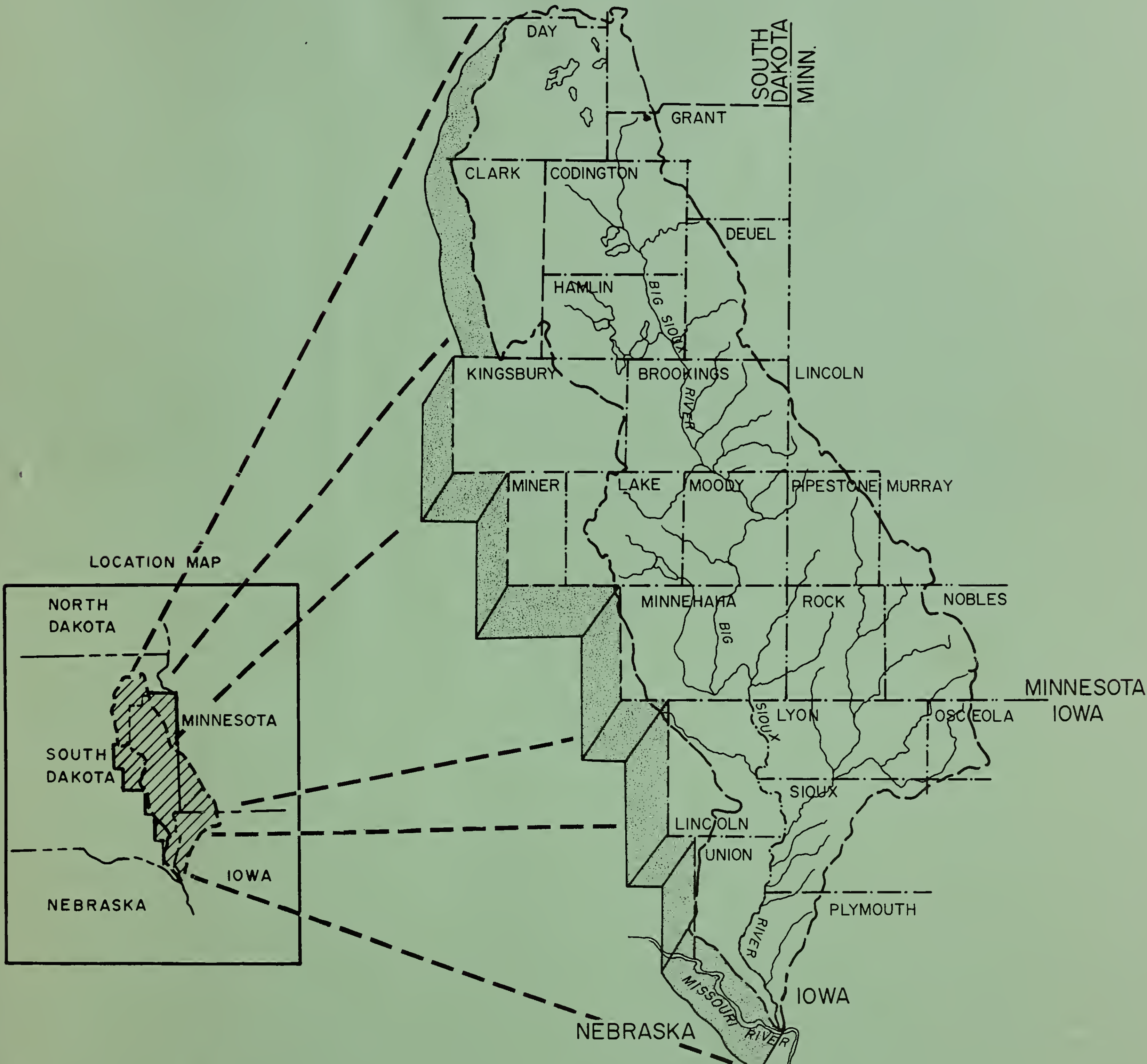
ER AND RELATED LAND RESOURCE

BIG SIOUX RIVER BASIN

AND RELATED AREAS

SOUTH DAKOTA - MINNESOTA - IOWA



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST SERVICE
ECONOMIC RESEARCH SERVICE

1973

USDA-SCS-LINCOLN, NEBR. 1973

BIG SIOUX RIVER BASIN AND RELATED AREAS

South Dakota — Minnesota — Iowa

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

ECONOMIC RESEARCH SERVICE

FOREST SERVICE

In Cooperation With:

South Dakota Water Resources Commission
South Dakota Conservation Commission
East Dakota Conservancy Sub-District
Minnesota Department of Natural Resources
Iowa Soil Conservation Commission

Under Direction of
USDA FIELD ADVISORY COMMITTEE

Huron, South Dakota

1973

TABLE OF CONTENTS

Pages

MAPS

FIGURES

TABLES

ADDENDUM

Average annual benefits and costs of structural measures
for the watersheds intensively studied
using 5.5% interest amortized over 100 years
Big Sioux Study Area

Delineated Watershed Identification				
Number	Name	Benefits	Costs	Benefit-Cost Ratio
7 -22	LaBolt Tribs.	11,280	13,250	.85:1
30 -12	Snake	68,330	30,220	2.3 :1
31 -10	Marsh Lake	43,670	26,530	1.6 :1
31 -16	Dempster	15,850	15,200	1.04:1
31 -21	North Deer	188,960	66,430	2.8 :1
31 -22	Six Mile	119,930	70,440	1.7 :1
31 -24	Deer	86,610	52,850	1.6 :1
31 -25	Volga Tribs.	90,360	21,120	4.3 :1
31 -26,27	Medary	165,150	63,250	2.6 :1
31 -36,37	Pipestone	134,440	125,980	1.07:1
31 -40	W. Pipestone	49,370	19,800	2.5 :1
31a-42	Otter	78,760	89,970	.87:1
31 -45,49	Skunk	105,050	75,710	1.9 :1
31 -61	Beaver	27,980	30,840	.91:1
31a-01	Upper Rock	78,540	57,680	1.4 :1
31a-09	Champepedan	84,410	67,310	1.2 :1
	Total	1,348,690	826,580	1.6 :1

SUMMARY

SUMMARY

OBJECTIVES

This cooperative Type IV Study was prepared by the U.S. Department of Agriculture at the request of responsible state agencies in Iowa, Minnesota, and South Dakota for the purpose of providing land, water, and related resource information to facilitate the planning and orderly conservation, development, utilization, and management of these resources in the Study Area. The main objectives include: (1) Inventory the natural resources; (2) Analyze the economy as to present and future need for resource development based on problems, needs, and projected economic activity; (5) Describe existing water and related land resource projects and programs; (6) Describe the physical potential or capability to supply water and related land resource developments for meeting identifiable needs; (7) Describe the opportunities for development through USDA programs and determining their impacts; and (8) Need for coordinating USDA activities and programs with those of other local, state, and federal agencies.

DESCRIPTION OF STUDY AREA

The Big Sioux Study Area is located in eastern South Dakota, southwest Minnesota, and northwest Iowa. It contains 7,582,080 acres, or 11,847 square miles and includes the 9,371 square miles of drainage of the Big Sioux River and an additional 2,476 square miles within the boundary of the East Dakota Conservancy Sub-District of South Dakota. About 76 percent of the Study Area is in South Dakota, 12 percent in Minnesota, and 12 percent in Iowa.

The climate is basically continental having temperature extremes of summer heat and winter cold. The average annual precipitation is about 23.5 inches; 75 percent occurs during the growing season. The average number of frost-free days above the temperature of 28 degrees F., varies from 152 days at Watertown, South Dakota, to 185 days at Sioux City, Iowa.

Agricultural land comprises 94 percent of the total area of which 76 percent is cropland, 20 percent is pasture and range, one percent is forest and woodland, and 3 percent other. Principal crops grown are corn, oats, alfalfa, wheat, and soybeans. A major portion of the feed grains and roughages are fed to livestock which are marketed as animal products. Livestock sales account for the bulk of the total farm sales of over $300 million. Agricultural related processing and service industries are also important to the economy of the area.

PROBLEMS AND NEEDS

The principal land, water, and related resource problems and needs are:

1. Floodwater and sediment damages from overbank flow. About 360,000 acres of the agricultural land and 2,200 acres of urban land are subject to flooding. In the tributary watersheds, flooding occurs on 262,600 acres of agricultural land while an additional 97,700 acres of agricultural land are flooded along the Big Sioux and Rock Rivers. The area subject to flooding represents about five

percent of the total Study Area. Average annual floodwater and sediment damages are estimated to be over $2 million.

2. Sheet, rill, gully, and wind erosion on cropland, pastures, and range. Severe sheet and rill erosion occurs throughout the Study Area on about 26 percent of the cropland. Gully erosion is most critical in the loess area in the southern portion of the Study Area. Wind erosion is a general problem for the entire area and occurs on lands with inadequate cover. Damages resulting from erosion include: Cost of sediment removal; loss of soil fertility; lower crop yields; increased costs of crop production; reduced surface water quality; and loss of capacity in streams, lakes, reservoirs, and wetlands. The total average annual damage from all types of erosion is estimated at $7.8 million.

3. Impaired drainage exists throughout the Study Area. The 1967 USDA Conservation Needs Inventory shows that 1,060,000 acres, representing 14 percent of the land in the area, have a dominant hazard or limitation due to poor drainage, wetness, high water table, or excess water from overflow. About 68 percent of this area is in cropland.

4. Need for irrigation. Moisture deficiencies caused by periodic droughts have brought about a gradual increase in irrigation through private ground water developments. The developments, about 7,000 acres, are on lands along the Big Sioux River and other areas where shallow underground water is available.

5. Need for water quality control. Sediment, livestock wastes, agricultural chemicals, and municipal and industrial wastes are the major pollutants to streams and lakes. The reduction in the capacity of stream channels and lakes, together with its eutrophic effect, is detrimental to fish and wildlife and water-based recreation.

6. Need for additional water-based recreation development. Due to the unequal distribution of existing water recreation areas, additional developments are needed in the southern half of the Study Area where the larger population centers are located.

7. Inadequate quality of rural water supply. All of the small communities and individual farms obtain their domestic water supply from ground water sources. Generally the quantity is sufficient but most of these water supplies are poor in quality and do not meet State Health Department standards.

8. Need for forestry management. The overgrazing of 26,000 acres of woodland areas depletes the ground cover, causing increased runoff and erosion.

FINDINGS AND CONCLUSIONS

The 1970 population census of 307,418 is a slight decrease from the 1960 population of 309,535. However, the projections indicate a population of 336,000 in 1980; 377,000 in 2000; and 418,000 in 2020. The rural farm population is to continue to decline from 99,330 in 1960 to 49,000 in 2020. The average size of farm increased from 252 acres in 1949 to 348 acres in 1969. This increase is expected to continue as farm population decreases.

Agricultural production is expected to increase from the current normal value of $305 million to $404 million in 1980, and $685 million in 2020. This will come about through crop yield increases reflecting the application of new technology and management techniques. Personal income is projected at $4.6 billion in 2020 compared to the current personal income of $0.7 billion.

At the present time there are 12 small watershed projects completed or under construction. These watersheds have a total drainage area of 488 square miles. Sixteen potential upstream watersheds were found to be feasible for project action and need to be installed in the next 10 to 15 years. These watersheds have a total drainage area of 2,266 square miles, about 19 percent of the total Study Area. The needed works of improvement include 12 floodwater retarding structures, of which 4 are multipurpose (including recreation), and 344 miles of multipurpose channel modification for flood prevention and agricultural water management. The 12 retarding reservoirs have a total floodwater capacity of 40,000 acre-feet, 5,010 acre-feet for sediment storage, and 5,670 acre-feet for water-based recreation use (surface area 782 acres). The total estimated installation cost of the structural measures is $12,934,900, of which the federal and nonfederal share is estimated to be $10,261,300 and $2,673,600, respectively. Average annual benefits are estimated at $1,348,690; average annual costs are $747,800. The installation of these 16 watershed projects will reduce the average annual flooding from 20,700 to 8,700 acres. Seven additional watersheds were found not feasible under present planning criteria. More detailed data on the 23 watersheds investigated are included in a separate appendix to this report.

Applications for planning assistance have been submitted on eight watersheds covering about the same area as seven of the sixteen feasible watersheds. Application for four other watersheds in the Study Area have also been submitted.

The acreage now under irrigation is small, about 7,000 acres, but it is expected to increase. During the past ten years the acreage has nearly doubled.

It is expected the increased irrigation will be by individual ground water developments and not by project-type developments.

Increased conservation treatment and management of agricultural lands is a continuing and important need throughout the Study Area. At the present time, about 43 percent of the agricultural land is adequately treated. It is estimated that from 1971 to 2000, an additional 2,263,900 acres will need to be treated at an estimated cost of $31.5 million. Of this amount, about 155,900 acres will be treated by an accelerated program through early action small watershed projects and the remainder will be applied through the on-going program. The total agricultural land adequately treated should increase to 76 percent by the year 2000.

There is a significant environmental need for continued windbreak and other forestation plantings as well as multipurpose management of the limited existing forested areas.

The implementation of the recommended USDA programs will improve the agricultural economy of the Study Area as well as improve the overall environmental quality by giving emphasis to proper land use and management and accelerating the installation of land treatment and conservation measures for the reduction of runoff, erosion, sediment deposition, and flood damages.

CHAPTER 1

INTRODUCTION

INTRODUCTION

This report, prepared by the United States Department of Agriculture in cooperation with the States of South Dakota, Minnesota, and Iowa, appraises the availability of land, water, and related resources to meet present and future needs. Related subjects such as watershed protection, flood damage reduction, soil erosion, sedimentation, drainage, irrigation, fish and wildlife, damage reduction, outdoor recreation, and environmental quality are also appraised. These appraisals and the opportunities for development through USDA programs are evaluated in physical, economic, and environmental terms.

Authority for this study is Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 83-566). This cooperative Type IV Study was requested by the South Dakota Water Resources Commission, South Dakota Conservation Commission, East Dakota Conservancy Sub-District, Minnesota Department of Natural Resources, and the Iowa Soil Conservation Commission.

The sponsors expressed a need for the study to coordinate USDA programs with those of other federal and state agencies for the purpose of arriving at an overall plan for the Study Area. Flood damage reduction, erosion control, land treatment, drainage, irrigation, municipal and industrial water, and maintenance of water levels in natural lakes for recreation and fish and wildlife were some of the specific needs expressed.

The study was under the direction of the USDA Field Advisory Committee consisting of a representative from the Soil Conservation Service, Economic Research Service, and Forest Service. The Soil Conservation Service representative served as chairman. This Committee provided overall guidance in the Study Area activities and in coordinating USDA efforts with other federal and state agencies. The Committee met at regular intervals to review planning procedures and progress of the study. Meetings were held with the sponsors to discuss progress and determine sponsor objectives concerning the scope of the study.

OBJECTIVES

Purposes of the study were to identify and appraise the land, water, and related resource problems and needs, and to suggest opportunities and potential solutions. The results will be used to assist in the development of state water plans presently being developed in the three states. The study included the following principal objectives:

1. Appraisal of the agricultural and nonagricultural damages caused by floodwater, water erosion, sediment, impaired drainage, and wind erosion.

2. Appraisal of land use and land treatment practices as they relate to soils, erosion, and the use of land within its capabilities.

3. Determination of an efficient system of land treatment and structural measures which would alleviate the problems relating to watershed protection, flood prevention, drainage, water supply management, pollution, fish and wildlife, water quality control, and recreation.

4. Identification of opportunities and solutions that can be carried out by the U.S. Department of Agriculture and other federal, state, and local agencies under existing authorities, and those activities that should be developed under amended or new authorities.

5. Evaluation of the impact of the proposed programs on the physical, economic, social, and environmental factors.

6. Preparation of a report describing present and future problems and needs pointing out the potential solution opportunities.

STUDY AREA

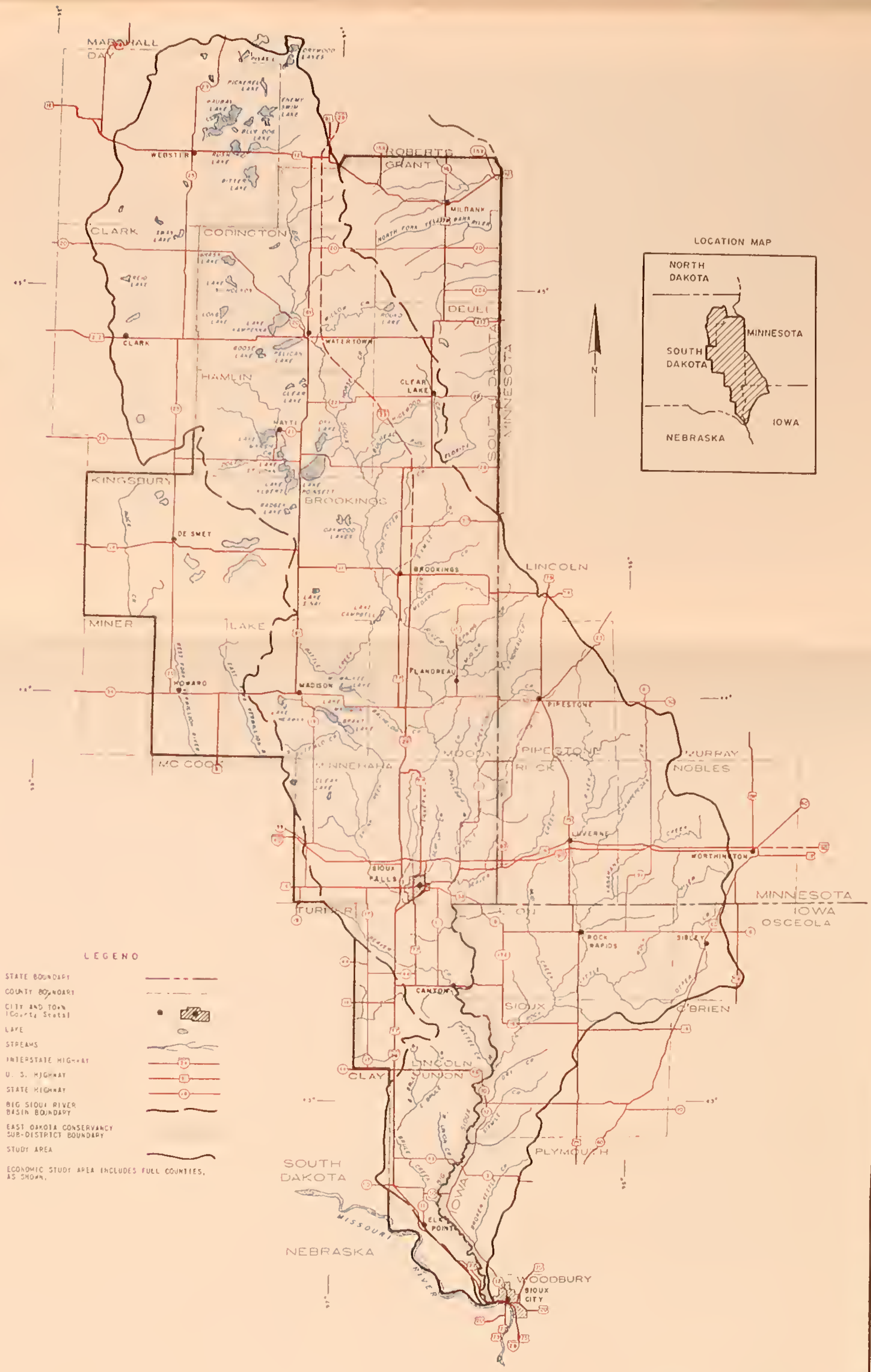
The total Study Area of 11,847 square miles (7,582,080 acres) comprises the drainage of the Big Sioux River (9,371 square miles), and an additional adjoining area (2,476 square miles) within the boundary of the East Dakota Conservancy Sub-District of South Dakota. The Study Area is located in eastern South Dakota, southwestern Minnesota, and northwestern Iowa. (See map following page 1-2.) The Big Sioux River originates in northeastern South Dakota and flows in a southerly direction discharging into the Missouri River at Sioux City, Iowa. Rock River, the largest tributary to the Big Sioux River, drains most of the Study Area in Minnesota and Iowa.

INTENSITY OF STUDY

The USDA River Basin Staff utilized available published and unpublished data and developed additional basic data needed for the study. Field reconnaissance surveys were made for each watershed delineated in the 1967 USDA Conservation Needs Inventory (CNI) as needing project action. (See Map No. 10.) Twenty-three upstream watersheds were selected for detailed study and evaluation. These watersheds contained a variety of problems and needs and appeared to have the greatest opportunity for project development. Other basic information was obtained from engineering field surveys and interviews with local people and public officials.

Flood routings were performed for different runoff events using prescribed Soil Conservation Service procedures and available automatic data processing programs. On the basis of these detailed studies, 16 watersheds needing early installation were found to have favorable benefit-cost ratios. Watershed Investigation Reports were prepared for these watersheds and included in a separate appendix which will have limited distribution. Also included in the appendix is a brief discussion of the benefits and costs for the six watersheds found not feasible.

For those watersheds where no detailed investigations were made, the 1967 USDA Conservation Needs Inventory was used to estimate the area



BIG SIOUX RIVER BASIN
AND
RELATED AREAS

BIG SIOUX RIVER BASIN
SOUTH DAKOTA, IOWA AND MINNESOTA
AND
ADDITIONAL AREAS OF THE COUNTIES WITHIN
THE EAST DAKOTA CONSERVANCY SUB-DISTRICT
IN SOUTH DAKOTA

SCALE 1/1,000,000

SCALE 10 0 10 20 30 40 MILES

LAMBERT CONFORMAL CONIC PROJECTION

SOURCE:
5,S-27,109 and information
furnished by field technicians.

5-25-72
5,S-30390

subject to flooding. This information was used as a base to determine the losses to floodwater and sediment damages.

Maps were prepared showing the location of bedrock and the recent glacial deposits. (See Maps Nos. 4 and 8.) A general soil association map was prepared to serve as a basis for study investigations and evaluations. This map, along with a discussion of the soil associations, is included in Appendix A of this report.

The 1967 USDA Conservation Needs Inventory served as a base for land use and land treatment needs data. This was supplemented with current information collected from farmer interviews, soil conservation district supervisors, and from SCS field personnel. Present and projected land use has been assessed, and ways and means of improving land management and land treatment are recommended. At present, 7,148,500 acres (95%) are used for crops, grazing, and forestry purposes. The amount of land available for agriculture is expected to decline throughout the projection period. Space requirements for an expanding population will be reflected through additional acres for housing, roads, industrial sites, and recreation areas. It is estimated an additional 86,100 acres of land will be taken out of the agricultural base by 2020.

The present rates of land treatment were assessed to determine the need for an accelerated program to protect the land base and enhance the environmental quality and economy of the Study Area.

Present agricultural production was estimated on the basis of current normal yields and land use. These were projected to the years 1980, 2000, and 2020 to determine the need for land, water,and related resource development if the area is to maintain its historic share of the nation's agricultural production.

The need to provide additional water-based recreational areas was evaluated. Four multipurpose retarding reservoirs have been proposed for construction in the next 10 to 15 years under the small watershed program. Other potential reservoir sites in which recreation could be incorporated as a purpose, if feasible, were also located. (See Map No. 11.) An inventory of present and future needs and potentials for development of fish and wildlife resources was prepared by the Soil Conservation Service with assistance from the U.S. Fish and Wildlife Service and the South Dakota Department of Game, Fish, and Parks.

USE OF REPORT

Information contained in this report will be useful to governmental agencies, groups, and individuals involved in planning and implementing programs to bring about the needed conservation, utilization, and development of land, water, and related resources. The information provided may also be used to coordinate USDA programs with those of other agencies.

State agencies in South Dakota, Minnesota, and Iowa have been making independent studies of the resources and potential of the Study Area.

Information in this report will be useful in planning and coordinating resource conservation and development.

The identification of problems, needs, and opportunities for solution in this report can be one of the tools used in planning for optimum land, water, and related resource development. Information collected in regard to small watershed projects and other USDA programs can be useful for developing preliminary investigation reports for watershed projects, for setting project priorities, and for developing alternative solutions.

The basic data collected and used in this study, including the Watershed Investigation Reports are on file at the State Office, Soil Conservation Service, 239 Wisconsin Avenue, S.W., Huron, South Dakota 57350.

Acknowledgment is given to the following agencies for their assistance and cooperation in the preparation of this report.

U.S. Department of Agriculture
- Agricultural Stabilization and Conservation Service
- Farmers Home Administration
- Statistical Reporting Service
- Federal Extension Service

U.S. Department of Interior
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Fish and Wildlife Service
- Geological Survey

U.S. Department of Defense
- Army Corps of Engineers

U.S. Department of Commerce
- National Oceanic and Atmospheric Administration

State Agencies
- South Dakota Water Resources Commission
- South Dakota Conservation Commission
- South Dakota Department of Game, Fish and Parks
- South Dakota Geological Survey
- South Dakota State University
- Minnesota Soil and Water Conservation Commission
- Minnesota Department of Conservation
- Iowa Conservation Commission

East Dakota Conservancy Sub-District

NATURAL RESOURCES OF THE STUDY AREA

LAKE AND POTHOLE REGION OF THE BASIN

LOESS HILLS IN THE EXTREME SOUTHERN PORTION OF THE BASIN.

NATURAL RESOURCES OF THE STUDY AREA

LOCATION AND SIZE

The Big Sioux Basin Study Area includes the drainage area of the Big Sioux River above its confluence with the Missouri River plus the additional area outside the Big Sioux River Basin that constitutes the remainder of the East Dakota Conservancy Sub-District. It is located in 19 eastern counties of South Dakota, 5 counties in southwestern Minnesota, and 6 counties in northwestern Iowa.

The Study Area includes an area of 7,582,080 acres, or 11,847 square miles. By states, the Study Area includes the following: 9,012 square miles in South Dakota; 1,460 square miles in Minnesota; and 1,375 square miles in Iowa. The Study Area represents about 2.3 percent of the total Missouri River Basin.

The Study Area includes the following separate river basins areas: Big Sioux River, 9,371 square miles; Minnesota River, 951 square miles; James River, 402 square miles; Vermillion River, 1,028 square miles; and 95 square miles that drain directly into the Missouri River.

The Big Sioux River originates in the Coteau des Prairies north of Watertown, South Dakota, and flows in a southerly direction to the Missouri River at Sioux City, Iowa. It is the state boundary between South Dakota and Iowa, from the vicinity of Sioux Falls to Sioux City.

CLIMATE

The climate is basically continental, generally sub-humid, having temperature extremes of summer heat and winter cold. Abrupt weather changes are brought about by invasion of large masses of air of different characteristics: Warm, moist air from the Gulf of Mexico; hot, dry air from the southeast, and cold, dry air from the interior of Canada. The yearly average wind speed is about 11 miles per hour. However, wind speeds of over 50 miles per hour occur occasionally throughout the year. The prevailing wind during the summer is from the south or southeast and during the winter from the northwest.

The average annual precipitation for the Study Area is about 23.5 inches, ranging from 20 inches along the northwestern boundary to about 26.5 inches along the southeastern boundary, (See Map No. 2.) On an average, about 75 percent of the annual precipitation occurs during the growing season from April through September. The average annual snowfall ranges from 23-34 inches. This usually falls in storms scattered throughout the winter season and seldom accumulates to more than a few inches. Occasionally heavy snowfalls can accumulate up to three feet.

The mean annual temperature varies from 42.4 degrees F., at Watertown to 48.4 degrees F., at Sioux City. The coldest month is January having a monthly mean of about 12.7 degrees F. The hottest month is July with a monthly mean of about 71.5 degrees F. Temperature extremes will range from about -40 degrees F., to 110 degrees F. The number of frost-free days above the threshold temperature of 28 degrees F., varies from 152 days at Watertown to 185 days at Sioux City. The mean annual evaporation is about 35 inches, ranging from 32 inches in the northern part to 38 inches in the southern part. The mean evaporation for the period May through October is about 80 percent of the mean annual.

PHYSIOGRAPHY

The Study Area lies in the Central Lowland Province of the Interior Plains Major Division. It includes two sections of the Central Lowland Province. The first is the Western Lake Section comprising young glaciated plains, moraines, lakes, and lacustrine plains. The second is the Dissected Till Plains Section comprising submaturely to maturely dissected till plains.

Rothrock 1/, using Fenneman's 2/ two provinces, divided South Dakota into seven physiographic divisions and 12 sections. Flint 3/ later modified these using the two provinces of Fenneman and making 12 divisions. Portions of five of these divisions are in the Study Area, (See Map No. 3.)

The five divisions are the Minnesota River-Red River Lowland, the Coteau des Prairies, James River Lowland, the Southern Plateaus, and the Missouri River Trench. The Minnesota River-Red River Lowland is in the northeastern portion of the Study Area in Grant and Deuel Counties. This division is a broad depression covered with glacial drift which has the appearance of a wide, shallow river valley. The depression is drained by the Red River to the north and the Minnesota River to the southeast. The Coteau des Prairies is the most conspicuous single topographic feature in eastern South Dakota. The Coteau is a massive highland which rises 800 feet above the adjacent Minnesota River-Red River Lowland. It is flatiron shaped trending northwest-southeast and is about 200 miles long. The Coteau generally follows the shape of the Big Sioux River drainage and covers all or part of every county in the Study Area with the exception of Union County, South Dakota, and Plymouth and Sioux Counties, Iowa. The James River Lowland is a broad lowland west of the Coteau. It touches the counties along the western edge of the Study Area. The Southern Plateaus in South Dakota is an area of loess covered tills with rolling hill topography. It covers parts of Lincoln and Union Counties. The area in Iowa adjacent to the Southern Plateaus is generally referred to as the "deep loess hills." The Missouri River Trench is a fairly wide, deep, river valley. The valley is alluvial filled with several terrace levels.

1/ Fenneman, N.M., Physiography of Eastern United States, McGraw-Hill, 1938

2/ Rothrock, E.P., A Geology of South Dakota, Part I: The Surface: South Dakota Geological Survey Bulletin 13, 1943

3/ Flint, R.F., Pleistocene Geology of Eastern South Dakota, U.S. Geological Survey Professional Paper 262, 1955

Topography

The headwaters of the Big Sioux River are the streams which originate in the lake area of the Coteau des Prairies. The surface is steeply rolling hills with numerous potholes, sloughs, and lakes. It is estimated that 2,765 square miles are internally drained lakes and sloughs which do not contribute to sustained stream flow and sediment to the Big Sioux River. Most of this area is in the northern part of the Coteau. The Coteau becomes less pronounced at the southern end with a more mature drainage system. The Coteau southeast of Sioux Falls is an undulating plain of moderate relief. The topography in Iowa and in Lincoln and Union Counties, South Dakota is generally rolling, moderate to steep hills of loess on glacial till. The loess thickens in Iowa and southern Union County. The most southern end of the Study Area is the nearly flat alluvial terraces and flood plain of the Missouri River Trench.

The topographic relief in the Study Area is about 960 feet. The highest point is about 2,050 feet in elevation and the lowest point is about 1,090 feet.

GEOLOGY

Most of the Study Area is underlain by Cretaceous Age marine sediments consisting of shales and sandstones. Precambrian Age granite underlies a small portion in Grant County. Granite is exposed in various parts of eastern Grant County and Sioux Quartzite is exposed over wide areas in the Sioux Falls, Luverne, and Rock Rapids area. Cretaceous Age sediments are exposed in road cuts, gullies, and stream channels from Sioux City to Day County.

Pleistocene Age and younger sediments cover most of the bedrock. The materials overlying bedrock are principally glacial drift, alluvium, and windblown (loess) sediments. Glacial drift is present in much of the area, alluvium is present along most stream valleys, and windblown sediments are scattered over the area with thick deposits in the southern portion. The glacial deposition is mainly Wisconsin Age with pre-Wisconsin Age glacial tills present in areas just north of Sioux Falls and in Union County, South Dakota. The area immediately adjacent to the South Dakota border in Minnesota and Iowa has some pre-Wisconsin glacial deposition.

Materials older than Wisconsin Age are on the surface only in limited areas exposed by erosion, by man-made excavation, or nondeposition of younger materials.

The tills consist of sand, gravel, cobble, and boulders in a clayey silt matrix. The ratio of the coarse fraction and finer matrix varies considerably. Outwash is generally coarse sand and gravels with some cobble. Few fines are present and the outwash is highly permeable. Alluvium, which in some areas is indistinguishable from outwash, varies from silts, clays, and fine sand derived from till and loess, to coarse sand and gravel derived from till and outwash. (See Map No. 4.)

Minerals

The principal resources are sand and gravel deposits associated with glaciation and stream deposition. Sand and gravel are found in alluvial and glacial land forms throughout the area. They occur in flood plains, glacial outwash plains, valley trains, and terraces. Other areas of deposition include end moraines, kames, kame terraces, eskers, and beaches of glacial lakes.

The Milbank Granite occurring in Grant County, South Dakota is high quality, dark to medium red stone, which takes a high polish. There are a number of quarries in the County.

The Sioux Quartzite, which was quarried mainly in the Sioux Falls area where is occurs near the surface, was formerly used for dimension building stone. Presently it is being used for coarse aggregate in concrete and riprap for faces of dams and stream channels.

NATURAL FEATURES

The Coteau des Prairies, which covers about one-fifth of the Study Area, rises like a low range of mountains above the Minnesota River Valley Lowlands and is the most prominent topographic feature. The top of the Coteau is a complex topography of hills, sloughs, potholes, and lakes. The larger and deeper lakes, of which there are a dozen, or more, are excellent fishing lakes. Sloughs and potholes are intermingled with cropland and pasture and are excellent producers of both upland and water-loving wildlife. This pothole region is an extensive area that includes the northern portion of the area and extends down the west side nearly to Sioux Falls.

The remaining four-fifths of the area is gently rolling hills except for the steep terminal moraines extending from the northeast corner of Brookings County, South Dakota, into Minnesota. These moraines are split in a number of places by the remains of ancient glacial rivers and are often called "holes in the hills." The hills in the eastern parts of Lincoln and Union Counties and across the River into Iowa contain some of the few natural forests in the area. Newton Hills State Park in Lincoln County, South Dakota, was created to preserve and develop this picturesque area.

Another prominent natural feature is the quartzite outcrop which forms the falls for which Sioux Falls was named. For a short reach, the Sioux River flows through a narrow deep gorge of this quartzite near Dell Rapids, South Dakota.

This same quartzite outcrop shows up north and east of Sioux Falls near Garretson, South Dakota, as Palisades along Split Rock Creek and on a small tributary known as Dead Man's Gulch. In Minnesota, the outcrop is visible in the vicinity of Luverne as a low range of rocky hills. Blue Mound State Park has been developed to take advantage of its scenic values.

Near Pipestone, Minnesota, there is an outcrop of a rare red fine-grained quartz bed. This stone was condidered by the Indians to be sacred and they came from great distances to mine the stone from which they fashioned peace pipes. This area has been set aside as the Pipestone National Monument. The mining of the stone is restricted to Indians who still use it for making peace pipes and pottery items. The Monument area includes one of the few remaining expanses of natural prairie.

LAND RESOURCES

Land Resource Areas

The Study Area lies within four Major Land Resource Areas, (See Map No. 5.) A Land Resource Area (LRA) is a geographical area of land, at least several thousand acres in extent, characterized by a particular combination or pattern of soils including slope and erosion, climate, water resources, land use and types of farming. Contrasts between LRA's are usually distinct and,in some cases, may be very abrupt.

LRA 55, The Black Glaciated Plains, includes the upper western eight percent of the Study Area. Nearly all of the area is in farms and ranches and approximately three-fourths is cropland. Wheat and flax are the major cash-grain enterprises. However, feed grains are the most important crops in terms of acreage. The more sloping thinner soils, amounting to about one-fourth of the area, are in range and pasture.

LRA 102, the Loess, Till and Sandy Prairies, occupies about 86 percent of the Study Area. Almost all of the area is in farms with over three-fourths in cropland. Corn, oats, and alfalfa grown mainly for feed are the major crops. Sizeable acreages of wheat, flax, and soybeans are grown for cash sales. About one-fifth of the area is in pasture and range. Some of the grazing land is in native grasses but, on the better soils, tame grasses and legumes are grown. Less than one percent of the area is forested. Wooded areas are mainly narrow bands along streams and shelterbelt plantings around farmsteads.

For purposes of analyzing the current and potential productivity of agricultural lands, LRA 102 was subdivided along the southern boundary of Kingsbury and Brookings Counties. The area north of this line is arbitrarily labeled LRA 202 and to the south, LRA 302.

Only a small portion of the Study Area lies within LRA 103, the Central Iowa and Minnesota Till Prairies; therefore, it was combined with LRA 107, the Iowa and Missouri Deep Loess Hills. These LRA's are relatively homogeneous when viewed from within the Study Area boundaries and are referred to collectively as LRA 107.

Nearly all of LRA 107 is in farms with about four-fifths as cropland. Corn and soybeans are the major crops. Moderate acreages of other feed grains and hay are harvested to supplement corn for raising and finishing livestock.

One-sixth of the area is in tame pasture. Narrow belts of steep slopes bordering stream valleys and some wet bottom lands are forested.

Soil Resources

A General Soil Association Map along with the descriptions, and a brief discussion of the 49 different soil associations, is in Appendix A.

The General Soil Association Map was compiled from county generalized soil maps or individual soil surveys in counties where surveys were available. Correlation was made among the counties and among the states of South Dakota, Minnesota, and Iowa.

As the detailed soil surveys progress in the Study Area and our knowledge of these soils is increased, the soil names on the legend of the General Soil Association Map may be changed. If more detailed soil information is needed about the soils, this can be obtained at the local office of the Soil Conservation Service. This includes soil descriptions, capability classification, interpretations and groupings for agronomy, engineering, urban, wildlife, woodland, pasture, range, and other special use groupings.

Soil Resource Groups

When considering slope, erosion, and other limiting characteristics, along with differences in soils nomenclature across states' lines, many soil breakdowns were identified. Consequently, land capability units and subunits were aggregated into Soil Resource Groups (SRG's) on a productivity basis. Additional meaning is provided through this classification because production costs, present and projected yields, and suggested management practices are relatively similar within each group. Also, they are applicable to each of the Land Resource Areas, thus providing a homogeneous base for use in further analysis.

The procedure used to identify SRG's and their associated characteristics is the same as that used in the Missouri River Basin Type I Comprehensive Framework Study. The descriptive material that identifies and briefly describes each SRG is in Appendix B.

LAND USE AND VEGETATION

Total area of the Big Sioux Study Area encompasses about 7.6 million acres. (See Table 1.) About 94 percent of this total is in agriculture and forestry land uses. The remaining 6 percent is in water areas, urban, and transportation uses, with a small amount of nonclassified federal land.

The 5.4 million acres of cropland is mainly devoted to corn, oats, alfalfa hay, and native hay. Other crops grown are wheat, flax, barley, and soybeans. About seven percent of the corn is raised for silage and the remainder is harvested as grain. Approximately 7,000 acres of cropland is presently irrigated, most of which is in corn or alfalfa. Most of this production is utilized as livestock feed on the farm on which it is raised or in the immediate neighborhood. However, some of the corn and barley and most of the flax, wheat, and soybeans is sold for consumption outside of the Study Area. There are an estimated 810,000 acres of temporary idle land. This acreage varies widely from one season to another depending upon the weather, market conditions, and federal farm land retirement programs.

About 1.5 million acres are managed as permanent pasture or range. The rangeland, which represents about 35 percent of this area, is land which has never been plowed. In the well-managed or less accessible areas there is a mixture of tall and mid-grasses characteristic of the true prairie. However, continued overuse of these lands results in the elimination of the tall grasses and the invasion of cool season short grasses such as Kentucky bluegrass and weeds. The remaining 65 percent of the total are in permanent pasture and hayland. They usually have been cultivated at some time in the past and have usually been seeded to bromegrass. Low, wet areas are often seeded to creeping foxtail or reed canarygrass. The pasture and rangeland furnish most of the summer roughage for the area's livestock industry.

There are about 48,800 acres of forest lands in the Study Area. A small amount is the remnant of naturally occurring woodlands on the steep lands on the east side of the Coteau and in the southernmost reaches of the Big Sioux River. Most of the natural forests were severely harvested from the time of settlement to about 1950 for firewood, fenceposts, and other farm needs. Since 1950, fuel oil, propane gas, and electricity has largely replaced wood as heating and cooking fuels, and manufactured products have replaced the need for fencing and other farm needs. As a result of these changes, the natural forests are improving in most areas.

Most of the land in forests were planted by the early settlers as tree claims and as farmstead shelterbelts. Throughout the years since settlement, the farmers have protected and improved their 2,500 miles of tree shelterbelts and field windbreaks. Other tree plantings have been practiced to develop field shelterbelts. Within the past ten years, one-row field shelterbelts have become popular with many of the farmers.

The most important use of the forests is to protect farmsteads and feedlots from blowing snow and chilling winter winds. They are also used to protect land from wind erosion and to improve the environment and livability of land which, naturally, was almost treeless. Other uses are for fireplace wood and farm fenceposts.

There will be shifts between agricultural and nonagricultural uses of land to accommodate the additional population projected in future time periods. Additional land will be required for housing, roads, industrial sites, shopping centers, and recreation resulting in less land available for agricultural purposes. Between 1980 and 2020, another 52,100 acres will be shifted to nonagricultural uses. (See Table 2.)

Table 1--Water area and major land uses
Big Sioux Study Area

Use	Acres	Percent
	-- Thousand --	
Water Area	208.1	2.7
Federal Land	12.6	.2
Transportation and Urban	212.8	2.8
Cropland	5,445.8	71.9
Pasture and Range	1,454.8	19.2
Forest Land	48.8	.6
Other Agricultural Land	199.1	2.6
Total Area	7,582.0	100.0

Sources: 1967 USDA Conservation Needs Inventory and Bureau of Census Area Measurement Report

Table 2--Current and projected agricultural and nonagricultural land
Big Sioux Study Area

Year	Agricultural					Non-Agricultural
	LRA 55	LRA 107 2/	LRA 202	LRA 302	Total	Total
	Thousand Acres					
1967 1/	571.0	403.2	3,011.7	3,162.6	7,148.5	279.6
1980	571.0	400.4	3,002.6	3,140.5	7,114.5	313.6
2000	571.0	397.5	2,996.6	3,124.7	7,089.8	338.3
2020	571.0	395.1	2,990.6	3,105.7	7,062.4	365.7

1/ 1967 USDA Conservation Needs Inventory
2/ Includes LRA 103

WATER RESOURCES

Surface Water

The Big Sioux Basin is the largest water producing area of South Dakota, except for the Black Hills Region. In estimating water yields, all of the USGS stream gaging stations in, and adjacent to, the Basin were analyzed. A 41-year stream gage record for the Big Sioux River at Akron, Iowa, shows an average annual runoff of 617,400 acre-feet. This amounts to 1.92 inches of runoff from the estimated contributing drainage area of 6,040 square miles. The greatest annual runoff, occurring in water-year 1/ 1969, was 1,802,000 acre-feet (5.60 inches). The lowest amount was 86,700 acre-feet (0.27 inch) occurring in water-year 1931. (See Table 3.) Figure 1 shows graphically the annual runoff volume for several stream gages.

1/ A water-year starts October 1 and ends September 30 the following year.

On an average annual basis, about 70 percent of the surface runoff will occur during a four-month period of March through June. Snowmelt runoff accounts for about 50 percent of the total runoff on an average annual basis and occurs during the period of March through the middle of April. The least amount of surface runoff occurs during the winter months. Normally this is return flows from shallow ground water aquifers in form of seeps or springs along the main streams.

Table 3--Historic runoff volumes by water year 1/
Big Sioux Study Area

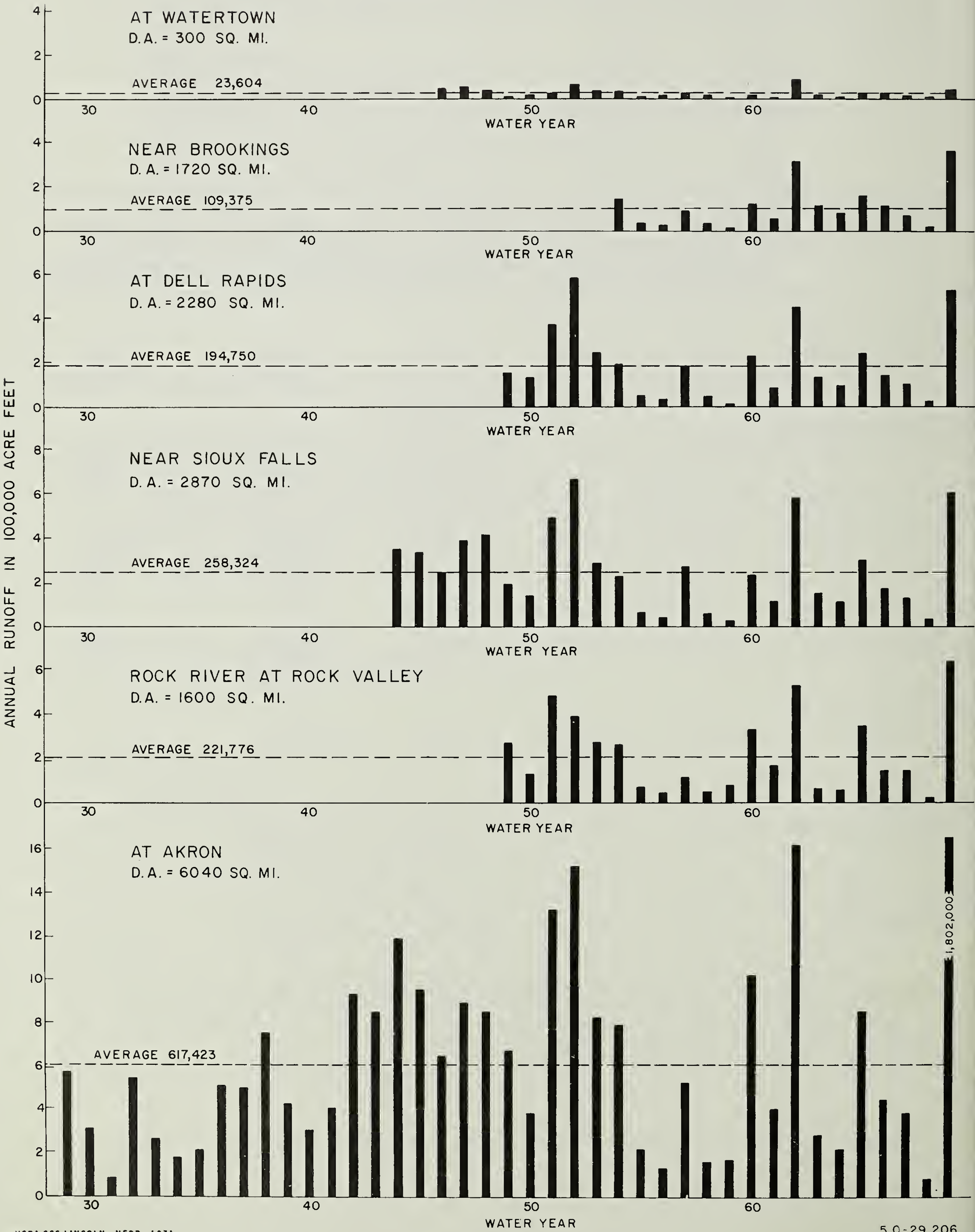
Stream Gage and Location	Drainage Area (Sq.Mi.) 2/	Period of Record (Years)	Average Annual Runoff (Ac.Ft.)	Max. Annual Runoff (Ac.Ft.)(Year)	Min. Annual Runoff (Ac.Ft.)(Year)
Big Sioux River at Watertown	300	1946-69	23,600	83,140 (1962)	147 (1959)
Big Sioux River at Brookings	1,720	1954-69	109,400	361,000 (1969)	11,230 (1959)
Big Sioux River at Dell Rapids	2,280	1949-69	194,800	584,600 (1952)	16,720 (1959)
Big Sioux River Sioux Falls-Brandon	2,870	1944-69	258,300	671,600 (1952)	24,600 (1959)
Big Sioux River at Akron	6,040	1929-69	617,400	1,802,000 (1969)	86,700 (1931)
Rock River at Rock Valley	1,600	1949-69	221,800	641,300 (1969)	22,160 (1968)
Skunk Creek at Sioux Falls	400	1949-69	36,800	95,980 (1962)	6,710 (1959)

1/ Runoff affected by Big Sioux River Diversions into Lake Kampeska, Lake Pelican, and Lake Poinsett

2/ Estimated contributing drainage area

FIGURE I

TOTAL ANNUAL RUNOFF FOR BIG SIOUX RIVER BASIN



USDA-SCS-LINCOLN, NEBR. 1971

5,0-29,206

In estimating water yields for the area, it is estimated that 2,765 square miles are noncontributing to stream flow in the Big Sioux River. (See Map No. 7.) This area, located in the northwestern portion of the Study Area, is characterized by large lakes and numerous shallow depressional areas of lakes and sloughs. About one-fourth of this area may contribute some surface water to the Big Sioux River for years of above normal runoff.

Mean annual runoff varies from about 1.25 inches in the northwestern part to about 2.50 inches in the southeastern part. (See Map No. 7.) This geographical runoff distribution varies in the same relationship as that of precipitation. Annual water yields for 80 to 50 percent chance[1/] can be estimated using Figure 2.

Ground Water

Two principal sources of ground water in the Study Area are the bedrock formations and glacial drift. The Big Sioux Basin is underlain by consolidated and unconsolidated sediments which extend from the Precambrian to Upper Cretaceous in age. (See Map No. 8.) These sediments vary from the dense, siliciously cemented Sioux Quartzite to the soft, erodible shales of the Pierre Formation. The oldest rock exposed is the Milbank Granite. Glacial drift blankets nearly all of the area. In many areas, loess covers the till or bedrock. The loess becomes thicker in Iowa and Union County, South Dakota. Ground water is obtainable in varying quantities and qualities from Precambrian to Quaternary sediments. Certain rocks have such limited water resources that they are not considered a source of water for any purpose. The water bearing materials are described in the following paragraphs from oldest to youngest age. (See Figure 3.)

Sioux Quartzite: The Sioux Quartzite outcrops in the Sioux Falls, Dell Rapids, Luverne area forming a broad band east to west with Sioux Falls in the southwestern part of the band. The quartzite is hard, pink siliciously cemented quartz sand with interbedded thin shales and pipestone. There are some uncemented sand beds. Where the rock is badly fractured or uncemented, it yields small quantities of variable quality water for domestic or livestock use. Quality seems to be good in areas where the quartzite is near the surface. The quality of the ground water becomes poorer where till, outwash, or Cretaceous sediments mantle the quartzite. Recharge is from direct precipitation on the overlying material and from surface runoff.

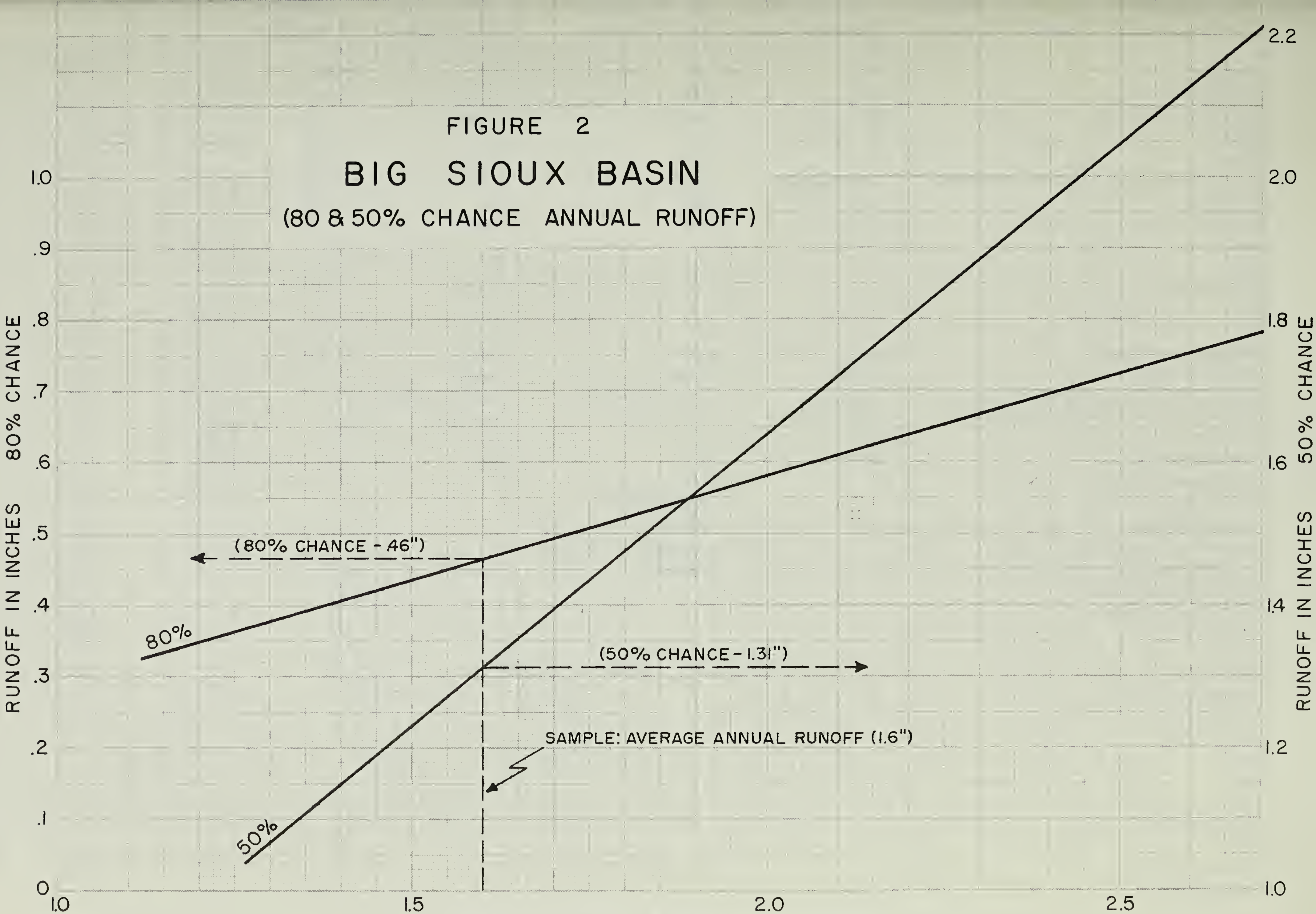
Dakota Sandstone: The Dakota Sandstone is the major artesian aquifer in eastern South Dakota. Dakota Sandstone, as used here, refers to those rocks which may, in part, be correlative with rocks assigned to the Belle Fourche, Mowry, Newcastle, and Skull Creek Formation and the Inyan Kara Group in the Black Hills. This is defined on page 180, South Dakota Geological Survey Bulletin 16, "Mineral and Water Resources of South Dakota." The Dakota is a fine-grained porous sandstone with interbedded dark shales. Yields from the Dakota in eastern South Dakota vary from less than 10 gpm to more than 1,000 gpm.

1/ Percent probability that the given event will be equaled or exceeded in any given year

FIGURE 2

BIG SIOUX BASIN

(80 & 50% CHANCE ANNUAL RUNOFF)



USDA-SCS-LINCOLN, NEBR. 1971

5,L-29,209

In the area, no flowing wells exist in the Dakota. Because of no flowing wells and lack of use as an aquifer, yields in the area are not readily known. The piezometric surfaces of the artesian aquifer has declined since the early 1900's. Water quality is generally saline and hard and is not suitable for irrigation.

Graneros Shale: The shales of the Graneros are not a reliable source of water.

Greenhorn Limestone: In eastern South Dakota, the Greenhorn is mainly limy shales and shaly limestones. Generally soft saline water suitable for domestic and stock water use is obtained from the Greenhorn. Water is limited and localized with little potential for further development.

Carlile Shale and Niobrara Formation: The Codell Sandstone member of the Carlile and the Niobrara appear to form an aquifer as much as 180 feet thick in eastern South Dakota. It is probably not that thick in the Study Area. Water from this quifer is generally saline and soft and is suitable for stock and domestic use. The Codell Niobrara is developed in central South Dakota and the southern James Valley for stock and domestic use. Some wells in the area are into this aquifer.

Pierre Formation: The Pierre Formation has little potential for development for any type of water supplies.

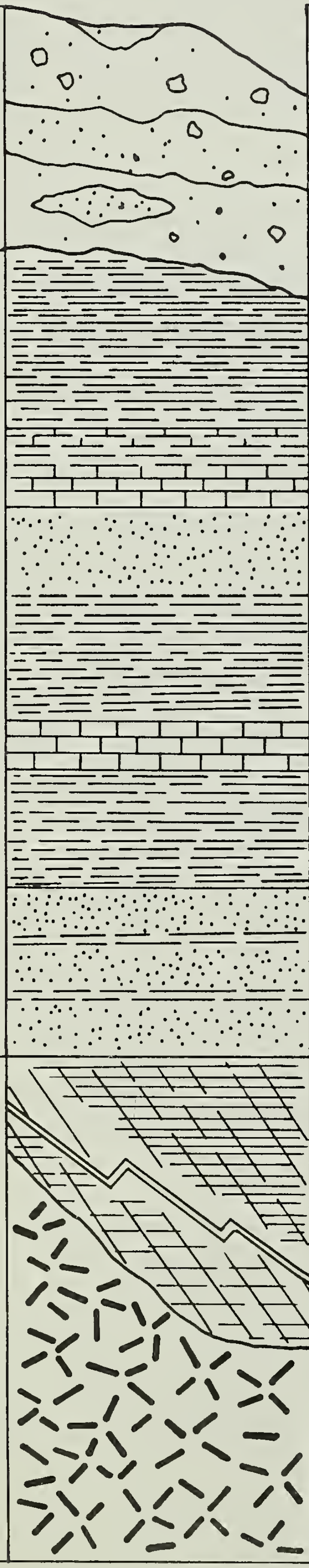
Outwash and Alluvium: The largest source of available ground water in the Study Area is the glacial outwash and alluvial materials which follow the Big Sioux River Valley and branch into many of the tributaries. The materials vary from fairly permeable clean sands and gravels to clays, silts, and fine sand. Yields from the sands and gravel are substantial in many places and could be developed for irrigation or municipal use. Several towns, including the city of Sioux Falls, obtain their water from this source. Irrigation is being developed along the Big Sioux Valley in a number of places but the potential is basically undeveloped. Water quality varies in the outwash and alluvial materials but it is generally high in dissolved solids and fairly hard. In some instances the water quality may make it unsuitable for irrigation. Water sample testing should be done before attempting to develop any ground water for irrigation. (See Map No. 9.)

Water Quality

The quality of the water in most reaches of the Big Sioux River is fairly good and suitable for such uses as municipal water and recreation. Dissolved solids and hardness are relatively low in comparison with other water sources in the area. However, nutrient concentrations permit extensive algal growths in the summer and coliform counts are usually high in the River below Sioux Falls. River level fluctuations cause wide variations in the quality. The

FIGURE 3

GENERALIZED STRATIGRAPHIC SECTION
BIG SIOUX BASIN



		THICK-NESS	NAME	DESCRIPTION	WATER BEARING POTENTIAL
QUATERNARY PLIESTOCENE	WIS. ILL. KANS. NEBR.	0'–900'	Glacial Drift Till and Outwash	Till-sand, gravel, silt, and clay mixtures with cobble and boulders	Limited amounts from sand lenses in till
				Outwash-sand, gravel, and boulders	High quantity Quality variable
CRETACEOUS		180'-300'	Pierre Formation	Black shales, silt-stones and claystones. Thin bedded	Low to none Poor quality
		30'–140'	Niobrara Formation	Chalk, marl, siltstone, limestone, fractured	Domestic and livestock Saline and soft
		80'	Carlile Formation – Codell Mem.	Sandstone up to 80′ thick	Domestic and Livestock
		180'-250'	Carlile Formation	Black shales	Low to none
			Greenhorn Fm.	Limestone	Small quantity
		135'-160'	Graneros Formation	Black shales	Poor
		50'-150'	Dakota Formation	Sandstone with interbedded shales	Domestic Livestock and Municipal Highly saline
PRECAMBRIAN		0'– 3000'	Sioux Quartzite	Dense hard pink quartz sand Siliceously cemented Interbedded pipestone and shale beds	Domestic or livestock where fractured Quality variable
			Milbank Granite	Dense dark granite	None

quality is degraded by high temperatures in the summer and the introduction of sediment, sewage effluent, and agricultural wastes.

The sources of surface water in the Study Area are the rivers and streams, lakes, ponds, and reservoirs. The principal sources of ground water occur in the glacial drift and bedrock formations. The main water uses are for human consumption, livestock, industry, fish, recreation, irrigation, and aquatic wildlife and migratory waterfowl.

The highest quality of water is needed for human consumption. Surface water supplies are seldom used for this purpose because of the uncertain supply, the high cost of treatment facilities, and a plentiful supply of ground water. The waters from glacial drift are usually of good quality although there are areas where these sources may become contaminated from waste dumps, sewage effluent, or agricultural chemicals and fertilizers. Farm wells are also likely to be contaminated from these sources. Subsurface water from bedrock is usually free of contamination but may be too high in dissolved solids to be desirable for washing purposes.

Water for livestock is plentiful and usually of good quality. Livestock water comes from both surface (lakes, ponds, small reservoirs, livestock watering dugouts, and streams) and ground water sources (glacial drift wells). Although these sources may contain some contaminants, these are seldom serious enough to cause animal health problems.

Considering the present industrial developments in the area, there is an adequate supply of water of good quality. The major source of industrial water, like the major source of water for human consumption, is from shallow glacial drift wells. This source may not be adequate for unlimited industrial expansion. However, other sources such as surface supplies from existing lakes, or from developed reservoirs, or from deep wells into the bedrock could be developed with proper treatment facilities. A limiting factor to industrial development in some areas would be the availability of sufficient water for the proper dilution of industrial waste effluents.

The quality of water for fish production is variable from season to season and in the various sources of surface waters. In general, the quality of water in the larger streams is good in the spring and early summer when there are good base flows. As the summer progresses, the flows usually decrease and the quality becomes poorer as the temperatures rise, microbiotic activity increases, and the supply of oxygen becomes limited. In the winter the flows cease in all smaller streams and become very low in the Big Sioux River. At these low flow rates, sewage effluent from urban areas seriously lowers the quality of water for fish. Therefore, it is only in the lowermost reaches of the Big Sioux River where the year around water quality can be depended upon to support fish production. A limiting factor in fish production in the lakes is the winter kill. Water quality is a factor in the severity of winter kill. Enrichment of an already fertile lake by plant nutrients such as phosphates and nitrogen cause excessive algae "bloom." In the winter the decomposition of the algae may reduce the oxygen content below the level which will support fish life. Highly enriched waters may also experience summertime fish kills.

The same factors which limit the quality of water for fish production limit its use for nearly all forms of recreation. High algal growth makes water undesirable for swimming and other water sports. The quality of water for fish and recreation is probably deteriorating at a more rapid rate than for the other water uses.

The qualities of water which limit its use for irrigation are the kind and amount of dissolved solids present in the water supply. Surface waters are usually low in dissolved solids, but may be of limited supply in drouth periods. Ground water from the bedrock usually has dissolved solids which may build up in the soil profile rendering it unprofitable to continuous irrigation.

In addition, the bedrock waters are frequently at too great a depth for profitable irrigation under current conditions. The present source of irrigation water is usually from the glacial deposits, particularly the alluvium and the glacial outwash. The quality of this water is generally good. The occasional pollutants from sewage effluent and agricultural chemicals do not generally limit use of this water for irrigation. However, sometimes this glacial drift water may contain excessive amounts of dissolved solids. Because of the variable quality, the use of ground water for irrigation should be studied on an individual project basis before large investments are made for land development and preparation.

The quality of water in lakes and streams is generally good for the production of wildlife and use by migratory waterfowl. There are instances where pesticides may be building up to a point which may be damaging to certain forms of wildlife.

Water Use and Management

Of the estimated 15 million acre-feet of water that annually falls as precipitation, approximately 800,000 acre-feet, or five and one-half percent, flows out of the Study Area as surface runoff. In addition, approximately 600,000 acre-feet evaporates from the 200,000 surface acres of permanent water. The remaining 13.6 million acre-feet of water, or over 90 percent of the total, is used to grow crops, pastures, and forest, to maintain the lakes and sloughs, and to replenish the underground aquifers.

The greatest use of water is for crop production, domestic, municipal, and industrial use. About 50 lakes are deep enough to support fish, support a small commercial fishery and provide many man-hours of recreation. The sloughs and remaining shallow lakes provide hunting and trapping recreation; but, more importantly, areas for habitat and water for many species of birds and small animals is provided.

Some of the 800,000 acre-feet of runoff water occur as floodwaters that damage crops, pastures, transportation facilities, houses, and other properties in the flood plain. Much of the runoff water provides water for fish and wildlife and for the enhancement of the environment. Surface runoff conveys and dilutes the sewage effluent from the cities and towns and agricultural wastes from farms and feedlots. Although the runoff water is a small part of the total available water, it is important from an aesthetic and an economic viewpoint.

Runoff water is detained in over a hundred natural lakes and thousands of smaller potholes. There are no major reservoirs in the Study Area although there are 14 small watershed floodwater retarding dams. Recreation is included as a project purpose in one of these. There are no storage reservoirs for runoff water for municipal, industrial, or irrigation water supply.

Channel construction and modification for the reduction of flood damages and the drainage of wet agricultural land has been practiced since the prairie was first broken up. Most of this has been done on the upper ends of the small tributaries. No inventory has been made of the extent of channel modification.

FISH AND WILDLIFE

Fisheries

The Big Sioux River supports year around fishing in its lower reaches. The discharge from the river is affected by sediments and other pollutants occurring from agriculture, urban, industrial, and construction activities. The river is turbid and has all the fish species common to the Missouri River Basin. Recreation fishing is mainly centered on catfish species, the most common of which is the black bullhead.

Approximately 1,340 miles of the Big Sioux River tributary streams have some fishery potential within South Dakota. This potential occurs mainly in reaches nearest their outlets. These fisheries are dominated by black bullheads although two short reaches of upper basin tributaries do support trout. Other tributaries have limited reaches that provide fair to good pan and game fish. The Rock River, a tributary of the Big Sioux River in Iowa, provides a 75-miles stream fishery of fair quality.

Natural lakes provide the greatest amount of fishing in the Study Area. There are about 50 lakes which can be depended upon to produce harvestable fish. The combined area of these lakes is 59,500 acres. They range in size from about 100 surface acres for the smallest to Lake Poinsett with nearly 8,000 surface acres. In addition, there are about 100 other shallow lakes, potholes, and sloughs which are designated as meandered lakes many of which, under favorable conditions, provide fishing of variable quality. The combined area of these lakes is 65,000 acres.

Man-made surface water bodies provide additional fish production. There is one multipurpose floodwater retarding and recreation structure with a pool area of about 90 acres,built under the Small Watershed Program, which has been stocked and provides excellent fishing. There are also 13 other small watershed floodwater retarding structures with combined sediment pools of about 185 acres that provide some fishing. Farm ponds in the Study Area are mainly the dugout type and have a low fishery potential. There are 43 embankment-type farm ponds that have a much higher potential and, in some instances, are favorable trout habitat.

The majority of the natural lakes are located north of the Moody-Brookings County line. Six of the better lakes, with a combined acreage of 1,340 acres, are south of this line. There are no natural lakes of this quality in the Study Area portions of Minnesota and Iowa.

Species providing the greatest amount of sport fishing are walleye, northern pike, crappie; sunfish species including large mouth bass; catfish species including bullhead; and yellow perch. Trout occur in a few high quality farm ponds and tributary streams. Minnows of many species, including carp and a number of sucker species, including buffalo, occur within the Study Area. The carp and buffalo are considered rough fish and furnish limited recreation. The rough fish species and bullheads provide a commercial harvest. Fourteen lakes within the Study Area in South Dakota have been fished commercially. These lakes produce an annual yield of approximately 100 pounds per acre. Any of these lakes, if managed specifically for commercial fish production, could produce a greater poundage of fish.

Wildlife

Wildlife species of greatest interest to the public are those that provide hunting recreation. Other species generally recognized as having importance are furbearers and some of the so-called nuisance animals.

The big game animals are white-tailed deer, mule deer, and pronghorn antelope. White-tailed deer are the most numerous, with both deer species occurring naturally. Antelope have been reintroduced within a very limited area in the northern portion.

The ring-necked pheasant is the most important wildlife game species. Other upland game birds of the area include wild turkey, grey partridge, bobwhite, quail, sharp-tailed grouse, and mourning dove. Partridge, turkey, and grouse do not occur in the Minnesota and Iowa portions, and mourning dove is not considered a game bird in those two states.

Waterfowl rival pheasants in importance within the Study Area. Considerable marsh habitat with high production value for ducks and shore birds occurs in the middle and northern portion of the area. The occurrence of natural waterfowl breeding habitat is not as plentiful in Iowa, Minnesota, and southern South Dakota.

Duck production is mainly blue-winged teal, shoveller, gadwall, mallard, and pintail with lesser production of scaup, canvas-back, redhead, buffle-head, green-winged teal, baldpate,and ruddy. There is some wood duck production in the southern portion of the area. A very limited amount of Canada goose production occurs in the lakes area of Day County. Coot, pied-billed grebe, western grebe, cormorant, pelican, American bittern, and many others are also produced in this area.

All the waterfowl game species produced in the Study Area as well as migrants of the same species and species not produced in the area such as snow and blue geese contribute to hunting recreation.

Furbearers of importance are muskrat, mink, and beaver. Jackrabbits and cottontail occur throughout the Study Area. Management of these species varies considerably among the three states.

Wildlife Habitat

Considering the number and variety of game birds and animals enumerated in the preceding section, it can be concluded that the wildlife habitat is generally good. The best habitat is available in the pothole region. Of the 208,100 acres of water shown in Table 1, nearly 57,000 acres occur as water areas less than 40 acres and greater than two acres. These potholes occur in the northern and western portions of the Study Area and are mainly in Soil Association Groups A and C. (See Map No. 6 in Appendix A.)

Because of the nature of pothole areas they are good habitat for wildlife production. They usually contain open water for aquatic species, a ring of emergent vegetation which provides food and cover for aquatic wildlife,and protected approaches to the water for upland game. Often there is a ring of trees and shrubs around the pothole which provide additional winter food and cover, and beyond these there is usually a grassland area which is often ungrazed and unmowed which also provides food and cover.

Intermixed with pothole topography is the upland farmland which provides a variety of conditions throughout the year which enhances the wildlife habitat.

During the fall and throughout the winter, wildlife can glean the crop residue and weeds for their livelihood.

Wildlife habitat in the nonpothole portion of the Basin is less plentiful. In this area there are fewer areas that cannot be cropped or grazed. Water may not be as plentiful. Winter cover may be lacking. However, what nature does not provide, farmers often do. Field and farmstead windbreaks offer nesting areas and food and cover for summer and winter. Stockwater dugouts and farm ponds provide water and, in many cases, food and cover. The control of wildfires has allowed brush and trees to grow on the steeper hillsides and the less heavily pastured areas which also provide cover.

QUALITY OF NATURAL ENVIRONMENT

In its primeval condition, the Big Sioux area was a magnificent grassland. This area of grasses and flowers was a part of what the early settlers called, "Prairie." In summer the prairie was a land of waving grasses appearing almost monotonous in its uniformity of cover. The dominance of grasses, a few shrubs, and the absence of trees, except along the rivers and streams, constituted its main features.

In the newly settled areas, the livestock were turned loose to graze on the grasses and other palatable vegetation while the owners were engaged in preparing the land for gardens and field crops. As more and more land was devoted to crop production, it was necessary to enclose the various areas with fences. From this naturally evolved the systematic fencing of fields and farms which can be seen throughout much of the area today.

The northern and western portion of the Study Area has many sloughs and lakes and few well defined drainage patterns. Much of this area remains in a condition similar to what the early settler first observed and areas that can be farmed profitably are being cultivated.

Today much of the landscape is changed. Groves of trees surround nearly every farmstead and field shelterbelts break up the once monotonous prairies. Prosperous looking farmsteads, served by a well kept system of roads, dot the horizon. There are many small towns and cities serving the farm populations. Some of the larger cities such as Sioux Falls, Watertown, Brookings, Madison, Pipestone, and Luverne have become manufacturing, cultural, and educational centers as well as serving the basic farming needs.

There are also damaging effects caused by a century of settlement and development. Among the more spectacular are the deep rugged gullies which are found in the steep areas of the southern part of the area. The hillsides show evidence of severe sheet erosion. Stream channels which once provided a good outlet for floodwaters have lost much of their original capacity to siltation so that flood damages are increasing and swamping along the channels is becoming more of a problem. Streams which once flowed clear now carry a silt load. There are abandoned farmsteads, junk yards, road signs, and other manifestations of our modern society.

Tree planting was started by the first settlers. In 1869 the Territorial Legislature encouraged tree planting with legislation providing certain tax exemptions and other inducements. The early settlers promptly responded by planting trees for shade, wind barriers, and woodlots. Tree planting was further stimulated by the blizzards of 1880 and 1881. The impetus given tree planting by the early laws, blizzards, and hot summer winds is now apparent in many miles of tree windbreaks, shelterbelts, and farm woodlands protecting farmsteads, crops, livestock, and wildlife from the weather in a land that was a treeless plain. The woodlands, shelterbelts, and windbreaks add to the colorful landscape, make a more pleasant environment, and help provide goods, services, and enjoyment which people demand. They provide habitat for wildlife and opportunities for development of outdoor recreation.

The landscape of the Study Area is primarily farmland and grassland interspersed with small stringer areas of woodland and small urban areas. Many times the land suffered during adverse climatic periods. Periods of drouth, high winds, blizzards, and extreme temperatures damaged the crops, natural vegetative cover, and the land itself. During the past 50 years, people have seen that improved farming practices and land treatment measures can stabilize the soil, protect the watershed, improve production, and enhance the environment. Strip farming, contour farming, terraces, grassed waterways, proper grazing use, grade stabilization structures, farm ponds, and miles of tree windbreaks are conserving the land resources and improving farm incomes and rural living. The implementation of these practices adds beauty to the landscape and enhances the quality of the environment. These benefits may not always be recognized but they are enjoyed by local people as well as by the tourists and travelers. These practices also protect and provide added habitat for fish and wildlife and opportunities for outdoor relaxation and recreation.

RECREATION RESOURCE

There are about 35,780 acres of land in state and federal ownership that are devoted in some way to recreational uses within the Study Area. In addition, a large number of the 208,100 acres of surface water area are also used at various times for recreation.

See Table 4 for general ownership, use, and geographic location of recreational lands and waters.

The most land used for recreation activity are the uplands associated with the wetlands purchased by the federal government and the states of South Dakota and Minnesota for waterfowl production. The two states have purchased a total of about 51,800 acres and the federal government has purchased about 27,000 acres for this purpose. It is estimated that about one-third of this acreage is land and two-thirds water. In addition to waterfowl production, these lands are also used for hunting and trapping. Iowa lies outside the pothole region and does not participate in this activity.

The acreage of water in the Study Area is shown by the 1967 USDA Conservation Needs Inventory to be 208,100 acres. There are 154 meander lakes in South Dakota with a combined acreage of 123,300 acres. A publication of the South Dakota Department of Game, Fish and Parks called, " A Consolidation of Natural Resource Information on the Big Sioux River," dated December 1, 1969, lists 51 lakes with a total acreage of 59,500. These lakes are the best fishing lakes in the Study Area. They are also used for boating, swimming, water skiing, and other water sports. Seven of the state parks and most of the State-owned fishing access areas are located on the shores of these 51 lakes. Most of these lakes have cabins, summer homes, and resorts along their shorelines.

The remaining 103 meander lakes are referred to as shallow lakes and sloughs and they usually have emergent vegetation over a major portion of their surface. Their primary recreational use is for hunting and trapping.

Most of the remaining 31,090 acres of water are in potholes greater than two acres in size but usually less than 40 acres. This water is on private land and its use is mainly waterfowl and other wildlife production. Recreation on these areas is usually limited to hunting and trapping. A portion of this remaining water area occurs as streams less than one-eighth of a mile wide.

Table 4--Ownership and use of recreation land and water
Big Sioux Study Area

	S. Dak. North 1/	S. Dak. South 1/	Minn.	Iowa	Total
			Acres		
Land					
Federal Monument	-	-	300	-	300
Federal Refuge	4,650	-	-	-	4,650
Land Area of Federal Waterfowl Production Areas	6,030	2,970	-	-	9,000
State and County Parks	1,600	1,400	2,000	110	5,110
Public Lake Accesses	400	120	-	-	520
Land Area of State Waterfowl Production Areas	13,600	3,000	600	-	17,200
Total Land	26,280	7,490	2,900	110	36,780
Water					
Water Area of Federal Waterfowl Production Area	12,070	5,930	-	-	18,000
Water Area of State Waterfowl Production Areas	26,700	6,500	1,400	-	34,600
Recreational Waters	50,800	8,700	35	75 4/	59,610
Shallow Lakes and Sloughs	60,600	4,200	-	-	64,800
Other Water Areas 2/	8,830	16,470 3/	3,465	2,325	31,090
Total Water	159,000	41,800	4,900	2,400	208,100

1/ Dividing line is the Brookings-Moody County line
2/ Farm ponds, sloughs and potholes in private ownership
3/ Includes South Dakota's and Iowa's share of Missouri and Big Sioux River which is more than one-eighth mile wide
4/ Includes the recreation lake to be constructed in Pioneer Watershed

CHAPTER 3

ECONOMIC DEVELOPMENT

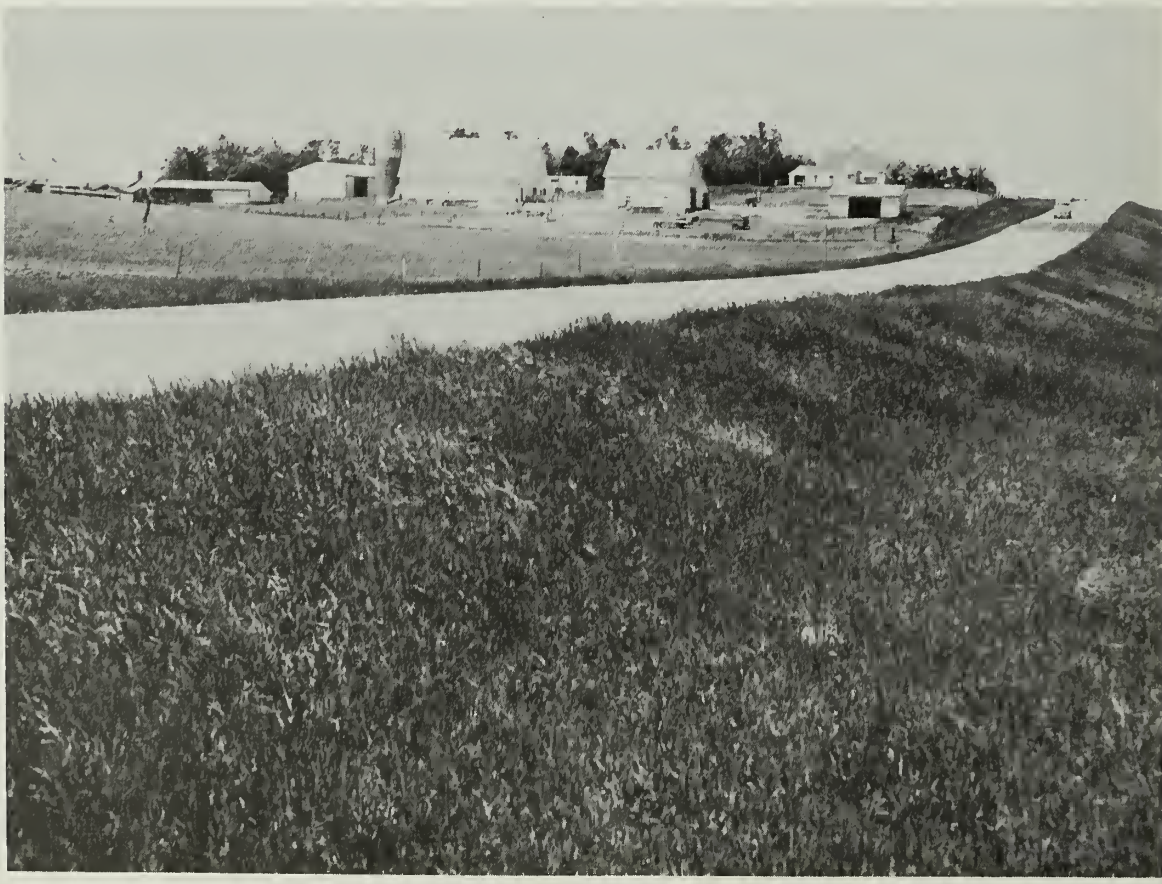
NEW 3-M PLANT BEING COMPLETED AT BROOKINGS, SOUTH DAKOTA.

THE REQUIRED LABOR FORCE WILL BE DRAWN LARGELY FROM UNDER-EMPLOYED SOURCES IN THE FARMING SECTOR.

MEAT PACKING - A MAJOR INDUSTRY IN SIOUX FALLS PROVIDES EMPLOYMENT AND INCOME FOR 2,800 FAMILIES.

ABANDONED FARMSTEAD - THERE ARE MANY IN THE BASIN.

CHANGES THAT ARE TAKING PLACE THROUGH ADVANCED TECHNOLOGY REQUIRING LARGE CAPITAL INVESTMENTS IN FARMING RESULT IN A REDUCTION IN THE NUMBER OF FARM UNITS.



OPERATORS WHO MAKE THE NECESSARY TECHNOLOGICAL AND ECONOMIC ADJUSTMENTS HAVE FARMSTEADS THAT BEAUTIFY THE LANDSCAPE.

ECONOMIC DEVELOPMENT

INTRODUCTION

Numerous factors have influenced the economic development of the Big Sioux Study Area. Population, employment, and income are the more important economic indicators affecting the area as it exists currently. In this chapter they are described historically, measured in terms of present status, and projected to the years 1980, 2000, and 2020. Other economic and social factors such as migration, dependency ratios, education, and selected institutional arrangements are only discussed and shown historically.

Much of the information about economic activity and social characteristics was obtained from published materials. Data from secondary sources are generally not available for areas smaller than whole counties or groups of counties. Therefore, a group of 18 counties believed to be most representative of the Study Area was selected as the geographic unit for economic study. Total area of these counties is only 2.5 percent greater than the Study Area. No major population centers were added or ignored by use of this delineation. The 18 counties, by state, are as follows:

South Dakota	Iowa
Brookings	Lyon
Clark	Sioux
Codington	
Day	Minnesota
Deuel	Nobles
Grant	Pipestone
Hamlin	Rock
Kingsbury	
Lake	
Lincoln	
Minnehaha	
Moody	
Union	

HISTORY

The Big Sioux Study Area was first seen by white men during the summer of 1679 when Daniel Greysolon, also known as the Sieur Dulhut (Duluth) sent a patrol into the Big Stone Lake Area. A few years later, Pierre Charles LeSueur, who maintained a trading post on the Minnesota River near the present site of Mankato, Minnesota, sent patrols into the lower Big Sioux Valley in the vicinity of present day Sioux Falls. The purpose of these early explorations was to determine the possibilities of establishing a fur trade in the area. Although there was an abundance of furbearers present, the trade did not become established on a regular basis until more than a century later.

In 1803 the Study Area became part of the United States of America, it being a part of the Louisiana Purchase. Previous to that time the area had been under the control of France, then Spain, and then France again. While these nations claimed the area, the British probably exerted the greatest European influence by maintaining friendly relations with the Indian occupants. Following 1803, fur trade with the Indians in the Upper Missouri increased rapidly as the United States gained control from the European nations who were preoccupied with wars. For a half century there prevailed a period of relative peace, prosperity, and progress for both the Indians and the white traders. The whites received great quantities of buffalo robes, deer skins, and pelts from beavers, otters, and muskrats. The Indians, in return, received guns, ammunition, kitchen utensils, sewing supplies, and basic foods such as flour, sugar, salt, pepper, and coffee.

The period from 1850 until about 1890 was a period of extreme stress for all inhabitants of the northern plains as the area underwent a transition from a hunting, trapping, and trading society to an agricultural society.

The first white settlers (farmers) came from the east; mainly Illinois, Wisconsin, and eastern Iowa and Minnesota, and settled in the southern portion of the Study Area. Sioux City was founded in 1855; Sioux Falls, Medary, and Flandreau, were plotted as townsites in 1857. All of these sites were abandoned in 1862 as a result of the Sioux uprising in Southern Minnesota. By 1868 the uprising was quelled and the Indians removed to western reservations and the immigration of white settlers recurred. The Sioux City and Pacific Railroad reached Sioux City in 1868 tieing the extreme southern tip of the area to the eastern cities. In 1873 the first railroad crossing the Big Sioux Valley in the vicinity of Elk Point began operating between Sioux City and Yankton. In 1879 the Chicago and North Western Railway crossed the Big Sioux River between Brookings and Volga. At about the same time, the Chicago, Milwaukee, St. Paul and Pacific Railroad crossed the Big Sioux River at Canton, South Dakota. During the decade of the 1880's, over 2,500 miles of railroads were built in South Dakota, much of it in the Big Sioux Study Area.

The planning and initiation of railroad construction started what became known as the Great Dakota Land Boom. In 1877, 164,000 acres of land was filed on. By 1883, nearly 5,500,000 acres were filed on in the single year. These figures cover the entire eastern South Dakota but indicate the rapid settling of the Study Area. The population of southeastern South Dakota increased from a few hundred in 1860 to ten thousand by 1870. In 1880 the population was estimated to be 82,000 and increased to 249,000 in 1885. By 1885 nearly all the land in the Big Sioux Basin Study Area was in private ownership.

Most of the settlers were not entire strangers to the area since they were usually born in the states immediately to the east and south. Their forefathers were usually from England, Scotland, Ireland, Germany, and the Scandinavian Countries. A large settlement of Hollanders occupied an area in the Minnesota and Iowa portion of the Study Area. There was also an important Norwegian settlement in Lincoln and Minnehaha Counties, South Dakota. Aside from these exceptions, no single nationality dominated in any area.

The earliest settlers considered the land suitable only for the raising of small grains. Accordingly, spring wheat was the main crop in the 1870's and 1880's. Later, corn and alfalfa were introduced and livestock production became the leading agricultural enterprise. Under the system of farming that developed, the rougher and wetter lands were used for pasture or native hay while the more level, better drained land was used for cropland. This pattern of development, virtually completed by 1890, was consistent with the pattern of development of the eastern areas from which most of the settlers came.

When the settlers first arrived, the area was almost treeless. Hardwoods grew along the shores of the lakes in the northern portion, along the river bottoms and streams throughout the area, and on slopes in the southern hills. Early pioneers transported tree seedlings long distances by covered wagons or collected seedlings from the stream bottoms for planting around their homesteads.

Incentives enacted by Congress and the Dakota Territorial Government, and later by the South Dakota State Legislature, encouraged tree planting on the plains. The Tree Culture Act by Congress in 1873 and the Tree Bounty by the State Legislature in 1890 were effective in promoting early tree planting.

While the economy of South Dakota depends heavily on an agricultural industry, there has been a continual attempt to establish an industrial base for the economy of the state. Such activity was initiated in the city of Sioux Falls, the state's largest city. Previous to 1900 there were attempts to start in Sioux Falls, a flour mill, a major meat packing plant, a cornstarch factory, an oatmeal mill, a canning plant, a soap factory, a woolen mill, a linen mill, a cigar making factory, and a brewery. Other industries in the Basin included a paint factory, a tow mill to process flax straw, an axle grease factory, farm machinery factories, wood working establishments, foundries and machine shops. Most of these industries were doomed to early failure. They were usually successful in supplying the local market but,because of high transportation costs, could not compete with eastern establishments. The enduring industries have been centered around the marketing and sale of agricultural products; the processing of dairy products; the marketing of cattle, hogs, and sheep; the butchering and processing of livestock; the marketing of small grain; and the mixing and distribution of livestock feeds. Small industries that capitalize on the skills of the people have also persisted. Thus, cabinet making, foundries, and machining shops are still prospering in the area. The industrial base in the Study Area is not large in comparison to the agricultural industry, but it is a growing base.

The patterns of economic growth in the Basin since 1890 evolved from a series of significant national events.

The panic of 1893 and the resulting depression was a difficult time for the young industrial developments. Most of the early manufacturing plants failed during this time.

World War I saw a rapid expansion of agriculture. High prices for farm products was an incentive to cultivate the virgin sod. Pastures were heavily grazed and cropland was farmed without concern for erosion and soil loss. The competition for farm land raised the price of land to unrealistic levels. When deflation occurred during the 1920's, many farmers found that their indebtedness exceeded the value of the land and capital investments they had procured with loans. Bankers found that security for loans was less than the debts. Many farmers lost their farms and many banks declared bankruptcy. People in the Study Area felt the effects of economic depression years before the nation-wide depression started in 1929.

The great depression of the 1930's intensified economic difficulties. Land values deflated still further and the prices of farm commodities dropped to an all time low. To compound the problem, the area experienced one of the most severe droughts since the land was settled. Farmers found themselves with high taxes, large debts, no crops to sell, and being forced to sell their livestock at low prices due to lack of feed. Nearly 20 percent of the farms in South Dakota were foreclosed during the period from 1921 to 1932. Seventy percent of the banks in the state went out of business during the same period.

Heavy use of the land brought about by inflationary farm prices of World War I, together with the drought, resulted in economic catastrophe. This heavy use continued in an attempt to maintain personal income through increased crop production. The introduction of the tractor and other improved farm machinery facilitated this activity. During the drought years the land had little or no cover and, consequently, eroded severely by both wind and water.

To relieve the situation, the federal government instituted public work measures which resulted in the planting of trees, building of dams, and the improvement of other public facilities. Soil conservation districts were organized by farmers and ranchers in order to implement conservation treatment and encourage the wise use and management of the soil and water resources. These districts have been organized in all counties of the Study Area and significant progress has been made in the conservation of land, water, wildlife, and related resources.

The Prairie States Forestry Project, started in 1936 and ended in 1942 by World War II, planted several thousand miles of shelterbelts and millions of trees and shrubs on the farmsteads and prairies. These plantings are furnishing wind barriers to protect soils and crops, shelter for livestock, habitat for wildlife, and enhance the beauty and environment of the land.

In the late 1930's the weather improved, the rains returned, farm prices rose, and the economic conditions returned to normal. World War II was the catalyst that ended the depression. Farm prices remained high through the decade of the 1940's.

The prosperity generated by World War II has generally continued to the present time. The cities and the larger towns especially have enjoyed a period of growth and development. In contrast, disruptive adjustments are underway in the smaller towns. These adjustments are the results of the adoption of advanced technology and the consequent increased efficiency in agriculture. These changes have resulted in fewer people needed to produce an abundance of food and fiber.

In the last two decades the number of farm operators in the Basin has decreased from about 29,500 to less than 23,000. Retiring operators and those unable to compete are not replaced. This factor, plus the migration of young people from the farm, has caused a significant reduction in the farm population. A readily visible effect is the occurrence of abandoned farms and vacant stores and buildings in the small towns.

POPULATION CHARACTERISTICS

Total population of the Study Area has had a very moderate growth since 1920 as shown in the following tabulation:

Census Year	Total Population	Percentage Change From Previous Census
1920	271,800	-
1930	282,400	3.9
1940	286,300	1.4
1950	296,200	3.6
1960	309,500	4.5
1970	307,400	-0.7

The trend in population growth is very similar for the Study Area and for South Dakota. It differs substantially from the national trend which has been increasing much more rapidly and consistently.

Population from 1940 to 1970 is shown by counties and place of residence in Table 5. Only 3 of the 18 counties gained more than 10 percent during the 30-year period. Meanwhile, 10 counties showed a 10 percent, or more, decline in population and 5 counties remained somewhat unchanged. In general, the counties showing a population decline are located in the north and west portions of the Study Area while the counties that gained or remained relatively stable are in the south and east portions. However, the major determinant affecting county population growth appears to be the presence or absence of a sizable city within its boundaries. The three counties with the greatest growth each contain a city of greater than ten thousand population.

Table 5--Population by county, economic study area
Big Sioux Study Area

State and County	1940	1950	1960	1970
	---------- Number ----------			
South Dakota				
Brookings	16,560	17,851	20,046	22,158
Clark	8,955	8,369	7,134	5,515
Codington	17,014	18,944	20,220	19,140
Day	13,565	12,294	10,516	8,713
Deuel	8,450	7,689	6,782	5,686
Grant	10,552	10,233	9,913	9,005
Hamlin	7,562	7,058	6,303	5,172
Kingsbury	10,831	9,962	9,227	7,657
Lake	12,412	11,792	11,764	11,456
Lincoln	13,171	12,767	12,371	11,761
Minnehaha	57,697	70,910	86,575	95,209
Moody	9,341	9,252	8,810	7,622
Union	11,675	10,239	10,197	9,643
Minnesota				
Nobles	21,215	22,435	23,365	23,208
Pipestone	13,794	14,003	13,605	12,791
Rock	10,933	11,278	11,864	11,346
Iowa				
Lyon	15,374	14,697	14,468	13,340
Sioux	27,209	26,381	26,375	27,996
Study Area Total	286,310	296,154	309,535	307,418
Urban	86,027	105,931	130,003	148,117
Rural Nonfarm	67,050	74,721	80,202	79,155
Rural Farm	133,233	115,502	99,330	80,146

Source: U.S. Census of Population

Urban population increased during the 1940-1970 period in absolute numbers as well as proportion of all persons. In 1940, 86,027 persons, or 30.0 percent of the total inhabitants, lived in cities or towns of 2,500, or more. The percentage had increased to 35.8 by 1950; 42.0 by 1960; and 48.2 by 1970. Meanwhile, the rural population declined from over 200,000 in 1940 to about 159,000 in 1970. Although the number of people living and working on farms is continuing to decrease, this area remains rural-oriented. In 1960, 32 percent of the Study Area's population was classed "rural-farm" as compared to 19 percent for the Missouri River Basin and 8 percent for the nation.

The number of towns are shown by size categories in Table 6. Currently, the three largest population centers in the Study Area contain almost as many people as the remaining 139 towns. The largest concentration of people is in Sioux Falls, South Dakota, where 72,500 lived in 1970. Sioux Falls is the hub of much economic activity in the Study Area. Locally, it is well known for agriculturally related marketing and processing industries as well as financial and educational institutions. Transportation facilities for the area are centralized in Sioux Falls. The two major transcontinental freeways serving South Dakota intersect immediately northwest of the city. For these reasons, the bulk of the expected urban growth will occur here.

The other two cities with a 1970 population of greater than 10,000 people are Watertown and Brookings, South Dakota. Watertown is the center of economic activity in the northern part of the area.

Brookings serves the same purpose for the central part of the area. In addition, Brookings is the home of South Dakota State University. The University may present additional opportunities for growth in industries closely related to the educational program. Other cities with a 1970 population of greater than 5,000 people include Madison, South Dakota; Worthington and Pipestone, Minnesota. These cities and a few of the other larger towns exhibit the greatest potential for future growth.

The population migration pattern of the Study Area is a familiar one to the Great Plains. Out-migration is a dominant trend among these 18 counties. During the decade from 1950-1960 there was a natural increase (births less deaths) of over 52,000 people; however 75 percent of this increase was erased through out-migration. From 1960 to 1970 the natural increase was considerably lower than during the previous decade. Meanwhile people continued to move elsewhere in sufficient quantities to exceed the natural increase which resulted in a population decrease. The loss in population through net out-migration from 1950 to 1970 was in excess of 72,000. This is equivalent to the combined population of the second, third, and fourth most populous counties,or of the nine least populous counties. Most of the out-migration comes from the rural-farm sector. A second important source is the towns with less than 2,500 population which have remained quite stable in size.

Many factors account for the export of people from the Study Area. Out-migration from the farming areas is due in part to increased mechanization which allows one worker to farm more acres. Since there is a fixed amount of land, it follows that there are limited opportunities for young people to remain on the farm. Migration tends to be a short-range response to economic opportunities, especially for persons in the working age groups. Economic opportunities in the nonagricultural sector have absorbed at least

Table 6--Population by size of towns 1940-1970
Big Sioux Study Area

Size Category	1940			1950			1960			1970		
	Places	Population		Places	Population		Places	Population		Places	Population	
		Number	Percent		Number	Percent		Number	Percent		Number	Percent
Less than 500	87	23,291	15.7	84	19,648	11.7	88	19,808	10.4	88	17,747	8.7
500-999	23	15,894	10.7	27	17,363	10.3	24	15,768	8.3	25	16,608	8.2
1,000- 1,499	9	10,381	7.0	10	11,933	7.1	10	12,447	6.5	10	12,820	6.3
1,500- 1,999	5	8,455	5.7	4	6,777	4.0	3	5,305	2.8	3	5,169	2.5
2,000- 2,499	2	4,385	2.9	2	4,359	2.6	3	6,813	3.6	3	6,484	3.2
2,500- 4,999	6	18,296	12.3	6	16,930	10.0	7	19,027	10.0	7	23,538	11.6
5,000-10,000	3	16,282	11.0	4	26,109	15.5	3	19,759	10.4	3	21,468	10.5
Over 10,000	2	51,449	34.7	2	65,395	38.8	3	91,217	48.0	3	99,593	49.0
Total	137	148,433	100.0	139	168,514	100.0	141	190,144	100.0	142	203,427	100.0

some of the available labor, but many others migrated to further destinations. In some rural areas, the population of childbearing age is becoming so depleted by out-migration that the average age is considerably above the national average.

The age structure of the population is another important indicator of economic well-being. Persons in the 20-64 age group are considered economically productive while youth under 20 and persons aged 65, and over, are considered the economically dependent segment of the populace. The relative size of each group at any given time has important implications in terms of income, production, tax structure, institutional and governmental needs and other social services. Population in an area which has a high proportion in the productive group requires less governmental and social service assistance than one highly dependent.

For the nation, the proportion of total population accounted for by persons between 19 and 65 dropped from 58.8 percent in 1940, to 57.9 percent in 1950, to 52.3 percent in 1960, then increased slightly to 52.5 percent in 1970. Meanwhile, increases in the dependency age groups were due partly to a decline in death rates among older people and to an increase in family size.

The age structure of the Study Area's population behaved somewhat differently. The working-age group fell from 56.1 years in 1940, to 54.6 in 1950, to 47.9 in 1960 and to 47.4 in 1970. A greater shift away from working-age toward dependent-age groups reflected the pattern of out-migration during the three decades. In 1970, those of retirement age accounted for 12.6 percent of the Study Area population as compared to 9.8 percent for the nation. It was found that in those counties with the heaviest out-migration, the dependency ratio increased. Consequently, if the governmental, educational, and other social services are to be maintained, it is important that the population be stabilized. This stabilization can be achieved by the more intensive use of farm land and by the development of nonagriculturally related industries in the affected areas.

Total population is expected to increase to 336,000 in 1980; 377,000 in 2000; and 418,000 in 2020, as shown in Table 7. The rural-farm sector is expected to follow recent trends and decline from 99,300 in 1960 to 49,000 by 2020. Increase in the other sectors will more than offset this loss. Population in the urban areas is projected to nearly double by 2020. Sioux Falls will probably experience most of the increase. Meanwhile, the rural nonfarm population will expand by an additional 50 percent.

Table 7--1960, 1970, and projected population
Big Sioux Study Area

Population Category	1960 1/	1970 1/	1980	2000	2020
	Number				
Urban	130,003	148,117	167,000	208,000	248,000
Rural Non-Farm	80,202	79,155	92,000	107,000	121,000
Rural Farm	99,330	80,146	77,000	62,000	49,000
Total	309,535	307,418	336,000	377,000	418,000

1/ Source: U.S. Census of Population

SOIL STRUCTURE AND INSTITUTIONAL ARRANGEMENTS

The Study Area was originally subdivided according to the rectangular survey system which established square townships containing 36 square miles. Consequently, the township is the smallest unit of rural government. However, when settlement occurred, the townships were too large for the efficient operation of a school system. Therefore, the townships were usually subdivided into two to four school districts. In actual practice, since the schools were established under county jurisdiction, their district boundary lines are not always common with township boundary lines. These schools were invariably of the one-room, one-teacher, elementary-type.

A third rural institution found throughout the Study Area is the rural church. These churches were usually established shortly after the land was settled and are of the dominant faith of first settlers.

Although the pattern is by no means regular, for about every three townships, a town was established. The town was usually located at the site of a railroad siding and served as a shipping point of farm produce and a shopping center for the local inhabitants. Usually the town has a high school and several churches of different faiths. The town nearly always has a post office and serves as a point of identification for its inhabitants and the farmers living in its trade territory. Although less true today than formerly, the town serves as the social, educational, recreational, and cultural center for the rural population.

Counties are made up of from 12 to 24 townships. One of the more centrally located towns was designated as the county seat. This usually meant that this town grew and became dominant over the other towns in the county. The county seat usually had more and larger stores. Frequently there were competing buyers of farm produce. The high schools were usually larger and presented a wide variety of educational experiences. In some county seats, colleges have been established. Therefore, the county seat towns are the center for much of the financial, educational, cultural, and recreational activities.

The social and governmental rural institutions were developed to service an agricultural society whose principal means of transportation was the horse and buggy. Improvements in transportation, increased educational requirements, and decreases of rural farm population have severely disrupted these traditional rural institutions. The influence of the township government has been eroded with the rural population looking more to county, state, and national governments for governmental needs. Most of the one-room schools and some of the smaller town high schools have closed, or may close in the near future. Many rural churches have a diffucult time servicing the religious needs of the farm population. The smaller towns have boarded up store fronts and are less able to service their traditional trade territory. The economic and political influence is tending to become more centralized in the larger cities and towns.

Local interest in national government is quite intense. This was evidenced in 1960 when 80 percent of those over 21 years of age cast their ballot during the presidential election. This compares with 78 percent for South Dakota, and 63 percent for the nation.

Based on the number of schools, educational facilities in the Study Area are adequate. The occurrence of a college education has become common. For people over 25 years old, the median number of school years completed was 10.2 for the Big Sioux Study Area; 10.4 for South Dakota; and 10.6 for the United States. In 1960, the percentage of those completing high school, or more, were 41.0, 42.2, and 41.1 for the Study Area, South Dakota, and the United States, respectively.

There are excellent colleges within the Study Area and its immediate vicinity. South Dakota State University at Brookings is a land grant college with an enrollment of over 5,000. Other well-known higher educational institutions in the Study Area are Augustana College and Sioux Falls College in Sioux Falls; Dakota State College at Madison, South Dakota; and Worthington Junior College in Worthington, Minnesota. The area is also served by South Dakota University in Vermillion, South Dakota; Morningside and Briar Cliff Colleges in Sioux City, Iowa; Northwestern College in Orange City, Iowa; Westmar College in LeMars, Iowa; and Southwestern State College in Marshall, Minnesota.

EMPLOYMENT AND ECONOMIC ACTIVITY

Four major categories of employment are evident in the Study Area. They are agriculture, manufacturing, construction, and trades and services. The first two and mining are referred to as basic sectors because they produce goods locally for export to other areas. The remaining occupations are derivative or service-oriented industries. They produce goods and services for consumption predominantly within the Study Area. Trades and services include those working in transportation, communication, utilities, finance, insurance, real estate, government, and personal and professional services. Total employment increased in the Study Area between 1940 and 1950 but decreased slightly between 1950 and 1960 as shown in Table 8. The increase in employment for the 20-year period was about one-fourth the national rate.

A significant trend is the reduction of the importance of agriculture as an employer of human resources since 1940. In 1940, nearly 48 percent of the employed people were in agriculture as compared to only 30 percent in 1960. The other industries were able to absorb these excess workers in approximately equal proportions. Table 9 shows the projected employment by industries. The significant point of this tabulation is the expected continued drop in agricultural workers both in actual numbers and in percent of the total employment. By 1980 it is expected that only 22 percent of the work force will be in agriculture and, further, a decrease to 16 percent and 11 percent, respectively, in 2000 and 2020. The percent of work force in manufacturing and construction is expected to remain quite stable over the next 50 years. The number and the percent of people in trades and services is expected to increase considerably.

Sales, value added, and bank deposits can be used in addition to employment as a means of measuring economic activity. Although data about monetary transactions within all sectors were not readily available, selected items for part of the nonagricultural industries are shown in Table 10. In the trade sectors, sales increased but fewer establishments during the decade following 1958 indicates that at least some of the survivors are expanding their operations. Little change has occurred in manufacturing. From 1960 to 1964, bank deposits showed a growth of 29 percent, or from $329 million to $425 million. This compares with an increase of 31.6 percent for South Dakota and 33.2 percent for the nation.

About 90 percent of the dimension stone granite mined near Milbank, South Dakota, is used for monuments. They are sold on a made-to-order basis to buyers throughout the nation. The value of dimension stone over the period of 1958-63 averaged about $2.7 million.

INCOME

Per capita income of the Study Area has historically been below the national average. Although this condition persists, it has been relieved somewhat the past few years. Per capita income is shown historically along with projections for the Study Area and the nation in Table 11.

Low income in the Study Area is partially explained by the high dependency ratio noted earlier. There is an unusually high percentage of older people living on past capital accumulations and/or small annuities. However, low income is probably affected more by the widespread dependence upon farm income. In 1959, 21.4 percent of the nation's families had annual incomes below $3,000 and 14.1 percent had incomes of at least $10,000. This compares with 32.5 percent and 7.4 percent, respectively, for the Study Area. Thus low income problems are further tempered by income distribution.

Per capita income is expected to continue upward throughout the projection period. The rate of increase is projected to be more rapid in the Study Area; however the level of income in 2020 will remain below the national average.

Table 8--Employment by industry
Big Sioux Study Area

Industry	1940	1950	1960	Percentage Change 40-50	Percentage Change 50-60	Percent Distribution
	--- Number of Persons ---			--Percent--		
Agriculture, Forest, & Fisheries	45,733	43,430	32,968	-5.0	-24.1	30.0
Agriculture	45,703	43,397	32,960			
Forest & Fisheries	30	33	8			
Mining	163	322	223	+97.5	-30.7	0.2
Contract Construction	3,228	6,135	5,504	+90.0	-10.3	5.0
Manufacturing	5,796	7,872	10,789	+35.8	+37.0	9.8
Food and Kindred Products	3,911	4,980	7,005			
Textiles and Apparel Products	43	78	125			
Lumber and Wood Products	214	287	181			
Printing & Publishing	798	859	1,221			
Chemicals and Allied Products	173	288	197			
Electrical & Other Machinery	238	582	893			
Other Vehicle Equipment	32	48	119			
Other Manufacturing	387	750	1,048			
Transportation, Communications and Public Utilities	4,119	6,355	6,040	+54.3	-5.0	5.5
Railroads & Railroad Express	1,191	1,453	811			
Trucking & Warehousing	1,314	1,897	2,146			
Other Transportation	222	542	529			
Communications	725	1,332	1,239			
Utilities	667	1,131	1,315			
Wholesale & Retail Trade	15,364	21,867	21,839	+42.3	0.0	19.9
Wholesale	3,370	5,000	4,767			
Retail						
Food & Dairy Stores	2,199	2,872	2,405			
Eating & Drinking Places	2,159	3,402	3,490			
Other Retail	7,636	10,593	11,177			
Finance, Insurance & Real Estate	1,958	2,619	3,473	+33.8	+32.6	3.2
Services	15,741	17,156	22,949	+9.0	+33.8	20.9
Lodging & Personal Services	2,324	2,358	2,558			
Private Households	3,479	1,778	3,341			
Business & Repair Services	1,909	3,210	2,340			
Entertainment & Recreation	778	916	836			
Professional Services	7,251	8,894	13,874			
Government	2,434	3,335	3,566	+37.0	+6.9	3.2
Public Administration	2,434	3,220	3,442			
Armed Forces	0	115	124			
Industry Not Reported	1,314	2,047	2,524			2.3
All Industries	95,850	111,138	109,875	+15.9	-1.1	100.0

Source: U.S. Census of Population

Table 9--Historical and projected employment
Big Sioux Study Area

Employment Category	1940 1/	1950 1/	1960 1/	1980	2000	2020
	Number					
Agriculture	46,371	44,240	33,718	27,600	22,600	17,800
Manufacturing	5,875	8,022	11,052	11,700	12,100	12,700
Construction	3,438	6,578	5,862	7,300	8,700	10,400
Other Trades and Services	40,166	52,298	59,243	80,800	99,800	117,600
Total	95,850	111,138	109,875	127,400	143,200	158,500

1/ Source: U.S. Census of Population

Table 10--Number of business establishments and
reported economic activity, 1958-1967
Big Sioux Study Area

Item	Unit	1958	1963	1967
Wholesale Trade:				
Establishments	Number	823	794	773
Sales	$ Million	568.6	621.3	797.0
Retail Trade:				
Establishments	Number	4,061	3,554	3,651
Sales	$ Million	359.0	406.7	503.0
Manufacturing:				
Establishments	Number	316	301	309
Value Added	$ Million	86.6	105.6	106.1
Mineral Industries:				
Establishments	Number	17	3	None
Value Added	$ Million	2.6	0.5	Reported

Sources: Census of Business
Census of Manufacturing

Table 11--Per capita income, Study Area, and U.S.
Big Sioux Study Area

Year	Per Capita Income		
	U.S.	Study Area	Study Area as a Percent of U.S.
	------ 1958 Dollars -----		-- Percent --
1929	1,274	817	64
1940	1,296	905	70
1950	1,805	1,520	84
1959	2,134	1,376	64
1962	2,258	1,670	74
1965	2,537	2,006	79
1966	2,660	2,100	79
1967	2,764	2,178	79
1968	2,889	2,224	77
1980	4,110	3,370	81
2000	7,160	6,070	84
2020	12,410	10,980	88

Sources: Derived or extracted from: "Preliminary Report on Economic Projections for Selected Geographic Areas,1929 to 2020." U.S. Water Resources Council and other information obtained from Office of Business Economics, U.S. Department of Commerce.

TRANSPORTATION

The transportation facilities within the Basin and to the rest of the nation are generally adequate. Two interstate highways traverse the Study Area; Interstate 90 accommodates east-west traffic and Interstate 29 is available for north-south traffic. These highways intersect at Sioux Falls. Other U.S. and State Highways link the Study Area cities and towns to each other as well as to surrounding areas. In addition, most villages and towns are linked by hard-surfaced county roads. Nearly every farm in the Big Sioux Study Area is served by a gravel road within a mile of the farmstead. Travel by car and freight hauling by truck is universally available to every portion of the Study Area in almost any kind of weather. Although air travel facilities are adequate, other forms of personal transportation, exclusive of private cars, are not as adequate. Sioux City, Sioux Falls, Worthington, Brookings, and Watertown are serviced by commercial airlines. Most of the other larger towns have airports which provide some degree of public and private air service. Travel by bus is possible on some of the major highways, but many of the smaller towns have no public transportation. Railroads still provide a network of lines through the area but there is no passenger service and freight service is often poor on the branch lines. A number of these branch lines have been abondoned in recent years and it is anticipated that more of them will cease to exist. Sioux Falls is the only city serviced by a city bus line. Barge traffic is available at Sioux City on the Missouri River during the ice-free months but this is far removed from most of the Study Area.

MAJOR CROP ENTERPRISES

Feed grains, including corn, oats, and barley, are grown more extensively in the Study Area than all other crops combined. The incidence of these crops reflects the area's location in relation to the "Cornbelt." The major share of feed grains and roughages grown are fed to livestock and poultry or grazed and sold as animal products. Cash crops are an important source of farm income in some areas. Major uses of agricultural land and the associated current cropping pattern of cropland for the Study Area and land resource areas are shown in Table 12.

Table 12--Current normal cropping pattern by land resource area
Big Sioux Study Area

Crop	Study Area	LRA 55	LRA 107	LRA 202	LRA 302
	----------	----------	Acres	----------	----------
Non-Irrigated Cropland					
All Wheat	182,029	61,556	1,413	70,600	48,460
Rye	16,434	9,071	-	4,111	3,252
Corn, All Purposes	2,048,938	55,426	147,341	764,231	1,081,940
Sorghum, All Purposes	54,975	12,808	207	21,150	20,810
Oats	940,539	86,893	38,868	409,516	405,262
Barley	56,014	12,907	178	25,386	17,543
Alfalfa Hay	695,157	46,093	34,451	313,110	301,503
Flax	186,359	35,478	856	92,350	57,675
Soybeans	317,555	-	49,127	52,480	215,948
Other Crops	4,417	-	753	3,525	139
Cropland Pasture	123,416	5,183	1,357	72,122	44,754
Idle Cropland	812,966	97,709	42,928	337,458	334,871
Subtotal	5,438,799	423,124	317,479	2,166,039	2,532,157
Irrigated Cropland	6,975	2,810	217	2,504	1,444
Total Cropland	5,445,774	425,934	317,696	2,168,543	2,533,601
Permanent Grassland					
Wild Native Hay	144,736	35,566	-	80,794	28,376
Range	516,809	45,779	-	316,595	154,434
Pasture	793,273	55,301	67,943	321,279	348,750
Subtotal	1,454,818	136,646	67,943	718,668	531,560
Forestland	48,785				
(Grazed)	(33,920)				
Other Agricultural Land	199,086				
Total Agricultural Land	7,148,463				

A CATTLE FEEDING OPERATION - THE LIVESTOCK INDUSTRY IS THE LARGEST SOURCE OF FARM INCOME.

MANY STOCKYARDS AND SALE BARNS THAT PROVIDE OUTLETS FOR THE FARMERS LIVESTOCK ARE LOCATED THROUGHOUT THE AREA.

CORN, THE PRINCIPAL CROP, PROVIDES CASH INCOME AND LIVESTOCK FEED.

THE AREA IS A SIGNIFICANT PRODUCER OF FLAXSEED. FLAX STRAW, SEEN IN THESE STACKS, IS USED BY PAPER MILLS AND PROVIDES ADDITIONAL INCOME.

Corn for grain is the predominant crop. It is grown on nearly two million acres and accounts for 41 percent of all cropland harvested. In addition, about 138,000 acres of corn are harvested as silage and forage. Nearly one million acres of oats and barley are grown mostly for livestock feed. This acreage is somewhat less than what had been planted to these crops previously. Historically,oats were used as feed for horses and mules, and as mechanization replaced animal power, oats production declined. These small grains are grown in rotation with corn and soybeans.

The acreage planted to grain sorghum is relatively small. Slightly over 696,600 acres of alfalfa hay are grown. It is the major source of roughage for livestock feed produced in the area. All hay crops, except for wild native hay, are combined and referred to as alfalfa hay for reporting purposes.

Cash crops include both food grains and oil crops. Approximately 182,000 acres of wheat are harvested annually. The major share of the acreage is hard red spring wheat. The recent international popularity of soybeans for oil, feed, and food uses is reflected in production trends. Soybean acreage has increased rapidly. It is estimated that more than 317,000 acres of soybeans are harvested currently. Nearly two-thirds of this acreage occurs in Land Resource Area 302. Most of the flaxseed produced in the United States is grown in South Dakota, Minnesota, and North Dakota. It is grown primarily for the seed, which yields linseed oil used in the manufacture of paint and other industrial products. Flaxseed is an important cash crop, especially in LRA 55 and LRA 202. Currently, nearly 186,400 acres of flaxseed are harvested each year in the area. The combined acreage of soybeans and flaxseed accounts for 10.9 percent ot total cropland harvested.

Small acreages of Irish potatoes and sugarbeets are, or have been, grown in the area. The amount grown has been variable from year to year. Marketing opportunities for these crops are limited and have influenced production.

In addition to harvested cropland, over 800,000 acres of cropland are not in production. Summer fallowing has been used in LRA 55 but is becoming less important. Farm programs have encouraged farmers to withhold a portion of their cropland from production. The acreage planted but not harvested is another important item especially in an area that is subject to adverse weather conditions.

Nearly all of the cropland production occurs on nonirrigated land. The current normal land inventory shows that about 7,000 acres are irrigated out of 5,445,700 acres of total cropland. Major irrigated crops are corn and alfalfa hay.

About 1.5 million acres are in pasture, range, and native hay; these forages provide 35 percent of total roughage production. This is supplemented by 172,900 acres of silage crops and about 696,600 acres of alfalfa hay which provide 16 percent and 44 percent of the forage, respectively. Grazed woodland and cropland pasture supply the remaining five percent.

MAJOR LIVESTOCK ENTERPRISES

Livestock and livestock products are of major economic importance in the Study Area. Nearly 80 percent of the total farm sales in 1964 and 1969 were from livestock enterprises. Most farms have some livestock. Over 60 percent of all farms rely on livestock production for over one-half of their total cash receipts.

Cattle, hogs, and dairying are the important livestock enterprises. Inventories of beef cattle and calves on farms increased from 715,000 in 1949 to 1,257,000 in 1964, an average increase of 27,000 per year. Cattle and calves sales also increased during this period. Hog and pig inventories are somewhat more variable; however the number sold has increased in recent years. Swine production is concentrated in the southern half of the Study Area. The number of milk cows has declined since 1949. Trends in dairying are toward fewer and larger operations producing whole milk in place of cream. Poultry products and sheep are of minor importance.

The majority of cattle, hogs, and sheep sold are fattened in farm feedlots. They consume the major share of feed grains and forages produced. Feeder cattle and sheep are imported from surrounding areas to be fattened. Livestock inventories and numbers sold from farms are shown in Table 13.

Table 13--Livestock on farms, livestock, and livestock products sold
Big Sioux Study Area

Item	Unit	1949	1954	1959	1964	1969
		---------- Thousands ----------				
On Farms						
Cattle and Calves	No.	715	967	981	1,273	1,257
Milk Cows	No.	183	163	144	153	113
Horses and Mules	No.	44	15	9	NA	9
Hogs and Pigs	No.	1,115	1,255	1,380	1,183	1,173
Sheep and Lambs	No.	246	409	551	458	267
Chickens, four months & over	No.	4,469	5,477	5,527	4,262	2,153
Sold from Farms						
Cattle and Calves	No.	411	482	658	857	1,025
(Cattle)	No.	(349)	(399)	(520)	(681)	NA
(Calves)	No.	(62)	(83)	(138)	(177)	NA
Hogs and Pigs	No.	1,464	1,229	1,832	1,826	1,910
Sheep and Lambs	No.	337	322	566	708	419
Wool	Lbs.	1,537	2,093	3,195	2,859	NA
Chickens	No.	3,652	3,013	3,416	2,997	2,059
Chicken Eggs	Doz.	40,855	41,548	53,816	53,045	NA
Whole Milk	Lbs.	109,898	173,638	529,008	997,530	NA
Cream	Lbs.	19,060	17,818	10,240	3,295	NA

Source: U.S. Census of Agriculture
NA - Not Available

VOLUME AND VALUE OF FARM OUTPUT

Data from the Census of Agriculture, Crop and Livestock Reporting Service reports, Agricultural Experiment Station bulletins, Conservation Needs Inventory, and preliminary Missouri River Basin Framework reports were utilized in estimating current agricultural production in the Big Sioux Basin. The amount of production during any one year or only a few years may not be typical and could lead to an unrepresentative estimate. A simple averaging of past years could have a depressing effect on production, since output in the early part of the period was achieved with lower levels of technology than currently exist. Consequently, these data were normalized. 1/

Current normal production and values of major crops and livestock products are shown in Table 14. Most of the prices used in determining these values are current normalized prices that have been recommended by the Water Resources Council for planning and evaluating water and related land resources in this area. Current normalized prices were not available for all roughages. Silages were arbitrarily priced at $8.00 per ton. Production from grazing is expressed in feed units 2/ and priced at 1.5 cents per feed unit, based upon a hay price of $16.72 per ton. Feed grains account for 53 percent of the total crop value. Roughages and cash crops make up 32 percent and 15 percent, respectively.

The value added through utilization of feed grains and roughages by livestock is reflected in livestock values. It is estimated that all roughages and about 90 percent of the feed grains produced in the Study Area were needed for livestock feed. Consequently, the aggregate value of production was adjusted downward according to the value of feed consumed by livestock. The adjusted gross value totaled 305.2 million dollars. This amount compares favorably with other estimates of agricultural sales from this area.

The U. S. Census of Agriculture publications reveal the following values of all farm products sold for selected years in the 18-county Study Area.

Year	Value of Farm Products Sold
	------- Million $----------
1949	237.6
1954	228.6
1959	293.1
1964	353.3
1969	520.1

1/ Normalization is a procedure whereby current production and acreage data for crops (or comparable items for livestock) are adjusted to minimize the effects of unusual weather or other random changes. Results of the procedure are referred to as current normal and they serve as a standardized base relating to projections.

2/ Feed unit - one feed unit has the feed value of one pound of shelled corn or its equivalent.

Total agricultural production in the Study Area has been generally increasing over the last decade. This is due, in part, to the development and use of herbicides, pesticides, fertilizers, hybrid seed, and feed additives among other technological factors. Variation in crop production has also been affected by localized and widespread climatic conditions. Regardless of the cause, fluctuations in crop production directly affect livestock production due to the dependence upon local feed supplies. Continued production increases can be expected in the future.

Table 14--Value of current normal crop and livestock production
Big Sioux Study Area

Item	Production		Price Per Unit	Value
	Quantity	Unit		
	-- Thousands--		--Dollars--	-1,000 Dollars-
Wheat	3,683.1	Bu.	1.93	7,108.4
Rye	369.2	Bu.	.92	339.7
Flaxseed	2,238.6	Bu.	2.85	6,379.9
Soybeans	6,480.6	Bu.	2.30	14,905.4
Corn, grain	82,669.1	Bu.	.99	81,842.4
Sorghum, grain	784.4	Bu.	.92	721.7
Oats	36,401.1	Bu.	.55	20,020.6
Barley	1,764.4	Bu.	.79	1,393.9
Silage	1,547.1	Ton	8.00	12,376.7
All Hay	1,750.8	Ton	16.72	29,273.1
All Grazing	1,412,136.7	Feed Unit	.015	21,182.0
Other Crops				1,081.3
Total Crops				196,625.1
Beef	690,000.0	Lb.	.2091	144,279.0
Pork	460,000.0	Lb.	.1444	66,424.0
Sheep	60,000.0	Lb.	.1764	10,584.0
Chickens	12,900.0	Lb.	.1430	1,844.7
Turkeys	12,100.0	Lb.	.2100	2,541.0
Eggs	79,600.0		.1607	12,791.7
Milk	850,000.0	Lb.	.0295	25,075.0
Wool	3,000.0	Lb.	.4900	1,470.0
Total Livestock				265,009.4
Aggregate Value of Production				461,634.5
Value of Feedstuffs Utilized by Livestock				156,412.5
Gross Value of Production				305,222.0

PROJECTED AGRICULTURAL PRODUCTION

Projected production levels for various agricultural products provide a basis for analyzing proposed water and related land resource developments. Projected production of agricultural products from the Study Area are based upon national and regional projections from the

Missouri River Basin Type I Study. National needs for farm products in 1980, 2000, and 2020 depend upon many factors. The most important factors are population, income, consumer tastes and preferences, per capita consumption, net exports, and industrial uses of agricultural products.

Regional projections are available for the Missouri River Basin and its eight subregions. Future agricultural production for the Big Sioux Basin was estimated on the basis of extrapolation of the historical trends between the Big Sioux and Subregion 4 (Eastern Dakota Tributaries). Thus, for each projected time period, the estimated level of production of each commodity reflects the competitive situation of the Big Sioux Basin relative to the Missouri River Basin.

Projections of food and oil crops, feed grains, and livestock products are shown in Table 15.

Table 15--Projected production of selected agricultural commodities and index of change
Big Sioux Study Area

Commodity	Unit	1980	2000	2020	Index, CN = 100		
					1980	2000	2020
		------------ Thousand ------------					
Wheat	Bu.	5,564.1	6,077.1	7,370.3	151	165	200
Rye	Bu.	505.8	576.0	510.8	137	156	138
Flaxseed	Bu.	1,583.8	2,014.7	2,450.4	71	90	109
Soybeans	Bu.	10,741.6	13,155.6	10,458.3	166	203	161
Corn, Grain	Bu.	107,407.5	128,963.8	203,891.5	130	156	247
Sorghum, Grain	Bu.	3,812.9	5,373.2	7,461.2	486	685	951
Oats	Bu.	48,706.8	46,593.4	20,800.0	134	128	57
Barley	Bu.	1,650.1	1,217.4	1,629.1	93	69	92
Beef	Lb.	946,300.0	1,255,800.0	1,653,900.0	137	182	240
Pork	Lb.	608,800.0	799,500.0	1,036,200.0	132	174	225
Sheep	Lb.	57,500.0	77,000.0	101,500.0	96	128	169
Chickens	Lb.	10,640.0	14,000.0	18,300.0	82	109	142
Turkeys	Lb.	16,245.0	20,900.0	27,300.0	134	173	226
Eggs	Doz.	69,438.0	90,509.0	117,681.0	87	114	148
Milk	Lb.	840,000.0	1,075,200.0	1,380,000.0	99	126	162
Wool	Lb.	2,800.0	3,600.0	5,100.0	93	120	170

Projected production of roughages, hay, and grazing are directly related to the requirements for livestock feed. The total quantity of roughage needed is influenced by composition of feed rations and the conversion ratio for each type of livestock to satisfy the projected quantities of livestock products. Generally, it was assumed that all roughage needed by livestock in the future will be produced in the Study Area and that all roughage production will be consumed within the Study Area. Current normal and projected ration composition, feed conversion rates, and total feed requirements for livestock and poultry are shown in Appendix C. The value of projected agricultural production is shown in Table 16.

Table 16--Value of projected agricultural production
Big Sioux Study Area

	1980	2000	2020
	Million Dollars		
Value of Crop Production	270.3	299.4	364.2
Value of Livestock Production	338.2	446.0	583.8
Aggregate Value of Production	608.5	745.4	948.0
Less Amount for Livestock Feed	-204.5	-228.7	-263.5
Gross Value of Production	404.0	516.7	684.5

Projections of crop yields for 1980, 2000, and 2020 made by Agricultural Experiment Station specialists, and others, for use in the Missouri River Basin Framework Study were used for the Big Sioux Study. These crop yield increases reflect the application of new technology and management techniques. The projected yields were arrayed by soil resource group and land resource area similar to those used in this Study. However, some adjustments were necessary to reflect local conditions. Current normal and projected average yields are summarized in Table 17.

Projected dryland and irrigated yields were applied to projected production which provided estimates of crop acreages for each time period. The sum of these acres did not exceed the amount of cropland available. More cropland was considered "not harvested" at each projected date than in current normal. Acreages of major crop categories, expressed as a percentage of total cropland, are shown in Table 18.

Table 17--Major crop groups-current normal (CN) and projected
Big Sioux Study Area

Crop Group	CN	1980	2000	2020
	Percent 1/			
Food Crops	3.8	4.4	3.9	4.0
Feed Grains	53.8	49.7	45.9	49.2
Roughage	18.2	20.0	16.6	15.9
Oil Crops	9.3	8.9	9.4	7.2
Not Harvested	14.9	17.0	24.2	23.7
Total	100.0	100.0	100.0	100.0

1/ Expressed in percent of total cropland acres

Table 18--Current normal (CN) and projected per acre yields and index of yield changes Big Sioux Study Area

Crop	Unit	Yields				Index		
		CN	1980	2000	2020	1980	2000	2020
						-- CN = 100 --		
Nonirrigated								
Winter Wheat	Bu.	13	17	20	24	132	161	192
Rye	Bu.	23	31	37	41	136	165	182
Spring Wheat	Bu.	21	27	33	30	128	156	184
Corn, Grain	Bu.	43	63	76	87	146	176	201
Corn, Silage	Ton	9	13.2	15.7	18.7	147	174	208
Sorghum, Grain	Bu.	36	55	67	79	151	184	216
Sorghum, Silage	Ton	8.8	13.5	16.3	18.4	153	185	209
Oats	Bu.	39	55	68	80	142	177	207
Barley	Bu.	32	47	55	63	147	176	200
Alfalfa Hay	Ton	2.2	2.9	3.3	3.7	-	150	170
Flaxseed	Bu.	12	20	26	29	163	214	244
Soybeans	Bu.	20	27	31	35	131	151	170
Cropland Pasture	F.U.1/	1481	1993	2292	2478	135	155	167
Irrigated								
Corn, Grain	Bu.	86	130	171	204	151	198	237
Corn, Silage	Ton	12	15	18.8	22.2	125	157	185
Sorghum, Grain	Bu.	77	97	107	114	126	139	148
Alfalfa Hay	Ton	3.4	4.2	5.3	6.2	124	156	182
Soybeans	Bu.	34	41	49	55	122	143	163
Other Forages								
Native Hay	Ton	1.4	1.6	1.8	1.9	114	129	136
Range	F.U.1/	598	789	931	1020	132	156	171
Pasture	F.U.1/	1144	1557	1767	1860	136	155	163
Grazed Woodland	F.U.1/	388	465	488	503	120	126	130

1/ F.U. - Feed Unit - one feed unit has the feed value of one pound of shelled corn or its equivalent

FARM NUMBERS, SIZE, AND TENURE

Several major changes have taken place in the structure of agriculture since 1949. Farms have been consolidated into larger, more efficient economic units. Although the number of farm units has declined, this change has not occurred uniformly among tenure categories. Farm numbers decreased from 29,571 in 1949 to 23,189 in 1964. Meanwhile, the number of part-owners increased. The tenant category was the largest in 1949, accounting for 40 percent of all farm operators. In 1964, farm units were almost equally distributed among full owners, part owners, and tenants, Table 19.

Table 20 showing the percentage distribution of farms by farm size further emphasizes the shift toward larger farms. Farms in the 100-219 acre category decreased by 11 percent in the 15-year period emphasizing the decline in importance of the traditional 160-acre farm. Farms in the 220 to 259-acre category declined by one percent. All size categories which show a percentage increase are greater than 260 acres. The percent of farms under 100 acres remains constant. Presumably people farming land in these categories are supplementing their income with off-farm employment.

Farms can also be grouped into two general economic classes; commercial and other farms, Table 21. The distinction between them is mainly based on value of products sold. Generally, all farms with sales of at least $2,500 were classed as commercial. However, if an operator under 65 years of age did not work off the farm over 100 days per year, his farm was classed commercial provided sales were at least $50. Although the number of part-time farmers is relatively small, over 6,000 farmers worked away from their farms in 1964. Of these, over 2,200 worked 100 days, or more, at another job.

Table 19--Number and average size of farms by tenure
Big Sioux Study Area

Tenure	1949			1959			1964			1969		
	Farms		Size	Farms		Size	Farms		Size	Farms		Size
	Number	Pct.	Acres	Number	Pct.	Acres	Number	Pct.	Acres	Number	Pct.	Acres
Full Owners	10,591	36	195	9,106	35	215	8,147	35	223	8,354	40	234
Part Owners	6,985	24	358	6,881	26	406	7,355	32	451	7,414	36	508
Managers	8	1/	2,254	56	1/	600	60	1/	1,020	NA	NA	NA
Tenants	11,987	40	239	10,041	39	261	7,627	33	289	5,024	24	300
All Farm Operators	29,571	100	252	26,084	100	284	23,189	100	319	20,792	100	348

1/ Less than .5 percent
Source: U.S. Census of Agriculture

Table 20--Percentage distribution of farms by size group
Big Sioux Study Area

Size Group	1949	1964	1969
----- Acres -----		Percent	
Under 100	12	12	13
100-219	37	26	24
220-259	12	11	9
260-499	32	36	35
500-999	6	13	16
Over 1,000	1	2	3
All Farms	100	100	100

Source: U.S. Census of Agriculture

Table 21--Farms by economic class, 1964 and 1969
Big Sioux Study Area

Class of Farm Value of Sales	Number		Percent	
	1964	1969	1964	1969
Commercial Farms	21,478	19,408	92.6	93.4
$40,000 or more	1,307	2,985	5.6	14.4
$20,000 - $39,999	3,309	4,903	14.3	23.6
$10,000 - $19,999	7,155	5,712	30.9	27.5
$ 5,000 - $ 9,999	6,132	3,386	26.4	16.3
$ 2,500 - $ 4,999	2,791	1,812	12.0	8.7
$ 50 - $ 2,499	784	610	3.4	2.9
Other Farms	1,711	1,384	7.4	6.6
Part-time	722	910	3.1	4.4
Part-retirement	985	468	4.3	2.2
Industrial Farms and Indian Reservations	4	6	--	--
All Farms	23,189	20,792	100.0	100.0

Source: U. S. Census of Agriculture

AGRICULTURAL RELATED INDUSTRIES

Agricultural related processing and service industries are important to the area's economy. However, descriptive data for these industries is not readily available on a county basis. Some products are sold off the farm for direct consumption, others are processed both locally and outside the Study Area, and still others are stored. Methods of marketing and processing vary among commodities as well as for individual commodities. Consequently, a portion of the farm production loses indentification as far as destination is concerned.

Processing of livestock and livestock products is important. Sioux Falls is the meat slaughtering and processing center; however smaller plants occur in other locations throughout the area. Dairy products manufacturing and processing plants are located mainly around the more populous areas. According to the 1963 Census of Manufacturers, the number of processing plants for selected livestock products are as follows:

Type of Plant	Number of Plants
Meat Slaughter and Processing	16
Creamery Butter	12
Fluid Milk	14
Natural Process Cheese	2
Poultry Dressing	5

Further expansion in the processing of agricultural products will likely occur along with projected increases in farm commodities. Movement of farm products from the place of origin to the consumer depends upon the type of commodity, its perishability, major market outlet, and transportation costs. A recent trend in the meat products industry has been the decentralization of slaughter houses in large cities to less populous areas located in or near sources of production. This trend is expected to continue resulting in additional employment opportunities.

Fluid milk can be transported rapidly and in large quantities through the use of stainless-steel tank trucks from local dairies to the large cities.

Increases in poultry production could attract additional processing plants or enlargement of those existing presently.

FARM INCOME

Farm income is that received in cash and nonmonetary allowances. It consists of four major items - farm marketing, consumption of home-grown products, rental value of farm dwellings, and government payments. Income from farm marketings is the sum of the quantities of each commodity produced times its current normalized price, less the value of crops utilized by livestock. Currently farm marketings total $305.2 million and are the principal component of farm income. Income from other sources contributes about 10 percent toward farm income.

The value of current normal production less estimated farm production expenses yielded a net of about $129.2 million. Derived income per agricultural employee amounted to $3,948. Projected farm income data is presented in Table 22. Most of the increased income in the future is due to projected increases in production. Income from other sources is held at the same relationship as current normal.

Table 22--Current normal (CN) and projected agricultural income
Big Sioux Study Area

	Unit	CN	1980	2000	2020
		Thousand			
Value of Production	Dollars	305,222	404,008	516,788	684,560
Other Receipts	Dollars	33,914	44,890	57,421	76,062
Total	Dollars	339,136	448,898	574,209	760,622
Total Expenses	Dollars	209,925	277,868	355,435	470,825
Net Income	Dollars	129,211	171,030	218,774	289,797
Agricultural Employees	Number	32.7	27.6	22.6	17.8
Income per Employee	Dollars	3.9	6.2	9.7	16.3

CAPITAL INVESTMENT

Capital requirements have expanded rapidly for most agricultural uses. The value of land and buildings in the Study Area is typical of this increase. Nonagricultural as well as agricultural interests have influenced this upward trend. The aesthetic value of farm ownership and rural living entices some nonagriculturalists to compete with farmers for agricultural land whether or not the return compares with alternative investments.

Total investment in land and buildings in 1969 was about 1.5 billion dollars. This is an average value of about $74,000 per farm, or $213 per acre. Comparable figures for 1949, 1954, 1959, and 1964 are shown in Table 23.

The value of land and buildings per farm is determined by farm size and value per acre. Changes in either or both affect the per farm value. However, the latter had a greater effect during the 1949-1969 period. Table 24 summarizes these changes between census time periods.

Other sizable investments in agriculture include machinery, equipment, livestock, and grain stocks. No attempt was made to measure their worth. However, investment in agriculture will increase as mechanization continues to replace the labor resource. Capital investments in agriculturally related input supplying and output handling and processing industries also will increase in the future.

Table 23--Value of land and buildings
Big Sioux Study Area

Value of Land and Buildings	1949	1954	1959	1964	1969
	Dollars				
Per Acre	101.53	124.90	153.87	160.22	213.35
Per Farm	25,564.00	32,589.00	43,711.00	51,153.00	74,146.00

Table 24--Changes in the value of land and buildings
Big Sioux Study Area

Change in Value Per Farm Due to:	1949-1954	1954-1959	1959-1964	1964-1969	1949 1969
	Dollars				
Increased Size	1,124	3,539	5,608	6,187	16,458
Per Acre Value	5,901	7,583	1,834	16,806	32,124
Total	7,025	11,122	7,442	22,993	48,582

FOREST RESOURCES AND RELATED ECONOMIC ACTIVITY

The forest resources are very limited. Less than one percent of the Study Area is covered with natural timber, most of which is in bottom land hardwood including cottonwood, elm, ash, and oak. Historically, timber resources from the forests have been used locally. Early settlers and timber cutters took the best trees of the more desirable species for fuel, fence posts, building material, and furniture. This practice continues today leaving the present woodlands made up largely of defective trees and low value species. Nevertheless, there are six sawmills within, or adjacent to, the Study Area producing rough lumber, pallet stock, wood chips, and wood shavings. Table 25 shows present and projected employment in timber related industries.

The conditions for tree growth are good and the average annual growth of all species is 1.5 million board feet per year. Forest site indices of the forest lands are very high. Pole production from new plantings is possible on 40-year rotation, post in 20 years, and Christmas trees on 8-year rotation. At the present time the commercially important species include cottonwood, ash, elm, and oak. There are approximately 35,000,000 board feet in trees of merchantable size. The present stumpage value of this timber is about $300,000 in the woods, or about $900,000 delivered to local sawmills or products plants.

The greatest but indirect value for the forest land, shelterbelts and windbreaks is for outdoor recreation and wildlife habitat. The use and economic benefits of the forest lands for these activities is included in the sections for these activities.

Table 25--Estimated employment in timber-based industries
Big Sioux Study Area

Year	Grand Total	Lumber and Wood: Total	Lumber and Wood: Sawmills and Planing Mills	Lumber and Wood: Other	Pulp, Paper and Allied Products	Timber Harvesting
	Number of Employees					
1952	110	50	30	20	10	50
1962	80	40	25	15	10	30
1980	80	40	25	15	10	30
2000	90	45	25	20	10	35
2020	100	55	35	20	10	35

OUTDOOR RECREATION AND RELATED ECONOMIC ACTIVITY

Considerably economic activity is created by the pursuit of outdoor recreation in the Big Sioux Study Area. Fishing accounts for a notable share of this activity. Fishing equipment represents a large share of the sales of sporting good departments and specialty sports stores. In addition, there are about 25 lakes with one or more private resorts that supply fishing equipment, bait, boats, and other services.

Public outdoor recreation developments are supplemented by private facilities. These include extensive hunting and fishing privileges on farms. Some farmers in the Study Area obtain supplemental income by charging for hunting and fishing and the use of other recreational facilities on their farms. In 1964, one hundred and thirty-two farmers received a total of more than $75,000 of recreational income, an average of about $600 per farm that charged for recreational privileges and facilities. Recreational income was less than $500 on 85 percent of these farms. Only eight reported recreational income in excess of $2,000. Many farmers do not charge the public for hunting or fishing on their property but require that permission be obtained. Consequently, the above figures in no way measure the full contribution of farms to satisfying the outdoor recreational demands in the Study Area.

Fishing waters are concentrated in the northern portion of the Basin. In the South Dakota counties located in the Study Area, about 53,000 fishing licenses have been sold annually in recent years. In the Iowa counties, about 20,000 fishing licenses, and in the Minnesota counties, approximately 11,950 fishing licenses have been sold annually. These fishermen probably spent more than eight million dollars in pursuing the sport. However, expenditures within the Study Area were much less as it is likely that many of the resident fishermen pursued the sport outside the Study Area in superior fishing waters.

Approximately 73,700 hunting licenses have been sold in the Study Area in recent years. Expenditures of these resident hunters may approach six million dollars. This expenditure is bolstered by expenditures of nonresident hunters attracted to the Basin by normally excellent pheasant hunting.

WILDLIFE

The economic returns generated through activities associated with fish and wildlife are substantial within the Study Area. Flood control and other water development projects that could include a sport fishery as part of their objectives would do much to increase this potential in the southern portion of the area. Much of the fishing is concentrated in the northern portion.

Fur harvest, bait harvest, and commercial fishing have a modest effect on the economy. It was not possible to estimate the annual dollar value; however, it would be low and does not appear to have a great potential for increase.

The Big Sioux River and its larger tributaries in South Dakota and Iowa support an estimated 50 to 100 fisherman days per mile per year. The larger lakes generally support less fishing per surface acre than do the smaller lakes. It is estimated that the average size natural lake provides 25 to 75 fisherman days per acre per year, and the smaller artificial lakes 25 to 100 fisherman days per acre per year. The fishing pressure on lakes within the Minnesota portion of the Study Area is light. The Minnesota tributaries of the Big Sioux River are also considered to be devoid of any measurable fishing pressure because of their high temperatures, shallowness, low flows and essentially rough fish populations.

WATER AND RELATED LAND RESOURCE PROBLEMS

WATER AND RELATED LAND RESOURCE PROBLEMS

The water and related land resource problems in the Big Sioux Study Area are many and varied. It is the purpose of this section to outline the extent of these problems, to locate them geographically, and to evaluate them in monetary terms.

EROSION DAMAGES

In terms of annual loss of income, the most significant land resource problem is excessive sheet erosion. The value of this loss is estimated to be $7,236,000 annually. These losses or damages occur in every county and are summarized in Table 26. The sheet erosion problem is concentrated in Soil Association Groups A, B, C, and D. (See General Soil Association Map in Appendix A.)

The principal causes of sheet and rill erosion are the lack of protective cover and improper management. When the land is unprotected, erosion generally accelerates. Experience has shown that with proper conservation practices for holding soil in place, soil erosion can be minimized even with cultivation. Contour cultivation increases the opportunity for water to infiltrate the soil, thereby reducing runoff and erosion. Long slopes increase the soil erosion hazard. The effective length of slopes can be reduced by strip cropping and terrace construction. Grassed waterways reduce erosion in areas where the water flow is concentrated. Crop residues maintained on or near the surface protect and improve the soil. By applying the above measures, and others, in correct combinations, substantial progress has been made in reducing soil losses by sheet erosion. However, recent studies indicate that 57 percent of the erosive soils still are not adequately protected. This represents about 22 percent of the Study Area.

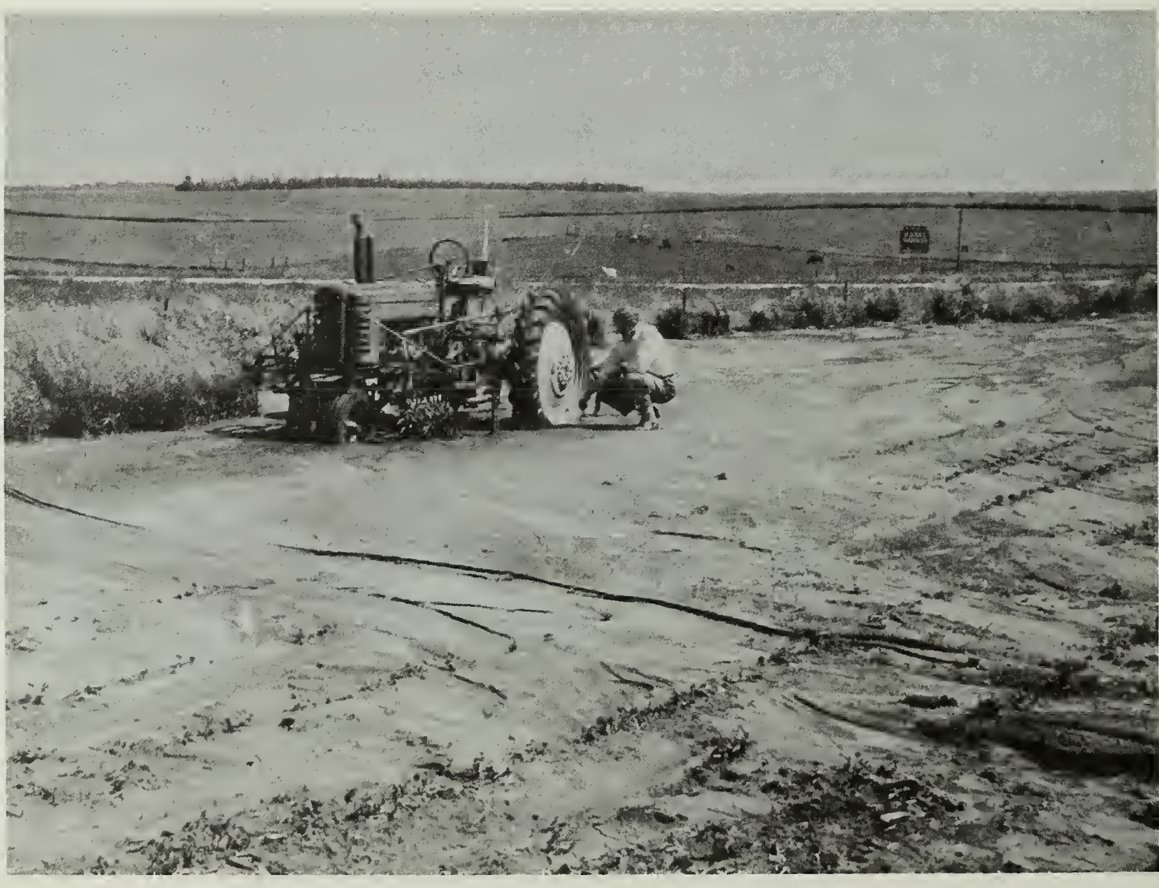
Rilled corn rows and consequent sediment accumulations following summer thunderstorms are evidence that soil erosion is a serious problem. However, farming operations quickly obliterate the evidence. The ease with which sheet and rill erosion are physically eliminated tends to obscure other effects. Monetary losses are ignored, one reason being the difficulty of placing a dollar value on their magnitude.

The following procedure was used to estimate in monetary terms the sheet erosion losses that cause a reduction in soil productivity. These losses were estimated at $2.39 per acre per year when the erosion was of moderate intensity. Moderate intensity is defined as an average loss of between four and eight tons of soil per acre annually. When the erosion was considered to be of severe intensity, a value of $4.78 was used. Erosion of severe intensity is defined as more than eight tons of soil loss per acre annually. These values vary according to the soil productivity of the different counties.

SEVERE EROSION AND HEAVY SEDIMENT ACCUMULATION RESULT FROM POOR CULTIVATION PRACTICES.

RUNOFF FROM ONLY 15 ACRES CAUSED THIS DEEP SCAR IN THE LANDSCAPE.

WIND EROSION CAUSES SOIL, CROP, FENCE, ROAD, AND OTHER DAMAGES. DUST STORMS, WHICH STILL OCCUR ARE AN UNDESIRABLE ENVIRONMENTAL, HEALTH, AND SAFETY HAZARD.



FERTILE TOPSOIL ERODED FROM LAND ABOVE CAUSES DAMAGES TO AREA BELOW.

The value of damages caused by sheet erosion is measured by its effect on productivity. From available soils information, it was determined that the average yield of corn from five soils commonly found in the Study Area was 49 bushels per acre. The yield from the eroded phases of these same soils was 32 bushels per acre. The soils used in this analysis were Moody, Nora, Kranzburg, Vienna, and Egan. The difference in net income under these two conditions is $13.77 per acre annually, using adjusted normalized costs and prices.

The average annual value of soil loss is based not only upon the loss of productivity but also upon the time required to go from the uneroded to the eroded phase. This is done by estimating the average annual soil loss and dividing this into the estimated total weight of the topsoil. Field investigations indicated that about 70 percent of the untreated erosive cropland has soil losses of moderate intensity. A rate of six tons of soil loss per acre per year was used for this area. The depth of the topsoil for the typical soil is estimated to average six inches and weigh about 980 tons per acre. Dividing 980 tons by 6 tons per year shows it would take 163 years to lose the $13.77 annual production value, or an incremental loss of $0.084 per year over the 163-year period. The present value of these incremental losses for a 100-year period is $75.56, using an interest rate of three percent. This amount amortized over the 100-year period at the same interest rate is $2.39. This is the value assigned to moderate intensity erosion. The value assigned to severe intensity erosion is calculated by the identical method using an average soil loss of 12 tons per acre and amounts to $4.78.

The above mentioned damages are measures of onsite damage at the location from which the soil is removed. Additional damages, however, are manifest also in the places to which the soil is transported. The redeposition at the bottom of the slope often smothers growing crops. It frequently obstructs waterways and outlet ditches causing expensive maintenance. There are further downstream damages which are discussed in the section on sediment damages. In view of these damages, both at the site and downstream, it is believed that the $2.39 value given to moderate intensity erosion and the $4.78 value given to severe intensity erosion is conservative.

Gully erosion is also a significant erosion problem in the Study Area. For the purpose of this analysis, a gully is a washout with sufficient size to require a grade stabilization structure for its control. These gullies, if not controlled, will cause an economic loss to the upstream areas because of land voiding, the depreciation of use of adjacent areas, and the destruction or increased maintenance cost of other properties such as roads, bridges, fences, and buildings in the path of the advancing gully head. Gullies that can be controlled by grassed waterways were not considered in this analysis. Gully erosion is not prevalent in all parts of the Study Area. Most of the gullies are in Plymouth County, Iowa and Union County, South Dakota. Gully erosion is most commonly found in Soil Associations Areas 12, 16, 19, and 24.

Gully erosion damages are dependent upon the erodability of the soil, the size of the drainage area, the amount of runoff, the stream gradients, the productivity of the land and value of the property through which it will travel, and the damaging effects from its resultant sediment. Because of these factors which vary from one gully head to another, accurate estimates of gully damages are difficult. It is estimated that the average annual damage per gully is $225 and that there are approximately 2,050 gullies requiring mechanical control. The total annual gully damage is estimated to be $460,000. Over 90 percent of these damages occur in Plymouth County, Iowa, and Union County, South Dakota. (See Table 26.)

Gully erosion also causes damages which cannot be evaluated in monetary terms; for example, the inconvenience of farming an area dissected by the gullies. Neither is it possible to put a monetary value on the loss of aesthetic values by an ugly gully scar. Such losses persist even though the gully head is controlled.

The third significant type of soil erosion is wind erosion. Wind erosion occurs throughout the Study Area in nearly every soil association area but Soil Associations in Group G are the most susceptible. The damage shown in Table 26 is the estimated average annual acres which may be damaged every year. The estimated average annual damages of a dollar per acre reflect the loss of productivity, the loss of crops, and the cost of removing windblown silts from ditches, waterways, and other areas.

Roadside erosion and flood plain scour were noted but no estimates of damages were made. Streambank erosion is present in some degree in most streams with a drainage area greater than about ten square miles. The 1967 National Assessment of Streambank Erosion Study showed that there are 66 miles of streambanks with a moderate erosion condition and 39 miles with a severe erosion condition within the Study Area. The average annual loss due to moderate erosion is $2,300 and for severe erosion is $3,030. Flood plain scour is often seen in the larger tributary watersheds after prolonged flooding. Roadside erosion often occurs in areas of new construction and along county and township roads in the critical sediment producing areas.

Sheet erosion is also occurring in poorly managed woodland areas. Current grazing practices in many of the woodlands destroy the ground cover and compact the soil. Forest hydrologic conditions, an index of sheet erosion, range mainly from very poor to poor. The small area in woodlands and the low rate of sheet erosion per unit as compared with cropland makes woodlands a minor component of the total erosion picture. The real damage is that these woodland areas cannot deal effectively in filtering water and sediments contributed from adjacent cropland areas. The overflow of this water has caused gully development or ditch drainage and the discharge of sediment-laden water directly into watercourses without any removal of sediment and debris.

The total average annual damages from all types of erosion are estimated at 7.9 million dollars.

Table 26--Estimated average annual erosion damages by counties
Big Sioux Study Area

County	State	Erosive Soils Presently Cropped	Erosive Soils Protected	Erosive Soils Not Adequately Protected	Sheet Erosion Average Annual Damage	Gullies in County 2/	Gully Erosion 2/ Average Annual Damage	Average Area Wind Erosion Damage	Wind Erosion Average Annual Damage	Total Average Annual Damage
		--Acres--	--Acres--	----Acres----	--Dollars1/--	- No.-	-- Dollars1/--	-Acres--	-- Dollars1/--	--Dollars1/
Brookings	S. Dak.	131,000	30,000	101,000	296,000	10	800	6,000	6,000	302,800
Clark	S. Dak.	237,000	86,000	151,000	274,000	4	400	20,000	15,600	290,000
Codington	S. Dak.	168,000	60,000	108,000	193,000	2	200	5,000	4,000	197,200
Day	S. Dak.	263,000	138,000	125,000	243,000	2	200	22,000	16,500	259,700
Deuel	S. Dak.	200,000	98,000	102,000	247,000	5	300	8,000	7,600	254,900
Grant	S. Dak.	141,000	75,000	66,000	155,000	10	1,000	8,000	7,100	163,100
Hamlin	S. Dak.	157,000	97,000	60,000	126,000	4	400	15,000	14,000	140,400
Kingsbury	S. Dak.	192,000	76,000	116,000	273,000	2	200	12,000	10,800	284,000
Lake	S. Dak.	140,000	72,000	68,000	236,000	5	300	5,000	4,900	241,200
Lincoln	S. Dak.	78,000	21,000	57,000	238,000	40	3,200	3,000	4,200	245,400
Miner	S. Dak.	82,000	40,000	42,000	97,000	0	0	3,000	2,000	99,000
Minnehaha	S. Dak.	250,000	140,000	110,000	454,000	20	1,500	3,000	3,800	459,300
Moody	S. Dak.	155,000	33,000	122,000	437,000	2	200	4,000	5,100	442,300
Union	S. Dak.	95,000	31,000	64,000	333,000	1,000	100,000	5,000	8,100	441,100
Lyon	Iowa	269,000	133,000	136,000	745,000	50	5,000	5,000	9,000	759,000
Osceola	Iowa	71,000	32,000	39,000	218,000	0	0	4,000	7,000	225,000
Sioux	Iowa	197,000	66,000	131,000	641,000	30	3,000	3,000	5,000	649,000
Plymouth	Iowa	98,000	24,000	74,000	455,000	650	325,000	2,000	3,000	783,000
Lincoln	Minn.	31,000	9,000	22,000	92,000	0	0	1,000	1,200	93,200
Murray	Minn.	28,000	4,000	24,000	98,000	50	4,000	3,000	3,200	105,200
Nobles	Minn.	133,000	53,000	80,000	377,000	5	300	6,000	9,000	386,300
Pipestone	Minn.	168,000	71,000	97,000	379,000	12	600	5,000	6,000	385,600
Rock	Minn.	201,000	98,000	103,000	629,000	150	13,400	6,000	9,000	651,400
Total		3,485,000	1,487,000	1,998,000	7,236,000	2,053	460,000	154,000	162,100	7,858,100

1/ Based on Adjusted Normalized Prices
2/ Gullies large enough to require a grade stabilization structure for its control. Gullies that can be controlled by vegetation are not included in this total.

SEDIMENT DAMAGE

Sediment damages are the result of soil erosion and are most evident downstream from eroding areas. These damages are found most commonly in Soil Association Groups A, B, C, and D. However, because the soils in Group H are on alluvial flood plains, the most severe sediment damages will be found in these soil association areas.

Sediment damages vary in type and severity throughout the Study Area. The deposition of sediment in streams reduces channel capacity and increases flooding on adjacent land; sediment deposition in lakes reduces their capacity and lowers the water quality; and sediment deposition in marshes and wetlands reduces or eliminates the wetland value for wildlife.

In the Union-Sayles Creek drainage area, located in Union County, South Dakota, intensive farming has increased sediment production and the resulting sediment has destroyed Nixon Lake as a fishing lake. This lake is now a marsh.

Sediment yields at the mouth of Union Creek, having a drainage area of about 42 square miles, has been estimated to be 59,000 tons annually, or about 1,400 tons per square mile. The sediment yield from Sayles Creek, with a drainage area of less than five square miles, is estimated to be 22,500 tons annually, or about 4,600 tons per square mile. It is estimated that the gullies in this drainage area yield about 27,000 tons of sediment annually. In Union County it is estimated that,in the critical sediment source areas, the sediment yield is about 50 tons per acre per year.

Sediment deposition in glacial and man-made lakes is a major concern. In addition, the nutrient enrichment of lakes is often attributed to runoff waters carrying nitrogen in solution and phosphates transported on sediment particles. Recreational values of resort areas around lakes are adversely affected by the accelerated eutrophication caused by sediment deposition and nutrient enrichment. The Big Sioux River is affected by the same type of sediment problems. This is especially evident during periods of low flows in the summer months. This effect of sediment in the lakes and streams will become more critical as demands for recreation increase. Infertile sands deposited on cropland lowers soil fertility. Sediment transported by summer floods covers crops and pastures, substantially reducing yields. The reduced capacity of highway bridges and culverts, due to the deposition of sediment, is a continuing maintenance cost and adds to the flooding problem.

Sediment damages may be either temporary or permanent. In either case, they are difficult to evaluate. An example of the temporary sediment damage is that sustained by crops in a deposition area. The area may have indefinite boundaries with varying degrees of damage. Some plants are killed, some are stunted, and some are apparently not affected. Examples of permanent sediment damage are deposition in potholes, sloughs, and lakes decreasing their value for water storage, recreation, fish and wildlife. Deposition in the stream channels decreases their capacity to carry floodwater, thereby increasing floodwater damages in the flood plain and to wildlife. Each sediment producing runoff event deposits sediment which displaces storage or channel capacity.

While sediment damage can be estimated in monetary terms for specific instances, (ie., cost of removal from roads, acres of crops destroyed) an analysis of sediment damage for the Study Area is beyond the scope of this study. The foregoing discussion illustrates the severity and extent of sediment damage.

FLOODWATER DAMAGE

The 1967 USDA Conservation Needs Inventory shows some 360,300 acres of agricultural land and 2,200 acres of urban land in the Study Area are subject to floodwater and sediment damage. In the tributary watersheds, flooding of agricultural land occurs on some 262,600 acres, the majority of which are in 103 of the 143 CNI delineated watersheds. (See Map 10.) Flooding along the Big Sioux River and Rock River accounts for about 97,700 acres occurring in 13 delineated watersheds. In the pothole region, 15 watersheds show very little flooding. Twelve of the CNI delineated watersheds are PL 566 watershed projects in which flood control and land treatment measures have been installed or are to be installed. (See Table 27.)

Intensive studies, including watershed investigation reports and PL 566 watershed work plans, were made on 45 of the 143 CNI delineated watersheds, representing about 33 percent of the Study Area. (See Map No. 12.) The average annual floodwater and sediment damage amounted to $793,000 on 127,280 acres, or $6.25 per acre. About 83 percent of these damages are to crops, pastures, and other agricultural facilities while the remaining 17 percent is to nonagricultural properties. The flooding of cropland causes the greatest damages and is in the form of lost production, reduction in crop quality, delays in farm operations and, sometimes, the necessity for reseeding. The greatest amount of damage to crops is during the early summer months. In many watersheds, damage to crops from flooding is associated with high water tables in the flood plain soils. Flood waters become trapped and aggravate an already serious problem. Generally the larger floods are a result of snowmelt runoff but, since crops are not planted, it usually does not cause extensive damage to cropland. Because of the flooding and inadequate drainage prevalent in many of the watersheds, much of the land near the streams is used for pasture. The small and frequent floods cause minor damages since grassland is usually not as seriously damaged as cropland. Floods of a five-year frequency, or greater, cause major damages.

Other agricultural property such as fences and farm roads are damaged by small frequent storms, but the larger storms, which occur less frequently than once in five years, cause most of the other agricultural damage. Occasionally farm buildings and stored hay and feed are damaged.

The largest share of the nonagricultural damage is to roads and bridges. Gravel and black-topped surfaces are often washed away. Roads are

ROAD AND BRIDGE DAMAGE FROM SPRING SNOWMELT 1969. THIS TYPE OF DAMAGE OCCURRED THROUGHOUT THE BASIN AND REPRESENTS A LARGE ECONOMIC LOSS.

GRAVEL WASHED OFF ROAD AND DEBRIS IN FENCELINES ARE TYPICAL DAMAGES FROM FLOODWATER.

FLOODWATER FROM SPRING SNOWMELT OF 1969 FLOODED THIS FARMSTEAD ON MEDARY CREEK NEAR BROOKINGS, SOUTH DAKOTA. ABOUT 6,000 ACRES WERE INUNDATED ALONG MEDARY CREEK.

RUNOFF FROM SNOWMELT IN 1969 OVERTOPPED THIS ROAD NEAR BROOKINGS, SOUTH DAKOTA, CAUSING EXTENSIVE DAMAGE.

breached and, quite frequently, bridges are washed out. Ten of the watersheds studied had damages to urban properties. In Six-Mile Creek, where the stream goes through the north side of Brookings, the urban damages are significant. Nonagricultural flood damages are usually minor from small frequent storm events since usually only the township roads are damaged. The large floods, usually from snowmelt runoff, cause most of the damages.

The flood damages are based on Adjusted Normalized Prices, projected yields, and land use to the year 2000 in those watersheds intensively studied and for which watershed investigation reports were prepared. In the watersheds where preliminary investigations for watershed work plans have been developed, the values were taken from those reports. Using the rate of $6.25 per acre, the estimated average annual floodwater damage to the 360,000 acres is over two million dollars.

IMPAIRED DRAINAGE

Impaired drainage problems exist in all parts of the Study Area. Excessive moisture, whether surface or subsurface, has an adverse effect on crop yields. Lack of drainage is mentioned as a problem in 28 of the 49 soil associations described in Appendix A. Some of the most serious drainage problems are found in Soil Association Groups A, E, and H.

The 1967 CNI shows that 1,060,000 acres, or about 14 percent, of the Study Area have seasonal problems of excessive moisture. Approximately 65 percent, or 718,000 acres, of this area is currently devoted to cropland. Increased production through the more efficient use of this cropland could be achieved on 339,000 acres by the installation of measures designed to correct the impaired drainage. Some of the 379,000 acres for which no increase in efficiency is claimed has already been drained and, for the remainder, the problem is not serious enough to justify drainage measures at the present time.

The value of this increased efficiency shown in Table 28 has been measured in terms of increased net income after deducting all associated costs of drainage. It is estimated that the total average annual value of the increased net income is $3,428,000. This increased efficiency would be achieved by enabling farmers to use more intensive practices including increased use of row crops, fertilizers, weed and insect control. In addition, 200,000 acres of pasture and rangeland is low producing because of excess water. This land could be improved through the installation of drainage measures. The value of this improvement, however, is not included in the estimates shown in Table 28. The cropland, pasture, and rangeland that could be improved by drainage falls into two categories; those which could be drained with existing outlets and those which need the development of adequate outlets. It is estimated that 330,000 acres could be drained by tile or open drains into existing outlets. The remaining 730,000 acres of wetlands need improved outlets. Lack of maintenance of legal drainage systems has allowed these outlets to become blocked with sediment, trees, and brush, thereby reducing their effectiveness. Sediment deposition in natural streams has reduced their depths, capacity, and effectiveness as outlets.

LACK OF MAINTENANCE, SUCH AS THE REMOVAL OF SEDIMENT, HAS REDUCED THE CHANNEL CAPACITY SO THAT THE ADJOINING LAND NO LONGER HAS AN ADEQUATE OUTLET. THE PLANTING OF CROPS IS DELAYED BEYOND OPTIMUM DATES CAUSING REDUCED YIELDS.

SHALLOW DEPRESSION NOT PRODUCING ALFALFA HAY OR PROVIDING GOOD WATERFOWL HABITAT.

Table 27--Summary of water and related land resource problems and needs
Big Sioux Study Area

Delineated Watershed Identification			FLOODWATER & SEDIMENT		GULLY EROSION		DRAINAGE		IRRIGATION	
No.	Name	Drainage Area	Area Having Problem 1/	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Present Irrig. Development	Potential Irrigable 2/
		Acres								
31 -01	Roslyn Bristol Area	212400	0	0	4000	0	46900	0	0	100
02	Waubay Lake Area	266100	300	300	4520	0	45600	0	0	0
03	Garden City Area	235200	0	0	21600	1800	54400	200	0	1960
04	Upper Big Sioux R. Reach	120200	1730	1730	9200	0	7810	0	0	710
05	Grass Lake Area	89600	200	200	2200	0	9900	0	0	250
06	Mahoney, Gravel Cr.R.Reach	91300	5850	5850	22400	0	7200	900	0	3640
07	Lake Kampeska Area	145800	430	430	4600	0	17690	2000	0	540
08	Willow Creek	80000	1700	1700	8700	0	8300	0	0	450
09	Clark Area	136200	510	510	16200	480	40160	0	0	1050
10	Lake Marsh Area	156800	4640	4640	7620	0	23875	4900	0	1200
11	Watertown,Big Sioux R.Rch.	71000	3890	3890	2400	0	7900	1400	0	1610
12	Castlewood Tributaries	28800	1000	1000	3500	0	2800	600	0	650
13	Stray Horse Creek	51900	1450	1450	6100	0	3860	0	0	1265
14	Upper Hidewood Creek	51800	1280	1280	4800	0	6000	2000	0	1200
15	Lower Hidewood Creek	57500	1640	1640	4800	0	1400	0	0	640
16	Dempster Tributaries	20400	1840	1840	2600	0	1600	0	0	950
17	Dolph Creek	198900	3350	3350	8490	0	18000	1600	0	740
18	Oakwood Lakes Area	64200	1150	1150	8000	0	20000	3000	0	0
19	Bruce, B.Sioux R. Reach	123200	15460	15460	450	0	27600	6800	520	4220
20	Peg Munky Run Creek	33300	900	900	6000	0	1200	200	0	1550
21	North Deer Creek	82100	6600	6600	3400	0	20600	10000	0	6590
22	Six-Mile Creek	47300	2460	2460	1800	0	12100	2000	160	2500
23	Up.Deer Cr.-L. Hendricks	20300	1741	1741	220	0	1240	240	0	140
24	Deer Creek	44200	2600	2550	1800	0	10800	2200	0	1065
25	Volga Tributaries	103400	1700	1700	9280	0	41100	20000	0	0
26	Upper Medary Creek	20700	1200	750	0	0	2500	800	0	0
27	Lower Medary Creek	68700	5000	5000	1500	0	25300	4000	460	4150
28	Battle Creek	130100	875	875	900	0	19400	5600	0	1200
29	Brookings-Moody Co. Cr.	20300	100	100	750	0	1500	0	0	140
30	Spring Creek	42300	1630	1630	0	0	4980	1380	180	1380

Continued

Table 27--Summary of water and related land resource problems and needs
Big Sioux Study Area

Delineated Watershed Identification		FLOODWATER & SEDIMENT			GULLY EROSION		DRAINAGE		IRRIGATION	
No.	Name	Drainage Area	Area Having Problem 1/	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Present Irrig. Development	Potential Irrigable 2/
		Acres								
31 -31	Flandreau Creek	66000	6155	4600	880	0	11200	800	0	985
32	Squaw Creek	39200	800	800	200	0	6500	500	0	210
33	Bachelor Creek	61800	600	600	240	0	12000	4000	0	350
34	Dell Rapids, B.Sioux R.Rch.	113000	9615	9615	2150	0	6200	1800	390	3390
35	Brookfield Creek	16200	500	500	0	0	1200	0	100	210
36	Upper Pipestone Creek	86300	9715	6010	0	0	17200	3000	0	0
37	Lower Pipestone Creek	40600	3165	2750	50	0	5786	1900	0	1030
38	Upper Split Rock Creek	71400	5920	3795	0	0	12505	1200	0	0
39	Lower Split Rock Creek	47400	4877	4736	0	0	6700	2200	0	1500
40	West Pipestone Creek	74400	3800	3800	0	0	7800	2200	0	530
41	Slip Up Creek	19300	200	200	1200	0	2400	0	0	180
42	Silver Creek	21500	4770	4770	0	0	1700	500	0	210
43	Sioux Falls, B.Sioux R.Rec	66900	3000	3000	2000	0	4550	1050	0	1000
44	Lake Madison Area	79500	270	270	0	0	14400	5000	0	600
45	Upper Skunk Creek	97300	4070	4070	500	0	15600	4500	180	3880
46	Buffalo Creek	61200	770	770	1200	0	9600	2500	0	2000
47	West Branch Skunk Creek	47600	1200	1200	500	0	7900	2000	0	0
48	Willow Creek	40600	300	300	2500	0	6300	1000	0	375
49	Lower Skunk Creek	80500	5520	5520	0	0	13140	2100	300	2785
50	Upper Beaver Creek	67400	6511	5500	0	0	8900	6000	0	0
51	Lower Beaver Creek	36800	2404	2330	0	0	3798	1400	0	270
52	West Bank Klondike R. Rch.	24100	1500	1500	2100	0	800	800	0	0
53	Blood Run Creek	21400	1191	1050	15750	10000	2250	200	0	0
54	E. Bank Klondike R. Reach	23600	2000	2000	9600	6000	250	0	0	0
55	Nine Mile Creek	37300	300	300	0	0	4300	3000	0	0
56	Unnamed Creek #1	6300	200	200	4800	1000	55	0	0	0
57	Pioneer Watershed	5300	150	150	3450	950	55	0	0	0
58	Klondike Creek	17800	450	450	13875	6000	650	0	0	0
59	Unnamed Creek #2	9400	275	275	7000	4000	125	0	0	0
60	Unnamed Creek #3	11100	150	150	8300	2000	175	0	0	0

Continued

Table 27--Summary of water and related land resource problems and needs
Big Sioux Study Area

Delineated Watershed Identification		FLOODWATER & SEDIMENT			GULLY EROSION		DRAINAGE		IRRIGATION	
No.	Name	Drainage Area	Area Having Problem1/	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Present Irrig. Development	Potential Irrigable2/
		Acres								
31 -61	Beaver Creek	86400	2400	2400	0	0	14800	9000	0	810
62	W.Bank,Fairview, Hudson, Richland B.Sioux R.Reach	56100	5250	5250	11000	2750	7000	1500	0	1500
63	E.Bank, Fairview, Hudson, Richland B.Sioux R. Reach	33700	6356	6356	2050	1700	3000	0	0	1000
64	Unnamed Creek #4	10100	300	300	15	0	15	0	0	0
65	Pattee Creek	25800	2741	2741	13000	10500	80	0	0	0
66	Dry Creek	32200	1250	1250	80	0	1250	350	0	320
67	Green Creek 3/	11900	320	320	8000	1952	1000	0	0	800
68	Scott Creek 3/	2800	1200	1200	500	0	600	0	0	700
73	Six-Mile Creek	69100	2688	2688	105	0	550	80	0	1000
74	Indian Creek	40300	2100	1600	5080	4080	2200	0	0	0
75	Beaver Creek	5700	190	190	1500	1000	0	0	0	0
76	Union Creek	29400	3500	3500	12000	6000	2000	2000	0	2000
77	Richland Creek	6300	1002	1002	2000	0	800	0	0	1000
78	Westfield Watershed	19300	650	650	6000	5000	0	0	0	0
79	Brule Creek	135800	7520	7520	32000	1700	4100	0	340	2600
80	Lewiston Ditch	36100	6000	6000	500	0	4700	350	170	6300
81	Gant Creek	8400	366	366	4500	4000	0	0	0	0
82	West Sunnyside Watershed	5700	150	150	5000	3990	0	0	0	0
87	Broken Kettle Creek	57500	2080	2080	18000	14460	3200	0	0	0
88	W.Bank,Elk Point,Jefferson, B.Sioux River Reach	27100	20060	20060	500	0	6000	500	1920	18400
89	E.Bank,Elk Point,Jefferson, B. Sioux River Reach	16500	3500	3500	1750	1400	3000	0	0	0
	Subtotal	4921400	221227	211060	367705	90762	730049	131250	4720	95825
31a-01	Upper Rock River	74500	7400	5500	0	0	13682	3000	0	3000
02	Chanarambie Creek	43400	3760	3460	750	750	9340	1500	0	1800
03	Poplar Creek	23100	1760	1496	3200	1000	3976	900	0	2000

Continued

Table 27--Summary of water and related land resource problems and needs
Big Sioux Study Area

Delineated Watershed Identification			FLOODWATER & SEDIMENT		GULLY EROSION		DRAINAGE		IRRIGATION	
No.	Name	Drainage Area	Area Having Problem 1/	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Present Irrig. Development	Potential Irrigable 2/
		Acres								
31a-04	Rock River (Direct)	68600	15720	7879	888	800	13854	2700	0	10000
05	Leota Creek	8300	801	480	0	0	1520	500	0	0
06	Hardwick Area	11700	1490	1330	0	0	3376	1650	0	0
07	Kenneth Creek	10400	1813	1265	0	0	3311	2300	0	0
08	Mound Creek	11100	1011	861	0	0	2316	1455	0	0
09	Champepedan Creek	47500	7361	5573	0	0	10000	5500	0	0
10	Elk Creek	41000	3800	2725	0	0	11940	6000	0	2000
11	Ash Creek	13300	1136	850	0	0	5700	2000	0	0
12	Unnamed Creek #5	4600	70	70	2300	0	100	0	0	0
13	Ellsworth Area	24300	2710	1020	0	0	4420	1000	0	0
14	Kanaranzi Creek	108900	10990	8860	860	0	19200	5500	0	4000
15	Moon Creek	7200	181	181	3500	0	250	0	0	0
16	Tom Creek	39700	910	860	20000	2500	2700	900	0	0
17	Unnamed Creek #6	4900	100	100	1500	0	160	0	0	0
18	Unnamed Creek #7	10800	300	300	5000	500	300	0	0	0
19	Mud Creek	24100	1124	756	0	0	5000	2700	0	800
20	Unnamed Creek #8	7400	230	160	3000	0	1575	60	0	0
21	Mud Creek	56900	1767	1767	15500	0	1470	0	0	0
22	Middle Rock R.(Main-Iowa)	26800	5030	5030	9000	3000	1000	0	0	0
26	W.Branch Little Rock R.	24600	3000	2200	0	0	6000	3000	0	0
27	Little Rock River	49200	7300	4300	1000	1000	15995	4030	0	0
28	Up. Little Rock River	58000	1855	1855	17400	8000	5085	1050	0	0
42	Otter Creek	134400	5296	4946	6940	40	16415	5310	0	0
43	Lower Little Rock River	37100	3250	3250	9900	3500	1400	0	0	0
44	Bun Oak Creek	24900	1600	1600	160	80	170	0	0	0
45	Dry Run Creek	32900	1200	1200	9080	380	580	0	0	0
46	Lwr.Rock River(Mainstem)	46500	6284	6284	450	440	90	10	0	3000
	Subtotal	1076100	99249	76158	110428	21990	160925	51065	0	26600
	Subtotal 31 and 31a	5997500	320476	287218	478133	112752	890974	182315	4720	122425

Continued

Table 27--Summary of water and related land resource problems and needs
Big Sioux Study Area

Delineated Watershed Identification		Floodwater & Sediment			Gully Erosion		Drainage		Irrigation	
No.	Name	Drainage Area	Area Having Problem 1/	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Present Irrig. Development	Potential Irrigable 2/
		Acres								
00 -66	Yankton, Elk Point River Reach	60500	0	0	0	0	18000	2000	2720	26200
	Subtotal	60500	0	0	0	0	18000	2000	2720	26200
7 -06	Hartford Beach Area	3000	0	0	0	0	400	0	0	0
16	Up. N. Fork Whetstone Rvr.	29900	200	200	14200	0	1000	0	0	0
17	Lwr.N. Fork Whetstone Rvr.	42400	600	600	3900	0	6000	0	0	660
18	S. Fork Whetstone River	108000	4500	4500	22620	0	4600	0	0	1230
20	Up.S.Fork Yellowbank Rvr.	47400	310	310	1335	0	5500	1000	0	500
21	Mud Creek	17100	1470	1470	5080	0	1400	0	0	180
22	S.Fork Yellowbank River	47600	1800	1800	300	0	6000	0	0	520
23	N.Fork Yellowbank River	115200	2400	2400	29400	0	15000	0	0	1240
7b-01	Up.Deer Crk.& L. Hendricks	6800	125	125	320	0	500	0	0	60
03	Oak-Fish Lake Area	31800	1000	1000	1700	0	2500	400	0	340
04	Canby Creek	700	0	0	0	0	100	0	0	0
05	Lazarus Creek	16800	0	0	375	0	2000	600	0	170
08	Cobb Creek	48900	2800	2800	1875	0	3000	0	0	530
10	Up.W.Fork Lac Qui Parle R.	38100	100	100	300	0	3000	0	0	400
11	Lost Creek	39900	1900	1900	9000	0	2000	800	0	440
12	W.Fork Lac Qui Parle River	15300	830	830	240	0	1500	0	0	170
	Subtotal	608900	18035	18035	90645	0	54500	2800	0	6440
29 -22	Pearl Creek	50000	1000	1000	1600	0	3000	0	0	200
23	Rifle Lake River Reach	4100	0	0	0	0	300	0	0	0
24	Redstone Creek	108200	4200	4200	4800	0	6900	400	0	0
33	Rock Creek	59700	1050	1050	1600	0	6220	350	0	250
45	Wolf Creek	35300	575	575	0	0	2570	0	0	990
	Subtotal	257300	6825	6825	8000	0	18990	750	0	1440
30 -01	Spirit-Preston Lake Area	145200	4200	4200	6700	0	11800	2650	0	3100
02	L.Thompson, Whitewood Area	149400	2000	2000	4000	0	17100	3600	0	2000
03	Up.E.Frk.Vermillion River	81500	4770	4770	12000	4000	11300	1800	0	500

Continued

Table 27--Summary of water and related land resource problems and needs
Big Sioux Study Area

Delineated Watershed Identification			FLOODWATER & SEDIMENT		GULLY EROSION		DRAINAGE		IRRIGATION	
No.	Name	Drainage Area	Area Having Problem 1/	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Area Having Problem	Area Needing Project Action	Present Irrig. Development	Potential Irrigable 2/
		Acres								
30 -04	Little Vermillion River	51600	600	600	0	0	7500	1800	0	280
05	Lwr.E.Frk. Vermillion Rvr.	7900	0	0	0	0	1300	200	0	0
06	Up.W. Frk. Vermillion Rvr.	75700	1000	1000	320	0	8800	1000	0	610
08	Up.Vermillion River Reach	5800	1200	1200	0	0	550	550	0	0
09	Elce Camp Creek	12100	0	0	0	0	2500	400	0	0
12	Long Creek	94700	1000	1000	0	0	14400	7300	0	1130
15	Ash Creek	33900	200	200	0	0	1900	1200	0	0
	Subtotal	657800	14970	14970	23020	4000	77150	20500	0	7620
	Total	7582000	360306	327048	599798	116752	1059614	208365	7440	164125
	Percent of Study Area	100.0	4.8	4.3	7.9	1.5	14.0	2.7	0.1	2.2

1/ Total flood plain area (includes both Corps of Engineer damage reaches and upstream watersheds studied by USDA).

2/ Denotes acreage that could be irrigated by surface water

3/ Green Creek and Scott Creek PL 566 watershed projects have been completed.

Table 28--Increased net annual income for on-farm improvement opportunities
Big Sioux Study Area

		Cropland					Pasture and Range		
		Drainage			Irrigation				
County	State	Area With Problem	Area That Could be Improved	Increased Net Income	Area That Could be Improved	Increased Net Income	Area That Could be Improved	Increased Net Income 1/	Total
		-Acres-	-Acres-	-Dollars-	-Acres-	-Dollars-	-Acres-	-Dollars-	-Dollars-
Brookings	S. Dak.	57,000	25,000	300,000	35,000	525,000	66,000	330,000	1,155,000
Clark	S. Dak.	14,000	5,000	38,000	10,000	120,000	129,000	697,000	855,000
Codington	S. Dak.	27,000	6,000	54,000	8,000	96,000	33,000	107,000	257,000
Day	S. Dak.	37,000	18,000	125,000	0	0	66,000	317,000	442,000
Deuel	S. Dak.	18,000	12,000	120,000	9,000	135,000	90,000	432,000	687,000
Grant	S. Dak.	24,000	18,000	194,000	8,000	96,000	80,000	360,000	650,000
Hamlin	S. Dak.	21,000	15,000	140,000	19,000	228,000	18,000	90,000	458,000
Kingsbury	S. Dak.	32,000	19,000	196,000	20,000	260,000	84,000	420,000	876,000
Lake	S. Dak.	45,000	21,000	252,000	10,000	150,000	35,000	140,000	542,000
Lincoln	S. Dak.	21,000	10,000	145,000	10,000	180,000	10,000	48,000	373,000
Miner	S. Dak.	11,000	8,000	56,000	0	0	30,000	87,000	143,000
Minnehaha	S. Dak.	37,000	30,000	360,000	40,000	720,000	45,000	225,000	1,305,000
Moody	S. Dak.	27,000	14,000	182,000	7,000	126,000	37,000	167,000	475,000
Union	S. Dak.	93,000	15,000	225,000	20,000	400,000	6,000	30,000	655,000
Lyon	Iowa	28,000	14,000	98,000	3,000	60,000	36,000	288,000	446,000
Osceola	Iowa	15,000	6,000	39,000	0	0	4,000	32,000	71,000
Sioux	Iowa	15,000	5,000	32,000	16,000	320,000	4,000	32,000	384,000
Plymouth	Iowa	5,000	4,000	26,000	15,000	300,000	22,000	121,000	447,000
Lincoln	Minn.	10,000	2,000	18,000	1,000	18,000	3,000	12,000	48,000
Murray	Minn.	14,000	8,000	72,000	0	0	3,000	12,000	84,000
Nobles	Minn.	65,000	35,000	315,000	6,000	48,000	7,000	34,000	397,000
Pipestone	Minn.	50,000	25,000	225,000	3,000	54,000	24,000	96,000	375,000
Rock	Minn.	52,000	24,000	216,000	20,000	320,000	10,000	64,000	600,000
Total		718,000	339,000	3,428,000	260,000	4,156,000	842,000	4,141,000	11,725,000

Adjusted Normalized Prices

1/ Does not include Pasture and Range improvements through drainage

WATER SHORTAGES

Water shortages for farm crops occur somewhere in the Study Area every year. In the driest years, crop yields have approached zero. However, most years, crop yields support a moderately prosperous agriculture. Average yields of corn are about 40 bushels per acre in the northwest and about 80 bushels per acre in the southeast portion. The better managers are able to increase these yields by approximately 30 bushels per acre. To achieve higher yields, supplementary irrigation is usually necessary.

Soils having a sand or gravel subsoil are the first to show the effects of water shortage. These soils are most commonly located in Soil Associations Groups G and H. In periods of normal or above normal rainfall, the yields of these lands are slightly below the yields on the soils with better water-holding capacity. In periods of below normal rainfall, yields are significantly less on these soils. These droughty soils are located on the terraces of the Big Sioux River and its major tributaries. These terrace soils often overlie ground water at less than 50 feet. The combination of droughty soils and available ground water has encouraged some development of irrigation on these sites and it is anticipated that future irrigation developments will be centered in these areas. It is estimated that there are 260,000 acres of this type of land with water available. Net irrigation requirements will vary with the crop to be grown and its location in the Study Area. Based on an 80 percent chance occurrence of effective rainfall, the net irrigation requirement for alfalfa varies from 13 inches in the northern portion to 16 inches in the south. For corn it will vary from 10 inches to 11 inches from north to south. For spring grain it will vary from six inches in the north to eight inches in the south. If irrigation measures were installed on all 260,000 acres, its estimated net income could be increased by $4,156,000. (See Table 28.)

Generally, rural water supply for farm home and livestock use from shallow wells has been adequate. With the modernization of farm homes and the increased numbers of livestock, the need for additional water has increased on most farms. There is also a need for better quality of water. The farms most likely to be affected are those located at higher elevations near watershed divides. Farms located along the major tributaries usually have an adequate water supply. The number of farms in need of additional water supply is not known. There are areas in the Study Area where water supply to farms is critical. Farmers in these areas are organizing water supply districts to study needs and costs of installation and operation of community systems. Eventually, if needs justify expenditures, it is expected that these districts will operate the water supply system.

Most small towns depend upon relatively shallow wells for their water supply. These wells usually supply adequate quantities of water for the present time and the foreseeable future. However, many of these water supplies are poor in one or more quality standards set by the State Health Department.

The larger cities such as Sioux Falls, Brookings, and Watertown also depend upon shallow wells for water supply and water supplies are adequate for current needs. If population and water use trends continue at their present rate, these cities will need additional water supplies before the year 2000. Sioux Falls is currently conducting a detailed study of its water needs and supply.

Water shortages frequently affect the wildlife potential. Periodic drouths, which may occur in nearly half the years, dry up most of the smaller potholes reducing the supply of food and cover available for wildlife. These variations in amount and availability of water-holes may be a limiting factor in the amount of wildlife produced within the Study Area.

During the 1930's, when the drouth persisted for a number of years, all the potholes and many of the major lakes dried up. The drouth was so severe and so prolonged that farmers were able to crop the bottoms of some of today's good fishing lakes. Under such conditions, water-based wildlife, as well as the fish populations, were decimated by the lack of water. The poor vegetation and wildfires reduced the supply of winter food and cover for all species of wildlife.

Water-based recreational facilities are also adversely affected by water shortages, particularly in the extremely dry years as exemplified by the 1930's. When lakes become mudholes they are not used for picnicking, swimming, fishing, or other watersports. In the less severe water shortage periods, lake levels may fall and water temperatures may raise resulting in increased biological activities which make the lakes and reservoirs less desirable for recreation.

PASTURE AND HAYLAND MANAGEMENT

In the Study Area, either low quality or quantity of forage production is a significant problem. There is a real opportunity to increase the net income from pasturelands in all soil association areas. In addition to increased net income, good pasture management reduces runoff which reduces damages from floodwaters, erosion, and sedimentation. Improved pasture management on the steeper areas will result in improved income from these lands and provide an incentive for farm operators to maintain the grasslands rather than converting them to cropland.

The 1967 USDA Conservation Needs Inventory indicates that there are 1,455,000 acres of pasture and rangeland in the Study Area. It is estimated that 842,000 acres could be improved by better pasture or range management practices such as proper grazing use, pasture plantings, range seeding, and pasture fertilization. This would increase net income by $4,141,000. (See Table 28.)

RANGE AND FOREST FIRES AND GRAZING PROBLEMS

The Study Area is predominately a farming area. Large contiguous areas of range and forest land do not exist. Range and forest fires that do occur are usually quickly controlled and confined to a few acres; however there is a continual threat of occasionally burning extensive areas. Most of the fires that occur are the result of human carelessness but some are started by lightning. In all counties of the Study Area, some degree of organized fire protection is available through rural fire control districts cooperating with the State Foresters' organizations. Fires destroy the ground cover of litter and humus; kill young trees and shrub reproduction; damage, but rarely kill, large pole and sawtimber trees; destroy wildlife habitat and existing livestock forage. In addition, fires frequently cause substantial damage to buildings, fences, and other improvements.

One of the greatest problems to proper forest management is caused by livestock use. Grazing and the use of forest lands for shade and shelter of livestock is practiced in much of the woodlands. Browsing soon kills seedlings and young trees and removes the understory vegetation. Trampling and trailing of livestock compacts the soils and humus and seriously impairs the capacity of the woodlands to retard erosion and reduce peak runoff. The 1967 USDA Conservation Needs Inventory indicates 26,000 acres are being damaged by improper grazing use.

Insect and disease cause losses in timber production through reduction in growth, lower quality, deformities, rot, and death of trees. The occurrence of the Dutch elm disease will probably kill most of the American elm. The loss of these trees leaves a void in the tree population which can be replaced by other species if not browsed. The dead trees increase damages to bridges during floods and add to the debris left on inundated lands.

The commercial production of lumber products has been a minor enterprise in the Study Area. Consequently, there has been little management of woodlands for the purpose of enhancing commercial production. Instead, they have been "picked over", the best trees taken, and the inferior trees left. Many forest areas have no planned replacement of trees and these areas have been invaded by dense stands of seedlings which consist of species which are less valuable for wood products and environmental purposes. The problem of providing proper management practices through timber surveys, management plans, and technical assistance for timber harvest and forest thinning occurs on about 26,000 acres. Many of the shelterbelts and windbreaks planted in the 1930's and the 1940's are deteriorating through lack of proper care, maintenance, and replacement of dead and severely damaged trees.

POLLUTION

The major pollution problem is water pollution. Air pollution from internal combustion engines, industrial smoke and fumes, and soil blowing are present. However, it is of minor concern in this predominately agricultural area with considerable air circulation by wind. Odors from livestock processing, feedlot operations, and municipal sewage treatment plants are forms of air pollution which are a nuisance.

There are three main types of agricultural water pollution: Sediment, livestock, and chemical. Sediment derived from sheet, rill, and gully erosion of farmland constitutes the major source of pollution by agriculture. Livestock waste is second and agricultural chemicals are third.

The loess area is a heavy contributor of sediment to streams and lakes. These highly erodible soils on cultivated fields, with rates as high as 65 tons per acre per year (about 0.4 inch of topsoil), are the principal sediment source.

Livestock wastes from feedlots are a problem of a lesser degree because of the limited area affected. Livestock waste production based on numbers of animals is often directly compared to human waste production. Such comparisons can conclude that livestock wastes are the major pollutants of our waters. Such a conclusion can be misleading due to the differences in the distribution and concentration of these sources of wastes. Measurements of feedlot runoff, conducted at South Dakota State University, indicate that less than five percent of the waste was removed by runoff. A survey made by John E. Foley, a graduate student at South Dakota State University, indicates there were 58 feedlots within one mile of the Big Sioux River in Brookings County. Twenty of these are considered to be a significant problem, 17 a slight problem, and 21 no problem.

With the increased use of agricultural chemicals, pollution from this source is increasing annually. South Dakota, at present, uses about half the amount as that used by Minnesota and Iowa. Nitrogen and phosphorus fertilizers are also essential nutrients needed in water to produce algae bloom. These chemicals are transported by surface runoff waters, either in solution or attached to soil particles. The effects of excessive amounts of sediment, together with chemical pollutants, are harmful to essentially all beneficial uses of water. This may be one of the causes of the deterioration of many glacial lakes.

Industrial pollution is difficult to isolate as the area does not have a highly developed industrial complex. Industries are usually connected with the municipal sewage treatment facility and are part of this pollution source. Much of the industry is associated with agriculture and livestock processing. Small creamery and meat processing plants create some local water pollution problems.

Pollution from municipal sewage discharged into streams creates problems in local areas. Of the 11 cities with a population greater than 2,500, 9 have primary and secondary treatment facilities, 1 has only a primary treatment facility, and 1 has no treatment. There are 40 towns and cities with a population between 500 and 2,500. Fourteen have primary and secondary treatment facilities, twenty-two have only primary treatment facilities, and four have no treatment. Of the 79 communities with a population of less than 500, 3 have primary and secondary treatment facilities, and the remaining 60 have no treatment.

Studies have been made by graduate engineering students from South Dakota State University of the pollution to the Big Sioux River at Sioux Falls. These studies show that the Sioux Falls sewage treatment plant removes 97 percent of the biochemical oxygen demand. There are times when the flow in the river is very low, especially during the winter months, which is not sufficient to dilute, to an acceptable level, the sewage effluent that enters. It is expected that this condition can become more critical in future years when the shallow ground water along the Big Sioux River is used more extensively for municipal water supply and for irrigation.

FISH AND WILDLIFE

While the primary land use is agriculture, wildlife is generally an important byproduct. Consequently, problems relating to wildlife are usually directly related to the manner in which farm operations affect wildlife habitat.

Modern farm technology is affecting both the quantity and quality of wildlife habitat. Soil conserving practices such as grassed waterways, ditch bank seeding, and field border planting are providing grassy islands of cover among the cultivated lands. Contouring and terracing create odd areas which are frequently planted with wildlife habitat improvement in mind. Improved pastures with their clumps of unharvested grass provide nesting areas as well as food and cover for several forms of wildlife. Field and farmstead windbreaks are being improved. Stockwater dugouts and farm ponds are being developed. Irrigation development frequently helps to improve the habitat due to spillover from irrigation water and because of the odd areas created by some methods of irrigation. Applications of commercial fertilizers improve winter food and cover by leaving more crop residues on the field and creating heavier growth in grassy areas adjacent to cropland.

Modern farm technology often tends to degrade or destroy wildlife habitat. High fixed costs tend to cause farmers to use every available acre of land for crop production. Large equipment works most efficiently on large rectangular fields and small odd areas in the field are eliminated. Improved crop varieties which have less tendency to lodge and hold their seeds better leave less winter food for wildlife. Insecticides sometimes leave a residue that is harmful to wildlife and which eliminates a major wildlife food source. Herbicides also reduce the winter food and cover by eliminating many weed patches. The method of application of herbicides sometimes damages wildlife habitat because the drift may defoliate or kill trees and shrubs.

While modern farming methods have brought about adverse as well as favorable effects on wildlife habitat, the adverse effects are more pronounced. In the Big Sioux Study Area, wildlife habitat is being more rapidly depleted in the nonpothole region where high land costs and intensive cropping is practiced than in the less intensively used pothole region.

Modern farming methods can affect fish production by the kind and amount of pollutants introduced into fishing waters from agricultural land. A large amount of sediment resulting from all kinds of erosion is deposited in the lakes and impoundments. These sediments not only fill the lakes but carry with them plant nutrients and animal wastes which may accelerate eutrophication. This is occurring to many of the lakes. Lakes have other problems such as inherent shallowness, fluctuating water levels, and improper biological balances.

Fish and wildlife enhancement funds available through most water development projects are not being utilized by many local sponsors. The development of improved wildlife habitat on private lands is influenced by the economic and the aesthetic wants of individuals. Control of flooding, improved drainage, and irrigation are developments which usually result in immediate economic gains. Most private land owners desire this type of economic development. Some individuals are willing to forego certain economic gains in order to gain the satisfaction of having abundant wildlife either to observe or to hunt and fish. An economic return to the private owner for hunting and fishing privileges may be the answer to providing abundant fish and game populations.

RECREATION

One of the problems restricting the use of lakes for recreation is siltation and eutrophication. Sediments carrying nutrients is the major cause of this eutrophication. Lake Herman is a prime example of this phenomenon. This lake originally had a depth of about 12 feet; the depth is now only about 5 feet. Most of the lakes in the Study Area have similar problems.

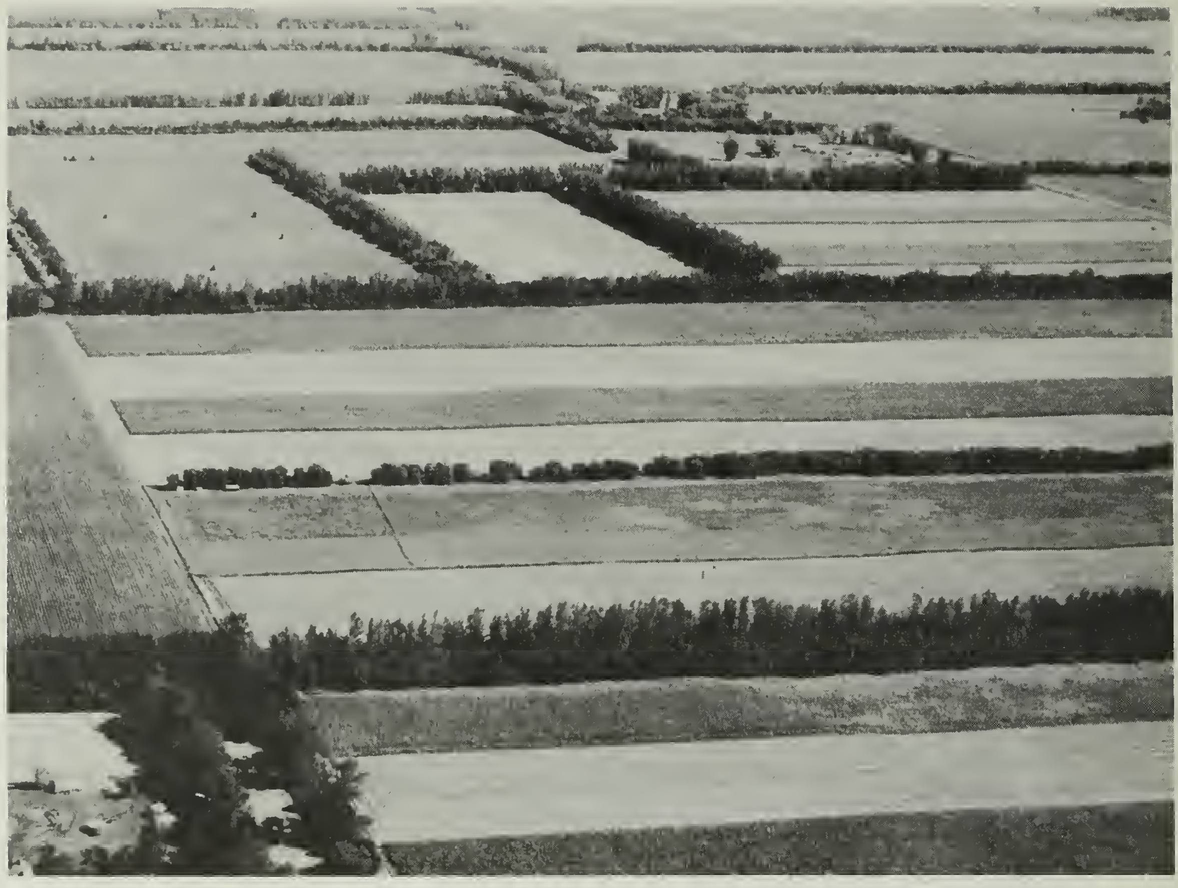
Another problem relating to recreation is the distribution of the natural lakes. Thirty-seven of the best recreation lakes are located in the sparsely populated northern portion of the Study Area while only fourteen are located in the more populated centers in the southern portion including the Minnesota and Iowa portions.

Table 4 shows the public hunting and waterfowl production areas. These areas are also concentrated in the northern portion of the Study Area. In general, the amount of land and water available for public recreation appears to be adequate in the portion of the Study Area north of the Brookings-Moody County line. To the south, including Minnesota and Iowa portions, high quality water-based recreation is not adequate to meet current demands.

PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

CONTOUR STRIP CROPPING REDUCES RUNOFF AND EROSION AND ENHANCES THE ENVIRONMENT.

MINIMUM TILLAGE - PLANTING CORN IN LAST YEAR'S RESIDUE.



THE PATTERN OF MANY SHELTERBELTS, TREE WINDBREAKS, AND STRIP FARMING REDUCES WIND EROSION, CONSERVES SOIL MOISTURE, AND ADDS BEAUTY TO THE LANDSCAPE.

TERRACES INTERRUPT LONG SLOPES, INCREASE INFILTRATION, AND REDUCE SHEET AND RILL EROSION.

MORE OF THESE MULTIPURPOSE RECREATION AND FLOOD PREVENTION RESERVOIRS ARE NEEDED THROUGHOUT THE STUDY AREA.

GRADE STABILIZATION STRUCTURES ARE NEEDED TO KEEP MULTIPURPOSE CHANNELS FROM ERODING.

PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

WATERSHED PROTECTION AND MANAGEMENT

The application and maintenance of proper land treatment is the basic element for the conservation, utilization, and development of land, water, and related resources of the Study Area. Land treatment measures for the control of erosion is an immediate need. The preservation of the soil resource is essential to the maintenance of the area's economic base.

The need for watershed protection and better land management is identified in Table 29. The table shows the different classes of land that need treatment. In Appendix D, soils mapping units are placed in the land capability class and subclass according to the major soils limitations and the severity of the limitation.

An analysis of the information in the table shows that about 1.7 million cropland acres are in land capability classes and subclasses I, IIc, and IIs. These lands require only cultural practices such as crop residue management and conservation cropping systems. About 297,300 acres, or about 18 percent, of these lands need treatment.

There are about 2,856,000 acres in land capability classes and subclasses IIe, IIIe, and IVe representing about 52 percent of the cropland. This area is subject to erosion and is the prime contributor of sediment and excess runoff. It is estimated that 2,028,000 cropland acres, or about 71 percent, of the land in these capability classes and subclasses need treatment to prevent excessive soil losses. Land treatment needed on these lands will include mechanical practices such as contour stripcropping, contouring, terraces, and grassed waterways as well as cultural practices including crop residue management, minimum tillage, and conservation cropping systems.

Cropland in capability classes and subclasses IIw, IIIw, and IVs amounts to 665,000 acres and represents about 12 percent of the cropland. About 440,600 acres, or about 66 percent, of these lands need treatment. The proper treatment of these lands will result in economic gains and decreased production costs. The failure to treat these lands will result in a loss to the soil resource of the Study Area. The treatment needed includes open and closed field drains, outlet ditches, crop residue utilization, conservation cropping systems, and the use of crops adaptable to lands with excessive moisture problems.

There are 148,900 acres, or about three percent of the cropland, in land capability classes and subclasses IIIs and IVs. These soils have a serious root inhibiting problem and often have a wind and water erosion problem also. These problems are severe enough to make these soils marginal for cropping. About 64 percent of these lands need treatment. Proper treatment consists of crop rotations which include a high percentage of hay, crop residue utilization, minimum tillage, and contour stripcropping.

The remaining 112,300 acres, or two percent of the land, is all in land capability classes V, VI, and VII. Proper treatment of these lands is to return them to permanent vegetation.

Table 29 indicates that 71 percent of the 1,455,000 acres of pasture and range need treatment. Although erosion rates from these lands are usually small, excessive runoff of water and poor production is the usual result of inadequate treatment. The treatment needed includes pasture and hayland management, pasture and range seeding, and proper grazing use.

Table 29--Land treatment needs by land capability classes and subclasses
Big Sioux Study Area

Land Capability Class 1/	Cropland			Pasture and Range		
	Total	Needing Treatment		Total	Needing Treatment	
	-Acres-	-Acres-	Percent	-Acres-	-Acres-	Percent
I	1,099,800	101,000	9	87,000	54,700	63
IIe	1,996,200	1,321,000	66	294,700	196,800	67
IIIe	709,900	581,700	82	126,000	102,700	82
IVe	149,600	125,200	84	94,900	85,400	90
VIe	39,700	30,000	76	103,000	74,200	72
VIIe	2,100	1,200	57	-0-	-0-	--
IIc	252,400	60,700	24	41,100	25,900	63
IIw	499,200	331,600	66	194,200	116,200	60
IIIw	162,700	106,200	65	61,800	44,800	72
IVw	3,200	2,800	87	2,000	2,000	100
Vw	27,700	14,500	52	89,200	57,000	61
VIw	17,400	14,500	83	51,000	37,900	74
IIs	311,800	135,500	43	103,200	86,200	84
IIIs	127,400	81,100	64	71,000	66,300	93
IVs	21,500	13,500	63	4,600	3,000	65
VIs	8,500	6,700	79	28,700	21,700	76
VIIs	16,900	10,800	64	102,600	58,100	57
Total	5,446,000	2,938,200	54	1,455,000	1,032,900	71

Source: 1967 USDA-CNI
1/ Appendix D contains a definition of land capability classes.

Table 30 is a summation of the land treatment needs for all agricultural land in the Study Area. The 1967 USDA Conservation Needs Inventory indicated 26,000 acres of forest and woodland need conservation treatment. The treatment includes tree planting for reestablishment and reinforcement of shelterbelts and windbreaks, timber stand improvement in woodlands, improvement of forage for livestock and wildlife habitat, and reduction or elimination of livestock grazing.

Table 30--Status of conservation land treatment and management on agricultural land 1/
Big Sioux Study Area

Land Use	Total	Treatment Adequate		Treatment Needed: Proper Management Practices Only		Treatment Needed: Proper Management Vegetation and/or Mechanical Practices	
	Thous. Acres	Thous. Acres	Percent	Thous. Acres	Percent	Thous. Acres	Percent
Cropland							
Non-Irrigated	5,438	2,508	46	1,151	21	1,779	33
Irrigated	7	2	29	5	71	-	-
Pasture and Range	1,455	422	29	876	60	157	11
Forest and Woodland	49	23	47	25	51	1	2
Other Ag.	199	148	74	25	13	26	13
Total	7,148	3,103	43	2,082	29	1,963	28

1/ Nonfederal rural land (excluding water, transportation, urban, and built-up areas) from 1967 USDA CNI

FLOOD PREVENTION

The previous section on "Floodwater Problems" indicates that nearly all the floodwater damages occur in 103 of the 143 delineated watersheds, excluding the flooding on the Big Sioux River and Rock River flood plain. These 103 watersheds, having a total area of 5,280,340 acres, or 8,250 square miles, represent 70 percent of the total Study Area. To reduce floodwater damages in these watersheds to an acceptable level, it is estimated that about 50 percent of the area would need to be controlled by impoundment structures. Assuming an average of 10 square miles of control by each structure, there would be a need for approximately 400 floodwater retarding structures. Generally, floodwater retarding structures are designed to impound the runoff from a 25 to 50-year frequency storm event. Even with a 50 percent control by floodwater retarding structures, it is estimated that some channel modification would be necessary. Channels are usually designed to carry the peak discharge resulting from the runoff of a 2 to 5-year frequency storm event. Where it is impossible to install floodwater impoundment structures, improving the carrying capacity of channels is necessary to reduce flood damages.

Tables 35 and 40 show 468 miles of channel modification for the 12 existing PL 566 watershed projects and the 16 feasible watersheds. This amounts to 0.17 miles of channel per square mile of the total drainage area in these

28 watersheds. Using this average rate, it is estimated that some 1,400 miles of channel modification would be needed for the 103 delineated watersheds. To control flooding on the Big Sioux and Rock River flood plains, large flood control reservoirs, together with channel modification, would be required. Large structures of this nature are not studied by the USDA.

The proper land treatment of the upland areas is an important and integral part of flood prevention measures. Such treatment may consist of contouring, terracing, grassed waterways, crop residue management, conservation cropping systems, and pasture and range improvement practices. These practices reduce surface runoff and substantially reduce erosion and sediment damages.

An alternative means for reducing floodwater damages is flood plain management to regulate the use of these flood prone lands to minimize floodwater damages. This is a most important nonstructural program which should be implemented by all jurisdictions in the Study Area.

LAND STABILIZATION AND SEDIMENT CONTROL

Table 26 shows the extent and location of the problems associated with gully erosion. These larger gullies are found throughout the Study Area. The most severe problems exist in the loess area of Plymouth County, Iowa, and Union County, South Dakota. In this critical area the land slopes are steep and the soils are very erosive. Land treatment practices such as terraces, proper land use, and others will not fully solve the problem; therefore structural measures are needed to control these gullies. The structural cost to control the 2,053 large gullies is estimated to be 30 million dollars.

DRAINAGE IMPROVEMENT

The 1967 USDA Conservation Needs Inventory shows about 1,059,614 acres of agricultural land have impaired drainage problems. See Table 27. This includes lands subject to damage due to periodic high water table or from flooding or swamping from surface runoff. It excludes all areas with permanent standing water. The agricultural production potential can be improved on the major portions of these lands through the application of surface and subsurface drainage systems.

Table 28 shows 339,000 acres now being cropped need improved drainage. About 1,600 miles of channel modification are needed to provide adequate outlets for the land now being cropped. These should be multipurpose channels for flood prevention and drainage. The estimated cost is about $45 million. In addition, field drainage systems are needed for the 339,000 acres. At an estimated cost of $100 per acre these would cost about $34 million. The total estimated cost of providing adequate outlets and field drainage systems is about $79 million.

The drainage of these croplands could be an important factor in the improvement of the area's economy and preservation of the soil resource. The "Problems" section of this report indicates that

71 percent of the soils with erosion hazards are inadequately treated. More intensive use of cropland having a wetness problem would allow farmers to use less intensive cropping systems on the upland soils that have an erosion hazard. In this way the drainage improvements would reduce erosion, sediment, and flooding losses.

There is a need to coordinate the desires of those wishing to improve the wildlife potentials and those who wish to improve the agricultural potential. Each individual drainage project needs to be planned and developed to use the land within its capabilities and treat it according to its needs for the protection and improvement of the total environment.

IRRIGATION

Irrigation tends to stabilize agricultural production in years of below normal precipitation. This practice is most successful on well-managed farms with soils having drought problems because of low water-holding capacity. There are an estimated 260,000 acres of land where these conditions exist. The greatest potential of ground water development for irrigation is associated with this land. For these acres it is estimated that 12 inches of additional water will be needed on an average annual basis. This would amount to about 260,000 acre-feet annually. It is assumed that these private developments would be from ground water sources. At the present time there are about 7,000 acres of this land under private irrigation development. If the present rate of increase of 10 percent per year continues, about 125,000 acres would be under irrigation by year 2000.

From a national viewpoint the development of irrigation may not be needed as the area can continue to produce its share of projected national food and fiber demands without irrigation. Should the need arise for additional food and fiber, a sizeable amount of cropland now withheld from production can be returned to productive status with little or no cost for resource development. It is within the national objective to encourage agricultural production that results in a lower cost per unit of output and that stabilizes the income of producers. If these efficiency gains are associated with resource development, such as irrigation, they warrant consideration for future implementation.

RURAL DOMESTIC AND LIVESTOCK WATER SUPPLY

The estimated present and projected water needs in rural areas are shown in Table 31. The U.S. Bureau of Census defines rural areas to include all towns with a population of less than 2,500 people. The rural nonfarm sector includes 128 small towns as well as nonfarm rural residents living out of town. Most of these towns have a central water supply from ground water sources with little or no treatment before distribution. In some small towns and rural areas, residents obtain their water from shallow wells of variable quality. In some areas people have to haul water for drinking and cooking purposes.

Water for livestock is obtained from both surface and subsurface sources. Ground water usually supplies water for livestock kept at the farmstead while water in streams, farm ponds, and dugouts supply livestock on pasture or range. Generally water supply from this source is adequate. In some cases, where livestock numbers have increased substantially, water shortages occur.

Table 31 shows the estimated water requirements for present and projected needs. This is based on population estimates assuming 50 gallons of water per person per day. Livestock water requirements vary from 2 gpd for sheep to 30 gpd for milk cows.

Table 31--Estimated 1960 and projected domestic and livestock annual water requirements
Big Sioux Study Area

Water Use Category	1960	1980	2000	2020
	acre-feet			
Rural nonfarm	4,500	5,200	5,600	6,800
Rural farm	5,600	4,300	3,500	2,700
Livestock	21,200	28,500	37,800	49,700
Total Needs	31,300	38,000	46,900	59,200

MUNICIPAL AND INDUSTRIAL WATER SUPPLY

It is estimated that the present needs for municipal and industrial water in the 13 urban areas in the Big Sioux Study Area is 26,450 acre-feet annually. This is based on present population with a daily per capita usage varying from 120 to 170 gallons of water. It is assumed that the larger the city population, the more per capita water is needed for industrial use.

The projected annual water needs for the years 1980, 2000, and 2020 are estimated to be 31,690; 41,760; and 52,600 acre-feet, respectively. This is based on the expected population increase and an estimated per capita increase of 10 gallons per day for each projected period. Present and projected water needs are shown in Table 32.

The present source of water is mainly from shallow aquifers near the urban areas. All of the water is treated before being used. Shortages occur occasionally during the summers in some areas. For the projected periods there will be a need for an additional amount for certain areas, especially for Sioux Falls.

Table 32--Present and projected annual needs for municipal and industrial water
Big Sioux Study Area

Cities	1970 Population	1970 Water Need	1980 Population	1980 Water Need	2000 Population	2000 Water Need	2020 Population	2020 Water Need
	-Number-	-Acre-Feet-	-Number-	-Acre-Feet-	-Number-	-Acre-Feet-	-Number-	-Acre-Feet-
Sioux Falls, S. Dak.	76,100	14,490	85,900	17,320	107,000	22,770	127,400	28,540
Brookings, S. Dak.	13,700	2,460	15,400	2,930	19,200	3,870	22,900	4,870
Watertown, S. Dak.	13,400	2,400	15,100	2,880	18,800	3,790	22,400	4,770
Worthington, Minn. 1/	9,800	1,760	11,100	2,110	13,800	2,780	16,400	3,490
Madison, S. Dak.	6,300	1,060	7,100	1,270	8,800	1,680	10,500	2,120
Pipestone, Minn.	5,300	890	6,000	1,080	7,400	1,410	8,900	1,790
Luverne, Minn.	4,700	740	5,300	890	6,600	1,180	7,900	1,500
Milbank, S. Dak.	3,700	540	4,200	660	5,200	870	6,200	1,110
Sioux Center, Iowa	3,500	510	3,900	610	4,900	820	5,900	1,060
Orange City, Iowa 1/	3,500	510	3,900	610	4,900	820	5,900	1,060
Hawarden, Iowa	2,800	380	3,200	470	3,900	610	4,700	790
Canton, S. Dak.	2,700	360	3,000	440	3,800	600	4,500	760
Rock Rapids, Iowa	2,600	350	2,900	420	3,700	580	4,400	740
Total	148,100	26,450	167,000	31,690	208,000	41,780	248,000	52,600

Population projections are made for total urban population (See Table 6.) They will not normally be accurate for individual cities.

1/ These cities lie outside the Big Sioux Basin but are within the economic study area (See page 3-1.)

RECREATION

Recreation demand may be considered the numerical expression of the present and future use of recreation resources if they are available. The 1965 use and projected demands for swimming, boating, waterskiing, picnicking, camping, sightseeing, nature walks, and hiking, used by the Bureau of Outdoor Recreation in the Missouri River Basin Framework Study, were estimated for the Big Sioux Study Area. Present recreation demands and expected increases are shown in Table 33. Factors considered in estimating demands for the various recreation activities were participation rates, income levels, and population. Demands were calculated only for the residents of the Big Sioux Study Area since the area does not attract many tourists from other areas.

Table 33--Present and projected recreation demands by activity
Big Sioux Study Area

Activity	Activity Occasions (1965)1/	Projected Increase (1965 = 100) Year 1980	2000	2020
Swimming	1,147,000	166	222	275
Boating	492,000	173	259	324
Waterskiing	51,000	224	331	390
Picnicking	863,000	132	163	172
Camping	154,000	179	273	308
Sightseeing	1,575,000	139	182	199
Nature Walks	519,000	139	172	187
Hiking	67,000	172	236	269
Total	4,868,000	150	200	230
Recreation Days 2/	1,947,000	150	200	230

1/ Activity occasion is defined as participation by one individual in one outdoor recreation activity during any part of a 24-hour period.

2/ A recreation day is computed as equal to 2.5 activity occasions.

Recreation demands within the Study Area are expected to increase greatly over the next 50 years, particularly for camping and the water-based activities of swimming, boating, and waterskiing. Increased demands are due to the projected population growth and increased per capita participation as more income and leisure time are available. The average individual engaged in about 6.1 recreation days in 1965; it is expected that he will enjoy about 10.7 recreation days in 2020. The extent that residents travel outside the area for their outdoor recreation activity will not infringe upon the recreation resources of the area. On the other hand, nonresidents will avail themselves of area outdoor recreation opportunities if attractive facilities are available. These factors are assumed to counterbalance each other;

therefore the values shown in Table 31 are believed to be reasonable estimates of the total demand on the recreational resources of the area.

Recreation needs or demands are converted into needs for land and water by subareas as shown in Table 34. This table shows that the area north of the Brookings-Moody County line has adequate recreation water for the projected future needs. The area south of this line, which contains the greatest population, does not meet the present needs. The areas in Minnesota and Iowa are practically void of any recreation water at the present time.

The quality of the existing recreational waters is generally good in some areas; however many of the lakes are shallow and in time will become useless.

Table 34 indicates that at present there is a shortage of land devoted to outdoor recreation in all areas except for the Minnesota portion. Even in this portion there will be a shortage of public recreation areas by 1980. Iowa and the southern portion of South Dakota is particularly short in land devoted to recreation.

There is a need to include recreation purposes in impoundment reservoirs to provide the need for boating, fishing, waterskiing, and swimming along with the aesthetic environment for picnicking, camping, sightseeing, and other outdoor activities.

FISH AND WILDLIFE

Projected fishing demands can probably be met through intensified management programs in the northern portion of the Study Area. This can be accomplished by periodic rehabilitation of public waters to increase their game-fish productivity. There will also be opportunities to better utilize some of the natural and constructed waters by obtaining public fishing access.

Other needs pertaining to fisheries include research on compatible predator-pan fish combinations for small lakes and research on the causes and opportunities to lessen winter kill, aquatic weed control, pollution control, and opportunities to effectively use fish barriers.

Present and future needs for water and related land resource development for wildlife, particularly game species, are great and varied within the Study Area. Hunting demands projected to 1980 are expected to increase by approximately 41 percent over the 1965 demand. A concerned and knowledgeable effort will be required by both private and public landowners to meet this demand. Progressive planning, which will include incentive opportunities for the private landowners, is necessary.

Resource considerations for wildlife include the following: (1) Adequate year-round habitat, with development concentrated on the habitat elements which may limit their abundance, (2) Preservation and development of habitat for migratory wildlife considering a shorter season of need, (3) The need for improved methods of incorporating wildlife habitat development and management into farm and ranch operations, (4) The need for more

MULTI-ROWED FIELD WINDBREAK PROVIDES EXCELLENT WILDLIFE HABITAT.

MANY DUGOUTS THROUGHOUT THE BASIN SUPPLY WATER FOR LIVESTOCK AND WILDLIFE.

THE BASIN HAS MANY MARSH AND WETLAND AREAS.

GOOD COVER SUCH AS THIS HELPS TO INCREASE POPULATION OF THIS UPLAND GAME BIRD.

information on the effects of climate on wildlife, and how adverse effects might be mitigated through the use of different plant materials, habitat patterns, location, and management, (5) An intensive program of public information and education to better align the hunter, landowner, and general public to wildlife resource objectives and opportunities should be carried out.

WATER QUALITY CONTROL

The greatest need to improve surface water quality is to reduce the quantity of sediment entering streams and lakes. This can be accomplished by the implementation of soil conservation practices such as terracing, grassed waterways, contour furrows, and proper grazing. Also practices to control and dispose of wastes from barnyards and feedlots need to be applied.

Municipal and industrial sewage treatment facilities need to be improved. About 40 percent of the incorporated towns and cities within the Study Area have secondary treatment but a number of these need to be expanded or improved. About 170,000 persons are served by these facilities. Smaller communities with inefficient or no system at all need to be improved to maintain the present water quality.

Steps need to be taken to reduce seepage from some sewage lagoons, municipal dumps, and some agricultural practices to protect the shallow ground water aquifers.

According to previous Federal Water Quality Administration Studies, low flow augmentation on the Big Sioux River is needed at Sioux Falls during most winter months. Other probable urban areas needing low flow augmentation would be Watertown, Brookings, Madison, and Pipestone.

RURAL POWER SUPPLY

The East River Electric Power Cooperative, Inc., of Madison, South Dakota, supplies electricity to the rural area in the South Dakota portion of the Study Area plus a small area in Minnesota. A rural load growth rate of two percent per year compounded is expected for the Study Area.

To meet these needs, East River Electric Power Cooperative, Inc., estimates that 46 distribution substations, 940 miles of transmission lines, 8 transmission substations, and 8 bulk supply switching stations will be required. At the present time the Study Area is adequately served.

Table 34--Recreational needs for land and water
Big Sioux Study Area

Item	Units	S. Dak. 1/ North	S. Dak. 1/ South	Minnesota	Iowa	Total
Population, 1960	No.	90,141	129,717	48,834	40,843	309,535
Population Distribution	%	29.1	41.9	15.8	13.2	100.0
1965 Activity Occasions	No.	1,416,000	2,040,000	769,000	643,000	4,868,000
Projected Activity Occasions						
1980	No.	2,125,000	3,059,000	1,154,000	964,000	7,302,000
2000	No.	2,833,000	4,080,000	1,538,000	1,285,000	9,736,000
2020	No.	3,258,000	4,691,000	1,769,000	1,478,000	11,196,000
Total 1965 Needs for Water	Ac.	11,100	15,900	6,000	5,100	38,100
Projected Water Needs						
1980	Ac.	20,400	29,200	11,000	9,400	70,000
2000	Ac.	30,400	43,500	16,400	14,000	104,300
2020	Ac.	37,500	53,700	20,300	17,300	128,800
Available Recreation Water 3/	Ac.	50,800	8,700	35	75	59,610
Present Add'l. Needs for Rec. Water	Ac.	-0-	7,200	5,965	5,025	18,190
Projected Add'l. Needs for Rec. Water						
1980	Ac.	-0-	20,500	10,965	9,325	40,975
2000	Ac.	-0-	38,400	16,365	13,925	68,690
2020	Ac.	-0-	45,000	20,265	17,225	82,490
Total Needs for Recreational Land	Ac.	2,640	3,840	1,410	1,210	9,100
Projected Land Needs						
1980	Ac.	4,420	6,430	2,360	2,030	15,240
2000	Ac.	6,140	8,930	3,270	2,810	21,150
2020	Ac.	6,920	10,080	3,690	3,170	23,860
Available Public Recreational Land 4/	Ac.	2,000	1,620	2,000	110	5,730
Present Add'l. Needs for Rec. Land	Ac.	640	2,220	-0-	1,100	3,960
Projected Add'l. Needs for Rec. Land						
1980	Ac.	2,420	4,810	360	1,920	9,510
2000	Ac.	4,140	7,310	1,270	2,700	15,420
2020	Ac.	4,920	8,460	1,690	3,060	18,130

1/ Dividing line is the Brookings-Moody County line.
2/ Total figure from Table 31
3/ Recreational waters shown in Table 4
4/ Total of state and county parks and public lake accesses shown in Table 4

CHAPTER 6

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

PUBLIC LAW 566 WATERSHED PROJECTS

The Watershed Protection and Flood Prevention Act (68 Stat. 666; 1954) authorizes the Secretary of Agriculture to cooperate with local organizations having authority under state law to carry out, maintain, and operate works of improvement for flood prevention or for the conservation, development, utilization, and disposal of water in watershed or subwatershed areas.

The Act provides for a project-type approach to the soil, water, and related resource development, use, and conservation. The Act further provides for technical and financial assistance by the Department of Agriculture to local organizations representing the people living in small watersheds. It provides for cost-sharing for flood prevention, agricultural water management, sediment control, fish and wildlife developments, and public recreation.

At the present time, 12 small watershed projects, covering about 312,600 acres, are completed or under construction. This represents about 4.1 percent of the Big Sioux Study Area. The primary purpose of these projects is for flood prevention, watershed protection, and erosion control. Structural measures include 37 floodwater retarding structures, 72 grade stabilization structures, and 124 miles of channel modification. The floodwater retarding structures have a total capacity for 18,430 acre-feet of floodwater storage and 4,920 acre-feet for sediment storage. Structural data is summarized in Table 35. See Map No. 12 for location and status of completion.

An important part of every small watershed project is the land treatment program. Seventy-five percent of the land above each retention reservoir must be adequately treated and fifty percent of the land above these structures must be under agreement with the local conservation district. To plan and apply needed soil conserving measures, additional funds for technical assistance are made available to the Soil Conservation Service. The accelerated land treatment program in these watersheds has made it possible to plan and apply adequate treatment to an estimated 100,000 acres. The treatment of these lands and the sediment stored in the floodwater retarding structures has reduced the amount of sediment leaving these watersheds.

When all structural and land treatment measures are applied on these 12 watersheds there will be a reduction of floodwater damages on 12,500 acres, amounting to an average annual benefit of about $192,000. This will bring about the more intensive use of 1,500 acres of cropland with a benefit of $23,400. The secondary benefits will be $27,700. The planned 72 grade stabilization structures will protect about 3,300 acres of land which otherwise would be destroyed in about 50 years. The multipurpose reservoirs contain recreation pools totaling 150 acres of surface water which will provide 37,000 visitor days use annually in that portion of the Study Area where there is now a shortage.

Table 35--P.L. 566 watersheds completed or approved for installation
Big Sioux Study Area

Delineated Watershed Identification		Drainage Area	RESERVOIR DATA											GRADE STAB. STRUCTURES			CHANNELS			Total Structural Installation Cost
			No.	Drainage Area Controld.	Storage Capacity				Watersurface Area (Top of Pool)			Installation Cost	No.	Drain Area Controlled	Installation Cost	Length	Land Rights	Installation Cost	
					Sediment	Rec.	Flood Water	Total	Sediment	Rec.	Flood Water								
Number	Name	Acres		Sq. Mi.	Ac.Ft.	A.Ft.	Ac.Ft.	Ac.Ft.	Acs.	Acs.	Acs.	$1,000		Acres	$1,000	Miles	Acres	$1,000	$1,000
7-21	Mud	16,580	1	4.6	80	-	480	560	12	-	40	104	-	-	-	11	250	108	212
31-23	Up.Deer-L.Hend.	36,610	1	16.8	130	-	1430	1560	36	-	160	152	1 1/	-	8 1/	11	270	147	307
31-42	Silver	20,660	6	11.5	470	-	1090	1560	134	-	288	273	-	-	-	15	370	187	460
31-57	Pioneer	5,280	1	6.1	410	500	710	1620	28	60	108	385	-	-	-	-	-	-	385
31-65	Pattee	25,460	4	16.6	600	840	1750	3190	104	90	272	482	4	7000	113	2	40	24	619
31-67	Green 2/	11,100	-	-	-	-	-	-	-	-	-	-	5	1950	57	-	-	-	57
31-68	Scott 2/	2,900	2	2.2	50	-	170	220	10	-	33	28	9	1760	34	3	65	7	69
31-76	Union	30,000	4	15.8	520	-	2160	2680	93	-	278	465	13	7900	389	2	40	38	892
31-77	Richland	6,520	1	6.0	290	-	620	910	47	-	128	54	-	-	-	4	80	6	60
31-79	Brule	142,720	17	60.4	2370	-	10020	12390	476	-	1197	855	4	1700	42	76	1940	869	1766
31-81	Gant	9,320	-	-	-	-	-	-	-	-	-	-	22	8100	481	-	-	-	481
31-82	W. Sunnyside	5,450	-	-	-	-	-	-	-	-	-	-	14	2590	275	-	-	-	275
	Total	312,600	37	140.0	4920	1340	18430	24690	940	150	2504	2798	72	31000	1399	124	3055	1386	5583

1/ Outlet control structure for Lake Hendricks
2/ These two projects are complete; Scott Creek is the only authorized Pilot Watershed Project in the Study Area

PUBLIC LAW 46 PROGRAMS

In April 1935, Congress passed Public Law 46, known as the Soil Conservation Act. The Act recognized soil erosion as " a menace to national welfare" and declared as "policy of Congress to provide permanently for the control and prevention of soil erosion and, thereby, to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors, protect public health, public lands, and relieve unemployment ..."

Under this Act, the U. S. Department of Agriculture, with leadership by the Soil Conservation Service, provides technical assistance through local conservation districts to assist farmers and ranchers in the planning and application of measures needed for the protection, use, and improvement of soil, water, and related resources.

Locally organized conservation districts have made a significant contribution to the soil and water conservation movement. These districts are designated as conservation districts in South Dakota and are soil and water conservation districts in Iowa and Minnesota. They are legally constituted units of state government created for the purpose of implementing soil, water, and related conservation programs, including fish, wildlife, and recreation. Each district is directed by a board of supervisors, usually resident landowners or operators, who are elected by people in the district. This board develops a district program and plan of action to meet the soil and water conservation needs of the district. The Study Area is covered by conservation districts.

Accomplishing proper land use and treatment, the basic element in the conservation of land, water, and related resources, is the goal of conservation districts. The application of conservation practices on the land by individuals and groups of landowners and operators is the largest single activity of these districts. The conservation districts accomplish this goal through the cooperation of landowners and operators together with local, state, federal, and private organizations interested in soil and water conservation.

The Soil Conservation Service furnishes technical assistance to plan and apply conservation practices on the land. The Agricultural Stabilization and Conservation Service shared the cost of establishing many needed conservation and environmental practices.

Table 36 contains a summary of the main land treatment practices applied under the district programs through June 1971. The table also includes an enumeration of the practices applied during fiscal year 1971 (July 1, 1970 through June 30, 1971).

The 1971 progress reports of the Soil Conservation Service show there are 17,300 farms containing 61 percent of the land in the Study Area under agreement with conservation districts. Seventy-four percent of these farms have basic conservation plans for the complete development of the soil and water resources on 44 percent of the land. At present, 43 percent of the land is adequately treated.

Table 36--Land treatment measures applied
Big Sioux Study Area

	Units	Total Applied Through 6/30/71	Applied 7/1/70 Through 6/30/71
New Cooperators	No.	17,320	352
	Ac.	4,613,100	130,300
Plans Prepared	No.	12,810	397
	Ac.	3,308,300	119,190
Plans Revised	No.		188
	Ac.		72,690
Land Adequately Treated	Ac.	3,832,900	164,480
Conservation Cropping System	Ac.	3,375,600	122,250
Contour Farming	Ac.	553,200	17,620
Crop Residue Management	Ac.	3,432,100	110,680
Ponds and Dams	No.	10,900	513
Grade Stabilization Structure	No.	281	13
Terraces and Diversions	Mi.	4,164	172
Disposal Lagoons	No.	11	7
Tree Planting 1/	Ac.	46,150	865
Field Shelterbelts	Mi.	2,310	138
Grassed Waterways	Ac.	28,780	790
Drainage Mains and Laterals	Mi.	335	4
Open Field Drains	Mi.	1,840	16
Closed Field Drains	Mi.	2,527	48
Pasture & Hayland Management	Ac.	958,660	38,730
Pasture & Hayland Planting	Ac.	344,310	16,300
Proper Grazing Use	Ac.	303,000	30,590
Wetland Wildlife Management	Ac.	60,400	3,530
Upland Wildlife Management	Ac.	57,700	4,030

1/ Includes farmstead and feedlot shelterbelts

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

The Agricultural Stabilization and Conservation Service (ASCS) administered the Rural Environmental Assistance Program (REAP). This program provided cost-share assistance to farmers and ranchers in implementing soil, water, woodland, wildlife conservation measures, and pollution abatement practices. In 1971, about 6,400 farmers participated in this program. This represents about 30 percent of the farmers in the Study Area. They received a total of $910,000. Since the cost-sharing rate is about 50 percent, about $1,820,000 was spent in applying conservation practices.

The Water Bank Program is a newly developed Agricultural Stabilization and Conservation Service program designed to preserve and improve wetlands for wildlife. It is operational in four counties in the pothole area of South Dakota. The program will make rental payments to farmers who designate certain wetlands for preservation for a ten-year contract period. The farmers sign an agreement not to drain, fill, burn, overgraze, or to otherwise destroy the natural habitat in and around the wetlands. Under the program, the federal government will cost-share with the farmer the costs of improving the area for waterfowl production.

The authority for County ASCS Committees to commit cost-sharing funds to the REAP and Water Bank Programs was terminated December 26, 1972. The long term contracts in effect will be fulfilled.

FARMERS HOME ADMINISTRATION

The programs of this agency strengthen family and rural communities and reduce rural poverty. The principal programs available are:

1. Operating Loans - Operating loans are made to eligible operators of not larger than family farms, to assist them in making improved use of their land and labor resources and make adjustments necessary for successful farming. Operating loans (614) totaling $3,484,000 were made in 1971.

2. Farm Ownership Loans - Farm ownership loans help family farmers obtain the resources needed to improve their living conditions and farm successfully. These loans are made to buy farms, to buy land to enlarge farms, construct or repair buildings, develop domestic water supplies, improve forests, develop fish farming resources, establish recreation enterprises, and refinance debts. In 1971 a total of $5,349,000 was loaned to 169 farmers to buy new farms or to expand their operations.

3. Soil and Water Conservation Loans - Loans are made to eligible individual farm operators and owners to develop, conserve, and make better use of their soil and water resources. In 1971 a total of $29,000 was loaned to nine farmers to develop and conserve the soil and water resources on their farms.

4. Watershed Loans - Watershed loans are made to local organizations to help finance projects that protect and develop land and water resources in small watershed projects. Loan funds may be used to

pay the sponsoring local organizations' share of the cost of flood control dams and reservoirs, water supply reservoirs, rural water supply distribution systems, diversion dams, irrigation canals, drainage facilities, recreation facilities, easements, and similar purposes. In 1971, one loan was made in the amount of $5,900.

5. Comprehensive Water and Sewer Plans - Most counties in the Study Area completed their comprehensive water and sewer plans for rural areas by the end of 1972. These plans should be considered in any development plans for the rural areas. The FHA no longer has funds available for water and sewer planning or development grants.

6. Rural Housing Loans - Rural housing loans are made to low to moderate income farmers and other rural residents in open country and small rural communities with populations of not more than 10,000. Loans are made to construct and repair needed homes and essential farm buildings and to purchase homes or buy sites on which to build homes. In 1971 a total of $2,324,000 was loaned to 253 residents in the Study Area to build or improve their homes. In addition, $594,000 was loaned to 10 residents to build or improve rental properties in small towns or rural areas.

7. Water and Waste Disposal System Loans - Loans for the construction of rural community water and waste disposal systems are made to public bodies and nonprofit organizations. In 1971, seven loans totaling $2,109,000 were made to rural communities.

RESOURCE CONSERVATION AND DEVELOPMENT PROGRAM

Resource Conservation and Development Projects are authorized by Section 102 of the Food and Agriculture Act of 1962, Public Law 87-703. These projects are locally initiated and sponsored to improve the economy and the quality of living in the project area by developing and carrying out a plan of action for the conservation, improvement, and development of human and natural resources of the area. Two applications have been made for RC&D projects covering portions of the Study Area. The Agassiz RC&D Project includes 2,370,000 acres and is about evenly divided between Minnesota and South Dakota on both sides of the Big Stone Lake. The Study Area counties included in the project area are Grant and Roberts. The other RC&D project application is the Dakota Lake Plain RC&D Project covering 4,660 acres and including within its boundaries Study Area counties, Day, Clark, and Marshall.

COOPERATIVE AGRICULTURAL EXTENSION SERVICE

The Cooperative Agricultural Extension work was established by the Smith-Lever Act of May 8, 1914, as amended. The legislation authorizes the Department of Agriculture to give, through the land-grant college, instruction and practical demonstrations in agriculture, home economics, and related subjects and to encourage the application of such information by means of demonstrations, publications, and otherwise,to persons not attending or resident in the collgges. Extension educational work is also authorized under the Agricultural Marketing Act of 1946.

The basic job of the Cooperative Extension Service is to help people identify and solve their farm, home, and community problems through use of research findings of the Department of Agriculture, the state land-grant colleges, and programs administered by the Department of Agriculture.

COOPERATIVE STATE-FEDERAL FORESTRY PROGRAMS

Cooperative state-federal forestry programs are active in South Dakota, Minnesota, and Iowa for woodland management, forestation, fire protection, and watershed management. Woodland management assistance is available to small woodland owners and small processors of primary forest products through the Cooperative Forest Management Act of 1950. Tree planting is encouraged through several federal-state programs. Records of the Soil Conservation Service indicate that about 865 acres of trees and about 138 miles of field shelterbelts were planted during the 1971 planting season. The cumulative total of trees planted in the Study Area with SCS assistance is 45,150 acres and 2,310 miles of field shelterbelts. Many of the tree plantings are farmstead feedlot shelterbelts.

Section 4 of the Clark-McNary Act of 1924 gives the U.S. Forest Service authority to cooperate with the states in growing and distributing tree seeds and planting stock to farmers and ranchers.

The Agricultural Act of 1956, Title IV, charges the Forest Service to assist states in bringing into production commercial forest land not adequately stocked with marketable tree species.

The Watershed Protection and Flood Prevention Act, Public Law 566, provides for planning and application of watershed protection and erosion control treatment measures on forest lands.

The Cooperative Forest Management Act of 1950 provides for programs designed to give assistance to private forest owners, especially owners of small woodlands. It also provides for assistance to loggers and processors of primary forest products.

Section 2 of the Clark-McNary Act of 1924 provides authority for cooperative fire control. Under the Clark McNary Act, the states and the federal government have joined to provide for, or make available, adequate fire control on nonfederal lands; the federal government can match state and private expenditures up to 50 percent. The Forest Service cooperates and gives technical assistance in forestry measures to private landowners following the usual policy of working through the State Forester.

U.S. FISH AND WILDLIFE SERVICE

The United States Fish and Wildlife Service, through the Bureau of Sport Fisheries and Wildlife of the Department of Interior, has direct responsibilities for programs which affect fish and wildlife. Their programs include the management of the Waubay National Refuge in Day County, South Dakota. This refuge has 4,651 acres of true prairie with potholes, lakes and inclusions of mixed deciduous natural woodlands. It is managed to perpetuate the nation's migratory bird resources.

The Bureau of Sport Fisheries and Wildlife also administers the wetlands acquisition program enacted by Public Law 87-7383. This law enables the Bureau to preserve, through a program of fee title acquisition or perpetual easement, endangered wetlands in a three-state area (South Dakota, North Dakota, Minnesota) of the United States. Nearly 200 different sites with a combined area of about 10,000 acres have been acquired within the Study Area. All of the Study Area, except the Iowa portion, is within the program area. Acquired sites are developed and managed to perpetuate and improve conditions for all wildlife species, with particular emphasis on waterfowl. Public hunting is also provided on these sites. Through the perpetual easement program, wetlands are protected against draining, filling, and burning. The owner continues to use and control access to these sites. The Bureau negotiates a single payment to the owner for easements.

Wetlands have been obtained through this program only in the South Dakota portion of the Study Area. To date, title has been obtained on more than 18,000 wetland acres and easements on an additional 43,000 acres. The Bureau completed a study report entitled, "Fish and Wildlife Resources of the Big Sioux River Basin" dated May 1970.

U.S. ARMY CORPS OF ENGINEERS

The Corps of Engineers has constructed a flood control project for the city of Sioux Falls. The project consists of a diversion channel to carry a major portion of flood flows of the Big Sioux River around the city and channel modification and diking along portions of the existing Sioux River and Skunk Creek in or near Sioux Falls. The Corps has also provided flood protection to the town of Hawarden, Iowa, from a tributary stream, with a flood diversion channel.

The Corps, over the past several years, has made studies in the Big Sioux River Basin. Initially a study was made for a local protection project for Sioux City-North Sioux City. This project consists of channel modification and enlargement of the lower 5.5 miles of the Big Sioux River.

The Flood Control Act of 1965 authorized construction of a project to improve the channel of the Big Sioux River from its mouth to a point about two miles north of Akron, Iowa. Over the objections of the State of Iowa, the project was authorized with the stipulation that an acceptable fish and wildlife mitigation plan be developed and that the project be compatible with a flood control plan for the Upper Big Sioux River channel modification project.

In 1964 the Corps initiated a study of the Big Sioux River Basin above the mouth of Rock River, including the Rock River drainage. The purpose was to provide reservoir storage for flood control, municipal and industrial water supply, water quality enhancement, irrigation, recreation, and fish and wildlife benefits. Initially, 11 reservoir sites were considered for evaluation. The locations of these sites are shown on Map No. 11. Further study eliminated six of these eleven sites. The five remaining sites include the Flandreau Reservoir and the Canton

Reservoir on the Big Sioux River; Skunk Creek Reservoir near Hartford, South Dakota; the Little Rock River Reservoir and the Rock River Reservoir near Doon, Iowa.

Following the flood of 1969, the City of Watertown requested the Corps, through the Small Flood Control Project, to investigate the possibility of providing local protection works for the city. This study is in progress.

BUREAU OF RECLAMATION

The Bureau has made, and is continuing to make, studies and investigations in the Big Sioux River Basin, mainly for the purpose of irrigation and municipal and industrial water. Two of the studies involved the importing of water from outside the Study Area. One proposal was to bring water from the Missouri River in the vicinity of Gavins Point Dam; a second proposal was to use the facilities of the Oahe Irrigation Project by importing water from the proposed Byron Lake Reservoir.

The Bureau has made a study of a proposed reservoir on Slip Up Creek for the purpose of providing municipal and industrial water supply for the city of Sioux Falls. This would include a pumping plant to provide water to the reservoir during high flows on the Big Sioux River. This project will also provide recreational benefits due to its location. The Bureau is also conducting studies relative to the availability of underground water supply and the availability of suitable land for irrigation.

RURAL ELECTRIFICATION

The East River Electric Power Cooperative and member cooperatives serve much of the South Dakota and Minnesota portion of the Basin. The Iowa portion is served by the Northwest Iowa Power Cooperative and the Lyon and Osceola Power Cooperative. The East River Electric Power Cooperative estimates that their power load will probably double in the next 12 years.

PROJECTS OF CONSERVANCY SUB-DISTRICTS

The East Dakota Conservancy Sub-District, with headquarters at Brookings, South Dakota, covers almost all the South Dakota portion of the Study Area. Conservancy subdistricts are provided for in Chapters 46-17 and 48-18, South Dakota Compiled Laws, 1967.

Conservancy subdistricts were created for the purpose of proceeding with the construction of water resource facilities for its conservation, storage, distribution, and utilization for multiple-purposes in order to provide for the future economic welfare and prosperity of people in the district; to provide for the irrigation of lands periodically afflicted with drought, thereby stabilizing crop production; to replenish and restore the depleted waters of lakes, rivers, streams, and underground waters; to reserve within the district, for present and future beneficial uses, all waters within the boundaries; to provide flood protection, navigation, erosion control; and in all other ways, to conserve, regulate, and control the waters in the district.

The East Dakota Conservancy Sub-District, showing their interest and cooperation, contributed $20,000 to this Type IV Study.

DRAINAGE AND SPECIAL PURPOSE DISTRICTS

In Minnesota, the county boards and the district courts are authorized to construct and maintain public drainage systems. Such boards and courts are also authorized by statute to improve natural channels or construct and maintain drainage ditches for the purpose of increasing the production on wet lands.

The public water policy underlying the drainage legislation is the reclamation of land by the removal or management of surface water.

In Iowa, special purpose districts may be formed to construct improvements for drainage of surface waters or the protection of land from overflow in conformity with an official plan filed with the county auditor and approved by the county board of supervisors. Districts may be formed by petition. Many drainage districts have been established in Iowa. Some of these districts are inactive since completion of the original construction while others have maintained continuing programs. Presently there is no state agency in Iowa to regulate, coordinate, or record activities of drainage districts.

In South Dakota, drainage districts are created through local petition, public hearings, favorable vote of the electorate of the proposed district, certification by the creating of public entity, and formal documentation of the creating actions. When any drainage system has been established and the improvement constructed, it is under the jurisdiction and supervision of the board of county commissioners. The financing and management of drainage districts is designed for local construction and operation and, therefore, are not appropriate subdivisions of state government to sponsor federal water projects. In the South Dakota portion of the Study Area, 102 drainage districts have been formed under this law.

STATE AND PRIVATE DEVELOPMENTS FOR RECREATION, FISH, AND WILDLIFE

The South Dakota, Minnesota, and Iowa state game and fish agencies have the responsibility for the protection and management of the fish and wildlife resources in their respective states.

The Minnesota Department of Natural Resources owns 13 wildlife management areas totaling 1,737 acres within the Big Sioux Study Area. These areas are managed for wildlife production and public hunting. This Department also has a program within the Study Area which encourages the development of wildlife habitat on private lands. This is accomplished by cost-sharing developments with the private landowner. The Minnesota program supplements the USDA cost-sharing program.

The Iowa Conservation Commission owns four wildlife production and public hunting areas in the Study Area. These areas total 514 acres. Iowa also has a farmer-sportsman cooperative program whereby emphasis is placed on the development, improvement, and management of wildlife habitat on private lands. It is a cooperative program between the farmer, a local sponsoring organization, the Soil Conservation Service, and the Iowa Conservation Commission.

The South Dakota Department of Game, Fish and Parks owns 253 game production and public shooting areas comprising 53,800 acres in the Study Area. Also within the South Dakota portion are 154 meandered lakes comprising 124,300 acres. South Dakota obtained ownership of these lakes at the time of statehood. They are held in trust for public use by the state with administration by the Department of Game, Fish and Parks.

The Department, through its Wildlife Habitat Improvement Program (WHIP), also provides technical and cost-sharing assistance to farmers for the development and management of habitat on private lands. This program is a supplement to existing USDA Programs.

Private organizations such as the Izaak Walton League and other sportsmen's clubs have developed programs of interest and leadership involving fish and wildlife resources. These organizations sponsor programs, provide information pertaining to resource management, counsel with public agencies and, in general, publicize and add emphasis to the need for a public awareness and involvement in resource management. Some of these clubs may own land and water for the production and harvesting of wildlife. There are no known private organizations or persons operating recreation, fish or wildlife enterprises exclusively for profit.

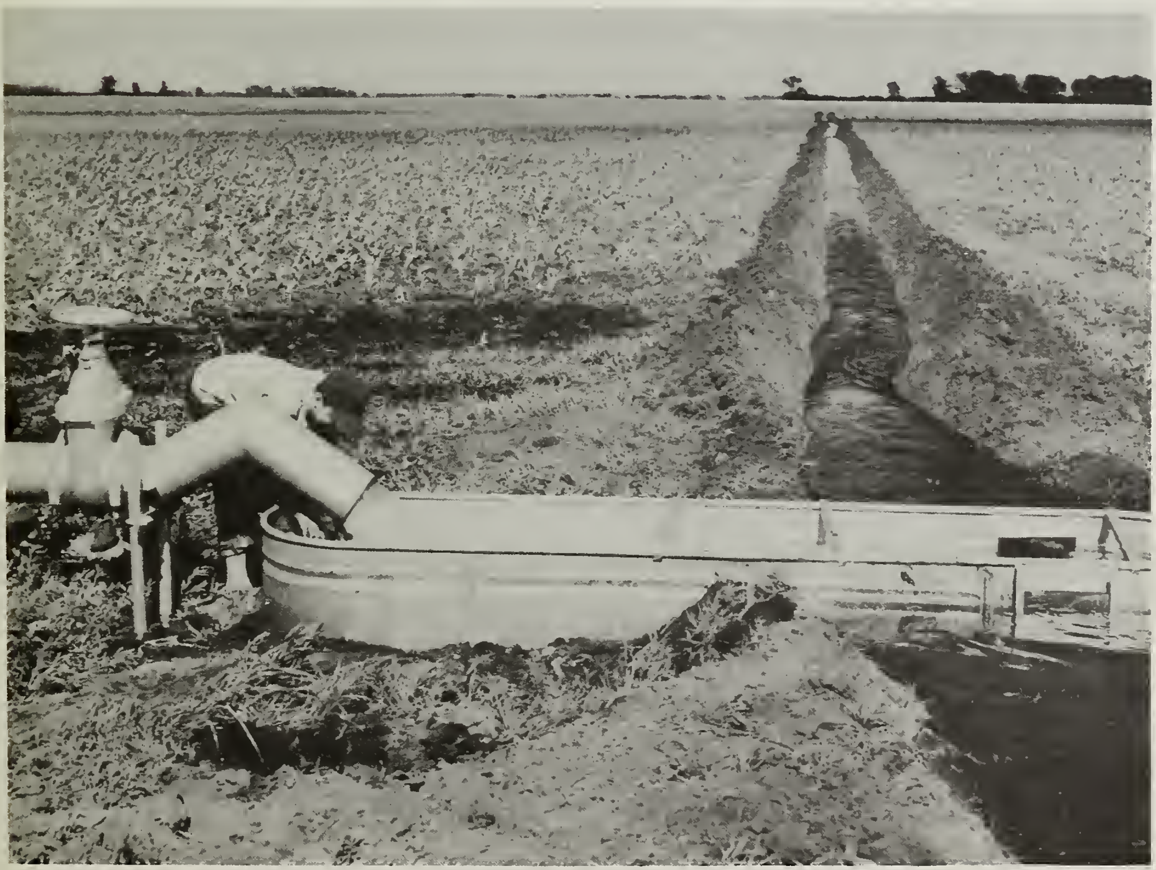
REGIONAL PLANNING AND DEVELOPMENT DISTRICTS

Multicounty planning agencies have been developed to identify problems inhibiting the orderly growth and development of the states' natural and human resources. It is their purpose to propose solutions and to seek federal, state, and local assistance and cooperation in solving these problems. Planning and Development District No. 1 is the first of these planning units to be established in South Dakota. It is intended that this planning unit will be a Model Rural Development Program illustrating that rural planning is an essential aid in the development of rural areas. The counties included in Planning and Development District No. 1 are Grant, Clark, Codington, Hamlin, Deuel, Kingsbury, Brookings, Miner, Lake, and Moody. These counties are all within the Big Sioux Study Area.

The loss of population within the area is the major concern of Planning and Development District No. 1. The District is seeking methods of stemming the outflow and adjusting to the new patterns of population distribution. They are seeking solutions to problems of transportation, education, urban development, health and medical facilities, recreation and resource development.

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

SPRINKLER IRRIGATION BOOSTS CORN YIELDS.



PUMPING FROM SHALLOW WELL FURNISHED WATER FOR GRAVITY IRRIGATION.

BEFORE - GULLY DAMAGING PASTURE AND THREATENING BUILDINGS.

AFTER - SAME GULLY CONTROLLED BY STRUCTURE AND BY SHAPING AND SEEDING, ABOVE STRUCTURE.

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Water and land resources of the Study Area have the physical potential for development to solve identifiable problems and needs of the people and their environment.

AVAILABILITY OF LAND

Sufficient land is available to permit a wide range of adjustments in land use. Increased land use for urban and industrial expansion, transportation, and recreational areas can be satisfied by conversion of agricultural land. The reduction of the agricultural land base is expected to be 34,000 acres by year 1980; 24,700 additional acres by 2000; and another 27,400 acres by 2020. See Table 2. The loss of production from agricultural land will be compensated by increased crop production through improved technology.

IMPOUNDMENTS

It is estimated there is a physical potential for 75 percent, or 300 reservoir sites, of the 400 needed. The main purpose for these reservoirs is flood prevention. Most of these sites have additional storage potential for recreation, fish and wildlife, irrigation, water quality control, municipal and industrial uses.

It is estimated that the total drainage area controlled by the 300 upstream reservoir sites is 3,000 square miles. The total potential storage capacity for these reservoirs is estimated to be 640,000 acre-feet. This includes 480,000 acre-feet for flood prevention, 80,000 acre-feet for sediment, and 80,000 acre-feet for conservation storage based on an 80 percent chance yield from the controlled drainage area. Some of the tributary watersheds have additional potential reservoir sites in their lower reaches. Map No. 11 shows 80 potential reservoir sites that were investigated in the Study Area. Also shown are sites investigated by the Corps of Engineers and Bureau of Reclamation.

There are physical potentials for the control of major gully erosion and land stabilization problems located primarily in the loess area in the southern portion of the Study Area. It is estimated that different types of structural measures in combination with land treatment measures will be needed to control major gullies and other land stabilization problems. Table 26 shows the location and extent of these major gully problems.

Acquiring landrights for the potential reservoir sites would probably be more difficult than obtaining the landrights for gully control structures.

CHANNEL MODIFICATION

There is a potential for the modification of the estimated 1,200 miles of multipurpose channels for flood prevention and drainage. The amount of control achieved by floodwater retarding reservoirs will determine the amount of channel modification needed. This would be determined by actual floodroutings.

In some areas, where adequate floodwater retarding reservoir sites are available, channel modification would be limited to restoring the existing channel to its original capacity by removing accumulated sediment. Some deepening of channels will be required in certain areas to provide adequate outlets for on-farm drainage systems.

In other areas, major channel work including realignment and enlargement will be needed for adequate flood protection due to the absence of any potential for control by floodwater retarding reservoirs.

There is a potential for channel modification for drainage in many tributary watersheds. These areas vary from the draining of existing cropland where production is limited by excess surface water or high water table, to the draining of areas in pastures which have potential for conversion to cropland. Channel modifications need to be based on a careful assessment of functional requirements of the project and a justification that considers environmental and economic values. The functional and economic aspects must be considered in terms of their effect on the environmental aspects of the project.

WATER TABLE CONTROL

As indicated in the "Problem Section", a problem of excessive moisture exists on 1,060,000 acres of agricultural land of which 718,000 acres are presently cropped. This constitutes a significant potential for improvement and can be accomplished by either open ditches or tile drainage, providing suitable outlets are available. Open ditches are least expensive to install but remove land from production and have relatively high maintenance costs. Tile drains are more expensive to install but do not take land out of production and, if well planned and constructed, require little maintenance. Detailed investigations would determine whether open ditches or tile drains would be more beneficial.

There is also a potential to provide drainage measures to the 339,000 acres of cropland as shown in Table 28. Also, if large acreages are developed for irrigation there probably will be a need for drainage measures on much of this land.

IRRIGATION DEVELOPMENT

The most important factor in determining the potential for irrigation is the availability of land with an adequate supply of water. There are over one million acres of land in the Study Area suitable for irrigation. However, the total available water supply, including surface and ground water, would support only about one-half million acres.

It is estimated that 260,000 acres of land suitable for irrigation overlies ground water aquifers. This land is located along, and adjacent to, the Big Sioux and Missouri River flood plains. Ground water depths and estimated yields vary from area to area; information in geological reports indicates there is sufficient ground water to irrigate this amount of land. (See Map No. 9.) Although there is a large potential for irrigation, actual development may be limited by other factors such as quality of available ground water and the degree of farmers'acceptance of irrigation.

In years of normal rainfall, most farmers are satisfied with their production. In dry years, farmers may consider irrigation as a means of stabilizing and raising their net income. The current initial cost of developing irrigation is usually in excess of $100 per acre and, depending upon the system used, labor costs may increase the farmer's investment. In addition, irrigators usually find that a high degree of skill is involved with proper management of irrigation water. For these reasons, irrigation development may not be as great as Table 28 indicates. In those instances where the above limiting conditions do not prevail, most irrigation systems will be individual farm systems using ground water located in or near the fields to be irrigated. Where deeper, more expensive wells are needed, small groups of farmers may cooperate in developing a system.

It is estimated there is sufficient surface runoff to irrigate about 164,000 acres. The availability of storage reservoirs is a limiting factor. To include irrigation storage in all of the potential reservoir sites would not be practical as many would not have sufficient capacity, the drainage area may be too small for an assured water supply, and there would be difficulty in conveying water from the reservoir to the irrigable lands. Investigations for project-type irrigation developments were not made in this study.

Seven thousand acres of land are presently being irrigated by private developments. About 80 percent is from ground water sources and the remainder is from streams or lakes. It is expected that much of the future developments will be by private operators. If the present rate of irrigation development continues, as much as 125,000 acres could be under irrigation by 2000.

RECREATION, FISH, AND WILDLIFE

There is considerable potential for the development of land and water resources which have specific or complementary benefits for fish and wildlife. However, the rate of development will depend on available funds and landowner and public support. USDA programs can be expected to facilitate the development of potential practices that will have direct and indirect benefits for wildlife. Based on the record of past accomplishments, those having direct fish and wildlife benefits will have the following annual rates of accomplishment in the Study Area:

1.	Farmstead and Feedlot Windbreaks	750 acres
2.	Field Windbreaks	150 miles
3.	Wildlife Watering Facilities	25 facilities
4.	Field Border Plantings	60,000 feet
5.	Farm Ponds	875 ponds
6.	Wildlife Habitat Development	3,000 acres
7.	Wildlife Wetland Development	750 acres

The greatest overall benefits for fish and wildlife will be derived from conservation treatments and management that are annually accomplished for other than direct benefits to fish and wildlife. These will involve the many measures applied to control runoff and erosion and to properly manage forage plants.

In every potential watershed studied there are potential sites for creating new marsh habitat through structural measures. In nearly every watershed there is a potential for improving existing marsh habitat by storing additional water or by creating open water areas. In five of the watersheds studied there is a potential for the restoration of partially drained marshes by blocking existing drainage outlets. Table 37 shows the potential for improving wildlife habitat in each of the watersheds investigated. To realize these potentials within a PL 566 watershed project, local sponsors must be willing and able to contribute 50 percent of the landrights and construction costs and be responsible for operating and maintaining these measures. There are many additional potentials for improving wildlife habitat outside the watersheds investigated.

In 13 of the 23 watersheds intensively studied there are structure sites which have potential for recreation developments. Table 37 identifies the watersheds where these sites exist. In each of these potential structures there is a potential for developing new fishing waters. Map No. 11 shows additional sites, most of which also have a potential for further recreational development. These potential recreation sites can be developed under PL 566 after it is established that the structure is needed for flood control or agricultural water management. Recreational developments can then be created when local sponsors are willing and able to contribute one-half of the construction costs allocated to the recreation pool and one-half of the costs of the needed recreational facilities. The local sponsors must also agree to operate, maintain, and replace the recreational facilities.

Watersheds that have been investigated for their fish and wildlife and recreational potential are shown in Table 37. Other watersheds not investigated may have similar potentials. The potential reservoir sites shown on Map No. 11 would have some potential for fish, wildlife, and recreational uses.

COOPERATIVE STATE-FEDERAL FORESTRY PROGRAM

A number of opportunities exist for landowners to use cooperative state-federal forestry programs to obtain technical assistance for forest management and/or financial assistance to provide trees and plant shelterbelts and windbreaks; to supply trees for planting areas best adapted to forest production; to thin and improve timber stands; and to provide fire protection.

Funds to assist landowners with the installation of the proposed practices are supplied by both state and federal agencies. Total cost of the proposed improvements have been included in the land treatment section of this chapter.

Table 37--Watersheds investigated and their potentials for improving recreation, fish, and wildlife Big Sioux Study Area

Name of Watershed	Improvement of Habitat				
	Establishing New Fishing Waters	Establishing Marsh Habitat	Improving Existing Marsh Habitat	Restoring Marsh Habitat	Recreation Potential
LaBolt Tributary		X			
Snake Creek		X	X	X	
Marsh Lake			X	X	
Dempster Creek		X			
North Deer Creek		X	X		
Six Mile Creek	X	X	X	X	X
Deer Creek	X	X	X		X
Volga Tributaries		X	X	X	
Medary Creek	X	X	X		X
Pipestone Creek		X	X	X	
West Pipestone Creek	X	X			X
Otter Creek		X	X	X	
Skunk Creek	X	X	X	X	X
Beaver Creek	X	X	X		X
Upper Rock Creek	X	X	X	X	X
Champepedan Creek	X	X			X
Peg Munky Run	X	X			X
Beaver Creek, Minn.	X	X			X
Broken Kettle Creek		X			
Chanarambie	X	X	X		X
Kanaranzi		X	X	X	
Little Rock Creek	X	X	X	X	X
Flandreau Creek	X	X	X		X

The following tabulation lists the major opportunities for land treatment measures on state and private lands for the next 10 to 15 years:

Table 38--Opportunities for state-federal forestry land treatment measures for the next 10 to 15 years
Big Sioux Study Area

Item	Unit	Amount
Timber surveys and plans	Acres	25,000
Forest management technical assistance for timber harvesting, thinning, prunning, and releasing	Acres	5,000
Distribution of seedling trees for reforestation, shelterbelts, and windbreaks	Trees	6,000,000
Tree seeding and planting	Acres	5,000
Shelterbelts and windbreaks	Miles	1,200
Maintain and improve fire control programs (forest and pasture)	Acres	1,000,000
Cooperative watershed protection and flood prevention program	Acres	1,000

Most of the forest land treatment can be installed on cost-sharing basis through cooperation with the State Forester. Measures installed are to be maintained by the landowners and operators. Since most of the merchantable volume and desirable species have been liquidated, the present average merchantable timber volumes are below those desired for industrial developments. However, there is some increased interest in localized areas, especially in the eastern portion of the area, to improve forest management, timber quality, wildlife habitat, and recreation opportunities.

WATER QUALITY CONTROL

The greatest potential for improving water quality in most streams and lakes in the Study Area is through control of pollutants at their source. Effective erosion control measures applied on the land would significantly reduce the sediment load in streams and lakes. These measures, along with the proper use of fertilizers, insecticides, and herbicides, would reduce the possibility of contamination. Low-flow augmentation would help alleviate anticipated water quality problems associated with effluent from feedlots, urban, and industrial wastes.

LAND TREATMENT AND ADJUSTMENTS

Land treatment measures need to be installed on 57 percent of the agricultural land. This includes 54 percent of the cropland; 71 percent of the pasture and range; 53 percent of the forest and woodland; and 26 percent of other agricultural land.

The potential use of land according to its capability would result in converting 979,000 acres of Class I, II, and III land, presently in pasture and range, to cropland. About 112,300 acres of Class V, VI, and VII cropland should be changed to less intensive uses. Some 141,500 acres of Class IV cropland needing treatment should also be changed to less intensive uses.

All agricultural land inadequately treated or not used within its capability has the potential for receiving adequate conservation management and treatment. Although this is the ultimate goal, only the amount of treatment that can be expected to be applied by year 2000 is used for this analysis.

The current and projected land treatment potential for the Big Sioux Study Area is shown in Table 39. It is estimated that the acreage of agricultural land adequately treated will increase from the present 3,103,000 acres to 5,366,900 acres by year 2000, or from 43 percent to 76 percent. Adequately treated cropland acreage will increase from the present 2,510,000 acres to 3,975,200 acres by year 2000, or from 46 percent to 74 percent. Comparable values for pasture and range, forest and woodland, and other agricultural land are shown in Table 39.

Table 39--Current and Projected status of agricultural land treatment - 2000
Big Sioux Study Area

Land Use	Current Total Acreage	Current Adequately Treated Total	Current Adequately Treated Percent	Projected Acreage 2000	Projected Land Treatment: Proper Mgmt.Pract.	Projected Land Treatment: Proper Mgmt.& Veg. or Mech. Pract.	Projected Land Treatment: Sub-Total	Projected Adequate Treatment by 2000: Total	Projected Adequate Treatment by 2000: Percent
	-- 1,000 Acres --		--- % ---	------ 1,000 Acres ------					-- % --
Cropland	5,445	2,510	46	5,400.1	743.6	721.6	1,465.2	3,975.2	74
Pasture & Range	1,455	422	29	1,443.9	636.5	113.8	750.3	1,172.3	81
Forest & Woodland	49	23	47	48.4	19.8	-0-	19.8	42.8	88
Other Ag. Land	199	148	74	197.4	14.0	14.6	28.6	176.6	89
Total Ag. Land	7,148	3,103	43	7,089.8	1,413.9	850.0	2,263.9	5,366.9	76

CHAPTER 8

OPPORTUNITIES FOR DEVELOPMENT AND IMPACTS OF USDA PROGRAMS

OPPORTUNITIES FOR DEVELOPMENT AND IMPACTS OF USDA PROGRAMS

SMALL WATERSHED PROJECTS - PL 566

The most immediate opportunity for watershed protection and flood prevention is to complete the land treatment and structural measures on the on-going watershed projects approved for operation. Pertinent data for these structural measures, including costs, are summarized in Table 35.

Further opportunities to reduce erosion, floodwater and sediment damages, and to preserve and protect the land, water, wildlife and related resources are available by implementing the 16 feasible watersheds within the next 10 to 15 years. Watershed Investigation Reports were prepared for each of the 16 watersheds and are included in a separate appendix. The proposed works of improvement in these watersheds include 12 floodwater retarding structures, 4 of which are multipurpose and include recreation, and a total of 344 miles of multipurpose channel modification for flood prevention and agricultural water management. These 16 watersheds have a total drainage area of 2,266 square miles. Physical and economic data are shown in Tables 40 and 41. (See Map No. 12 for location of projects.)

The proposed 12 floodwater retarding structures, located in 7 of the 16 watersheds, control a drainage area of 263 square miles. The retarding reservoirs are designed to detain the runoff from a 25-to 50-year frequency storm event. Total floodwater detention storage in these reservoirs is 40,000 acre-feet; an additional 5,010 acre-feet is allotted to sediment storage. The recreation storage in the 4 multipurpose reservoirs is 5,670 acre-feet and the water surface area is 782 acres.

The 344 miles of channel modification are designed to remove the excess runoff from a 10-year frequency storm in 24 hours. Channel modification will also provide outlet conditions for individual and group farm drainage systems.

The total installation cost of the structural measures in the 16 feasible watersheds is $12,934,900 which includes $12,257,400 for flood prevention, $416,100 for drainage, and $261,400 for recreation. Estimated federal and nonfederal costs are $10,261,300 and $2,673,600, respectively. (See Table 42.) In addition, the estimated nonfederal costs for operation and maintenance is $111,790 annually.

Average annual benefits expected from the 16 feasible watersheds are estimated to be $1,348,690. This includes floodwater and sediment damage reduction benefits of $206,290; recreation benefits of $84,530; changed and more intensive land use benefits of $796,800; and secondary benefits of $261,070. The average annual benefits ($1,348,690) to the average annual costs (747,800) is 1.8 to 1. (See Table 41.)

Table 40--Summary of structural measure data - quantities and costs
for the feasible watersheds
Big Sioux Study Area

Delineated Watershed Identification		Drainage Area	RESERVOIR DATA										CHANNELS			Total 1/ Structural Installation Cost
					Storage Capacity				Watersurface Area (Top of Pool)							
			No.	Drainage Area Contrld.	Sediment	Rec.	Flood Water	Total	Sediment	Rec.	Flood Water	Installation Cost	Length	Land Rights	Installation Cost	
Number	Name	Acres		Sq. Mi.	Ac.Ft.	Ac.Ft.	Ac.Ft.	Ac.Ft.	Acs.	Acs.	Acres	$1,000	Miles	Acres	$1,000	$1,000
7 -22	LaBolt Tribs.	25,600	-	-	-	-	-	-	-	-	-	-	8	150	204	204
30 -12	Snake	42,140	-	-	-	-	-	-	-	-	-	-	36	580	464	464
31 -10	Marsh Lake	38,400	-	-	-	-	-	-	-	-	-	-	15	300	414	414
31 -16	Dempster	20,480	-	-	-	-	-	-	-	-	-	-	8	150	242	242
31 -21	North Deer	78,720	1	13.2	370	-	2,030	2,400	65	-	200	198	36	700	832	1,030
31 -22	Six Mile	48,640	2	31.0	810	-	4,530	5,340	142	-	500	522	14 2/	360	620	1,142
31 -24	Deer	60,800	2	61.3	690	3,900	10,490	15,080	120	420	750	560	13	260	310	870
31 -25	Volga Tribs.	104,580	-	-	-	-	-	-	-	-	-	-	7	160	337	337
31 -26,27	Medary	83,840	1	30.2	780	-	4,400	5,180	120	-	490	408	24	760	580	988
31 -36,37	Pipestone	144,640	-	-	-	-	-	-	-	-	-	-	34	870	1,916	1,916
31 -40	W. Pipestone	58,240	-	-	-	-	-	-	-	-	-	-	10	230	306	306
31a-42	Otter	132,000	-	-	-	-	-	-	-	-	-	-	51	1,130	1,330	1,330
31 -45,49	Skunk	407,680	2	50.5	1,230	720	6,820	8,770	198	100	940	536	18	230	677	1,213
31 -61	Beaver	80,640	-	-	-	-	-	-	-	-	-	-	13	250	487	487
31a-01	Upper Rock	72,960	2	49.3	750	490	7,340	8,580	160	185	830	454	28	550	470	924
31a-09	Champepedan	51,200	2	27.6	380	560	4,160	5,100	74	77	510	576	29	550	492	1,068
	Total	1,450,560	12	263.1	5,010	5,670	39,770	50,450	879	782	4,220	3,254	344	7,230	9,681	12,935

1/ Price Base - current construction costs
2/ Includes 2.1 miles of floodway through the city of Brookings

Table 41--Average annual benefits and costs of structural measures for the feasible watersheds
Big Sioux Study Area

Delineated Watershed Identification		AVERAGE ANNUAL BENEFITS					AVERAGE ANNUAL COSTS 1/		
		Flood Water Sediment	Recreation2/	Changed & More Intensive Land Use	Secondary	Total	Amortization of Installation Cost	Operation & Maint. Cost	Total
Number	Name	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
7 -22	LaBolt Tribs.	1,440	-	7,620	2,220	11,280	10,010	2,000	12,010
30 -12	Snake	-	-	55,390	12,940	68,330	22,840	4,550	27,390
31 -10	Marsh Lake	15,000	-	18,750	9,920	43,670	20,360	3,650	24,010
31 -16	Dempster	1,480	-	11,360	3,010	15,850	11,880	1,850	13,730
31 -21	North Deer	13,370	-	139,090	36,500	188,960	50,620	9,540	60,160
31 -22	Six Mile	29,610	-	74,330	15,990	119,930	56,140	7,340	63,480
31 -24	Deer	16,830	16,500	38,180	15,100	86,610	42,800	4,750	47,550
31 -25	Volga Tribs.	-	-	64,350	26,010	90,360	16,570	2,500	19,070
31 -26,27	Medary	18,560	-	114,820	31,770	165,150	48,600	8,630	57,230
31 -36,37	Pipestone	34,310	-	74,450	25,680	134,440	94,190	20,120	114,310
31 -40	W. Pipestone	2,730	-	35,180	11,460	49,370	15,040	2,900	17,940
31a-42	Otter	24,420	-	38,160	16,180	78,760	65,370	16,500	81,870
31 -45,49	Skunk	15,600	18,030	52,500	18,920	105,050	59,660	8,660	68,320
31 -61	Beaver	8,930	-	12,950	6,100	27,980	23,970	3,910	27,880
31a-01	Upper Rock	6,360	25,000	30,470	16,710	78,540	45,450	6,600	52,050
31a-09	Champepedan	17,650	25,000	29,200	12,560	84,410	52,510	8,290	60,800
	Total	206,290	84,530	796,800	261,070	1,348,690	636,010	111,790	747,800

Source: Watershed Investigation Reports

1/ Price Base - Estimated 1980 construction costs, adjusted normalized prices are for benefits and operation and maintenance. Installation cost amortized at 4-7/8% over 100 years.

2/ Benefits have been reduced to reflect an average annual cost for basic facilities.

Table 42--Cost-sharing summary of feasible watersheds
Big Sioux Study Area

Delineated Watershed Identification		Structure (Facility) Purpose						Total		
		Flood Prevention 1/		Drainage		Recreation				
Number	Name	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	Federal	Non Federal	Grand Total
		Dollars								
7 -22	LaBolt Tribs.	145,100	54,400	1,800	2,300	0	0	146,900	56,700	203,600
30 -12	Snake Creek	315,500	116,400	14,250	18,350	0	0	329,750	134,750	464,500
31 -10	Marsh Lake	298,000	101,600	6,400	8,100	0	0	304,400	109,700	414,100
31 -16	Dempster Creek	150,800	83,500	2,850	4,450	0	0	153,650	87,950	241,600
31 -21	North Deer Creek	810,900	131,200	45,250	42,150	0	0	856,150	173,350	1,029,500
31 -22	Six Mile Creek	924,400	195,100	11,600	10,700	0	0	936,000	205,800	1,141,800
31 -24	Deer Creek	619,950	101,050	12,800	15,000	71,000	50,600	703,750	166,650	870,400
31 -25	Volga Tribs.	213,100	93,500	12,800	17,600	0	0	225,900	111,100	337,000
31 -26,27	Medary Creek	736,400	208,400	21,300	22,300	0	0	757,700	230,700	988,400
31 -36,37	Pipestone Creek	1,627,900	239,800	24,950	22,950	0	0	1,652,850	262,750	1,915,600
31 -40	W.Pipestone Creek	221,200	75,600	4,050	5,050	0	0	225,250	80,650	305,900
31a-42	Otter Creek	1,112,900	190,100	13,500	13,000	0	0	1,126,400	203,100	1,329,500
31 -45-49	Skunk Creek	875,850	276,550	7,300	6,800	27,400	19,400	910,550	302,750	1,213,300
31 -61	Beaver Creek	301,600	181,000	1,800	3,000	0	0	303,400	184,000	487,400
31a-01	Upper Rock River	707,050	177,650	7,300	9,200	13,300	9,800	727,650	196,650	924,300
31a-09	Champepedan Creek	847,500	123,400	12,500	14,700	41,000	28,900	901,000	167,000	1,068,000
	Total	9,908,150	2,349,250	200,450	215,650	152,700	108,700	10,261,300	2,673,600	**12,934,900**

1/ Includes floodwater retarding structures and channel modification

An important phase of a small watershed project is the land treatment program planned to be installed before, or concurrently with, the structural measures. In the 16 watersheds it is expected that 224,200 acres will be treated at an estimated cost of $3,185,000. This includes 155,900 acres through an accelerated program and 68,300 acres through the on-going program. The planning and application of these practices will be accomplished with technical assistance from the Soil Conservation Service and Forest Service. The estimated cost for this assistance is $946,800 of which $651,300 is expected from accelerated land treatment funds (PL 566) and the remaining $295,500 from the on-going program funds. Data on the land treatment needed for early action PL 566 projects for accelerated and on-going programs is shown in Table 43.

APPLICATION OF LAND TREATMENT MEASURES

The application of needed land treatment measures is the primary consideration for full resource conservation and development. If land treatment is to fulfill its essential role in proper resource use and development, it will have to be applied at an accelerated rate. It is estimated that from 1971 to 2000 an additional 2,263,900 acres of agricultural land will be treated with current application rates. This would make a total of 5,366,900 acres that would be adequately treated by 2000, and would represent 76 percent of the total agricultural land in the Study Area. The estimated cost of applying this land treatment is 31.5 million dollars. To apply land treatment to the additional 1.7 million acres would require accelerating the present rate. This would cost an additional $12 million.

All of the land in the Study Area is within soil conservation districts. The U. S. Department of Agriculture, through the Soil Conservation Service; the Forest Service in cooperation with the State Forester; the Extension Service, and other agencies of the Department, has established a cooperative relationship with each district. The purpose is to provide technical assistance to cooperating landowners and operators for the planning and application of land treatment measures and the proper management and use of the soil and water and other related resources within the districts.

Financial assistance for the application of land treatment measures has been furnished through the Rural Environmental Assistance Program (REAP) administered by the Agricultural Stabilization and Conservation Service, USDA. This cost-sharing assistance has averaged about 50 percent of the cost of installing these environmental conservation practices. Requests from individual landowners for this program have often exceeded funds available. The funding activity under REAP was terminated December 26, 1972.

The estimated costs for technical services for the planning and application of the land treatment measures on the 2,263,900 acres of agricultural land is about $9.4 million. The estimated cost for planning and application on the additional 1.7 million acres is $7.1 million. The kind and amount of land treatment measures to be applied under the 16 PL 566 projects and the on-going PL 46 program are shown in Table 43.

Table 43--Estimated land treatment accomplishments by 2000
Big Sioux Study Area

Conservation Treatment Practices	Early-Action P.L. 566 Projects and Complementary Programs			Early-Action Programs Not Associated With P.L. 566 Projects		Total Study Area			
	Present Needs	Going Program	Accelerated Program	Present Needs	Going Program	Present Needs	Going Program	Going and Accelerated Programs	Remaining Needs in 2000 1/
	Acres								
Cropland									
Annual cover	42,000	31,000	11,000	164,800	123,000	206,800	154,000	165,000	40,400
Sod in rotation	178,900	100,100	35,400	702,800	393,500	881,700	493,600	529,000	341,200
Contouring only	108,800	30,400	10,800	427,400	119,700	536,200	150,100	160,900	363,100
Strips, terracing & diversions	190,100	88,600	31,300	746,700	348,500	936,800	437,100	468,400	453,200
Permanent Cover	12,900	8,400	3,000	50,800	33,200	63,700	41,600	44,600	18,500
Drainage	62,400	17,500	6,200	245,400	68,600	307,800	86,100	92,300	208,500
Irrigation cultural management	200	200	-0-	800	800	1,000	1,000	1,000	-0-
Irrigation water management	800	800	-0-	3,200	3,200	4,000	4,000	4,000	-0-
Subtotal	596,100	277,000	97,700	2,341,900	1,090,500	2,938,000	1,367,500	1,465,200	1,424,900
Adequately treated	508,500	-	-	2,001,500	-	2,510,000	-	-	3,975,200
Total	1,104,600	-	-	4,343,400	-	5,445,000	-	-	5,400,100
Pasture and Range									
Protection only	174,200	119,700	46,500	684,800	470,300	859,000	590,000	636,500	213,800
Improvement only	18,500	12,700	4,900	72,900	50,100	91,400	62,800	67,700	22,800
Brush control	2,000	1,400	500	8,100	5,600	10,100	7,000	7,500	2,500
Reestablishment of cover	9,700	6,700	2,600	38,100	26,200	47,800	32,900	35,500	11,800
Brush control & reestablishment	900	600	200	3,300	2,300	4,200	2,900	3,100	1,000
No treatment feasible	4,200	-0-	-0-	16,300	-0-	20,500	-0-	-0-	19,700
Subtotal	209,500	141,100	54,700	823,500	554,500	1,033,000	695,600	750,300	271,600
Adequately Treated	85,700	-	-	336,300	-	422,000	-	-	1,172,300
Total	295,200	-	-	1,159,800	-	1,455,000	-	-	1,443,900
Forest									
Needing Treatment	5,200	3,700	1,500	20,800	14,600	26,000	18,300	19,800	5,600
Adequately treated	4,700	-	-	18,300	-	23,000	-	-	42,800
Total	9,900	-	-	39,100	-	49,000	-	-	48,400
Other Agricultural land									
Needing treatment	10,300	5,400	2,000	40,700	21,200	51,000	26,600	28,600	20,800
Adequately treated	30,000	-	-	118,000	-	148,000	-	-	176,600
Total	40,300	-	-	158,700	-	199,000	-	-	197,400
Agricultural Land									
Total needing treatment	821,100	427,200	155,900	3,226,900	1,680,800	4,048,000	2,108,000	2,263,900	1,722,900
Total adequately treated	628,900	-	-	2,474,100	-	3,103,000	-	-	5,366,900
Total Agricultural Land	1,450,000	-	-	5,701,000	-	7,151,000	-	-	7,089,800

1/ Remaining needs were adjusted to reflect the estimated decreases in agricultural land area by year 2000.

COOPERATIVE STATE AND FEDERAL FORESTRY PROGRAMS

In the Small Watershed Program (PL 566), accelerated land treatment measures are included for the forest and woodland areas in the feasible small watershed projects. The opportunities in this program can be effective in accelerating improvement or development of farmstead shelterbelts and windbreaks. The existing cooperative federal-state forestry programs described earlier in this report will continue to be active and provide opportunities for forest land treatment, promotion of woodland management and tree planting, and forest fire, disease, and insect protection.

Forestry measures including technical assistance, protection, timber plans and surveys, establishment renovation, and maintenance of shelterbelts and windbreaks will preserve and enhance the beauty of the landscape, contribute to improve hydrologic condition, and help reduce surface flow and soil loss. Wildlife habitat, particularly for upland game species, will be enlarged and enhanced. Thinning, weeding, and cultural treatment of natural forest stands can improve timber production and provide for continuing supplies to meet local needs for wood products. These cultural treatments can also contribute to environmental quality by insuring the continuation of healthy forest stands. (See Table 44 for amounts and costs of state-federal forest land treatment measures.)

RESOURCE CONSERVATION AND DEVELOPMENT PROGRAM

Although there are no active Resource Conservation and Development projects in the Study Area, two applications for RC&D assistance are pending approval. The opportunities provided under RC&D programs could be beneficial by providing additional funds for resource development. The acceleration of soil surveys, conservation planning, developing and managing water resources for recreation, wildlife, agriculture, industry and municipalities, and encouraging new industries to locate in the area to process and market local products could improve the economy of the area and provide for a better life in rural America.

RURAL DEVELOPMENT PROGRAM

The Rural Development Program recognizes the importance of rural America to the national economy and to society. The distinctive feature of the program is that the competence and experience of the U. S. Department of Agriculture is oriented and directed toward improving and developing rural communities into economically and socially viable areas. In this effort the USDA works cooperatively with local and state leaders and other federal and state agencies. The technical assistance, cost-sharing, and loans mentioned previously are all brought to bear on local needs and wants.

FARMERS HOME ADMINISTRATION PROGRAMS

The programs of this agency are to assist rural families and communities by making loans for the purpose of providing the resources needed to improve living conditions. The different kinds and amounts of loans made during 1971 are presented in Section 6, "Existing Programs." It is assumed that these types of loans will continue to be made depending on available funds.

Table 44--Estimate amount and cost of state-federal forest land treatment measures
Big Sioux Study Area

MEASURE	EARLY ACTION OPPORTUNITIES: Measures in feasible PL-566 Watersheds		EARLY ACTION OPPORTUNITIES: Measures not in feasible PL-566 Watersheds		LONG RANGE OPPORTUNITIES	
	Amount	Estimated Cost (Dollars)	Amount	Estimated Cost (Dollars)	Amount	Estimated Cost (Dollars)
Forest management - technical assistance	1,500 acres	28,500	3,700 acres	70,300	34,000 acres	646,000
Timber surveys and plans	9,900 acres	49,500	15,100 acres	75,500	24,000 acres	120,000
Tree planting to reinforce shelter-belts and windbreaks	1,500 acres 400 miles	135,000	5,300 acres 800 miles	477,000	19,200 acres 2,500 miles	1,728,000
Thin, weed, prune & other cultural practices	1,500 acres	99,000	3,700 acres	244,200	34,000 acres	2,244,000
Control grazing on forest land	9,900 acres	376,200	21,600 acres	820,800	23,000 acres	874,000
Improve fire protection on forest land	9,900 acres	1,000	2,100 acres	200	37,000 acres	3,700

Source: Conservation Needs Inventory, Forest Survey Reports, Forest Service Field Investigations, and State Forestry Survey Reports

Cost figures based on Union Creek Forestry Work Plan (9/69) adjusted upward by 27% to account for inflation. Rate assumed at 5% per annum for 5 years.

PHYSICAL AND BIOLOGICAL EFFECTS

The acceptance of the principles of good land management and the application of land treatment measures on 2,263,900 acres by landowners and farm operators would have a significant effect on the reduction of erosion and sediment damages and about a 10 percent reduction of floodwater damages. It is estimated that treatment measures will be applied on about 700,000 acres of cropland with an erosion hazard which, at present, is inadequately treated. This would reduce the average annual erosion damages from 7.2 to 4.7 million dollars. The installation of these land treatment measures will improve the environmental quality and scenic values of the area. It would also reduce the amounts of pollutants entering streams and lakes, improve wildlife habitat, and provide additional recreational opportunities. The installation of the 16 watershed projects will reduce flooding on approximately 65,000 acres. The average annual acreage flooded will be reduced from 20,700 to 8,700 acres. In addition, there are about 80,800 acres of flood plain soils with a high water table which will become more productive by the installation of drainage measures. It is estimated that 5,010 acre-feet of sediment will be trapped in the 12 reservoirs in a 100-year period. This is equal to about 10,000 tons of soil annually. The sediment pools will also provide a limited amount of recreation and habitat for wildlife. The four multipurpose floodwater and recreation structures will provide an estimated 75,000 visitor days use annually. The total surface area of the flood pools in the 12 floodwater retarding structures is 4,220 acres. The slow release of the floodwaters from these flood pools through uncontrolled outlets will prolong downstream flows. Along with the floodwater retarding structures, channel modification will benefit the flood plains of which 40 percent is cropland, 50 percent pasture, and 10 percent in other uses such as roads, farmsteads, idle areas, and channels. It could be expected that the wet cropland, so protected, would be drained which would increase crop yields. About 23,000 acres, or 70 percent, of the pastureland is suitable for and would be converted to cropland. As the soils with low erosion hazards are converted to cropland it can be expected that soils with high erosion hazards will be returned to grass or other permanent cover crops. This will result in an overall reduction in erosion and sediment damages.

Construction and maintenance techniques will be employed to protect or mitigate damage to plant, fish, and wildlife resources along the modified channels. All channel modification planning will be based upon a careful assessment of the functional demands of channels, the need for protection and enhancement of affected resources, and a justification that considers environmental and economic values.

Water Quality

The Small Watershed Program and the technical assistance furnished to farm operators through the conservation districts provides many opportunities to improve the quality of water in streams, lakes, and wetlands. Soil erosion will be reduced as land treatment and structural measures are applied which will reduce the amount and rate of runoff. This will result in less sediment and nutrients deposited in streams and lakes.

Technical assistance provided by the Soil Conservation Service and the Extension Service, along with other USDA assistance programs for the planning and installation of feedlot waste management systems, will reduce pollutants entering streams and lakes.

Sedimentation

The application of adequate conservation treatment measures to agricultural land and the conversion of high erosion hazard croplands to permanent cover will reduce the amount of sediment delivered to streams, lakes, wetlands, and bottom lands, and help to maintain the capacity of streams and rivers thereby reducing floodwater damages.

It is estimated that over 50 percent of the high-hazard soils now being cropped are losing over 15 tons of soil per acre per year. The application of adequate conservation land treatment measures will reduce these losses at least 10 tons per acre per year.

The 12 needed floodwater retarding structures will store approximately 5,010 acre-feet of sediment. This is equivalent to 10,000 tons annually from the drainage area controlled.

Fish and Wildlife

The application of needed land treatment measures will have a significant impact on wildlife. Grassed waterways, grass turn strips in terraced and contoured fields, and herbaceous plantings along channels will provide additional cover, nesting areas, and travel lanes. The planting of trees and management of existing woodlands will be beneficial to many wildlife species, including the numerous songbirds in the area.

The installation of floodwater retarding structures and channel modifications which reduces the floodwater damages on the flood plain will have a beneficial effect on the terrestrial wildlife which normally inhabit and reproduce along the channels and in the flood plain.

The sediment pools of the floodwater retarding structures will provide water for wildlife, resting areas for migratory waterfowl and, in many instances, nesting cover. There is an opportunity to enhance wildlife cover by protecting these sediment pools from overgrazing. The shoreline will then produce excellent habitat.

ECONOMIC IMPACT

The economic effects of implementing resource development suggested earlier in the report were analyzed to view changes in local, regional, and national economies. Assessment was restricted to the effects of proposed resource conservation and development in the 16 watersheds found to be economically feasible. (See Tables 40, 41, and 42.)

The economic impact can be quantified in terms of increased income, population, and employment within agriculture as well as other sectors. Because of the relationships that exist between various sectors of the area's economy and differences occurring among area economies, it is difficult, if not impossible, to determine all changes likely to ensue. Nevertheless, installing watershed works of improvement and land treatment provides a measurable amount of stimulus toward economic growth and development. In measuring the economic impact of a specific investment for resource development there is no exact method of determining how many jobs will be created; how much new income, population and employment will accrue; or how much can be saved in the cost of producing a given level of agricultural production. Effects of these improvements by 1980 were not analyzed because they could not be totally implemented by that time. However, it is expected that the 16 watershed plans will be installed and in operation by 2000. The latter time period was used throughout the analysis.

The combined effects of changes in land use and crop yields upon the benefited acres are the major determinants used in evaluating the economic impact. There are 79,528 acres of cropland and pasture to be benefited in the 16 watersheds. Corn, wheat, soybeans, flax, and alfalfa acreages are estimated to increase while oats, wild hay, pasture and idle land acreages decline. Although land use changes are estimated to occur on only part of the acres, nearly all of the benefited area will be used more intensively and efficiently. In addition to the agricultural benefits evaluated in this section, other benefits will accrue to recreation and wildlife as well as the nonagricultural sectors.

The linear programming model was used to determine the acreages of each crop needed to meet the projected agricultural production at minimum cost under conditions "prior to" and "after" resource development. Information about the 16 feasible watersheds were included with the balance of the Study Area. Several computer runs were necessary, using various assumptions and constraints, to obtain the estimates of economic effects.

With resource developments and management implemented in the 16 feasible watersheds, the projected level of agricultural crops in the entire Study Area can be produced at a lower cost. The reduction in total production costs, or on-farm efficiency gains, are estimated at $397,000 annually. This saving is primarily due to increased crop yields associated with diminishing the hazards of flooding and impaired drainage. It is further estimated that on-farm efficiency gains could be as much as $1.4 million annually if agricultural production was expanded until it reached a level considered the maximum [1/] prior to any developments. With the works of improvement in place and operative, the maximum total value of agricultural production from the area can be further increased about one percent. After deducting the additional on-farm costs of production, net farm income would increase $703,000 annually. Total cost of the watershed projects is shared between local people and the federal government. Since the economic impact is dependent upon increased income after all costs, the cost of project works to be borne by the local people is also deducted. The remainder, $481,500, is the amount of additional annual income (economic benefits) accruing to agriculture.

Projected economic benefits will be realized and will contribute to economic development objectives. To the extent that additional agricultural production and associated economic activity merely displaces production and activity in other areas or affects market prices, the benefits may not truly be national gains. Therefore, it is assumed that output increasing effects of the proposed developments are so small, on an interregional basis, that any displacement or price effects would be insignificant.

The impact analysis can be further extended to estimate changes in employment or per worker income through the addition to agricultural income. If projected agricultural labor resources are fully employed when agricultural production is at a maximum, the additional income results in increased employment. The $481,500 of new income at a rate of $9,680 per worker would add 43 additional agricultural employees. Conversely, if human resources are underemployed to the extent that additional income affects per worker earnings without influencing employment, each of the 22,600 agricultural employees in year 2000 would realize an average of $20 per year.

Associated with the increase in personal income in the farming sector will be the additional employment generated in the remaining sectors of the local economy. One way to estimate this impact is through use of the employment multiplier. This measure estimates changes in total employment when new jobs are created in certain industries.

Employment data, as shown in Table 45,is divided into two major occupational groups. The basic or nonservice employment group contains persons employed in agriculture, forestry, mining, and manufacturing. They produce goods and services locally for consumption mainly outside the area. The second occupational group consists of the derivative or service-oriented industries whose goods and services are mainly consumed

---

1/ This level was determined by allowing the production of selected major crops to increase until most excess idle cropland was utilized (at least five percent of each soil resource group was maintained in the idle category.) At this point, total value of crop production was 15 percent greater than the projected level consistent with national demands.

locally. A change in the basic activities sets a sort of chain reaction in motion among the various sectors of the economy.

Since agricultural production is the most important income generating segment of the total economy of the Study Area, it seemed applicable to use an employment multiplier derived by relating the two occupational groups. In 1960, 109,875 persons were employed. Of this total, 43,980 were in the basic group and the remaining 65,895 in the derived group. When the derivative employment is divided by the basic employment, the quotient is called the basic-derivative ratio. For 1960 the ratio is thus 1:1.50. Further extension of this concept reveals ratios of 1:2.22 in 1980; 1:3.09 in 2000; and 1:4.15 in 2020. 2/ Consequently, for each additional person employed in agriculture by 2000, an additional three persons will be needed to service the basic employee.

Earlier it was concluded that under specific conditions, agricultural employment could be expanded by 43 workers. Thus, 43 times 3.09, or 133 persons, will be needed to service the 43 basic employees and a total of 176 persons could be employed because of the projects.

The increase in personal income is available for successive rounds of consumption spending. This additional income generates further expenditures which are a multiple of the original increase in income. A portion of this increase is spent in the Study Area and, in turn, respent within the area until its marginal effect becomes zero. A summation of these successive rounds of spending is commonly called the income multiplier.

A study at South Dakota State University, based upon previously established spending patterns, indicates that as an initial increment of personal income is respent in the Big Sioux trade area, the total effects is approximately 2.07 times greater. 3/ Using this multiplier, if the entire $481,500 were dispersed in the area, the total income effect would be $996,705 (481,500 x 2.07) annually. No attempt was made to project the income multiplier for 2000. However, as the basic-derivative employment ratio increases, the income multiplier will react in a similar fashion.

An additional local benefit is possible through the investment of non-local funds for resource developments. The federal expenditures during the construction phase represents new money to the local economy. Federal cost-sharing in 16 feasible watersheds, plus the approved (but not constructed) PL 566 watershed projects, is $10,983,400. 4/ If a

---

2/ These ratios are derived from employment projections contained in Table 9, page 3-14.

3/ See Table 9, page 16 of Christensen and Matson,"Impact of Irrigation Development of Income and Trade, Eastern and Central South Dakota," Bulletin 550, Feb. 1969. The 2.07 multiplier is a weighted average of Sioux Falls and Brookings-Madison trade areas.

4/ This total does not include federal engineering and administrative costs because they are spent outside the Study Area.

15-year period is assumed for project installation and federal funds are available each year in equal increments, this annual investment can represent as much as $1.5 million of new income to the Study Area. The total impact of this annual investment is influenced by the income multiplier (2.07), given that a local contractor is selected who purchases labor, machinery, and supplies within the Study Area.

Table 45--Industrial classification of persons employed
Big Sioux Study Area

Employment	1940	1950	1960
	Number		
Basic Industries:			
Agriculture	45,703	43,397	32,960
Forestry & Fisheries	30	33	8
Mining	163	322	223
Manufacturing	5,796	7,872	10,789
Total	51,692	51,624	43,980
Derivative Industries:			
Construction	3,228	6,135	5,504
Transportation	2,727	3,892	3,486
Communication	725	1,332	1,239
Utilities	667	1,131	1,315
Wholesale Trade	3,370	5,000	4,767
Retail Trade	11,994	16,867	17,072
Finance, Insurance, & Real Estate	1,958	2,619	3,473
Services	15,741	17,156	22,949
Public Administration	2,434	3,220	3,442
Other	1,314	2,162	2,648
Total	44,158	59,514	65,895
Total Employment:	95,850	111,138	109,875
Basic-Derivative Ratio:	1:0.85	1:1.15	1:1.50

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

Full development of land, water, and related resources of the Big Sioux Study Area can be achieved only through a coordinated effort of the local people and federal, state, and local agencies. This report has determined that a high potential exists for achieving full development of these resources. Present programs of the USDA agencies will contribute to developing these resources. However, coordination is often difficult because of special interests of individuals and groups and availability of funds. For example, structures which store water for flood control, recreation, irrigation, municipal and industrial use, and other beneficial uses will occupy land that could be used for crop production. The restoration of channels to their original capacity to reduce floodwater damages will often disrupt the ecology that has developed along these channels. These examples illustrate the need for an overall plan for land, water, and related resource development. Consideration should be given to achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities, and enhance the quality of renewable resources. A resource development plan must be flexible so that it can be adapted to changing technology and the changing needs and desires of the people.

ALTERNATIVE APPROACHES

The reduction of damages by floodwaters can be achieved by several alternatives. One alternative is the installation of small watershed projects for flood prevention in those watersheds of less than 250,000 acres which meet the current criteria for development and to accept continued flooding on the mainstem.

Another alternative is to accept flooding of the smaller watersheds and build mainstem structures which will reduce downstream flooding along the mainstem.

A third alternative may be a combination of the above flood control alternatives plus a plan developed according to current and future needs. The Skunk Creek Watershed may be used to illustrate this type of planning. It may be advantageous at this time to install the watershed projects with a 50-year life. After this 50-year period has elapsed, the demand from the metropolitan area for water and recreation may show the need for a mainstem reservoir.

Still another alternative is local zoning regulations to eliminate future development of properties within the flood-prone area. For those developments currently located in the flood plain, subsidized flood insurance is available through the National Flood Insurance Program, authorized by the Housing and Urban Development Act of 1968 (Public Law 90-448). The program is administered by the Federal Insurance Administration of the U.S. Department of Housing and Urban Development in cooperation with the private insurance companies.

The intent of the program is to (1) provide insurance on structures and contents against flood damages with insurance rates based on the hazard and frequency of flooding; (2) regulate development in flood-prone areas; (3) implement local land use and management programs in the flood plain area.

PROJECTS OR MEASURES NEEDED BUT NOT PRESENTLY AVAILABLE THROUGH USDA PROGRAMS

Sheet erosion has been shown in the "Problems" section of this report to be the most serious land resource problem in the Study Area. Progress in solving this problem, along with other related problems correctable by land treatment measures, is inadequate for the protection of the soil resource under existing USDA programs at the present rate of funding. It would be desirable to seek new methods of attacking these problems. A program similar to the Great Plains Conservation Program wherein land treatment practices are planned and applied on a contractual basis would appear to have merit in the acceleration of needed land treatment measures. Expansion of the area served by the Great Plains Conservation Program to include the Big Sioux Study Area or to develop a similar type program to deal more specifically with the erosion problem is needed.

Resource Conservation and Development Projects could be used to develop and carry out long-range programs to reduce the gully erosion problem. To implement such action will require the organization of an RC&D project to include Lincoln and Union Counties, South Dakota, Plymouth and Sioux, and perhaps other counties in the loess area of Iowa. The organization of such a project would facilitate the gully control program by increasing the available funds for planning and application.

OTHER AGENCY PROGRAMS AND THEIR IMPACTS

The programs designed to improve the wetland wildlife habitat and the programs designed to reduce flooding and develop better drainage outlets frequently appear to be in direct conflict with one another. However, it is believed that on a case by case basis, if each interest group works toward an equitable solution, a balanced program can be achieved. The result would be a stronger agricultural economy, improved wildlife habitat, and a pleasing environment.

The U.S. Army Corps of Engineers has proposed a series of four or five major dams on the Big Sioux River, Skunk Creek, Rock River, and Little Rock River. These large reservoirs would reduce flood damages on the lower reaches of these streams. They would also create recreational opportunities and supply water for municipal and industrial uses and irrigation. However, these impoundments would inundate large areas of bottom lands presently in agricultural production.

It should be pointed out that the Corps' proposal and the small watershed proposals contained in this report are in no way alternative proposals. The Corps' proposal is specifically designed for control of flooding on the lower Big Sioux, Skunk, and Rock Rivers. In addition, the proposed Corps' reservoirs are expected to be designed to include water for recreational, municipal, industrial and irrigational uses. The small watersheds proposed are primarily designed to control flooding on the small tributary watersheds. They will have little effect on the downstream areas which the Corps' structures are designed to protect. The small watershed proposals contain no provisions for storage of water for irrigation or municipal and industrial uses. They do propose recreational use in four floodwater retarding impoundments; however these proposed recreational sites are smaller and are expected to satisfy community needs rather than the regional needs which the Corps' structures proposals are designed to serve.

NEW PROGRAMS OR CRITERIA TO MEET NEEDS

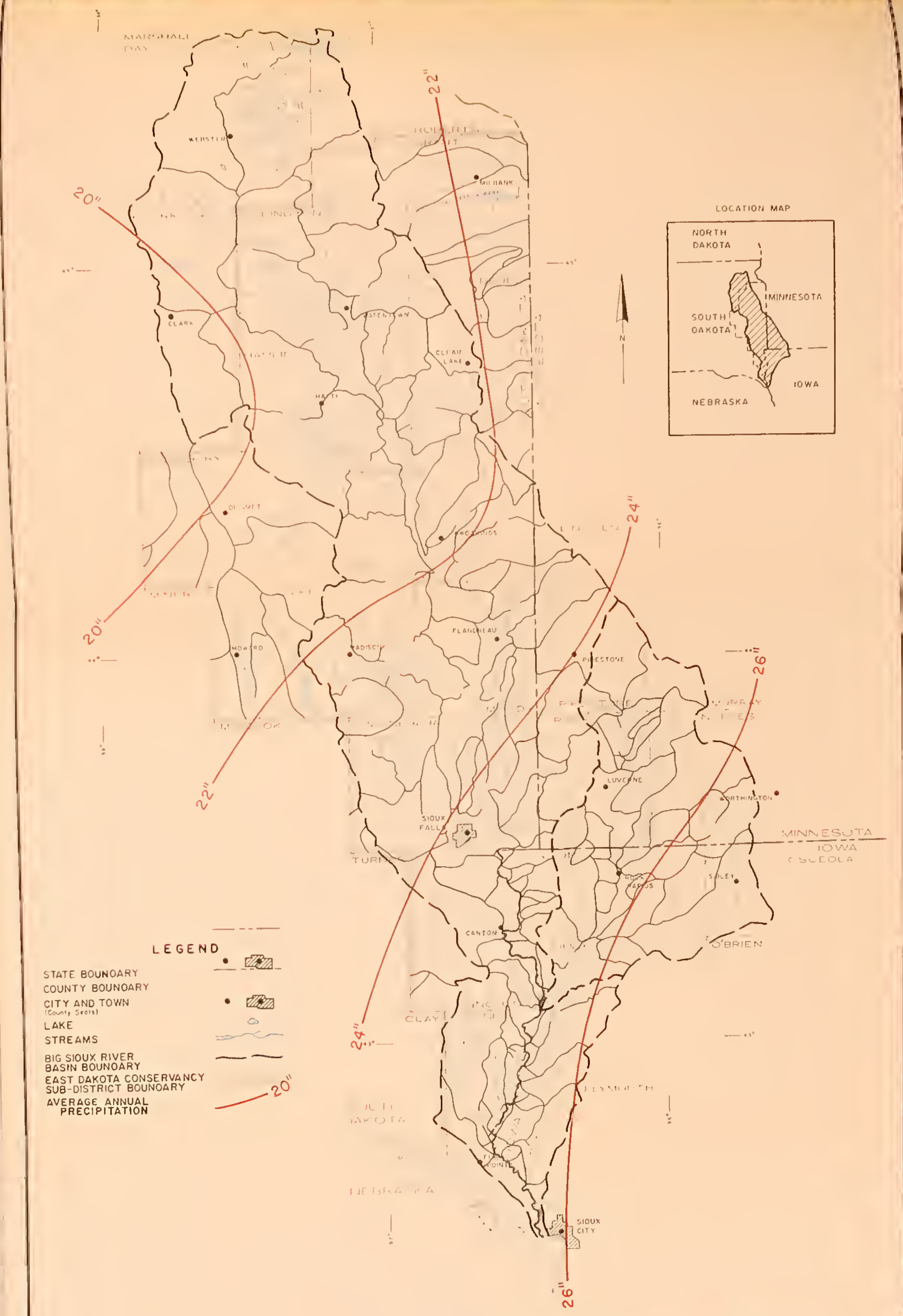
Control by project action of the severe gully erosion in the loess area usually cannot be economically justified using current procedures. The people affected by the gully want the gully head controlled and the area stabilized. The benefits from saving land from destruction and identifiable downstream sediment damages often do not justify structural measures needed to accomplish this objective. It would be desirable to include nonmonetary benefits, such as environmental quality, to justify these measures. Revision of existing policies and procedures are needed to establish guidelines for using these benefits.

In planning PL 566 Watershed Projects, it is often suggested that multiple-purpose floodwater and irrigation structures should be developed. From the experiences gained in the watershed investigation studies, it would appear that adjustments in the program are necessary if this alternative can be considered in watershed planning. One of the adjustments needed is the lifting of the restriction on total storage that can be included in PL 566 watershed reservoirs. At present, the limit is 12,500 acre-feet of floodwater detention storage and 25,000 acre-feet of total storage.

There is a demonstrable need for water-based recreation in the vicinity of Sioux Falls, South Dakota, and Minnesota and Iowa. Although multipurpose recreation and flood control structures have been proposed in the watershed investigation studies, these structures may not be ideally located from the standpoint of easy access by the expected users. Likewise, there are structure sites which are more favorably located but do not provide sufficient flood damage reduction benefits to justify the structural measures. In administering PL 566, consideration should be given to the justification of structural measures based on recreation as the single purpose.

MAPS

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE



MAP NO.2

AVERAGE ANNUAL PRECIPITATION

BIG SIOUX RIVER BASIN

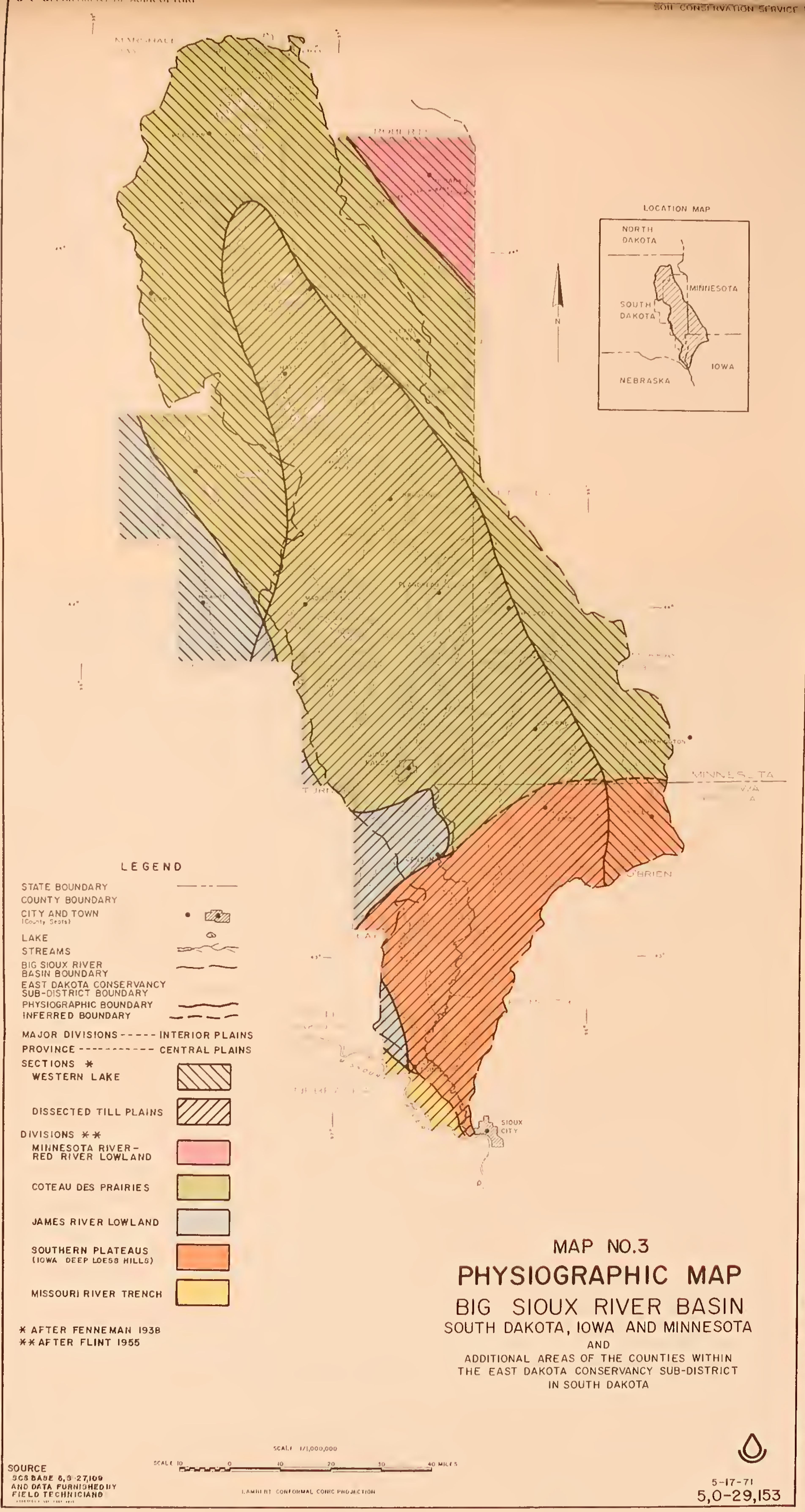
SOUTH DAKOTA, IOWA AND MINNESOTA

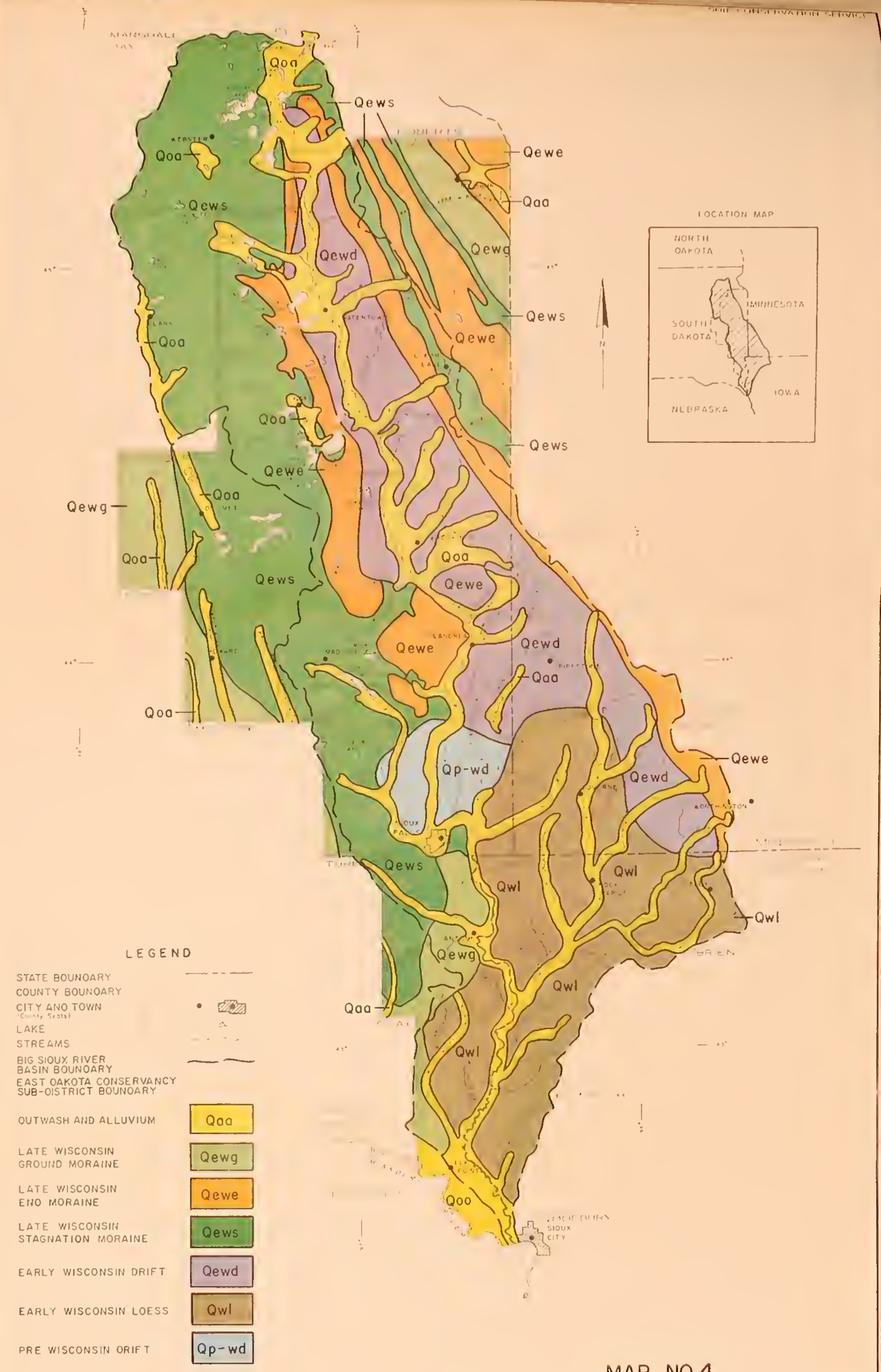
AND

ADDITIONAL AREAS OF THE COUNTIES WITHIN THE EAST DAKOTA CONSERVANCY SUB-DISTRICT IN SOUTH DAKOTA

SOURCE
SCS BASE 5,S-27,109
AND DATA FURNISHED BY
FIELD TECHNICIANS

5-17-71
5,0-29,152

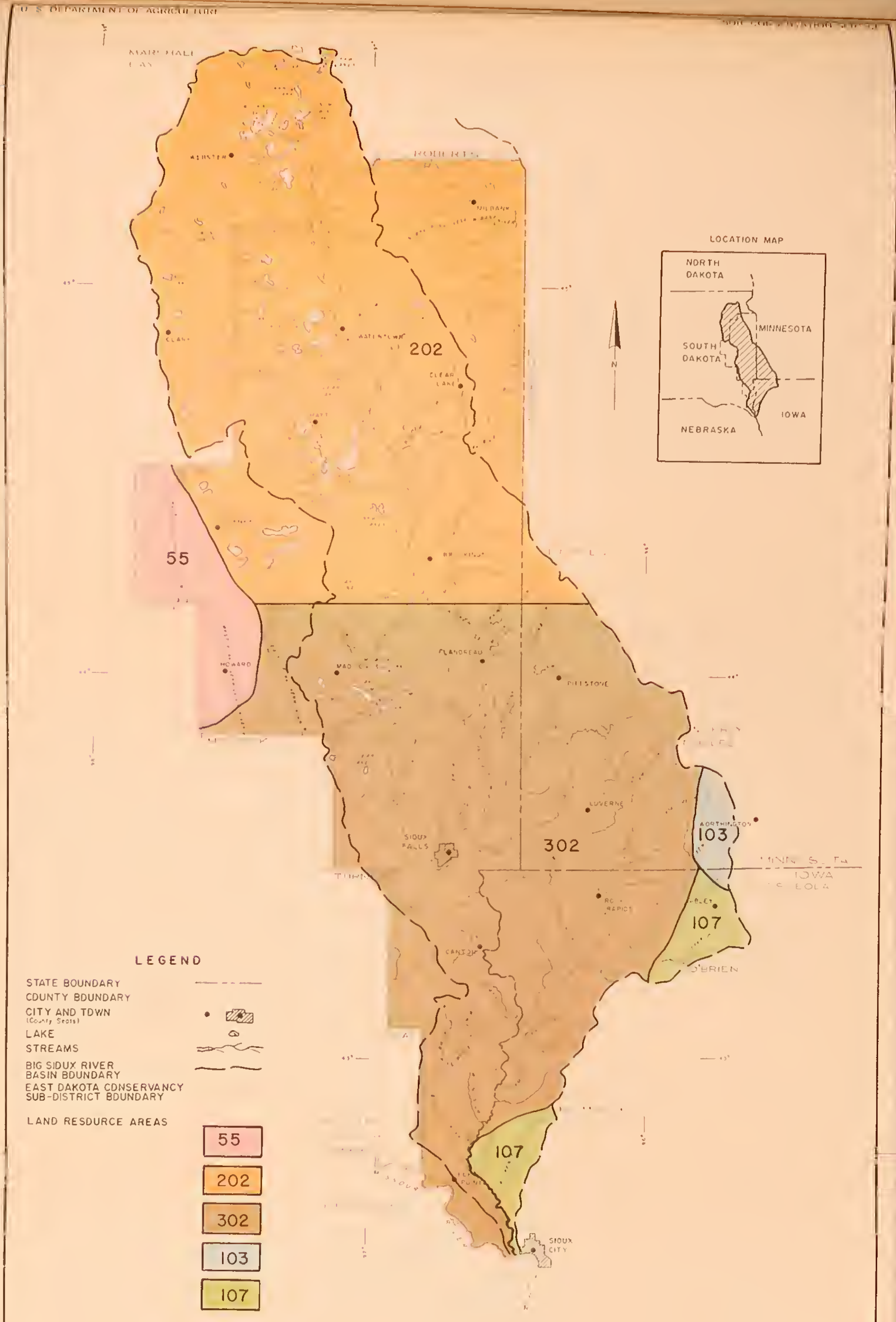

SOIL CONSERVATION SERVICE
LOCATION MAP
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
IOWA
NEBRASKA
N
O'BRIEN
SIOUX CITY
LEGEND
STATE BOUNDARY
COUNTY BOUNDARY
CITY AND TOWN (County Seats)
LAKE
STREAMS
BIG SIOUX RIVER BASIN BOUNDARY
EAST DAKOTA CONSERVANCY SUB-DISTRICT BOUNDARY
PHYSIOGRAPHIC BOUNDARY
INFERRED BOUNDARY
MAJOR DIVISIONS ----- INTERIOR PLAINS
PROVINCE ----------- CENTRAL PLAINS
SECTIONS *
WESTERN LAKE
DISSECTED TILL PLAINS
DIVISIONS **
MINNESOTA RIVER-RED RIVER LOWLAND
COTEAU DES PRAIRIES
JAMES RIVER LOWLAND
SOUTHERN PLATEAUS (IOWA DEEP LOESS HILLS)
MISSOURI RIVER TRENCH
* AFTER FENNEMAN 1938
** AFTER FLINT 1955
MAP NO.3
PHYSIOGRAPHIC MAP
BIG SIOUX RIVER BASIN
SOUTH DAKOTA, IOWA AND MINNESOTA
AND
ADDITIONAL AREAS OF THE COUNTIES WITHIN THE EAST DAKOTA CONSERVANCY SUB-DISTRICT IN SOUTH DAKOTA
SCALE 1/1,000,000
10 0 10 20 30 40 MILES
LAMBERT CONFORMAL CONIC PROJECTION
SOURCE
SCS BASE 6,3-27,109
AND DATA FURNISHED BY
FIELD TECHNICIANS
5-17-71
5,0-29,153



MAP NO.4
PLEISTOCENE GEOLOGY MAP
BIG SIOUX RIVER BASIN
SOUTH DAKOTA, IOWA AND MINNESOTA
AND
ADDITIONAL AREAS OF THE COUNTIES WITHIN THE EAST DAKOTA CONSERVANCY SUB-DISTRICT IN SOUTH DAKOTA

SOURCE:
SOUTH DAKOTA GEOLOGICAL SURVEY, WISCONSIN GEOLOGICAL SURVEY, AND QUATERNARY LANDSCAPES OF IOWA BY R.U. RUHE (1969) IOWA STATE UNIV. PRESS; AND SCS BASE 5,0-27,109 AND DATA FURNISHED BY FIELD TECHNICIANS.

REV. 10-20-71
5,0-29,154



NOTE:
LRA 102 HAS BEEN SUBDIVIDED INTO 202 AND 302

MAP NO. 5

LAND RESOURCE AREA MAP

BIG SIOUX RIVER BASIN

SOUTH DAKOTA, IOWA AND MINNESOTA

AND

ADDITIONAL AREAS OF THE COUNTIES WITHIN THE EAST DAKOTA CONSERVANCY SUB-DISTRICT IN SOUTH DAKOTA

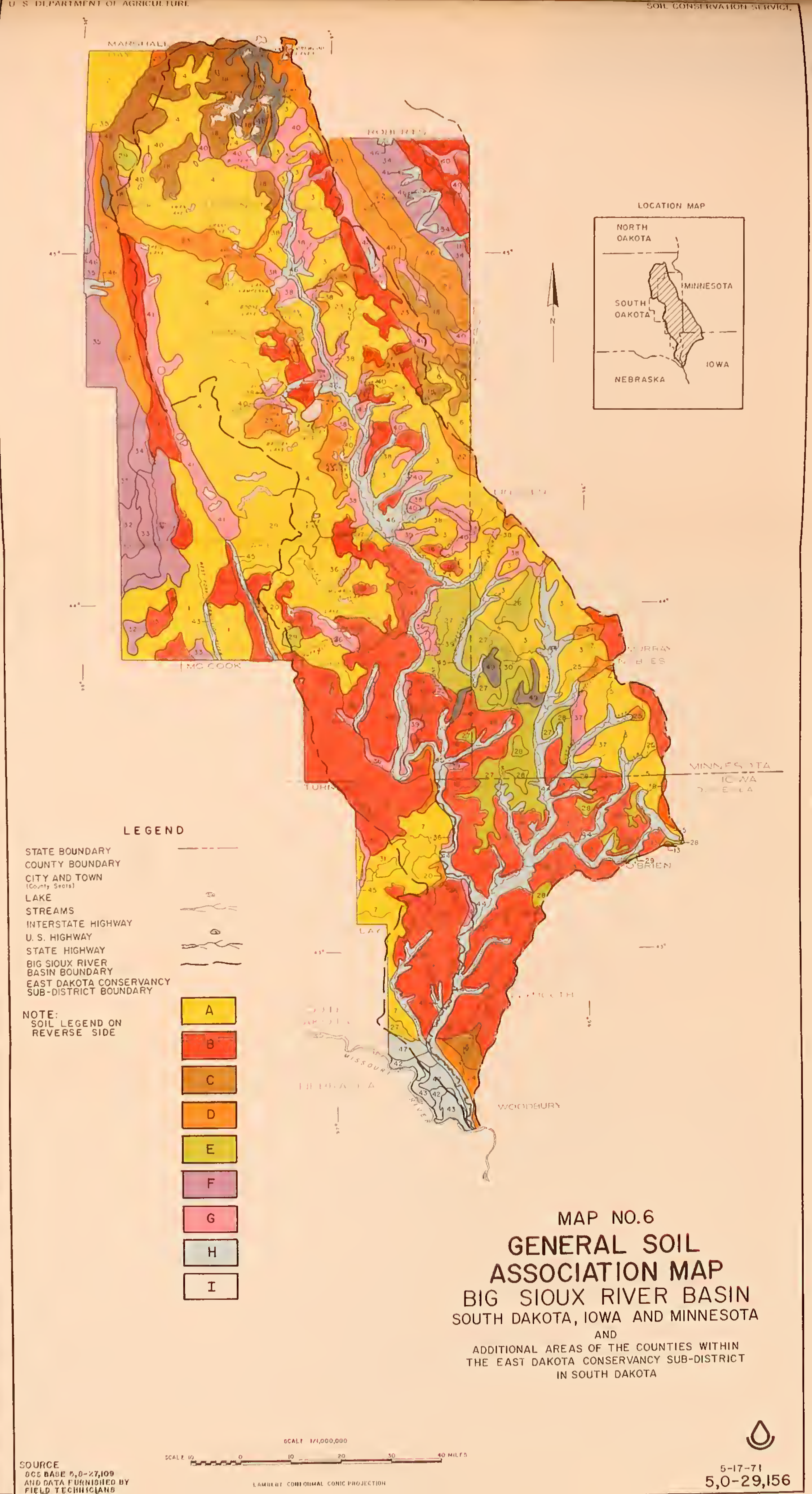
SCALE 1/1,000,000

SCALE 10 0 10 20 30 40 MILES

LAMBERT CONFORMAL CONIC PROJECTION

SOURCE:
SCS BASE 5,S-27,109
AND DATA FURNISHED BY
FIELD TECHNICIANS

5-17-71
5,0-29,155



MAP NO. 6

GENERAL SOIL ASSOCIATION MAP

BIG SIOUX RIVER BASIN

SOUTH DAKOTA, IOWA AND MINNESOTA

AND

ADDITIONAL AREAS OF THE COUNTIES WITHIN THE EAST DAKOTA CONSERVANCY SUB-DISTRICT IN SOUTH DAKOTA

SOURCE
SCS BASE 5,0-27,109
AND DATA FURNISHED BY
FIELD TECHNICIANS

5-17-71
5,0-29,156

GENLRAL SOIL MAP

LEGEND

A. OEEP. NEARLY LEVEL ANO GENTLY UNOULATING OR GENTLY SLOPING SOILS ON UPLANOS; INCLUOES POORLY ORAINEO OEPRESSIONS.

1. HOUOEK-PROSPER ASSOCIATION
2. KRANZBURG ASSOCIATION
3. KRANZBURG-VIENNA ASSOCIATION
4. POINSETT-WAUBAY ASSOCIATION
5. SAC-PRIMGHAR-EVERLY ASSOCIATION
6. SINGSAAS-OAK LAKE ASSOCIATION
7. WENTWORTH-EGAN-VIBORG ASSOCIATION

B. OEEP. UNOULATING ANO SLOPING SOILS ON UPLANOS: INCLUOES POORLY ORAINEO OEPRESSIONS ANO SOME GENTLY UNOULATING ANO ROLLING SOILS.

8. CLARION-WEBSTER ASSOCIATION
9. CLARNO-ETHAN ASSOCIATION
10. EGAN-WENTWORTH-CLARNO ASSOCIATION
11. FORMAN ASSOCIATION
12. GALVA-IOA ASSOCIATION
13. GALVA-PRINGHAR-SAC ASSOCIATION
14. HEIMOAL-SISSETON-SVEA ASSOCIATION
15. HOUOEK-ETHAN-WORTHING ASSOCIATION
16. MOOOY-NORA-CROFTON ASSOCIATION
17. VIENNA-LISMORE ASSOCIATION

C. OEEP. ROLLING UPLANO SOILS; INCLUOES POORLY ORAINEO OEPRESSIONS. UNDER CULTIVATION. WATER EROSION HAS OFTEN REMOVEO THE SURFACE SDIL.

18. FDRMAN-AASTAO-PARNELL ASSOCIATIDN
19. IDA-MDNDNA ASSDCIATIDN

D. OEEP. RDLLING AND STEEP SOILS ON SIDE SLOPES ANO STEEP MORAINIC UPLANDS. INCLUOES STONY AREAS ANO PODRLY ORAINED DEPRESSIDNS.

20. BETTS ASSOCIATIDN
21. BUSE-BARNES ASSOCIATION
22. FDRMAN-BUSE ASSOCIATION
23. FORMAN-BUSE-AASTAO-PARNELL ASSOCIATION
24. IOA-HAMBURG-MONOMA ASSOCIATION
25. STOROEN-EVERLY ASSOCIATION

E. OEEP. LEVEL OR NEARLY LEVEL UPLANO SOILS.

26. BROOKINGS-HIOEWOOO ASSOCIATION
27. MOOOY-TRENT ASSOCIATION
28. PRIMGHAR-MARCUS ASSOCIATION
29. SINAI-WENTWORTH ASSOCIATION
30. TRENT-MARCUS ASSOCIATION
31. WAKONOA-TETONKA ASSOCIATION

F. OEEP. NEARLY LEVEL OR GENTLY UNOULATING SOILS THAT HAVE CLAYEY OR CLAYPAN SUBSOILS.

32. BEAOLE ASSOCIATION
33. BEAOLE-STICKNEY-OUOLEY ASSOCIATION
34. PEEVER ASSOCIATION
35. PEEVER-CAVOUR ASSOCIATION

G. NEARLY LEVEL TD ROLLING SDILS ON UPLAND SLOPES AND TERRACES UNDERLAIN WITH SANOY ANO GRAVELLY MATERIALS AT 20 TO 40 INCHES.

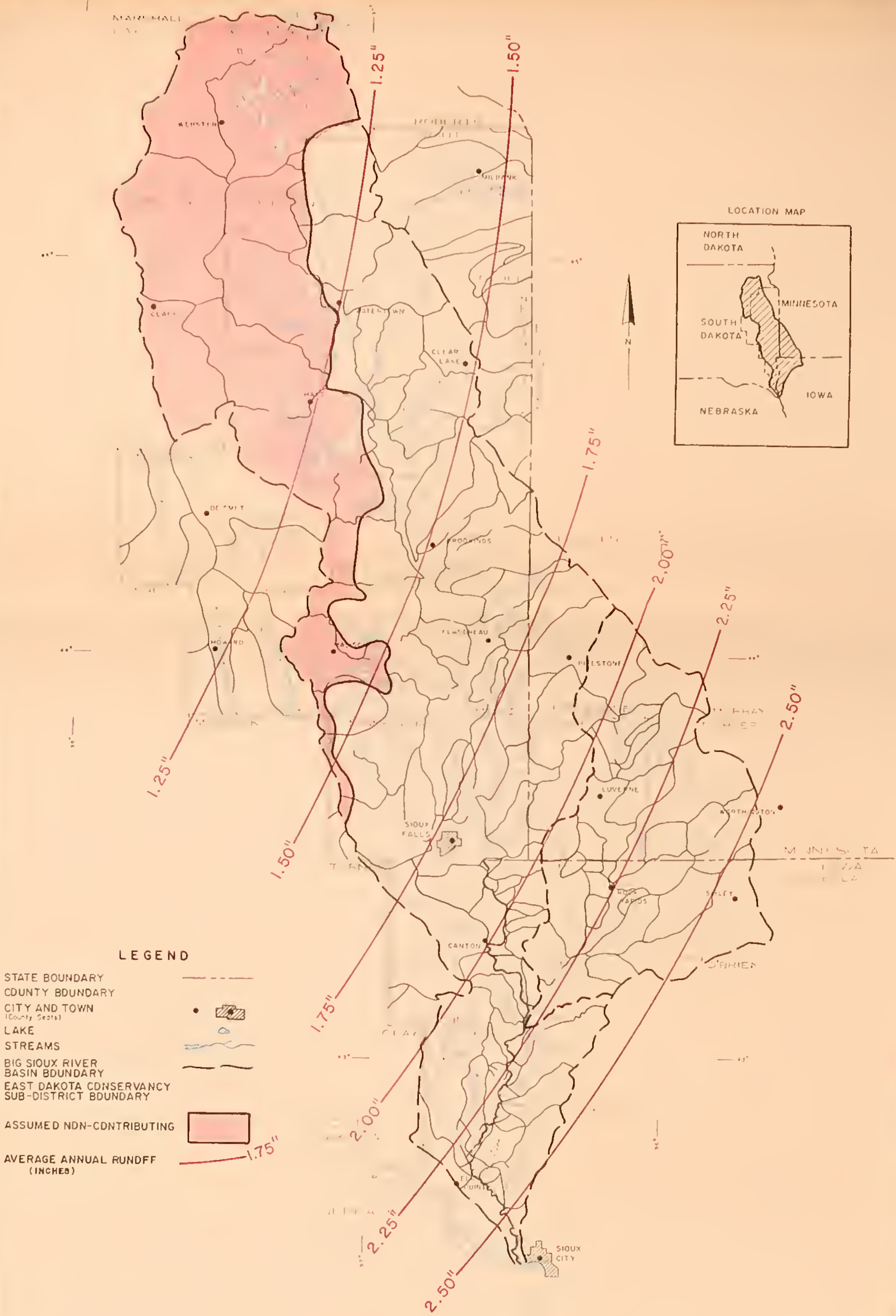
36. ENET-OEMPSTER ASSOCIATION
37. FAIRHAVEN-WAOENA ASSOCIATION
38. FOROVILLE-ESTELLINE ASSOCIATION
39. HENKIN ASSOCIATION
40. RENSHAW-FOROVILLE ASSDCIATION
41. RENSHAW-FOROVILLE-OIVIDE ASSOCIATION

H. OEEP. WELL ORAINEO TO POORLY ORAINEO ALLUVIAL SOILS ON BOTTOM LANDS.

42. ALBATON-HAYNIE ASSOCIATION
43. HAYNIE-SARPY ASSOCIATION
44. BOTTOM LANDS AND TERRACE
45. LAMO ASSOCIATION
46. LAMOURE ASSOCIATION
47. LUTON ASSOCIATION

I. SHALLOW. GRAVELLY ANO ROCKY SOILS

48. RENSHAW-FOROVILLE-SIDUX ASSOCIATION
49. IHLEN-RDCK OUTCROP



MAP NO.7

AVERAGE ANNUAL RUNOFF

BIG SIOUX RIVER BASIN

SOUTH DAKOTA, IOWA AND MINNESOTA
AND
ADDITIONAL AREAS OF THE COUNTIES WITHIN
THE EAST DAKOTA CONSERVANCY SUB-DISTRICT
IN SOUTH DAKOTA

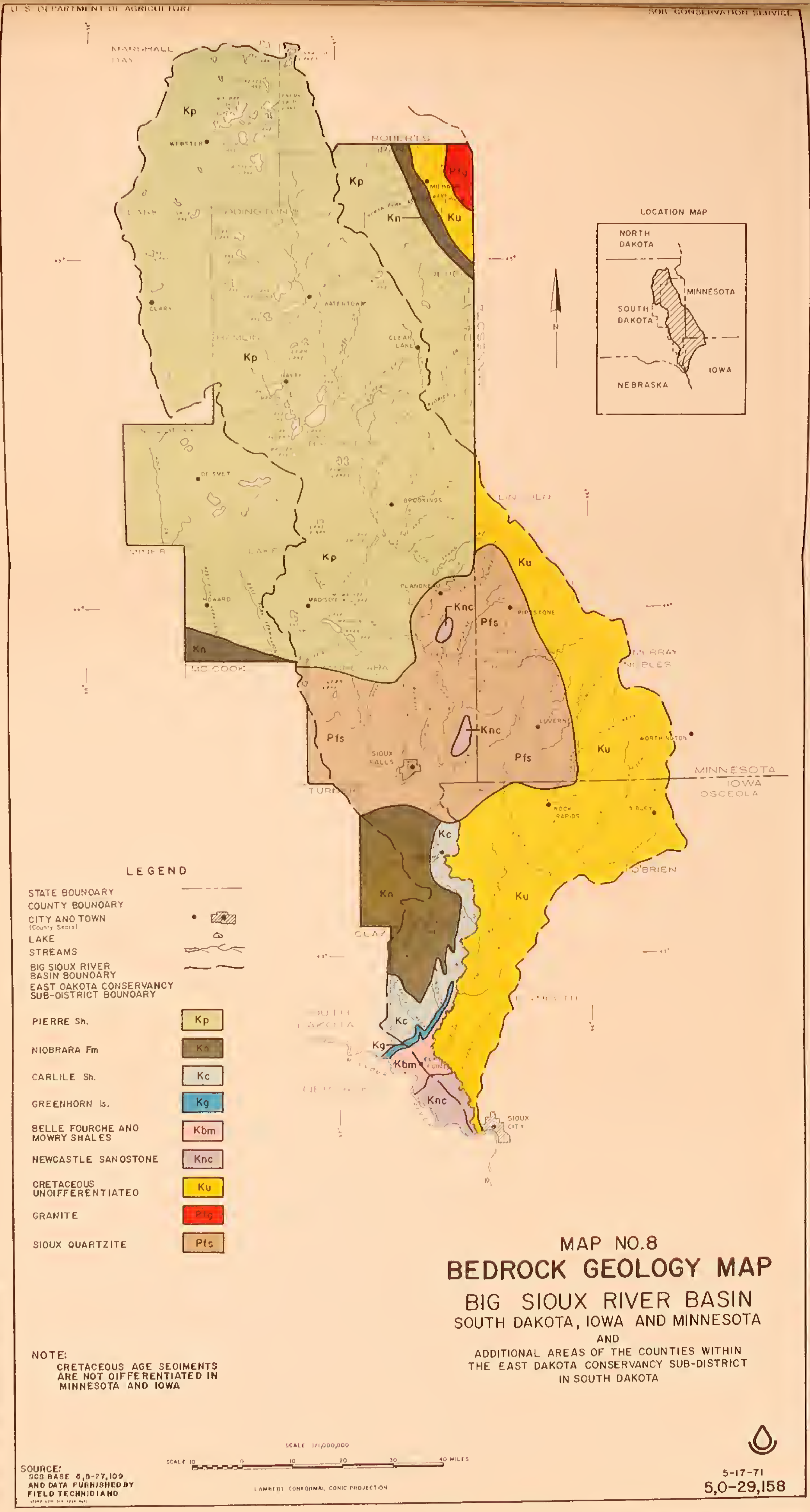
SCALE 1/1,000,000

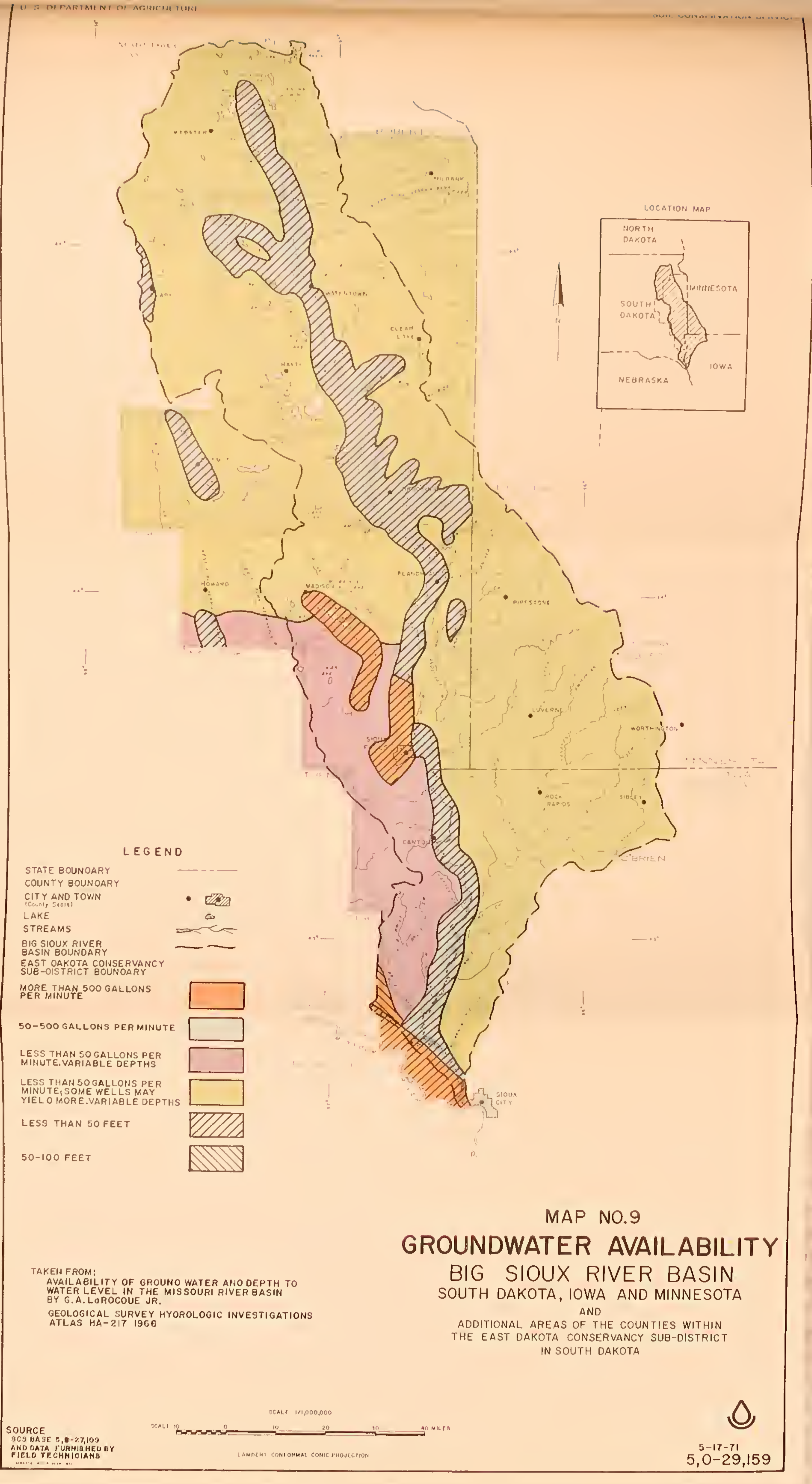
SCALE 10 0 10 20 30 40 MILES

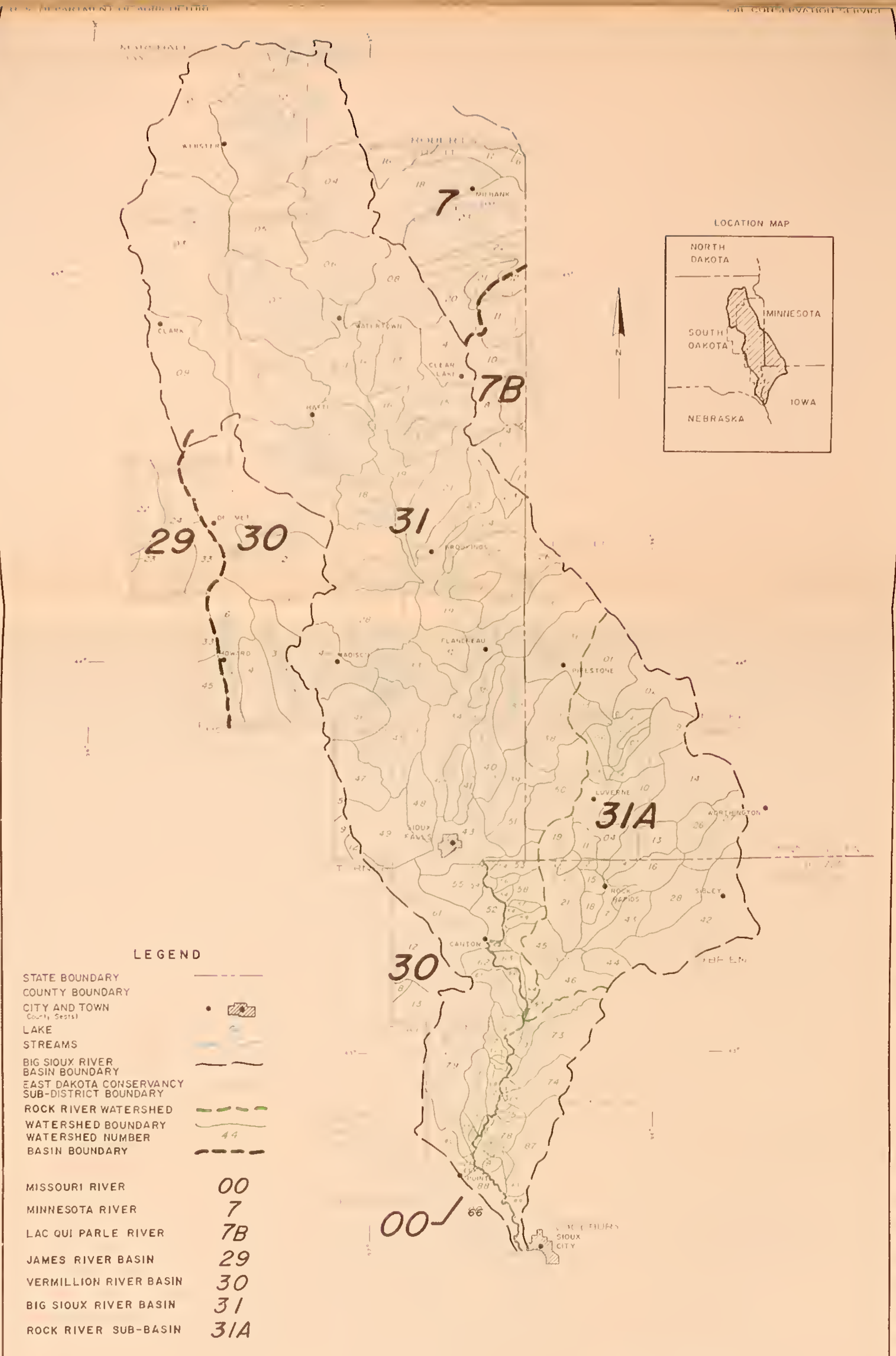
LAMBERT CONFORMAL CONIC PROJECTION

SOURCE
SCS BASE 5,S-27,109
AND DATA FURNISHED BY
FIELD TECHNICIANS

5-17-71
5,O-29,157


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MARSHALL
ROBERTS
LOCATION MAP
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
IOWA
NEBRASKA
Kp
Kn
Ku
Pfg
Knc
Pfs
Kc
Kg
Kbm
WEBSTER
CLARK
WATERTOWN
CLEAR LAKE
BROOKINGS
FLANDREAU
MADISON
HOWARD
PIPESTONE
LUVERNE
SIOUX FALLS
WORTHINGTON
ROCK RAPIDS
SIBLEY
SIOUX CITY
MC COOK
TURNER
CLAY
MINNESOTA
IOWA
OSCEOLA
O'BRIEN
LEGEND
STATE BOUNDARY
COUNTY BOUNDARY
CITY AND TOWN (County Seats)
LAKE
STREAMS
BIG SIOUX RIVER BASIN BOUNDARY
EAST DAKOTA CONSERVANCY SUB-DISTRICT BOUNDARY
PIERRE Sh. Kp
NIOBRARA Fm Kn
CARLILE Sh. Kc
GREENHORN ls. Kg
BELLE FOURCHE AND MOWRY SHALES Kbm
NEWCASTLE SANDSTONE Knc
CRETACEOUS UNDIFFERENTIATED Ku
GRANITE Pfg
SIOUX QUARTZITE Pfs
NOTE:
CRETACEOUS AGE SEDIMENTS ARE NOT DIFFERENTIATED IN MINNESOTA AND IOWA
MAP NO.8
BEDROCK GEOLOGY MAP
BIG SIOUX RIVER BASIN
SOUTH DAKOTA, IOWA AND MINNESOTA
AND
ADDITIONAL AREAS OF THE COUNTIES WITHIN THE EAST DAKOTA CONSERVANCY SUB-DISTRICT IN SOUTH DAKOTA
SCALE 1/1,000,000
SCALE 10 0 10 20 30 40 MILES
LAMBERT CONFORMAL CONIC PROJECTION
SOURCE:
SCS BASE 5,8-27,109
AND DATA FURNISHED BY
FIELD TECHNICIANS
5-17-71
5,0-29,158


U.S. DEPARTMENT OF AGRICULTURE
WEBSTER
MILBANK
WATERTOWN
CLEAR LAKE
HAYTI
HOWARD
MADISON
FLANDREAU
PIPESTONE
LUVERNE
WORTHINGTON
ROCK RAPIDS
SIBLEY
CANTON
O'BRIEN
SIOUX CITY
LOCATION MAP
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
IOWA
NEBRASKA
N
LEGEND
STATE BOUNDARY
COUNTY BOUNDARY
CITY AND TOWN (County Seats)
LAKE
STREAMS
BIG SIOUX RIVER BASIN BOUNDARY
EAST DAKOTA CONSERVANCY SUB-DISTRICT BOUNDARY
MORE THAN 500 GALLONS PER MINUTE
50-500 GALLONS PER MINUTE
LESS THAN 50 GALLONS PER MINUTE, VARIABLE DEPTHS
LESS THAN 50 GALLONS PER MINUTE, SOME WELLS MAY YIELD MORE. VARIABLE DEPTHS
LESS THAN 50 FEET
50-100 FEET
MAP NO.9
GROUNDWATER AVAILABILITY
BIG SIOUX RIVER BASIN
SOUTH DAKOTA, IOWA AND MINNESOTA
AND
ADDITIONAL AREAS OF THE COUNTIES WITHIN
THE EAST DAKOTA CONSERVANCY SUB-DISTRICT
IN SOUTH DAKOTA
TAKEN FROM:
AVAILABILITY OF GROUND WATER AND DEPTH TO
WATER LEVEL IN THE MISSOURI RIVER BASIN
BY G.A. LaROCQUE JR.
GEOLOGICAL SURVEY HYDROLOGIC INVESTIGATIONS
ATLAS HA-217 1966
SCALE 1/1,000,000
10 0 10 20 30 40 MILES
LAMBERT CONFORMAL CONIC PROJECTION
SOURCE
SCS BASE 5,0-27,109
AND DATA FURNISHED BY
FIELD TECHNICIANS
5-17-71
5,0-29,159



MAP NO.10

WATERSHED DELINEATION

BIG SIOUX RIVER BASIN

SOUTH DAKOTA, IOWA AND MINNESOTA

AND

ADDITIONAL AREAS OF THE COUNTIES WITHIN THE EAST DAKOTA CONSERVANCY SUB-DISTRICT IN SOUTH DAKOTA

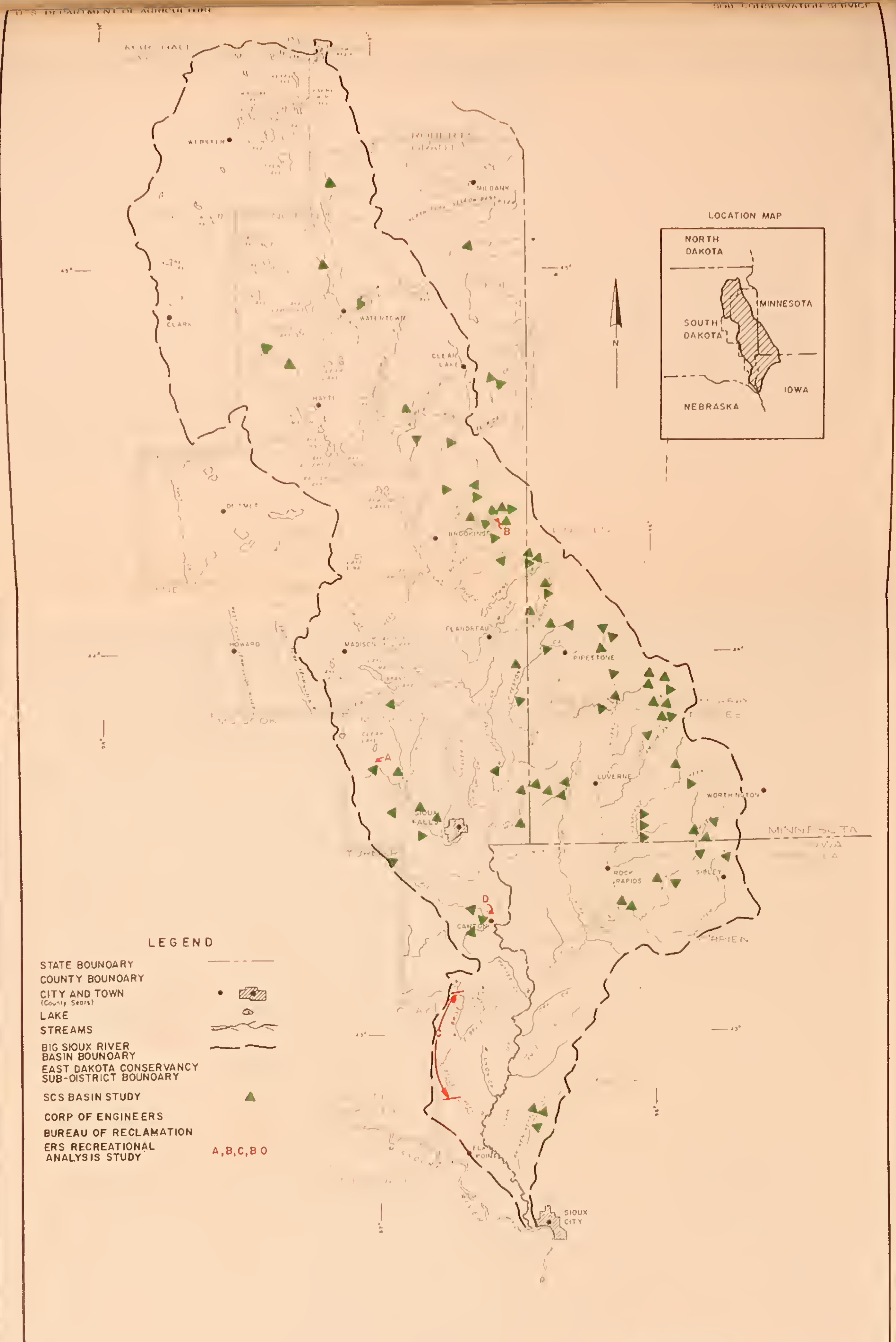
SCALE 1/1,000,000

SCALE 10 0 10 20 30 40 MILES

LAMBERT CONFORMAL CONIC PROJECTION

SOURCE
SCS BASE 5,8-27,100
AND DATA FURNISHED BY
FIELD TECHNICIANS

5-17-71
5,0-29,160



MAP NO. II

POTENTIAL RESERVOIR SITES

BIG SIOUX RIVER BASIN

SOUTH DAKOTA, IOWA AND MINNESOTA

AND

ADDITIONAL AREAS OF THE COUNTIES WITHIN THE EAST DAKOTA CONSERVANCY SUB-DISTRICT IN SOUTH DAKOTA

SOURCE:
SCS BASE 5,S 27,109
AND DATA FURNISHED BY FIELD TECHNICIANS

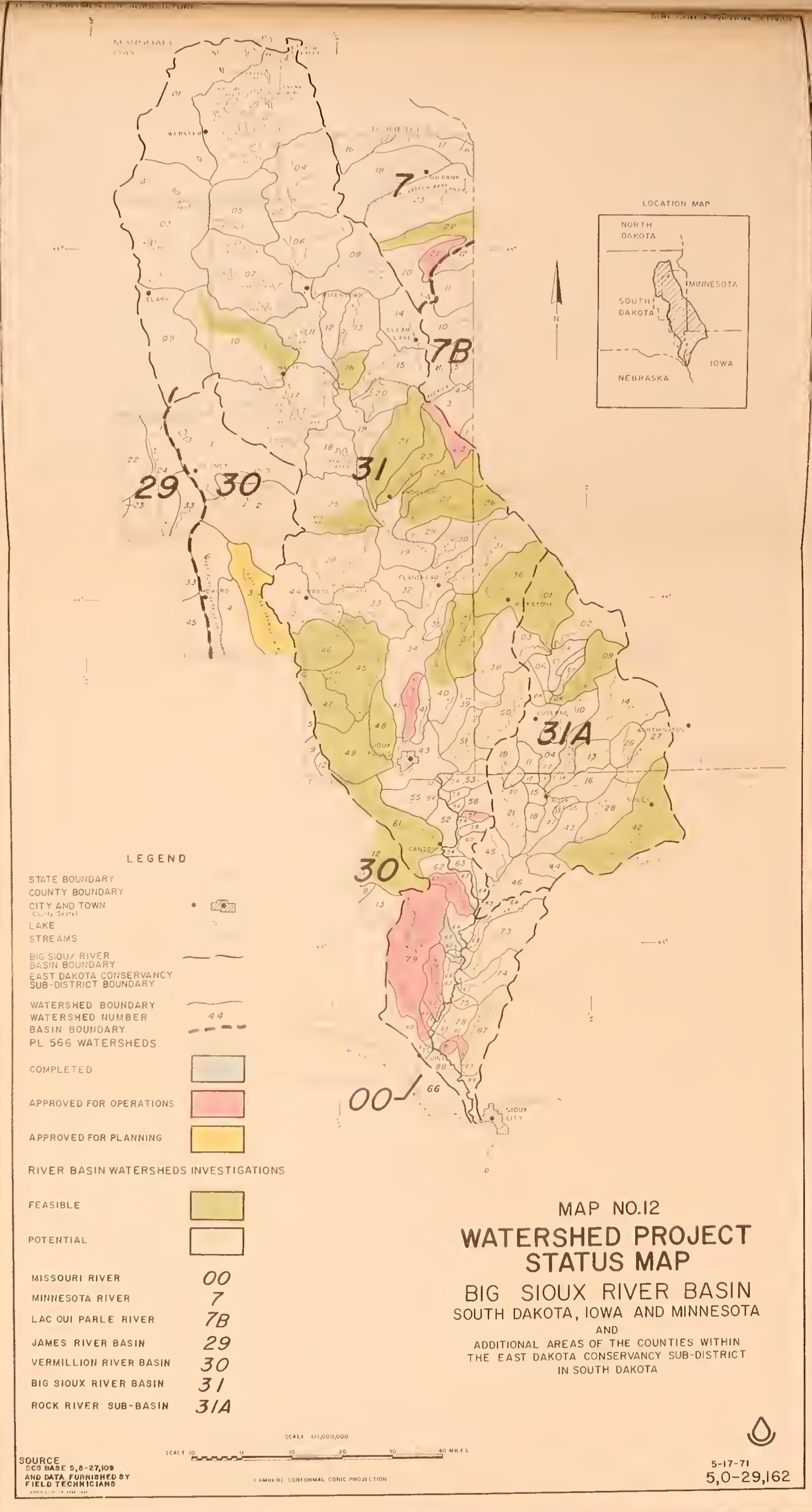
SCALE 1/1,000,000

SCALE 10 0 10 20 30 40 MILES

LAMBERT CONFORMAL CONIC PROJECTION

5-17-71

5,0-29,161



MAP NO.12

WATERSHED PROJECT STATUS MAP

BIG SIOUX RIVER BASIN

SOUTH DAKOTA, IOWA AND MINNESOTA
AND
ADDITIONAL AREAS OF THE COUNTIES WITHIN
THE EAST DAKOTA CONSERVANCY SUB-DISTRICT
IN SOUTH DAKOTA

SOIL ASSOCIATIONS

SOIL ASSOCIATIONS

INTRODUCTION

The General Soil Association Map No. 6 shows the location, extent, and distribution of the soil associations in the Big Sioux Study Area. This map shows only the predominate soils for each association even though other soils are present. The name of each association is derived from the predominate soil within it. The soils of one association may also be present in another association, but in a different pattern and in different amounts.

Although the soils within an association are closely related, geographically, they may differ from each other in physical properties such as slope, color, natural drainage, or other features that influence land use and management. Because of these differences, the soils within an association usually vary in their suitability for agricultural or nonagricultural use. The following is a brief description of each soil association.

A-Deep, nearly level and gently undulating or gently sloping soils on uplands; includes poorly drained depressions.

1-HOUDEK-PROSPER ASSOCIATION - is in Lake, Miner, and Kingsbury Counties, South Dakota, and makes up about three percent of the Study Area. Small potholes or depressions occur throughout this association. The Houdek are deep, well-drained, loamy soils on uplands and Prosper are deep, moderately well-drained soils in gentle swales and concave positions. These soils are well suited for cropping. The main crops grown are winter wheat, oats, corn, and alfalfa.

2-KRANZBURG ASSOCIATION - is in Day County, South Dakota, and makes up about one percent of the Study Area. Kranzburg are deep, well-drained, silty clay loam soils formed in 20-40 inches of loess deposits overlying glacial till. Kranzburg soils are well suited for cropland. The major crops grown are spring wheat, oats, and alfalfa.

3-KRANZBURG-VIENNA ASSOCIATION - is in several counties of Minnesota and South Dakota in the northern part of the Study Area. Topography consists of broad ridgetops and long smooth side slopes that end in drainageways. Combined, the areas make up about nine percent of the Study Area. Kranzburg are deep, well-drained, silty clay loam soils formed in 20-40 inches of loess that overlies glacial till. The Vienna are deep, well-drained, loamy soils that formed in glacial till. Poorly drained soils are in the depressions and drainageways. The major land use is for production of small grain, corn, and soybeans. The long smooth slopes are well suited for terracing and contour farming. Water erosion and soil blowing are the principal hazards.

4-POINSETT-WAUBAY ASSOCIATION - occurs in several northern counties in South Dakota and makes up about 12 percent of the Study Area. The Poinsett are deep, well-drained, silty or loamy soils on the mid and upper parts of ridges and knolls. Waubay are deep, moderately well-drained soils on flats and in slight swales in close association with the Poinsett. Poorly drained soils are in the depressions. These soils are well suited for cropland. Small grain and alfalfa are the principal crops grown.

5-SAC-PRIMGHAR-EVERLY ASSOCIATION - is in Nobles County, Minnesota, and Osceola County, Iowa, and makes up about two percent of the Study Area. Slopes are long, uniform, and smooth. Sac and Everly are deep, well-drained, silty clay loam or clay loam soils on the mid and upper parts of convex ridges and knolls. Primghar are deep, moderately well-drained silty clay loam soils on nearly level ridge tops or in slightly concave positions. Minor amounts of poorly drained soils are in small depressions. These productive soils are used almost entirely for growing of corn, soybeans, and small grain. The long, smooth slopes are well suited for contouring and terracing. A well planned water disposal and management system is essential on these soils.

6-SINGSAAS-OAK LAKE ASSOCIATION - is in Grant and Brookings Counties, South Dakota, and Lincoln County, Minnesota. Some steep slopes occur in the association which makes up less than one percent of the Study Area. Singsaas are deep, well-drained, silty and loamy soils formed in friable, clay loam glacial till, but the profile has been thoroughly mixed by earthworms. The Oak Lake soils are similar to the Singsaas except they are moderately well-drained and occupy lower positions in the landscape. These soils are well suited for cropping and the main crops grown are oats, corn, flax, and alfalfa. Water erosion is the main hazard.

7-WENTWORTH-EGAN-VIBORG ASSOCIATION - is in several southern counties in South Dakota, and makes up about five percent of the Study Area. Wentworth are deep, well-drained, silty clay loam soils formed in stratified silty and loamy deposits of glacial drift. The Egan are deep, well-drained soils formed in stratified silty and loamy deposits less than 40 inches thick over glacial till. The Viborg are deep, moderately well-drained soils with thick, dark colored silty clay loam surface layers and subsoil layers. Viborg soils are on flats and in gentle swales, while the Egan and Wentworth soils are on slightly higher upland positions. This association is used extensively for growing corn, soybeans, small grain, and alfalfa.

B-Deep, undulating and sloping soils on uplands; includes poorly drained depressions and some gently undulating and rolling soils.

8-CLARION-WEBSTER ASSOCIATION - is in Murray and Nobles Counties, Minnesota, and Osceola County, Iowa, and comprises about one percent of the Study Area. Slopes are short and uneven in pattern with numerous small enclosed pockets or depressions of very wet soils. The Clarion are deep, well-drained, loamy soils formed in loamy glacial till. Webster are deep, poorly drained, clay loam soils on the nearly level to slight concave positions of the landscape. Clarion soils are on the higher parts of the landscape. Most of these soils are used for growing of corn, soybeans, and small grain. Water erosion and sedimentation are the major hazards and erosion control practices are essential on these sloping soils. Tile drainage of the wetland is necessary for optimum crop production. The wetness of the Webster soils and erosion on the slopes imposes moderate or severe limitations for most uses.

9-CLARNO-ETHAN ASSOCIATION - is in Lake, Minnehaha, Lincoln, and Miner Counties, South Dakota, and makes up about one percent of the Study Area. The Clarno and Ethan are both deep, well-drained, loamy soils. The Ethan have thinner surface and subsoil layers and are on the crests or convex portion of knolls and ridges above the Clarno soils. Most of these soils are used for growing corn, small grain, and alfalfa, with some steeper areas used for native grassland. Water erosion and sedimentation are the major hazards on sloping areas under cultivation.

10-EGAN-WENTWORTH-CLARNO ASSOCIATION - is in several southern counties in South Dakota and makes up about four percent of the Study Area. The Egan are deep, well-drained, silty clay loam soils formed in 20-40 inches of loess overlying glacial till. The Wentworth are deep, well-drained, silty clay loam soils formed in glacial drift. The Clarno are deep, well-drained, loamy soils formed in glacial till. Most of these soils are used for growing of corn, small grains, soybeans, and alfalfa. Water erosion and sedimentation are the main hazard on sloping areas when cultivated.

11-FORMAN ASSOCIATION - is in Clark, Kingsbury, and Grant Counties, South Dakota, and makes up about two percent of the Study Area. The Forman are deep, well-drained, loamy soils formed in glacial till. Poorly drained soils are in depressions. Forman soils are used mostly for growing of spring wheat, oats, flax, and alfalfa. Water erosion and sedimentation is the main hazard.

12-GALVA-IDA ASSOCIATION - is in Sioux and Plymouth Counties, Iowa, and makes up less than one percent of the Study Area. The Ida are deep, well-drained, silty soils with thin surface layers overlying calcereous silty materials and occur in small patches on convex positions within areas of Galva soils. Larger areas of Ida soils are on some of the more sloping parts of the landscape. Galva are deep, well-drained, silty soils on less sloping topography. Corn, soybeans, and hay are the major crops. Water erosion and sedimentation are the main hazards and, without adequate control, soil and water losses are severe. Level terraces are used on these soils as well as other conservation practices such as contouring, grassed waterways, gully control structures, and minimum tillage.

13-GALVA-PRIMGHAR-SAC ASSOCIATION - is in Osceola, Lyon, and Sioux Counties, Iowa, and Rock County, Minnesota, and makes up about three percent of the Study Area. The Galva and Sac are deep, well-drained, silty soils, typically on long slopes, and are subject to moderate to severe water erosion. The Primghar are deep, silty clay loam, somewhat poorly drained soils on nearly level ridge tops or in slightly concave positions. Artificial drainage increases production on some of the wetter Primghar areas, but most produce well without tile. The Sac soils have less permeable subsoils than Galva and Primghar, and there is a possibility of ponding or springs developing in unusually wet periods. There are some poorly drained soils in waterways, and these are normally tiled. Corn and soybeans are the major crops.

14-HEIMDAL-SISSETON-SVEA ASSOCIATION - is in Grant County, South Dakota, and makes up less than one percent of the Study Area. The Heimdal are deep, well-drained soils with loamy surface layers and loamy to stratified silty and moderately sandy subsoils and substrata. The Heimdal soils are on mid and lower parts of the landscape and the Sisseton soils are on the knobs and ridges. The Sisseton soils are similar to the Heimdal but have thin surface layers and are limy at the surface which give them a light gray to white color when cultivated. The Svea are deep, moderately well-drained, loamy soils in slight swales and shallow drainageways. These soils are well suited to cropland or grassland. Corn, oats, flax, soybeans, and wheat are the principal crops grown. Water erosion control practices are necessary on the more sloping areas to prevent erosion and sedimentation. Soil blowing is a hazard on the cultivated ridges and knolls.

15- HOUDEK-ETHAN-WORTHING ASSOCIATION - is in Miner and Kingsbury Counties, South Dakota, and makes up less than one percent of the Study Area. The Houdek and Ethan are both deep, well-drained, loamy soils formed in glacial till. The Ethan have thinner surface and subsoil layers and are on the convex portions and crests of ridges. The Worthing are deep, dark, poorly drained, clayey soils in depressions. These soils are well suited to cropland or grassland and are used principally for growing of small grain, corn, and alfalfa.

16-MOODY-NORA-CROFTON ASSOCIATION - is in the southern part of the area in South Dakota, Iowa, and Minnesota, and makes up about 10 percent of the Study Area. The Moody are deep, well-drained, silty clay loam soils formed in loess. The Nora are deep, well-drained, silty soils occurring on higher parts of the landscape than the Moody soils and have thinner surface and subsoil layers. Crofton are deep, well-drained, silty soils also formed in loess. They are on knobs, ridges, and the steeper parts of the landscape. They have thin surface layers which often have been removed by water erosion. The major land use is the growing of corn, soybeans, small grain, and alfalfa. The slopes, which are long and smooth, have a severe water and sedimentation hazard. Most slopes lend themselves to contour farming and terraces, and, along with the other minimum conservation practices and rotations, will help maintain yields on these soils.

17-VIENNA-LISMORE ASSOCIATION - is in the northern part of the area in several counties of South Dakota and comprises about two percent of the Study Area. The Vienna and Lismore are deep, upland soils with silty surface layers and loamy subsoil and substrata formed from glacial till. The well-drained Vienna soils are on the higher parts of the landscape and the moderately well-drained Lismore soils are on flats and in swales. Poorly drained soils are in depressions. These soils are well suited to cropland or grassland. The major land use is for growing of oats, flax, wheat, corn, and alfalfa. Water erosion and sedimentation are the main hazard. The long, smooth slopes are well suited to contour farming and terracing. Tile drainage is beneficial on some areas of Lismore soils.

C-Deep, rolling upland soils; includes poorly drained depressions. Under cultivation, water erosion has often removed the surface soils.

18-FORMAN-AASTAD-PARNELL ASSOCIATION - is on a morainic upland known as the Coteau des Prairies in several northern counties of South Dakota and makes up about four percent of the Study Area. Stony areas, intermittent lakes, marshes, and depressions are common. The Forman are deep well-drained, loamy soils formed in loamy glacial till. The Aastad are deep, moderately well-drained soils that are on nearly level fans, flats, and in swales. The Parnell are deep, poorly drained, clayey soils located in depressions. The Forman and Aastad soils are well suited to cropland or grassland, but the slopes make water erosion and sedimentation a serious hazard. Wheat, oats, flax, and alfalfa are the principal crops grown. The poorly drained Parnell soils are not suited for cultivation unless artificially drained.

19-IDA-MONONA ASSOCIATION - is in Plymouth County, Iowa, and comprises less than one percent of the Study Area. The Ida are deep, well-drained, silty soils with thin surface layers that overlie yellowish brown, very friable, calcareous, silty loess deposits. Monana soils are similar but have thicker surface layers and subsoils. Sheet and gully erosion are severe hazards on these soils. Most of this land is planted to rotations that include row crops, small grain, and hay. Contouring, terracing, and other conservation practices are necessary to maintain yields. The two main limitations are the steep slopes and the erosion hazard.

D-Deep, rolling and steep soils on side slopes and steep morainic uplands. Includes stony areas and poorly drained depressions.

20-BETTS ASSOCIATION - is in Lake and Lincoln Counties, South Dakota, and makes up less than one percent of the Study Area. Betts are thin surfaced, loamy, calcareous soils that have excessive runoff because of steep slopes. Most of these soils are used for pasture or native grassland.

21-BUSE-BARNES ASSOCIATION - is along the northeastern edge of the Basin and makes up less than one percent of the Study Area. Slopes are short, choppy, and erratic. The Buse are deep, well-drained, loamy soils with thin surface layers that are underlain with calcareous, loamy glacial till. The Barnes are deep, well-drained, loamy soils formed in glacial till. They usually occur below areas of Buse soils. Poorly drained soils are in depressions. Pasture and hay is of major importance on steeper areas. The major land use on undulating areas is the growing of row crops and small grain. Erosion control practices are necessary.

22-FORMAN-BUSE ASSOCIATION - is on morainic topography in the northern portion of the area in South Dakota and makes up about four percent of the Study Area. Numerous drainageways, stones and boulders are part of the landscape. The Forman are deep, well-drained, loamy soils formed in glacial till. The Buse are deep, loamy soils with thin surface layers overlying calcareous glacial till. This association is best adapted to grassland or hayland. The main crops grown on some of the gentler slopes are wheat, oats, flax, and alfalfa. Water erosion is a severe hazard on cropland. Most of this association provides excellent wildlife habitat.

23-FORMAN-BUSE-AASTAD-PARNELL ASSOCIATION - is mostly in the moraine referred to as the Coteau des Prairies in the northern portion of the area and makes up about five percent of the Study Area. Depressions, drainageways, stones, and intermittent lakes dot the landscape. The Forman and Buse have been described in the previous association. The Aastad are deep, moderately well-drained soils that occur on nearly level toe slopes, flats, and in swales. The Parnell are deep, poorly drained, clayey soils in depressions. This association is best adapted for grassland or hayland. A few areas on gentler slopes are used for growing of wheat, oats, and alfalfa.

24-IDA-HAMBURG-MONONA ASSOCIATION - is along the Big Sioux River in Plymouth County, Iowa and makes up less than one percent of the Study Area. These silty soils are formed in thick loess deposits. There are some rock outcrops near the Big Sioux River. Large gullies are common. Ida are deep, well-drained, silty soils with thin surface layers. The Hamburg are similar to the Ida, but are coarser textured. The Monona are deep, well-drained, silty soils. The Ida and Hamburg soils occupy the more sloping parts of the landscape. Most of this land is in pasture or in trees. Some of the less sloping areas are planted to row crops and small grain. Water erosion is a severe hazard and large gullies are common.

Adequate erosion control normally involves several intensive conservation practices. The steep slopes and the severe erosion hazard are serious limitations for continuous cropping. They are excellent for wildlife habitat and recreational uses.

25-STORDEN-EVERLY ASSOCIATION - is in Nobles County, Minnesota, and makes up less than one percent of the Study Area. Storden and Everly are deep, well-drained, loamy soils formed in calcareous, clay loam glacial till. Slopes are short and uneven and there are numerous small, wet draws and enclosed depressions. Many areas have thin light colored soils on knobs and crests of ridges. The steeper slopes are used for pasture and hay. On the less rolling lands, corn, soybeans, and oats are grown. Erosion control systems are essential on the rolling slopes. Drainage systems are required on the wet areas. The soils in this association have moderate or severe limitations for most uses due to steepness of slope or wetness.

E-Deep, level or nearly level upland soils.

26-BROOKINGS-HIDEWOOD ASSOCIATION - is in Pipestone County, Minnesota, and makes up less than one percent of the Study Area. Brookings and Hidewood are deep, moderately well and somewhat poorly drained silty clay loam soils. The soils are well suited for cultivated crops and intensive agriculture is normal with emphasis on corn and soybeans. Tile drainage is required on the Hidewood soils for maximum yields.

27-MOODY-TRENT ASSOCIATION - is in the southern part of the area and makes up about three percent of the Study Area. The Moody and Trent are both deep, silty clay loam soils developed in loess. The Moody soils are well drained and are on the slightly higher areas than the moderately well-drained Trent soils which are on the lower positions or shallow swales. The major land use is growing of corn and soybeans. Long, smooth slopes lend themselves to contouring and terracing. Well planned water disposal systems are essential on the long slopes. Tile drainage is beneficial to many of the draws and flats.

28-PRIMGHAR-MARCUS ASSOCIATION - is in Iowa and Minnesota and makes up about one percent of the Study Area. The slopes are long, smooth, and uniform. The Primghar and the Marcus are deep, moderately well-drained and poorly drained silty clay loam soils. The major land use is growing of corn and soybeans. Water erosion is a moderate hazard on the Primghar soils. Excessive wetness is a limitation on the Marcus soils. A good system of water management and dispersal is necessary to control soil erosion on the long slopes.

29-SINAI-WENTWORTH ASSOCIATION - is in the central portion of the area in South Dakota and makes up about two percent of the Study Area. The Sinai are deep, well-drained, clayey soils. The Wentworth are deep, well-drained, silty clay loam soils. These soils are well suited for cropland. The main crops grown are small grain, corn, soybeans, and alfalfa.

30-TRENT-MARCUS ASSOCIATION - is in Rock County, Minnesota, and occupies less than one percent of the Study Area. The Trent and Marcus are deep, moderately well-drained, and poorly-drained soils. Corn, soybeans, and small grains are the principal crops grown on these highly productive soils. Drainage is necessary on the Marcus soils for maximum production and water erosion control measures are needed on the slopes.

31-WAKONDA-TETONKA ASSOCIATION - is in Lincoln County, South Dakota, and makes up less than one percent of the Study Area. The Wakonda are deep, moderately well-drained and somewhat poorly-drained, silty clay loam soils with concentrations of lime or calcium carbonate at the surface. The Tetonka are deep, poorly-drained, clayey soils in shallow depressions. These soils are used mostly for growing of corn, small grain, and alfalfa. Intermittent or seasonal wetness limits the selection of crops.

F-Deep, nearly level and gently undulating soils that have clayey or claypan subsoils.

32-BEADLE ASSOCIATION - is in Kingsbury and Miner Counties, South Dakota, and makes up about two percent of the Study Area. Beadle are deep well-drained, soils with loamy surface layers and clayey, slowly permeable subsoils. Small grain, tame and native pasture are the principal uses of these soils.

33-BEADLE-STICKNEY-DUDLEY ASSOCIATION - is in Kingsbury and Miner Counties, South Dakota, and makes up about one percent of the Study Area. The Beadle are deep soils with loam surface layers and clayey, slowly permeable subsoils. Stickney soils have loamy or silty surface layers with dense, clayey, slowly permeable subsoils. Dudley have thin surface layers with slowly permeable claypan subsoils that have visible salts below the claypan. The Dudley is in the microdepressions or slightly concave positions and the Stickney and Beadle soils are on slightly higher areas. The major uses of these soils are for growing of small grain, pastureland, and hayland.

34-PEEVER ASSOCIATION - is in Deuel, Grant, Kingsbury, and Roberts Counties, South Dakota, and makes up about two percent of the Study Area. The Peever are deep, well-drained soils with loam surface layers and clayey, slowly permeable subsoils. This soil association is well suited to cropland. The main crops grown are wheat, flax, oats, and alfalfa.

35-PEEVER-CAVOUR ASSOCIATION - is in Clark, Day, and Kingsbury Counties, South Dakota, and makes up about two percent of the Study Area. Peever are deep, well-drained, soils with loam surface layers and clayey, slowly permeable subsoils. The

Cavour have loam surface layers with slowly permeable claypan subsoils that have visible salts below the claypan. Cavour soils are in the microdepressions or slightly concave positions with the Beadle on the slightly higher positions in the landscape. Small grain and alfalfa are the major crops grown with many areas used for pastureland and hayland.

G-Nearly level to rolling soils on upland slopes and terraces that are underlain with sandy and gravelly materials at 20 to 40 inches.

36-<u>ENET-DEMPSTER ASSOCIATION</u> - is in Lake, Lincoln, Minnehaha, and Moody Counties, South Dakota, and makes up less than one percent of the Study Area. The Enet soils formed in 20 to 40 inches of dark colored, loamy materials overlying sand and gravel. The Dempster soils are similar but are more silty. Some soils with gravel at 10 to 20 inches also are in parts of the association. The major land use is for growing of corn, small grain, and alfalfa. The low available water capacity of these soils limits yields.

37-<u>FAIRHAVEN-WADENA ASSOCIATION</u> - is in Nobles and Rock Counties, Minnesota, and makes up less than one percent of the Study Area. These loamy soils are well-drained and are moderately deep over loose sand and gravel. Very minor amounts of poorly drained soils occur in enclosed pockets or in seep areas at the base of slopes. This association is primarily used for growing corn, soybeans, and small grain. The moderate available water capacity of these soils limits the average yield.

38-<u>FORDVILLE-ESTELLINE ASSOCIATION</u> - is in the north-central part of the area in South Dakota and Minnesota and makes up about two percent of the Study Area. The well-drained Fordville soils are formed in 20 to 40 inches of loamy materials that overlie outwash gravel and sand. The well-drained Estelline soils are similar in depth to sand and gravel but are more silty. Some poorly drained soils are in drainageways and depressions. Small grain, corn, and alfalfa are the main crops grown, but yields are influenced because of the low or moderate available water capacity. These soils are suitable for irrigation. Soil blowing is a hazard under intensive cropping.

39-<u>HENKIN ASSOCIATION</u> - is along the Big Sioux River in Brookings, Moody, and Minnehaha Counties, South Dakota, and makes up less than one percent of the Study Area. The Henkin are deep, well-drained, sandy soils. This association is used mostly for growing corn, small grain, and alfalfa. Soil blowing is a hazard on cropland on these sandy soils.

40-<u>RENSHAW-FORDVILLE ASSOCIATION</u> - is in most of the counties in the northern portion of the Study Area and makes up about three percent of the area. Renshaw soils formed in 10 to 20 inches of loamy or sandy material over sand and gravel while the Fordville soils formed in 20 to 40 inches of loamy material over sand and gravel. The more gentle slopes in this association are used mostly for growing of small grain and alfalfa while the steeper slopes are used for rangeland or hayland. Low or moderate available water capacity limits crop yields. Some areas are suited to irrigation.

41-RENSHAW-FORDVILLE-DIVIDE ASSOCIATION - occurs along the poorly drained drainageways and includes sandy and gravelly outwash areas and steep side slopes in Clark and Kingsbury Counties, South Dakota, and comprises about one percent of the Study Area. The Renshaw and Fordville soils are as described in the previous association. The Divide are somewhat poorly drained limy soils formed in 20 to 40 inches of loamy material over sand and gravel. They have a seasonal water table. This soil association is best suited for rangeland or hayland, but some of the gentler slopes are used for growing of small grain and alfalfa.

H-Deep, well-drained to poorly-drained alluvial soils on bottom lands.

42-ALBATON-HAYNIE ASSOCIATION - is on bottom lands of the Missouri River in Union County, South Dakota, and makes up less than one percent of the Study Area. Albaton are deep, clayey, poorly drained, calcareous soils that formed in clayey alluvium. Haynie are deep, light colored, well-drained soils with silt loam or very fine sandy loam, calcareous surface layers that overlie stratified silty and sandy sediments. Haynie soils are on slightly higher elevations than Albaton. Most of this association is used for growing of corn, soybeans, and alfalfa. Dams along the Missouri River have substantially decreased the flooding hazard on this association.

43-HAYNIE-SARPY ASSOCIATION - is on the Missouri River bottom land in Union County, South Dakota, and makes up less than one percent of the Study Area. The Haynie soils have been described in the previous association. The Sarpy are deep, very sandy soils. Most of this association is under cultivation for corn, soybeans, and alfalfa. Some areas are developed for irrigation. Wind erosion is a severe hazard.

44-BOTTOM LANDS AND TERRACES - is a land type that occurs adjacent to major streams principally in Iowa and Minnesota and makes up about four percent of the Study Area. The topography is essentially level; however, the bottoms are decidedly dissected by old stream channels. The bottom land soils are medium or moderately fine textured and poorly drained to well drained. The terrace soils are loamy or silty and are shallow, moderately deep, or deep over sand and gravel. They are well-drained through somewhat excessively drained. Pasture and meadow is the major land use on the bottom lands that are subject to frequent flooding. Row crops and small grains are grown on the terraces and on bottom lands that are flooded infrequently. Flood control and drainage are needed in the bottom lands for maximum production. Soil blowing and droughtiness are problems on the terrace soils.

45-LAMO ASSOCIATION - occurs extensively on bottom lands and drainageways leading to the Big Sioux River in the southern part of the Study Area, and makes up about two percent of the area. Lamo are deep, somewhat poorly drained silty clay loam soils that are limy at or near the surface. They formed in silty to clayey calcareous alluvium. Where flooding is not a problem, the Lamo soils are cultivated for growing of corn, soybeans, small grain, and alfalfa. The wetter areas are used for pastureland or hayland.

46-LAMOURE ASSOCIATION - occurs extensively on bottom lands and drainageways in the northern part of the Study Area in South Dakota and makes up about two percent of the area. The Lamoure are deep, moderately well to poorly-drained silty clay loam soils that are limy at or near the surface. They formed in silty to clayey alluvium. Where flooding is not a hazard, Lamoure soils are cultivated for production of corn, small grain, and alfalfa and tame grasses. The wetter areas are used for pastureland or hayland.

47-LUTON ASSOCIATION - is on bottom land between the Missouri and Big Sioux Rivers in Union County and makes up less than one percent of the Study Area. Luton are deep, poorly-drained, clay soils. When not artificially drained they are saturated with water during part of the growing season. When not drained, the soils are used mostly for hayland. With drainage, these soils are under cultivation. Flooding is a major hazard.

I-Shallow, gravelly and rocky soils

48-RENSHAW-FORDVILLE-SIOUX ASSOCIATION - is on nearly level to rolling terraces and outwash plains. It makes up about one percent of the Study Area. Stones and boulders are commonly scattered over the landscape. The Fordville soils formed in 20 to 40 inches of loamy materials over sand and gravel. Renshaw soils have 10 to 20 inches of loamy material over sand and gravel. Sioux soils have a few inches of loamy or sandy material over sand and gravel. This soil association is best suited to rangeland. The soils are fair to good sources of sand and gravel.

49-IHLEN-ROCK OUTCROP - is a land type on nearly level to sloping topography in Minnehaha County, South Dakota, and Lincoln and Rock Counties, Minnesota. The areas make up less than one percent of the Study Area. The soils are moderately deep to shallow, silty soils over quartzite interspersed with quartzite outcrops. The deeper soils are cultivated but areas of shallow soils and rock outcrop limit the use of machinery so most areas are used for pasture. Erosion is a serious hazard on the shallow soils. The presence of the rock on the surface or a few feet below the surface seriously restricts most uses of this land.

SOIL RESOURCE GROUPS

Soil Resource Group Number	Description
Uplands and Terraces	
102	Deep, well and moderately well-drained, medium to moderately fine-textured soils. Moderately to moderately slowly permeable. Bedrock or gravel may be encountered deep within profile. Nearly level.
104	Same as 102 except gently sloping
106	Same as 102 except sloping
108	Same as 102 except moderately steep
110	Same as 102 except steep
112	Deep, well-drained medium-textured soils. Moderately permeable. Calcareous, nearly level to sloping.
114	Same as 112 except moderately steep
120	Deep, moderately well to somewhat poorly drained, moderately fine to fine-textured soils. Moderately to slowly permeable soils with firm to very firm subsoils. Nearly level to gently sloping.
136	Moderately deep, well to somewhat poorly drained, medium to moderately fine-textured soils overlying sand and gravel or bedrock. Nearly level.
138	Same as 136 except gently sloping
140	Same as 136 except sloping
142	Same as 136 except sloping to moderately steep
144	Deep, poorly drained, medium to moderately fine-textured soils. Moderate slowly permeable. Includes moderately deep soils over bedrock and/or gravel. Nearly level.
160	Deep well-drained granular clay soils nearly level to gently sloping

Soil Resource Group Number	Description
Uplands and Terraces	
168	Moderately deep loamy soils with columnar B horizons in complex with deep loamy soils. Nearly level to gently sloping.
174	Deep moderately well to excessively drained, coarse-textured soils. Nearly level to sloping.
211	Moderately well-drained, medium to moderately coarse-textured soils. Shallow to bedrock and sand or gravel. Nearly level to sloping.
231	Organic soils; agricultural soils when drained
Bottom Lands	
310	Deep poorly drained fine-textured soils. Slowly to very slowly permeable. Level to nearly level.
320	Deep poorly drained medium to moderately fine textured soils. Moderate to moderately slowly permeable. Subject to overflow. Level to nearly level.
330	Deep and moderately deep well to somewhat poorly drained, medium to moderately fine-textured soils. Moderate to moderate slowly permeable. Fine-textured lower horizons may occur throughout lower portions of profile. Level to gently sloping.
420	Bottom lands subject to frequent overflow or so severely dissected by old streamchannels as to make cultivation infeasible.
Depressions and Flatlands	
510	Deep, poorly drained, medium to fine-textured, moderately slow to slowly permeable depressional soils. Occasionally ponded.

Soil Resource Group Number	Description
Saline and Alkali Soils - Uplands	
624	Strongly solonized; level to sloping
Non-Arable Lands	
705	Shallow to deep. Includes very stony soils on gentle to steep slopes. Also lands destroyed for cultivation because of severe gullying.

APPENDIX C

CURRENT NORMAL AND PROJECTED FEED RATIONS CONVERSION RATES AND REQUIREMENTS

Table C-1--Projected ration composition for livestock or livestock products 1/
Big Sioux Study Area

Item	Year			
	Current	1980	2000	2020
	Percent			
Beef and Veal 2/				
Roughage	51	44	44	43
Feed Grains	43	51	52	54
Supplemental Protein	6	5	4	3
Pork				
Roughage	7	7	6	6
Feed Grains	83	84	86	87
Supplemental Protein	10	9	8	7
Lamb and Mutton				
Roughage	78	74	70	69
Feed Grains	20	23	27	28
Supplemental Protein	2	3	3	3
Chickens				
Feed Grains	65	72	78	80
Supplemental Protein	30	25	20	18
Other	5	3	2	2
Turkeys				
Feed Grains	70	71	73	74
Supplemental Protein	25	25	24	24
Other	5	4	3	2
Eggs				
Feed Grains	80	85	90	90
Supplemental Protein	20	15	10	10
Milk				
Roughage	69	65	62	59
Feed Grains	27	32	35	39
Supplemental Protein	4	3	3	2

1/ Composition of ration as corn equivalent feed units. A feed unit is the feed value of one pound of shelled corn or its equivalent.

2/ Conversion rates for beef were adjusted to reflect importance of slaughter cattle relative to all cattle.

Source: "Projections of Livestock Feeding Efficiency; 1980-2000-2020; Missouri River Basin States," Great Plains Agricultural Council Pub. No. 31; Univ. of Nebraska, Lincoln, Nebr., May 1968.

Table C-2--Projected feed conversion rates for livestock and livestock products 1/
Big Sioux Study Area

Item	Year			
	Current	1980	2000	2020
	Feed Units			
Beef 2/	9.6	8.7	7.2	6.4
Pork	4.3	4.0	3.5	3.0
Lamb	13.5	11.4	9.3	8.1
Chickens	2.4	2.1	1.9	1.8
Turkeys	3.7	3.3	3.0	2.6
Eggs	3.4	3.0	2.7	2.4
Milk	1.31	1.12	1.00	.87

1/ Feed Units per pound of liveweight produced (or product for eggs and milk). A feed unit is the feed value of one pound of shelled corn or its equivalent.

2/ Conversion rates for beef were adjusted to reflect importance of slaughter cattle relative to all cattle.

Source: "Projections of Livestock Feeding Efficiency; 1980-2000-2020; Missouri River Basin States," Great Plains Agricultural Council Pub. No. 31; University of Nebraska, Lincoln, Nebraska, May 1968.

Table C-3--Current normal(CN) and projected livestock feed requirements and production
Big Sioux Study Area

Item	Feed Grains	Roughage	Other 1/
	Million Feed Units		
CN Requirements:			
Beef	2,848.3	3,378.2	397.5
Pork	1,641.8	138.5	197.8
Sheep	162.0	631.8	16.2
Chickens	20.1	-	10.8
Turkeys	31.3	-	13.4
Eggs	216.5	-	54.1
Milk	300.7	768.3	44.6
Total	5,220.7	4,916.8	734.4
Production:	5,802.5	3,885.0	N.A.
1980 Requirements:			
Beef	4,198.7	3,662.4	411.6
Pork	2,045.6	170.5	219.2
Sheep	150.8	485.1	19.7
Chickens	16.1	-	6.3
Turkeys	38.1	-	15.5
Eggs	177.1	-	31.2
Milk	301.1	611.5	28.2
Total	6,927.5	4,929.5	731.7
Production:	7,700.4	5,537.9	N.A.
2000 Requirements:			
Beef	4,701.7	3,978.4	361.7
Pork	2,406.5	167.9	223.9
Sheep	193.3	501.3	21.5
Chickens	20.8	-	5.9
Turkeys	45.8	-	16.9
Eggs	219.9	-	24.4
Milk	376.3	666.6	32.2
Total	7,964.3	5,314.2	686.5
Production:	8,907.5	5,602.1	N.A.
2020 Requirements:			
Beef	5,715.9	4,551.5	317.5
Pork	2,704.5	186.5	217.6
Sheep	230.2	567.3	24.7
Chickens	26.4	-	6.6
Turkeys	52.5	-	18.5
Eggs	254.2	-	28.2
Milk	468.2	708.4	24.0
Total	9,451.9	6,013.7	637.1
Production:	12,486.6	6,008.8	N.A.

1/ Includes supplemental protein among other feedstuff

APPENDIX D

LAND CAPABILITY CLASSIFICATION

LAND CAPABILITY CLASSIFICATION

The capability classification is a grouping of soils that have about the same influence on production and responses to systems of management of common cultivated crops and pasture plants.

In this system, all soils are grouped into capability classes and subclasses. The eight capability classes are designated by Roman numerals I through VIII. The risks of soil damage or limitations in use become progressively greater from Class I to Class VIII. Soils in the first four classes are capable, under good management, of producing adapted plants such as forest trees or range plants, and the common cultivated crops and pasture plants. Soils in Classes V, VI, and VII are suited to the use of adapted native plants. Some soils in Classes V and VI are capable of producing specialized crops under highly intensive management involving elaborate practices for soil and water conservation. Soils in Class VIII do not return on-site benefits for inputs of management of crops, grasses, or trees.

The grouping of soils into capability units, classes, and subclasses is done primarily on the basis of their capability to produce common cultivated crops and pasture plants without deterioration over a long period.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter e, w, s, or c, to the class numeral, for example - IIe. The letter e shows that the main limitation is the erosion hazard. The letter w means wetness. The letter s shows that the soil is limited mainly because it is shallow, droughty, or stony. The letter c is used in only some parts of the country and indicates that the chief limitation is a climate that is too cold or too dry for most commonly raised crops.

The eight capability classes and the subclasses found in the Big Sioux Study Area are described as follows:

Class I - Soils that have few or no limitations which restrict use.

Class IIe - Soils subject to moderate erosion by wind or water. Erosion can usually be controlled by simple practices such as contouring, conservation cropping systems, or crop residue management.

Class IIw - Soils that have moderate limitations because of excess water in, or on, the surface. These soils are usually cropped but crops frequently drown. Grassed waterways, open ditches, or tile drainage are needed to correct the problem.

Class IIs - Soils that have moderate limitations because of a droughty gravel layer. These soils are somewhat limited in yield expectations because of limited water-holding capacity. They frequently are considered for irrigation.

Class IIc - Soils in this group are limited by a cold climate. They are too far north for optimum production of such crops as corn, soybeans, or sorghums.

Class IIIe - These soils are subject to severe erosion by wind or water if improperly managed. Soils in this group require a high percentage of hay and pasture in the rotation or a combination of practices such as terracing, contouring, and crop residue management.

Class IIIw - These soils are severely limited by water in, or on, the soil. They usually cannot be cropped except in dry years unless drained by tile or open ditches.

Class IIIs - These soils have severe limitations of moisture retention capacity as topsoil tilth.

Class IVe - Soils in this group are subject to very severe erosion, if cropped. The best use of these soils is for hay or pasture.

Class IVw - Soils in this group have severe limitations because of water in, or on, the surface. They also usually have a further limitation such as low fertility or high salt concentrations. The soils should usually be used for hay or pasture with only occasional cropping.

Class IVs - Soils in this group have severe limitations because of low fertility and drouthiness. They should be used for hay or pasture.

Class Vw - These soils are too wet for cultivation and drainage measures are impractical. They should be used for wetland meadows or wildlife usage.

Class VIe - These soils are severely limited by excessive erosion if permanent cover or abused by overgrazing. The best use of these soils is for pasture or rangeland.

Class VIw - Soils in this group usually occur along a river or streambed and are subject to frequent overflow and may be cut by old stream channels. They are best used for pasture unless they can be protected from flooding by structural measures. If protected, they may be used for cropland.

Class VIIe - These soils are too erosive for ordinary grazing. Their best use is for limited grazing or woodland.

Class VIIs - These soils are severely limited by stones at, or near, the surface. Their best use is for limited grazing or woodland.

APPENDIX E

RECREATION ANALYSIS

RECREATION DEVELOPMENT

In view of the current and prospective pressures on existing water-based recreation facilities in the lower basin, a special analysis was made of economic benefits obtainable from development of potential reservoir sites for recreation as a multiple or single purpose. In estimating demands, the following factors were considered: (a) present and projected population growth, (b) present and projected socio-economic characteristics of the population, (c) the location of the population with respect to existing recreation sites, and (d) the patterns of water-based recreation activities of households of different income levels. In addition to being affected by population growth and projected household incomes, the level of benefits estimated for each potential reservoir was basically determined as savings in time and travel costs and increased participation due to locating reservoirs nearer to population centers than existing alternative facilities.

Only the resident population of the Study Area was considered in the analysis, except for a portion of the population of the Sioux City SMSA which could be expected to utilize recreation facilities in the lower Big Sioux Basin. Projected population and per capita income levels used were consistent with those given in Tables 6 and 10.

Recreational benefits were evaluated for five potential reservoirs, two of which were considered as a single site. The location of these reservoirs is shown on Map No. 11. Site A is located on Skunk Creek in Minnehaha County, northwest of Sioux Falls. Site B is located on Deer Creek, northeast of Brookings. Site C consists of two reservoirs, one located on Brule Creek in Union County and the other on West Brule Creek just above the Union County line.

Site D is located on Beaver Creek southeast of Sioux Falls in Lincoln County. Projected use and estimated associated recreation benefits for the system of sites evaluated are given in Table E-1.

Table E-1--Projected recreation days use and estimated annual gross recreation benefits, evaluated sites Big Sioux Study Area

	1980		2000		2020	
	Recreation Days	Recreation Benefits	Recreation Days	Recreation Benefits	Recreation Days	Recreation Benefits
	-- Days --	--- $ ---	-- Days --	--- $ ---	-- Days --	--- $ ---
Site A	24,600	55,700	29,100	68,100	37,300	90,700
Site B	32,900	45,100	44,500	61,100	64,400	93,500
Site C	47,400	83,500	57,100	103,500	74,200	138,700
Site D	12,000	26,100	14,800	33,200	19,400	45,100
Total	116,900	210,400	145,500	265,900	195,300	368,000

Computations were made for three time periods: 1980, 2000, and 2020. The proposed system will provide approximately 117,000 recreation days in 1980; 145,000 in 2000; and 195,000 in 2020 above those available from existing facilities.

Total recreation values from these sites increase from $210,000 in 1980 to $266,000 in 2000, and $368,000 in 2020. Consequently, average values per recreation day are $1.80, $1.83, and $1.88 for the three time periods. These values per recreation day approximate those normally used by federal agencies in project evaluation.

With the system of evaluated reservoirs, people who would have had to recreate at reservoirs 45 to 60 miles away could find these recreational opportunities within 10 to 20 miles, with a considerable increase in economic benefits. Although these gains were not evaluated, construction and operation of the facilities would generate additional local and regional economic gains.

All projected recreation needs of the area would not be satisfied with the sites evaluated. In particular, additional facilities would be needed for Sioux Falls residents. Perhaps some of these needs could be met by enlargement of the Skunk Creek site (Site A).