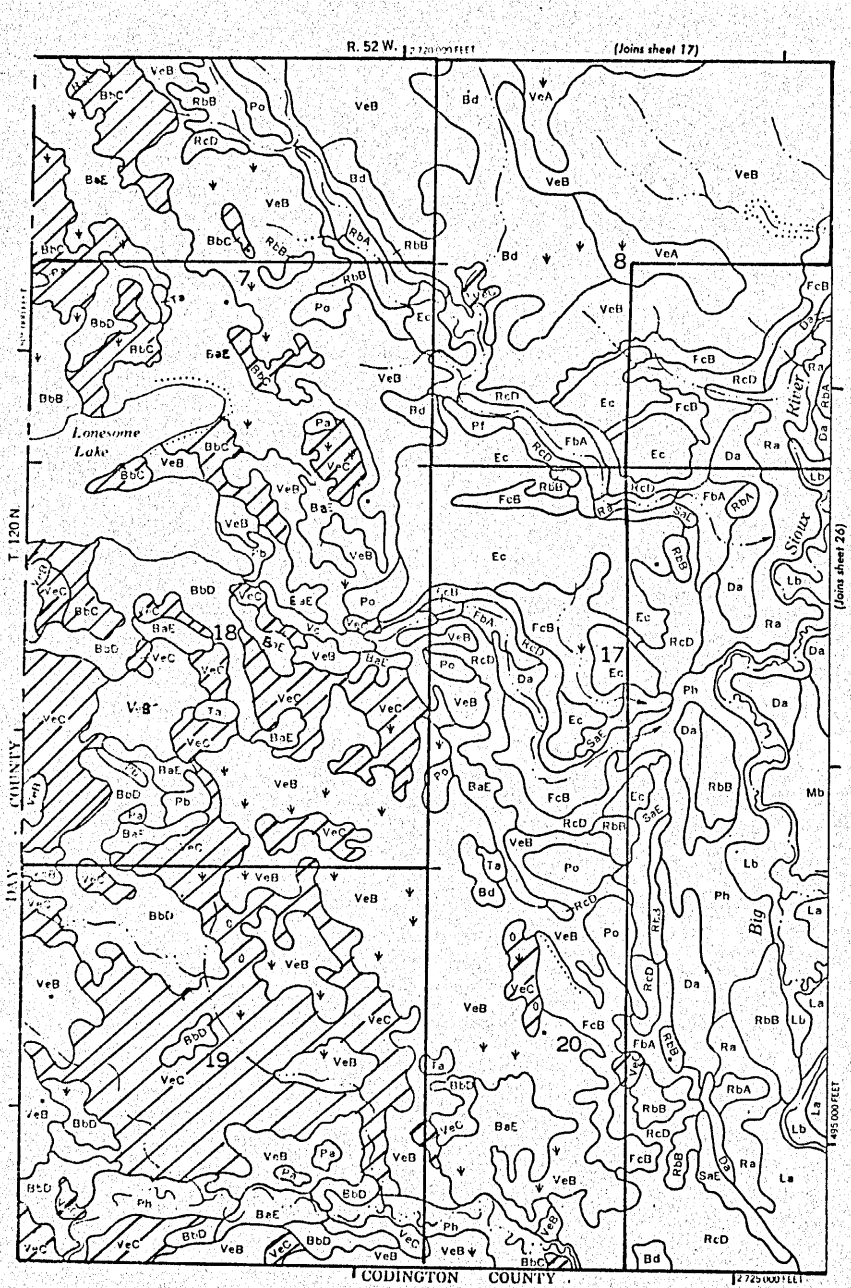


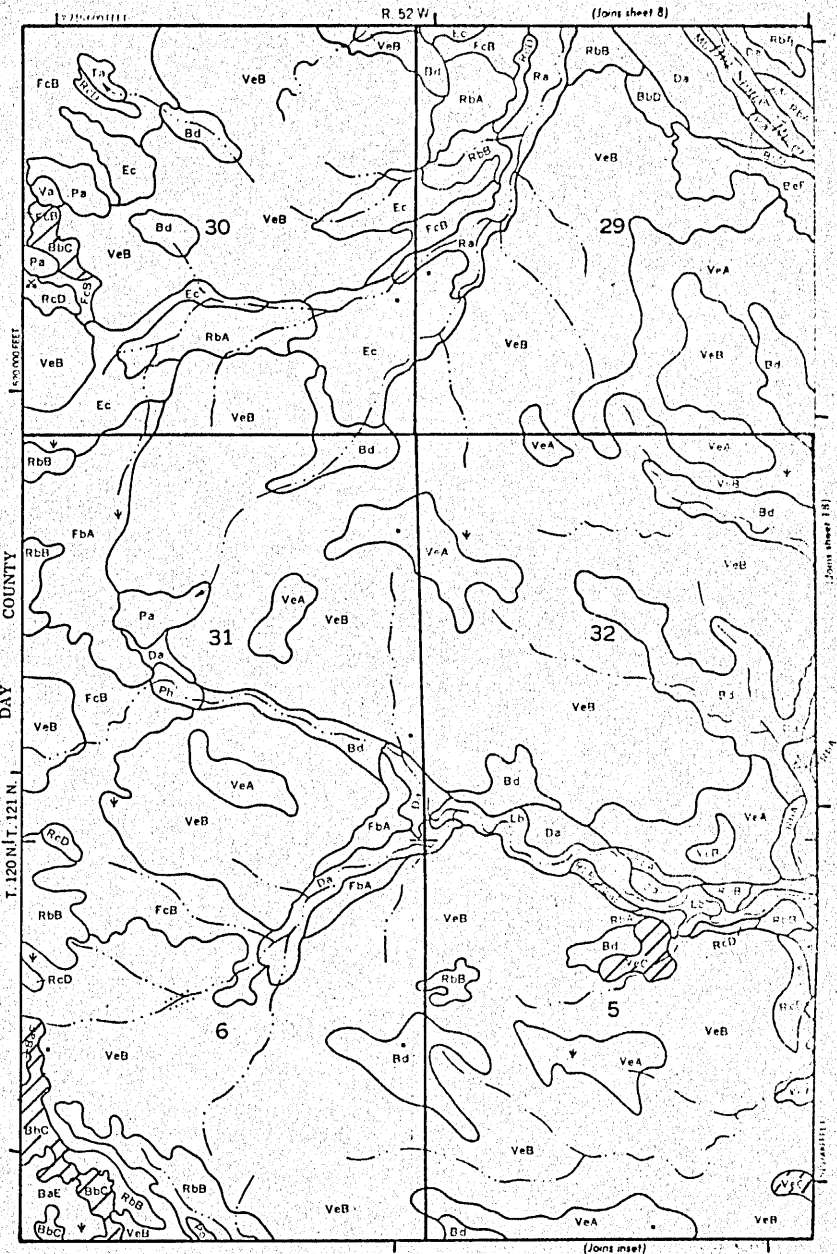
GRANT COUNTY, SOUTH DAKOTA — SHEET NUMBER 9



GRANT COUNTY, SOUTH DAKOTA — SHEET NUMBER 10







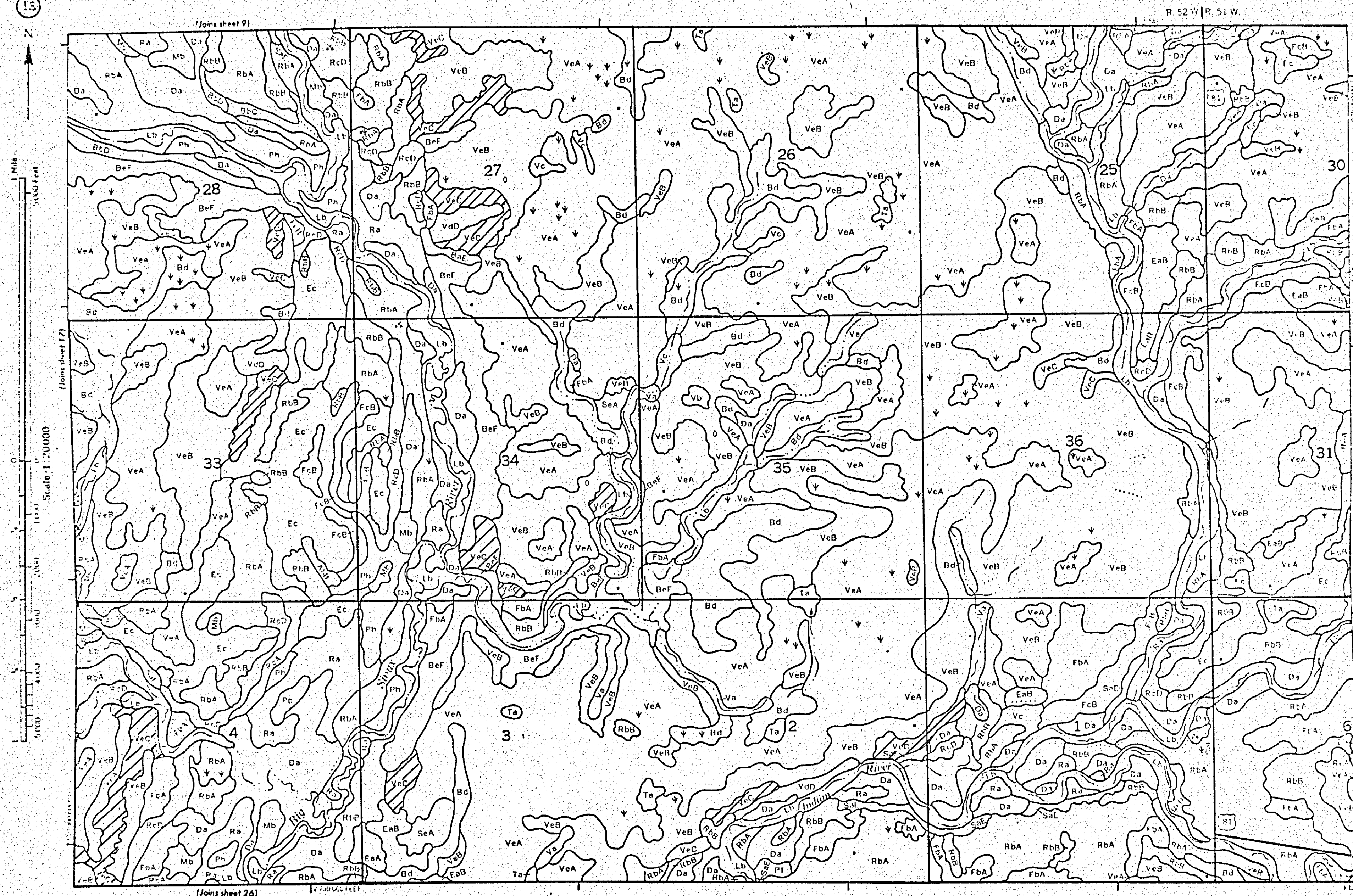
17

N

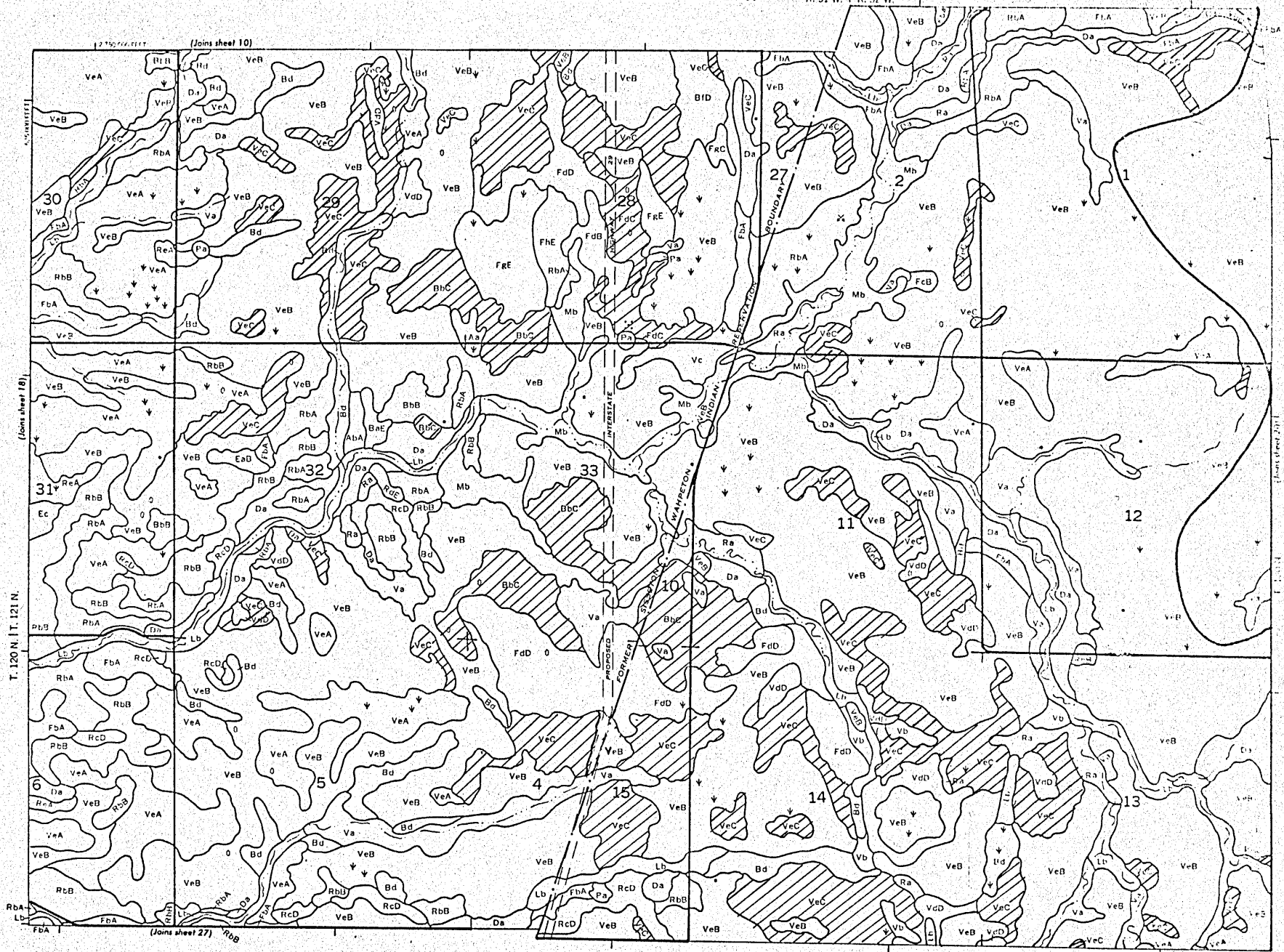
1 Mile

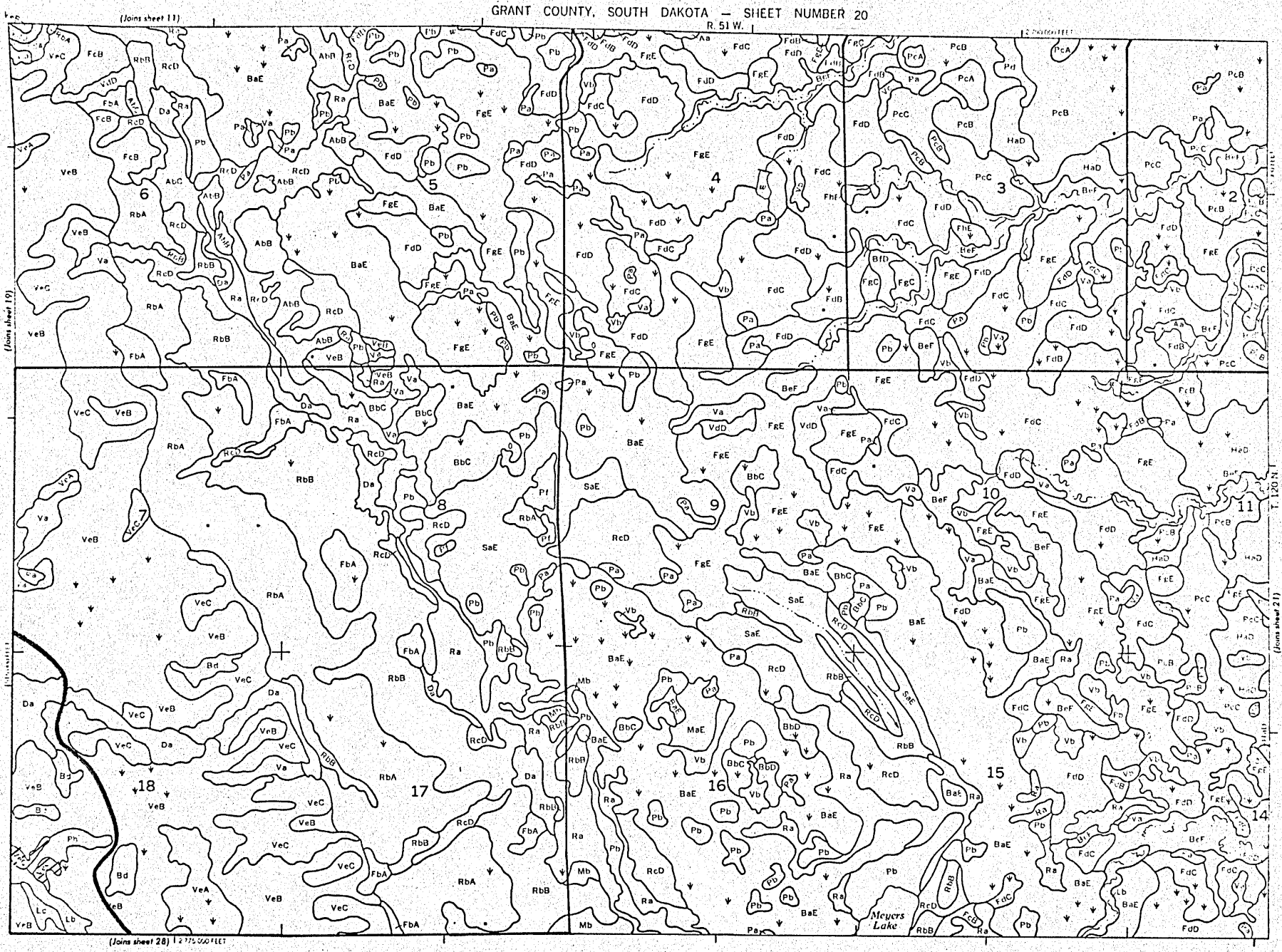
5000 Feet

GRANT COUNTY, SOUTH DAKOTA — SHEET NUMBER 18

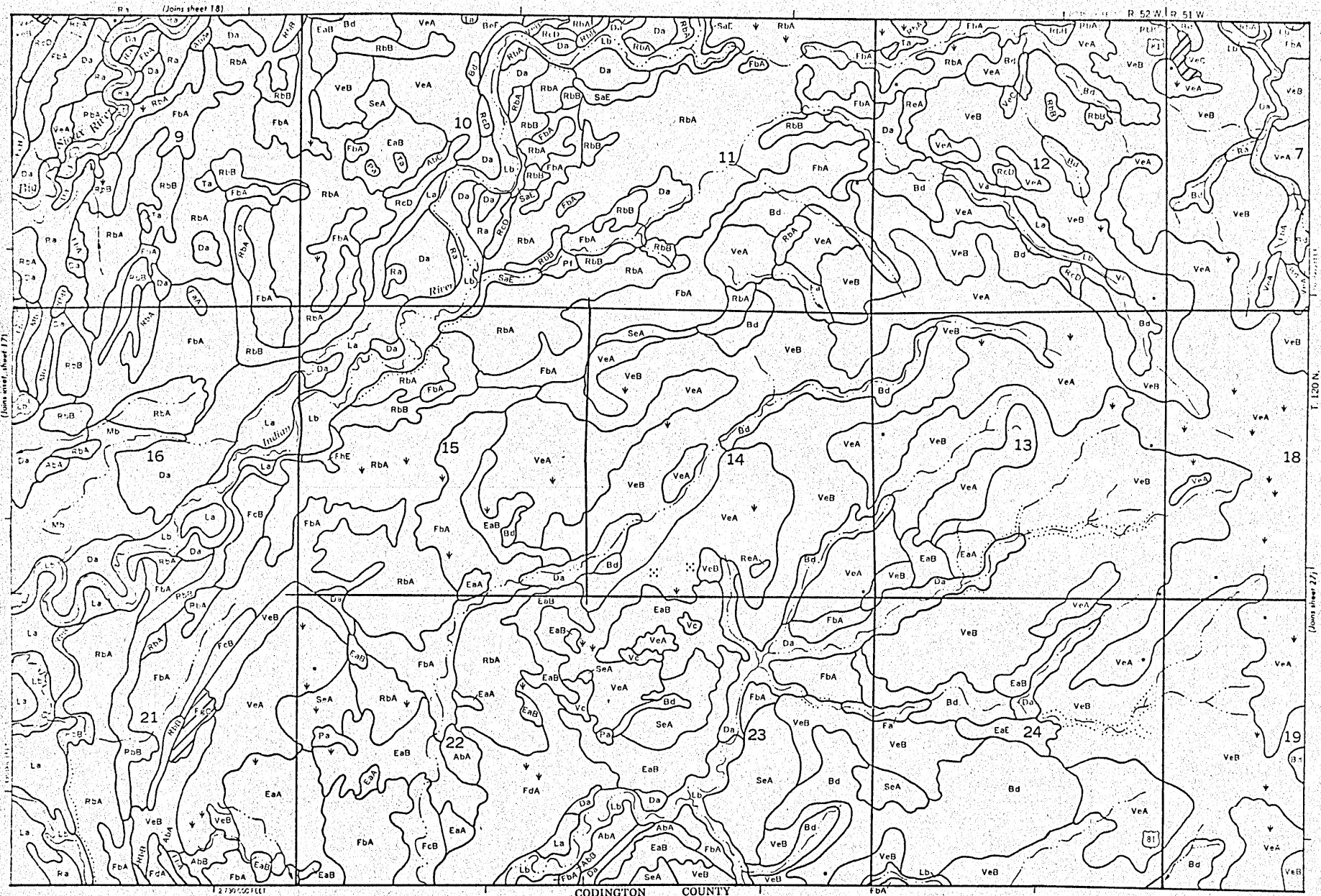


GRANT COUNTY, SOUTH DAKOTA -- SHEET NUMBER 19

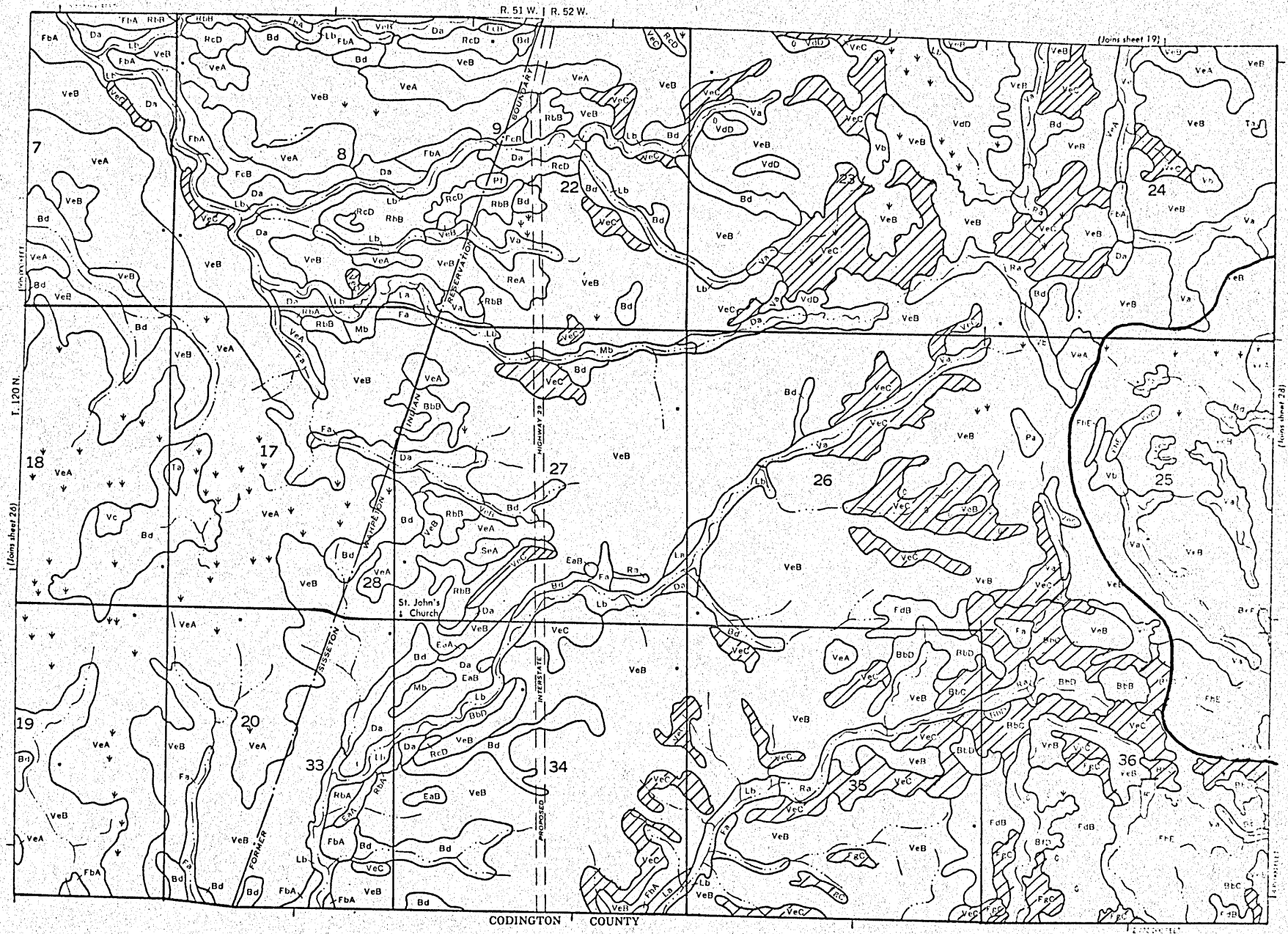



GRANT COUNTY, SOUTH DAKOTA — SHEET NUMBER 20
R. 51 W.
T. 120 N.
(Joins sheet 11)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 28)
Meyers Lake
Scale 1:20000
1 Mile
5000 Feet

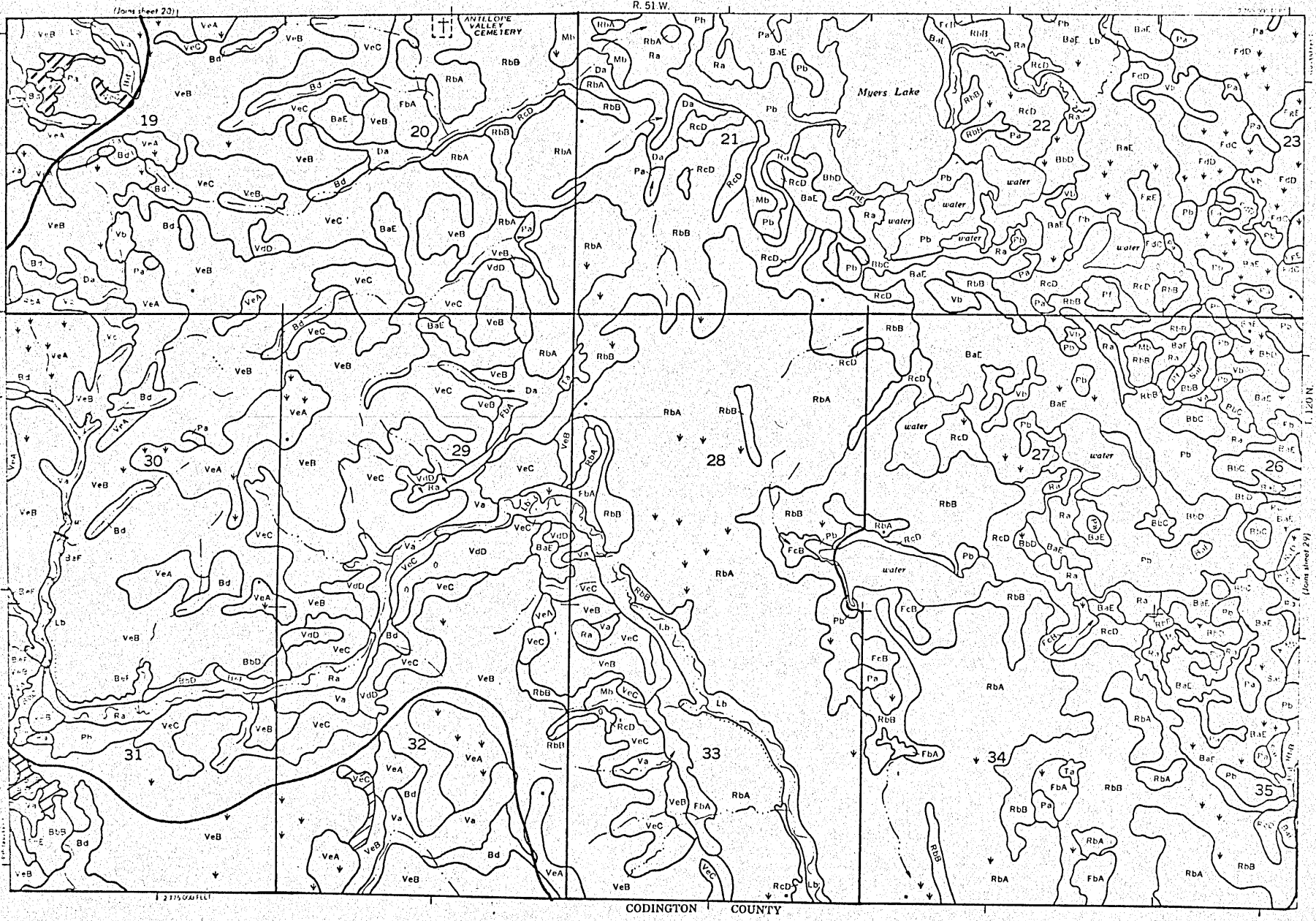
GRANT COUNTY, SOUTH DAKOTA — SHEET NUMBER 26

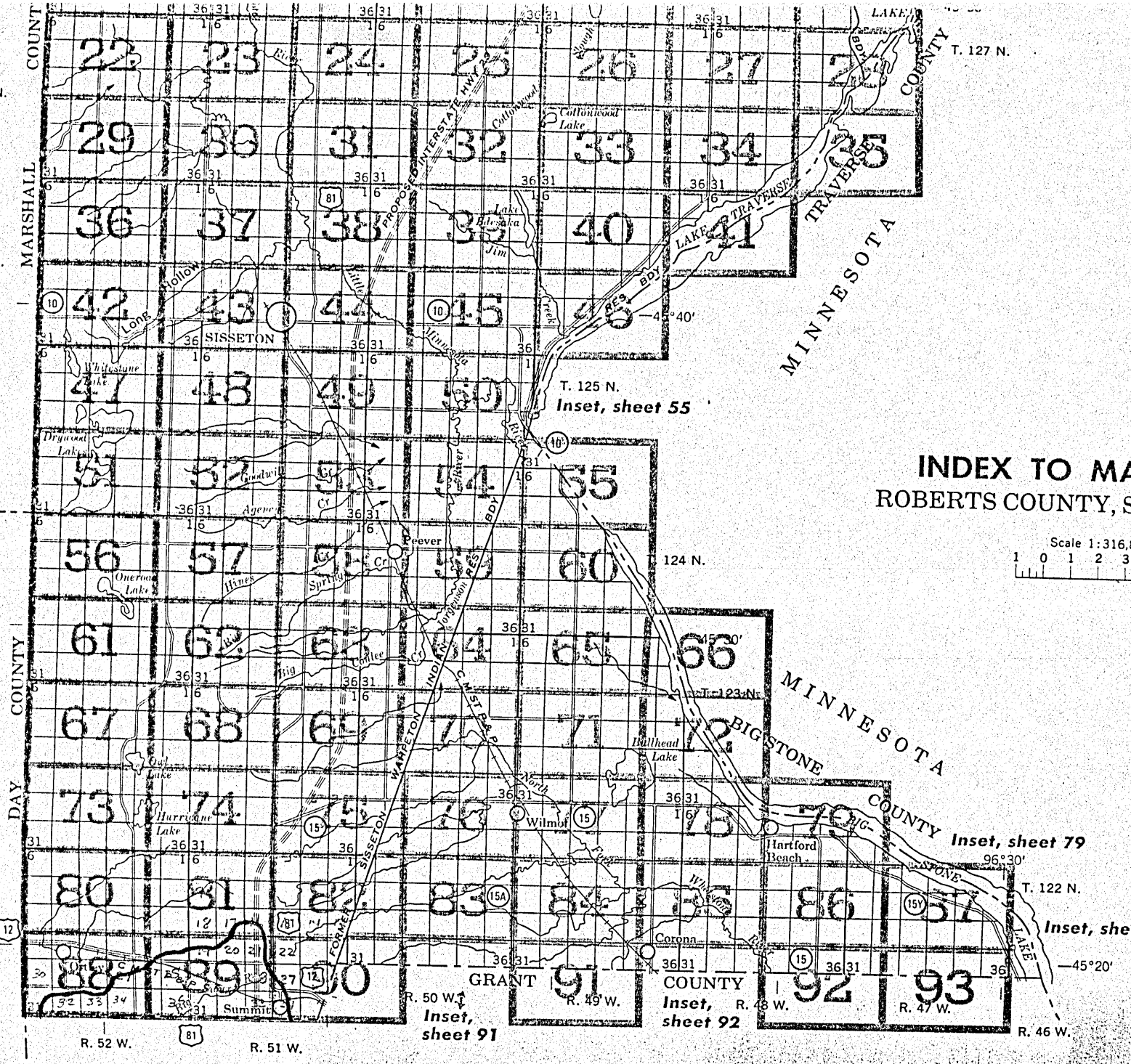


GRANT COUNTY, SOUTH DAKOTA — SHEET NUMBER 27



GRANT COUNTY, SOUTH DAKOTA — SHEET NUMBER 28





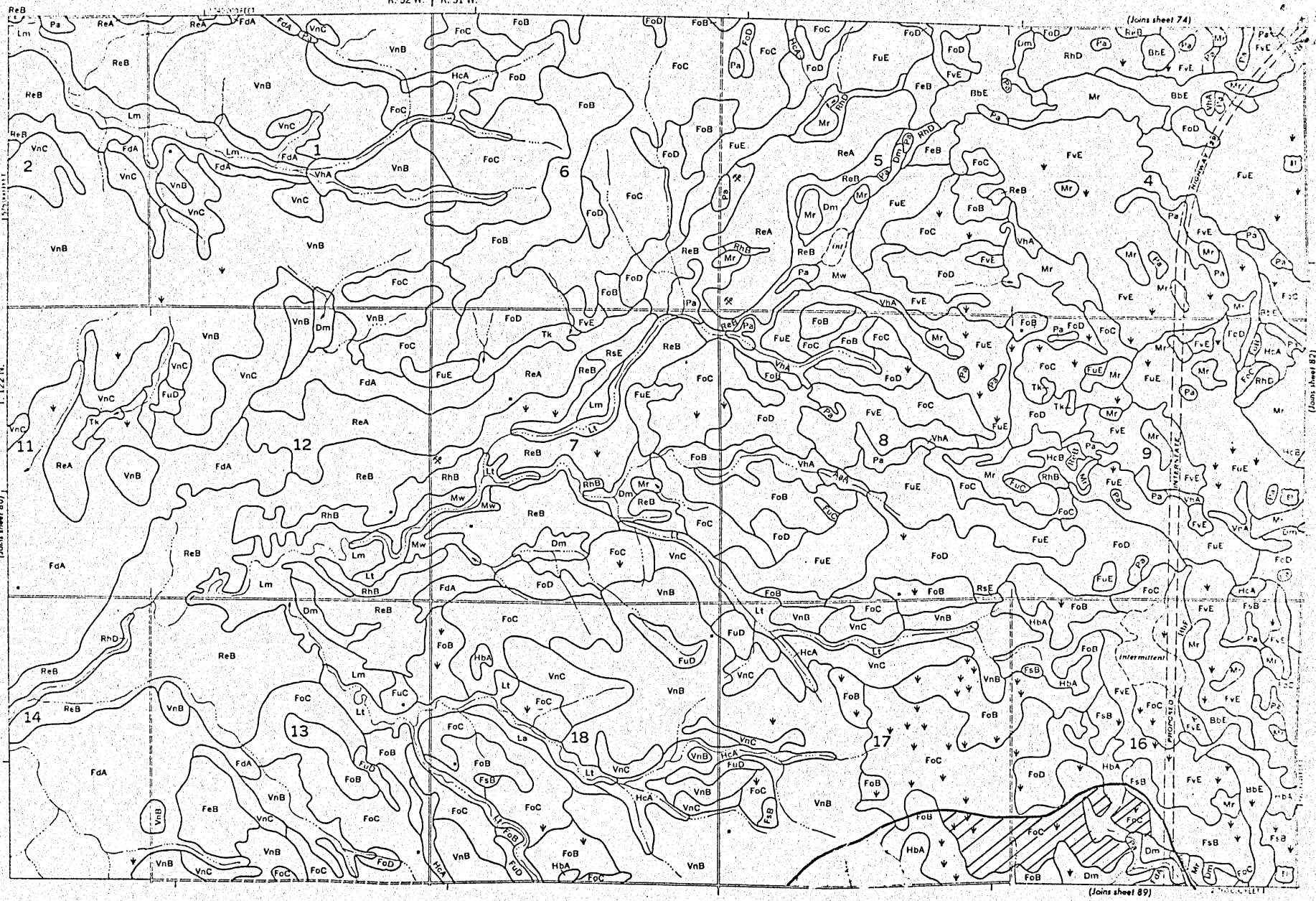
INDEX TO MAP SHEETS

ROBERTS COUNTY, SOUTH DAKOTA

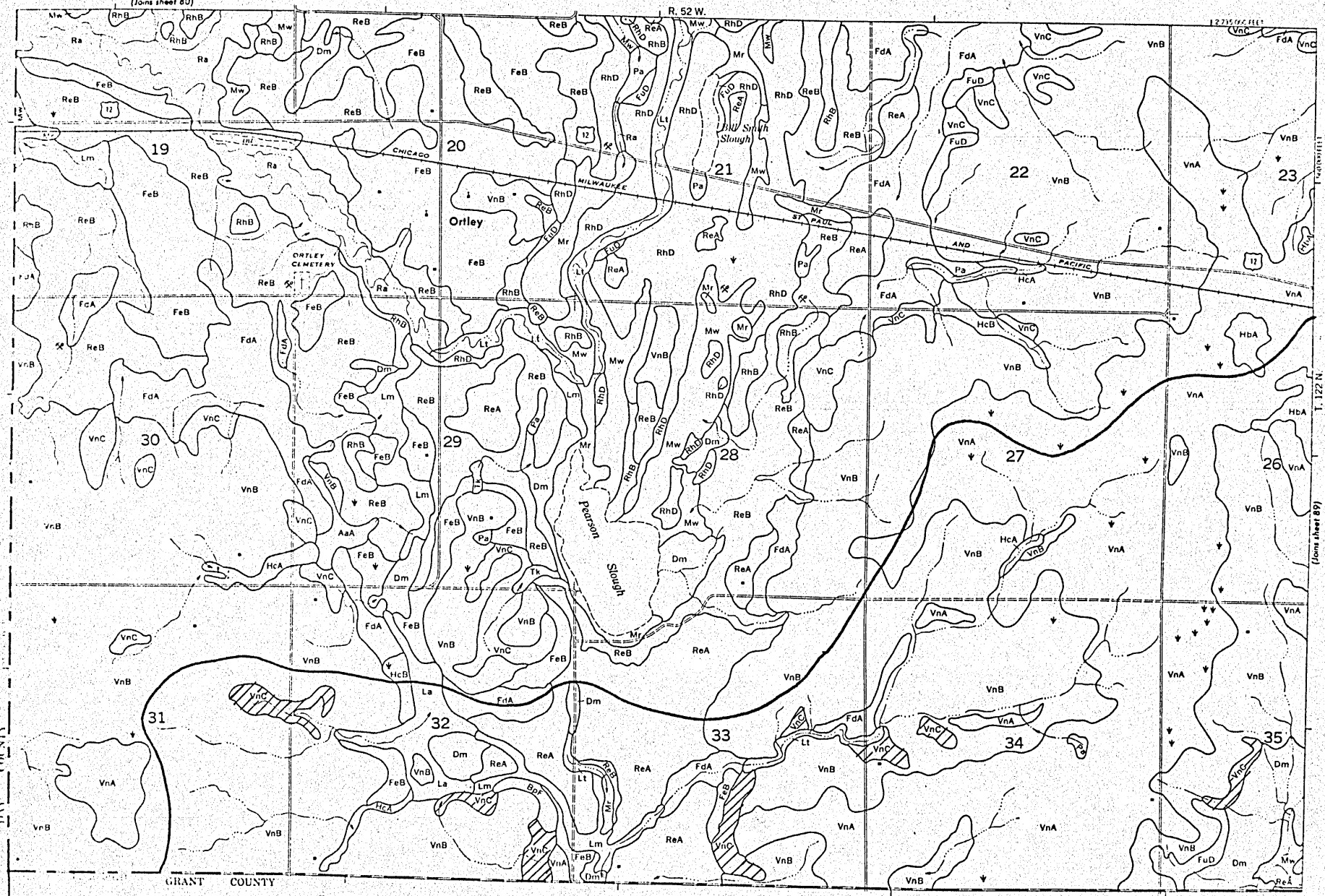
Scale 1:316,800

1 0 1 2 3 4 5 Miles

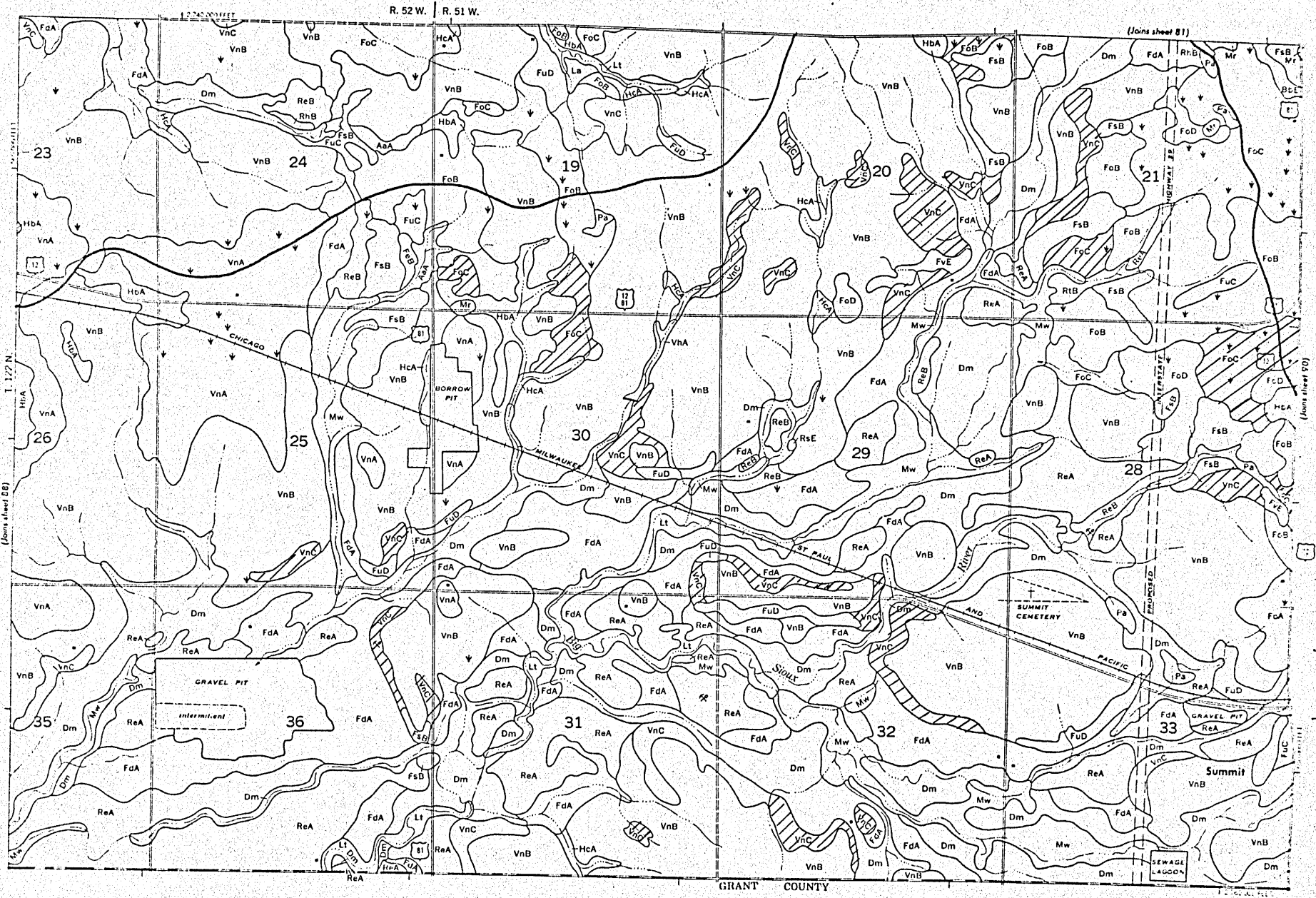
ROBERTS COUNTY, SOUTH DAKOTA — SHEET NUMBER 81



ROBERTS COUNTY, SOUTH DAKOTA — SHEET NUMBER 88



ROBERTS COUNTY, SOUTH DAKOTA — SHEET NUMBER 89



ROBERTS COUNTY, SOUTH DAKOTA — SHEET NUMBER 90