SDSU-RSI-75-02

USE OF REMOTE SENSING TECHNOLOGY FOR INVENTORYING AND PLANNING UTILIZATION OF LAND RESOURCES IN SOUTH DAKOTA

ORIGINAL CONTAINS
COLOR ILLUSTRATIONS

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ABSTRACT

A comprehensive land use planning process model is being developed in Meade County, South Dakota, using remote sensing technology. The proper role of remote sensing in the land use planning process is being determined by interaction of remote sensing specialists with local land use planners. The land use planners determine the kinds of data needed from remote sensing. Together the remote sensing specialists and planners make recommendations. Local officials make planning decisions based on basic soil, land use, and thematic maps, and on recommendations. This report is the status of the project to date.

The data that have been collected by remote sensing techniques are as follows:

1. Level I land use data interpreted at a scale of 1:250,000 from false color enlargement prints of ERTS-1 color composite transparencies.
2. Detailed land use data interpreted at a scale of 1:24,000 from enlargement color prints of high altitude RB-57 photography.
3. General soils map interpreted at a scale of 1:250,000 from false color enlargement prints of ERTS-1 color composite transparencies.

In addition to use of imagery as an interpretation aid, the utility of using photographs as base maps has been demonstrated. Base maps to be used include:

1. A false color mosaic at a scale of 1:250,000 for Meade County from enlargement prints of ERTS-1 color composite transparencies.
2. A false color mosaic of Black Hills area of county at a scale of 1:125,000 from high altitude RB-57 photography.
3. A color mosaic of Black Hills area of county at a scale of 1:24,000 from high altitude RB-57 photography.
4. Black and white photography at scales of 1:7,920 and 1:4,800 for Black Hills area.

Two fold-out maps with soil and soil management illustrative information on a LANDSAT background format were printed and are receiving wide circulation. The space imagery background for resource maps gives an added dimension valuable for interpretation purposes.

A project for normalization of soil radiance as registered on imagery, to minimize background anomalies has produced good initial results. Success on this project has great potential for increasing the accuracy of crop identification and for predicting crop yields.

As energy sources become more scarce and fuel costs continue to increase, those responsible for allocating and conserving energy are looking for ways to reduce energy consumption. The report briefly describes ways in which heat can be lost from structures and gives an illustration of a flight with a thermal scanner over Brookings, South Dakota that produced imagery showing roofs of buildings at various temperatures. The report describes a generalized relation between the amount of insulation in ceilings and rooftop temperatures. Thus it illustrates the potential for rapidly determining the need for insulation over broad areas using remote sensing.

In the Bicentennial activity, a map of South Dakota is being produced with a number of organizations participating. It will show a LANDSAT mosaic of the state along with numerous points of interest. One side of the map will have colored photos or prints of points of interest throughout the state. The Parks and Recreational Development in Sioux Falls, a Bicentennial activity is using remote sensing imagery for planning purposes. RSI personnel are working with planners to produce an optimum plan.

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ACKNOWLEDGEMENTS

1. The NASA technical officer for this grant is J. A. Vitale, NASA Headquarters, Office of University Affairs, Room 6125, 400 Maryland Avenue, S.W. Washington, D.C. 20546.
2. The Sixth District Council of Local Governments planners who are cooperating with this project are Archie Judson, Phil Cerveny and Tom Devine.
3. The South Dakota State University Cooperative Extension Service Rural Development Specialist cooperating with this project is Arnold Bateman.
4. The USDA Soil Conservation Service soil scientists cooperating with this project are Don Bannister and T. J. Ollila.
5. The Meade County Planning and Zoning Administrator cooperating with this project is Kirk Carlsen.

RESOURCE INVENTORYING AND PLANNING IN SOUTH DAKOTA

INTRODUCTION

This activity by the Remote Sensing Institute involving a NASA University Affairs grant has been directed toward the utilization of remote sensing techniques by action groups. This report describes progress for the first half of FY 1974-75 in the various applications areas which are being pursued. The efforts included here are being funded in part by the State of South Dakota and by each of the action agencies involved.

South Dakota is experiencing land use problems similar to those occurring throughout the country. Conflicting demands for limited land resources place severe strain upon social, economic and political institutions. Unfortunately, land use planning and management in the past have left a record of uncoordinated, haphazard, and inefficient land use patterns which often do not reflect the desires of the people.

The 1974 South Dakota Legislature enacted a bill requiring county planning commissions to prepare a comprehensive land use plan by July 1, 1976. Many South Dakota counties do not have land use plans and do not have personnel to accomplish this task. The multi-county planning districts in the state will provide assistance if requested by the counties. However, their resources are limited and facilities for data collection are almost nonexistent. Development of a comprehensive land use planning process model which encompasses available remote sensing technology is the main scope of the present South Dakota activity and should be useful to the various counties.

PENNINGTON COUNTY FOLLOW-UP ACTIVITIES

There has been a planned coordinated effort resulting from the NASA-sponsored project which was initially applied to Pennington County, South Dakota. The objective was to develop technology for using remote sensing imagery to rapidly develop general soils and land use inventories for implementing operational programs. The project utilized LANDSAT-1 satellite and high altitude RB-57 imagery to produce land use maps and broad soil surveys for the agricultural portion of the county.

Pennington County and State of South Dakota officials were involved in the planning and decision-making processes. The Director of Equalization, the County Commissioners and Sixth Planning District personnel were actively involved, and the Black Hills Conservancy Sub-district and other groups to a lesser extent. The State Department of Revenue also was active in the program. Principal involvement by RSI personnel was in finalizing and evaluating dollar figures placed on the soils areas.

Substantial follow-up work has been underway in Pennington County during the 1974-75 fiscal year. The county commissioners have called upon RSI personnel several times to meet with groups to discuss the land use, soils and land evaluation products. The commissioners purchased a set of large scale (1:24,000) RB-57 imagery from RSI for detailed studies by county planners. They are presently drafting overlays of section boundaries, present land use and zoning delineations on these enlargement prints.

A publication, "Use of ERTS-1 Imagery for Land Evaluation in Pennington County, South Dakota," attached hereto (Appendix A), describes the methodology for arriving at a soilscape map, a land value map, and describes the practical application of the soilscape map. The soilscape map was interpreted also for limitations for urban development and the soils for resource opportunities for agricultural production. The land value assessment and the interpretations are to be published soon in a popular publication entitled, "Soilscapes Interpreted from LANDSAT Imagery-Pennington County, South Dakota."

It is not possible to estimate the dollar savings or returns resulting from these remote sensing efforts, but one can easily visualize, for example, the value of the NASA-RSI program in Pennington County whereby planners have been provided with a soil association map, land use and land use potential maps, and other resource maps, using remote sensing technology. Under other circumstances, Pennington County would not have had this information for many years. At the same time, procedures were established whereby other counties can be provided with similar data products and information. A letter from M. T. Norton, Area Appraiser for the Department of Revenue, giving his appraisal of the value of the project in easing his responsibilities is enclosed in Appendix A.

THE MEADE COUNTY CRITICAL AREAS AND THE PLANNING ACTIVITY

Meade County, South Dakota was selected for study because the planning commission was in the process of developing a comprehensive land use plan in cooperation with the multi-county planning unit located in that portion of South Dakota (Sixth District Council of Local Governments).

Meade County is located in western South Dakota and is the largest county in the state (88,720 hectares). The area is predominately rangeland with winter wheat and alfalfa being the principal agricultural crops. A small portion of forest land (Black Hills) also is included in the county.

The major land use planning problems in Meade County as determined by the planning commission are:

1. Unregulated and unorganized strip growth occurring adjacent to an interstate highway in the forested region of the county, where the physical restraints of steep and unstable slopes, shallow soils, and flood plains present a variety of problems in providing sewage disposal, fire protection, road construction and maintenance and other public services.
2. Loss of highly productive agricultural lands to more intensive land uses, such as housing developments and trailer parks which are being located on the best agricultural soils in the county.

The groups or individuals involved and their responsibilities in the Meade County land use planning process are listed below:

1. People of Meade County - determine needs and wants for county.
2. County Commissioners - legislative authority of county.
3. Planning Commission - preparations of comprehensive plan, advisory to county commissioners.
4. Planning and Zoning Administrator - administers zoning ordinances, advisory to planning commission.
5. Sixth District Council of Local Governments - technical consultants to planning commission.
6. Rural development Extension Specialist - public education on land use planning process.

Meetings were held with groups or individuals listed above to explain remote sensing procedures and to determine the proper role of remote sensing in the land use planning process. The Sixth District Council of Local Governments was the principal agency which specified remote sensing data needed for the comprehensive plan. The following basic resource data were determined to be needed for development of a comprehensive plan:

1. General land use
2. General soils
3. Detailed land use for urban portion of county (Black Hills area)
4. Detailed soils for urban portion of county (Black Hills area)

Following collection of the above basic data, meetings continued with the Planning Commission and the Sixth District to determine the interpretations needed for planning and zoning. The following interpretations were thought to be needed:

1. County
    a. Development restrictions
    b. Resource opportunities
    c. Floodplains
    d. Water areas
2. Black Hills area
    a. Slope
    b. Floodplains
    c. Suitability for roads
    d. Suitability for dwellings
    e. Suitability for septic tanks

In addition, it is anticipated that other interpretations may be needed to provide information to the planners as the comprehensive planning process continues.

APPLICATION OF REMOTE SENSING TECHNOLOGY IN MEADE COUNTY LAND USE PLANNING PROCESS

LAND USE

County

Assessment of general land use was made using LANDSAT-1 Level I categories (Anderson, Hardy and Roach, 1972). The various land use areas were delineated by visual photo interpretation techniques on a mosaic of 1:250,000 prints of false color composite transparencies of band 4, 5, and 7 of LANDSAT-1 imagery taken in July, 1973 (Figure 1). Agricultural land, which consists of cropland and hayland was delineated by the geometric pattern and color characteristics of the fields. Rangeland areas have uniform color and few definite geometric patterns. Forest lands have dark reddish colors. Urban and built-up lands have relatively bright white signatures. Areas covered by water appeared very dark blue.

The data were transferred using a reflecting projector to a base map at a scale of 1:63,350 (1" = 1 mile) in accordance with specifications by the Sixth District Council of Local Governments. This map was colored for presentation to the planning commission. In addition, a false color mosaic at a scale of 1:250,000 with the land use overlay was prepared for use in Meade County.

Land use inventories are basic data for the development of comprehensive land use plans. The inventories are to be used for adopting regulations, goal and objective setting, assessing future trends in land use, and as a basis for revising and updating changes in land use. The land use map prepared by remote sensing techniques offers spatial information not presently available with existing tabular data. It is of interest to note that previous estimates of agricultural land were 10 to 11 percent of the county while by the land use interpretation from LANDSAT-1 imagery, agricultural land comprises 21.6 percent of the county.

Black Hills Area

Detailed land use data were needed for the Black Hills area which is experiencing uncontrolled and unregulated growth. The land use classification used was developed in consultation with the Sixth District Council of Local Governments (Table 1).

Two alternative were considered for obtaining these data:

1. Low altitude aircraft photography at a scale of 1:24,000
2. Enlargement prints at a scale of 1:24,000 from high altitude NASA color photography obtained July, 1974.

The enlargement prints of the NASA photography were determined to be suitable for interpretation.

Table 1. Land Use Categories of the Black Hills Area

LEVEL I	LEVEL II	LEVEL III
Urban		
	Residential	
		Single family
		Multi-family
		Mobile home
		Mobile home park
	Commercial	
		General commercial
		Motel/Hotel
	Industrial	
		Light industrial
		Heavy industrial
	Transportation	
		Dual highway
		Primary road
		Secondary road
	Extractive	
	Institutional	
		Schools
		Churches
		Cemetaries
		Hospitals
		Public Buildings
	Parks/Recreational	
Agricultural Land		
		Cropland
		Hayland
Rangeland		
Forest land		
Water		
Barren land		

MEADE COUNTY

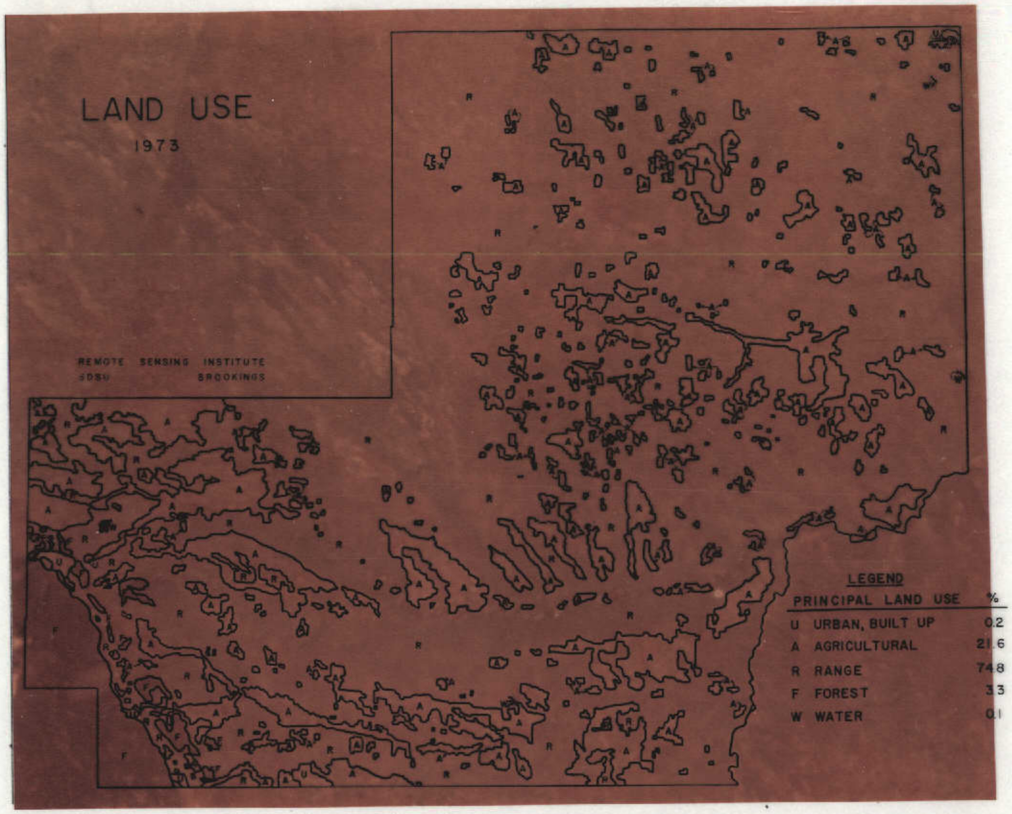


Figure 1. LANDSAT-1 color composite of bands 4, 5, and 7 of Meade County, South Dakota, July, 1973. Accompanying overlay is the interpreted Level I land use catagories. Scale = 1:1,000,000.

The USGS 7½-minute topographic quadrangle maps were used as base maps for enlarging and scaling the NASA photography. The prints were interpreted in the office and field checked. These data are being plotted and color coded on overlays over black and white ASCS photographs taken in 1968 at a scale of 1:7,920 (8" = 1 mile). Considerable discussion was held in deciding whether to plot the data on a blank map or a photographic base map. It was finally decided to use the photographic background after the usefulness of the photographs was demonstrated (Figure 2).

SOILS AND MISCELLANEOUS PRODUCTS

The techniques developed in Pennington County by Frazee et. al., in 1974 were used to develop a general soils map at a scale of 1:250,000 for northern Meade County. This map was combined with a map prepared by the USDA Soil Conservation Service from their standard soil survey of southern Meade County to compile a soils map for the entire county (Figure 3). The legend for this map is included in Table 2. Various interpretations are to be prepared from these data.

In addition to the use of remote sensing imagery for collecting land use and soils data, the use of imagery for various scales of base maps has been demonstrated. A mosaic at a scale of 1:125,000 (½" = 1 mile) from 1969 RB-57 color infrared imagery was prepared for the Black Hills area. It provides land use data for the entire Black Hills area so areas can be viewed and compared to each other.

A mosaic was prepared of the Black Hills area at a scale of 1:24,000 (2.6" = 1 mile) from the 1974 RB-57 color photography. This mosaic was presented to the planning commission and has proved very useful in locating areas for which subdivision development plotting has been requested.

Figure 2. Comparison of the detailed land use between the Blackhawk area of Meade County, South Dakota on RB-57 imagery and a line map interpretation.

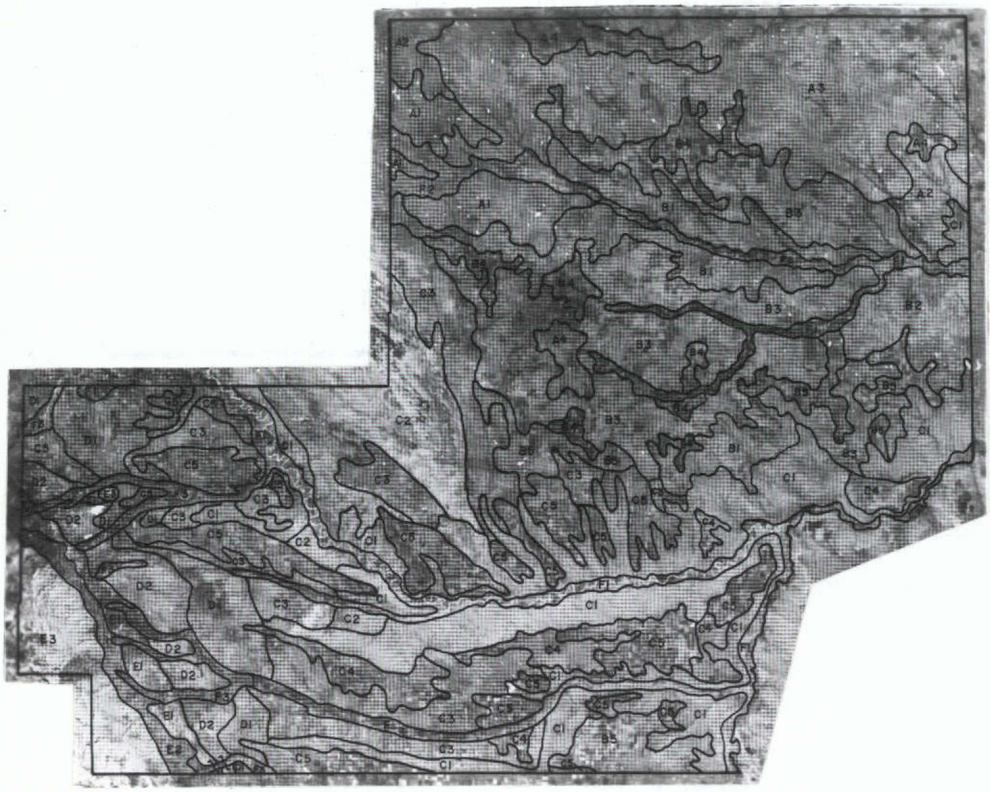


Figure 3. General soils map of Meade County, South Dakota. Scale = 1:1,000,000.

Table 2. Soilscapes of Meade County

UNIT	LAND FORM	GEOLOGIC MATERIAL	SOILS	RANGE SITE	LAND USE	LCS*
A Soilscapes from Hell Creek formation						
A1	Sloping to steep uplands	Interbedded calcareous sand, silt, and clay and colluvium from Hell Creek formation	Shallow loamy and deep claypan soils	Shallow-thin claypan	Rangeland	7e-6s
A2	Undulating to moderately steep uplands	Interbedded calcareous sand, silt, and clay of Hell Creek formation	Moderately deep loamy and deep claypan soils	Sandy-thin claypan	Rangeland	6e-6s
A3	Undulating to rolling uplands	Colluvium from interbedded calcareous sand, silt, and clay of Hell Creek formation	Deep claypan, loamy claypan and moderately deep loamy soils	Thin claypan sandy claypan	Rangeland	6s-4e-4s
A4	Undulating to steep uplands and buttes	Colluvium from calcareous shales of Ludlow and White River formations	Moderately deep to deep clayey soils and shallow to moderately deep loamy soils	Clayey-silty-shallow	Cropland-Rangeland	3e-7e
B Soilscapes from Fox Hills Formation						
B1	Steep breask	Calcareous sandstone of Fox Hills formation	Shallow loamy soils	Shallow	Rangeland	7e
B2	Rolling to hilly uplands	Colluvium from silty shale of Fox Hills formation	Shallow loamy and moderately deep clayey soils	Shallow-silty	Rangeland	6e-4e
B3	Rolling uplands	Colluvium from interbedded sand and silt of Fox Hills formation	Moderately deep to deep loamy soils	Thin upland-sandy	Rangeland-cropland	6e-4e

UNIT	LAND FORMS	GEOLOGIC MATERIAL	SOILS	RANGE SITE	LAND USE	LCS*
B4	Undulating to sloping uplands	Coluvium from interbedded sand and silt of Fox Hills formation	Deep loamy soils	Sandy-silty-thin upland	Cropland	4e-3e-6e
B5	Undulating to sloping uplands	Colluvium from silty shale of Fox Hills formation	Moderately deep to deep clayey soils	Silty	Cropland	3e-4e
<u>C Soilscapes from Pierre Shale</u>						
C1	Steep breaks	Pierre shale	Shallow to moderately deep clayey soils	Shallow-clayey	Rangeland	7e
C2	Sloping uplands	Pierre shale	Shallow to moderately deep clayey soils	Dense clay-shallow dense clay	Rangeland	6e
C3	Undulating to sloping uplands	Colluvium from Pierre shale	Moderately deep to deep clayey and deep claypan soils	Clayey-thin claypan	Rangeland-Cropland	4e-6e-6s
C4	Dissected sloping terraces	5-10' of terrace alluvium over Pierre shale	Thin to deep loamy and shallow gravelly soils	Thin upland-clayey-shallow to gravel	Rangeland-cropland	6e-4e-6s
C5	Undulating terraces	5-20' of terrace aluvium over shale	Deep loamy soils	Clayey-silty	Cropland	3e-3c
<u>D Soilscapes of Black Hills Footslopes</u>						
D1	Sloping uplands	Colluvium from Niobrara formation, Carlisle shale and Greenhorn limestone	Moderately deep clayey and shallow to deep loamy soils	Silty-thin upland	Rangeland-cropland	6e-7e-4e
D2	Sloping uplands	Terrace aluvium and colluvium from Graneros formation	Shallow to moderately deep clayey soils	Shallow-clayey	Rangeland	6e

UNIT	LAND FORM	GEOLOGIC MATERIAL	SOILS	RANGE SITE	LAND USE	LCS*
E Soilscapes of the Black Hills						
E1	Hilly to steep Hogback Ridge	Sandstones and shales of Inyan Kara group	Shallow to deep loamy soils	Shallow	Rangeland-Forestland	7e-6e
E2	Undulating to rolling valley	Colluvium from sandstone of Sundance formation and sandy shales of Spearfish formation	Moderately deep to deep silty and shallow gravelly soils	Silty-thin upland-shallow to gravel	Rangeland-Cropland	3e-3c-6e-6s
E3	Hilly to steep ridges and valley	Colluvium from Minnekata limestone, Opeche formation, Minnelusa sandstone and Pahasapa limestone	Shallow to deep loamy soils	Shallow	Forestland	7e-6e-7s
F Soilscapes of Floodplains						
F1	Nearly level floodplains and low terraces	Loamy and clayey alluvium	Deep loamy and clayey and deep claypan soils	Overflow-sandy-thin claypan	Rangeland	6w-3c-4e-6s
F2	Nearly level floodplains and low terraces	Clayey alluvium	Deep clayey and claypan soils	Overflow-thin claypan	Rangeland	4s-6s
F3	Nearly level floodplains and low terraces	Loamy alluvium	Deep loamy soils	Overflow-silty	Cropland	3c-3e

C. J. Frazee
Plant Science Department
South Dakota State University
Brookings, South Dakota
December, 1974

SUMMARY AND CONCLUSIONS

The application of remote sensing technology to comprehensive land use planning in Meade County is being demonstrated. The kind of data to be collected by remote sensing techniques was determined by consultation with the planners responsible for development of the land use plan. To date, the following data have been provided:

1. Level I land use data at scales of 1:63,350 and 1:250,000 for entire county.
2. Detailed land use data at scales of 1:24,000 and 1:7,920 for Black Hills area of county.
3. General soils map at scales of 1:63,350 and 1:250,000 for entire county.

In addition, the utility of using photographs as base maps for plotting data has been illustrated to the land use planners in Meade County.

SOIL AND SOIL MANAGEMENT ILLUSTRATIVE INFORMATION ON LANDSAT BACKGROUND FORMAT

A fold-out map entitled "Soil Texture, Soil Slope and Soil Test Results on an ERTS Mosaic of South Dakota (SDSU - RSI-74-03) was recently printed. Several thousand copies were produced and distributed. A letter from Mr. Charles F. Gordon, Marketing Research Analyst for Rohm and Haas, and agricultural chemical company, to Dr. Fred Westin, complimenting him on the information map is attached as Appendix B.

A printed circular entitled "Land Use Data Interpreted from ERTS-1 Imagery" (SDSU-RSI-75-01) describing some of the results of the Pennington County studies is included in Appendix B.

NORMALIZATION FOR MINIMIZING SOIL BACKGROUND RADIANCE ANOMALIES AFFECTING LANDSAT AND AIRCRAFT IMAGERY (SUMMARY REPORT)

Crop radiances from LANDSAT and aircraft imagery for cropland areas contains background influences caused by soil differences. Studies have been underway, financed largely by the Agricultural Experiment Station but also in part by the NASA Office of University Affairs.

This report is an overview and summary of preliminary work performed in order to normalize the soils of a LANDSAT-1 scene of Brookings County, South Dakota and to develop a crop acreage inventory, in as complete a form as is possible through available 1974 imagery.

The soils normalization portion of this study has not been completed at this time. Field data have been collected by the use of a model 100 Exotech field spectroradiometer with recording wavelengths that correspond to LANDSAT-1. Statistical analysis of these data is presently being performed by detection of spectral differences among six soil associations that occur within the flight line. Preliminary F-test values, Table 3, for soils are significant at the 1% level. Further analysis will determine between which soil associations these differences are occuring and at what dates and under which type of vegetation they are most pronounced.

Figure 4 shows an obvious spectral difference among wheat fields of approximately the same physiological maturity on Vienna loam, a glacial till upland soil, and on Fordville loam, a shallow alluvial terrace soil. The decrease in infrared reflection on the Fordville soils is due to the severe draught stress causing an increase in the quantity of air-mesophyll interfaces found within the plant leaves. A reduction in photosynthetic processes in the stressed plants has caused the increased reflection of band 5 (red light).

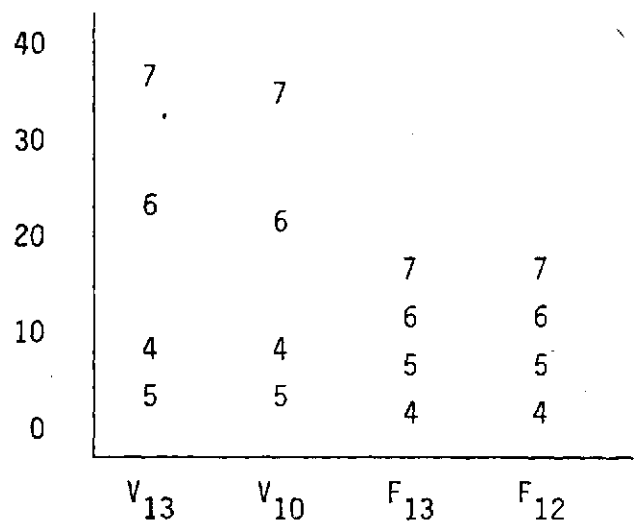
Computer compatible tapes of this June 30, 1974 imagery are now being analyzed for soil differences. Stepwise discriminate analysis is being performed on training data from each soil association for corn, small grain and grass sites. This procedure will allow for the detection of soil differences under several types of vegetation.

Table 3. Analysis of Variance of Spectroradiometer Measurements on Corn, Brookings County, 1974.*

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F Test
Soils(S)	5	1,793.84	385.76	53.81**
Bands(B)	14	65,255.91	4,661.13	699.17**
Dates(D)	6	14,944.42	2,490.73	373.61**
SB Interaction	70	2,366.70	33.80	5.07**
SD Interaction	30	3,073.53	102.45	15.36**
BD Interaction	84	18,301.10	217.87	32.68**
SBD Interaction	420	4,113.77	9.79	1.46**

* Exotech refers to Radiometer
** Significant at the 1% level

Figure 4. Reflectance of Four Wheat Fields on Vienna and Fordville Soils in Four Radiometer Bands Simulating ERTS-1, Brookings, South Dakota, June 30, 1974



V_{13}: 80cm, Green Heads (Vienna)
V_{10}: 75cm, Brown Heads (Vienna)
F_{13}: 60cm, Heads Turning (Fordville)
F_{12}: 55cm, Heads Turning (Fordville)

0.5-0.6	mu	4	0.7-0.8	mu	6
0.6-0.7	mu	5	0.8-1.1	mu	7

REMOTE SENSING DETECTION OF ENERGY LOSSES FROM STRUCTURES

THE PROBLEM

As energy sources become more scarce and fuel costs continue to increase, those responsible for allocating and conserving energy are looking for ways to reduce energy consumption. An obvious way is to reduce waste of energy. Frequently, however, the energy consumer is not aware that he is wasting energy. One important form of wasted energy is lost heat since a great amount of our energy requirements are in the form of heat to keep indoor areas comfortable. Some of the more common reasons why heat losses occur from structures are:

1. Inadequate insulation thickness
2. Improperly installed insulation
3. Damaged insulation
4. Wet insulation
5. Worn or damaged roofing materials
6. Factors related to structural design
7. Inadequate sealants

A study by the Government Operations Committee of the U.S. House of Representatives, soon to be released, gives the U.S. only five years to cut in half its rate of increase in energy consumption. Otherwise the quality of life in the United States will erode. The study places emphasis upon conservation of energy. The guidelines suggested in the report is to reduce the rate of growth of our energy consumption from 4.5 percent to two percent annually. The report declares that, for builders to get federal loans, their designs must include far more insulation. Even old houses with federal loans should have their insulation upgraded. The Federal Energy Administration figures that a 25 percent tax credit for such purchases as insulation for unfinished attics, and storm windows and doors, could lead to a reduction of 50,000 to 100,000 barrels of oil per day.

According to the Government Operations Committee report, 20 percent of our total energy is consumed in privates homes and apartments, over half of it for heating. Much of the heat escapes through poorly insulated roofs. An example given on an innovative idea to save energy was the case of Michigan Consolidated Gas, which contracted with its gas customers to put up to six inches of insulation in their homes and add the cost to the gas bill, interest free. The energy savings: 17 percent for houses more than 35 years old; 10 percent for newer homes.

William Simon, who served earlier as Energy Administrator, stated (Time, January 21, 1974) that the U.S. wastes 30 percent to 40 percent of our energy. "We need a national energy audit, sweeping legislation to study how we use our energy. We have to look at what is possible without restricting freedoms. We need to change building codes, reduce lighting, increase car pooling, improve mass transit."

Heat loss studies of structures in the past have shown that a high percentage of the loss is into the attic and out through the roof. Under such conditions variations of roof temperatures would be expected depending upon the rates of heat loss through ceilings.

It has been suggested recently that a federal tax credit be given homeowners for proper home insulation. But detection of structures needing insulation on a national scale, or even in a single city would require a tremendous effort. Few people are aware of the adequacy or condition of their insulation. A national program for determining structures that are wasting energy and in need of additional insulation would be extremely time consuming to conduct, visiting and inspecting each house, or even a majority of them. Some rapid method is needed initially to qualitatively measure energy losses from homes and businesses.

THE REMOTE SENSING INSTITUTE PROGRAM

A technique called thermography is a development of recent years that permits scientists to turn temperature measurements into a thermal picture. Valuable information can be obtained by overflying an area with heat sensing recording equipment and properly analyzing the results. These surveys include the operation of an airborne infrared scanner.

The Remote Sensing Institute approach is to record the thermal infrared scanner data on magnetic tape during the flight. At the conclusion of the flight, the tape is electronically processed to enhance the information that is of special interest. Because the infrared signals are recorded on magnetic tape, a wide variety of information can be extracted for specific interests by replaying the tape and selecting different thermal ranges if desired. The scanner data is "quantitative", that is, it can measure absolute temperatures to accuracies of a fraction of a degree centigrade, since the scanner has internal controlled temperature sources.

To illustrate the feasibility of gathering thermal imagery for relating it to inadequate insulation properties of structures, the Remote Sensing Institute flew a thermal scanner over a portion of Brookings, South Dakota at about 2:00 AM on the night of December 8, 1974. Figure 5, is a thermogram showing indicated roof top temperatures for a portion of the area flown. Figure 6 is a color-encoded product produced by digitizing and processing the thermal data.

Discussions with home owners and a contractor gave evidence that the warmer roofs are generally on older homes constructed with about 3½ inches of ceiling insulation but the cooler roofs are generally on newer houses constructed with about 7 inches of ceiling insulation. This exploratory flight demonstrates the capability for very rapidly surveying large areas to detect structures that may need insulation or may have damaged insulation or damaged roofs.

Analysis of data similar to that in the figures should make it possible to determine the extent to which temperature mapping of rooftops can be used to infer heat loss from homes and businesses. It should be possible to determine the structures with excessive heat loss and permit rapid checking of vast areas to determine need for new, additional or replacement insulation.

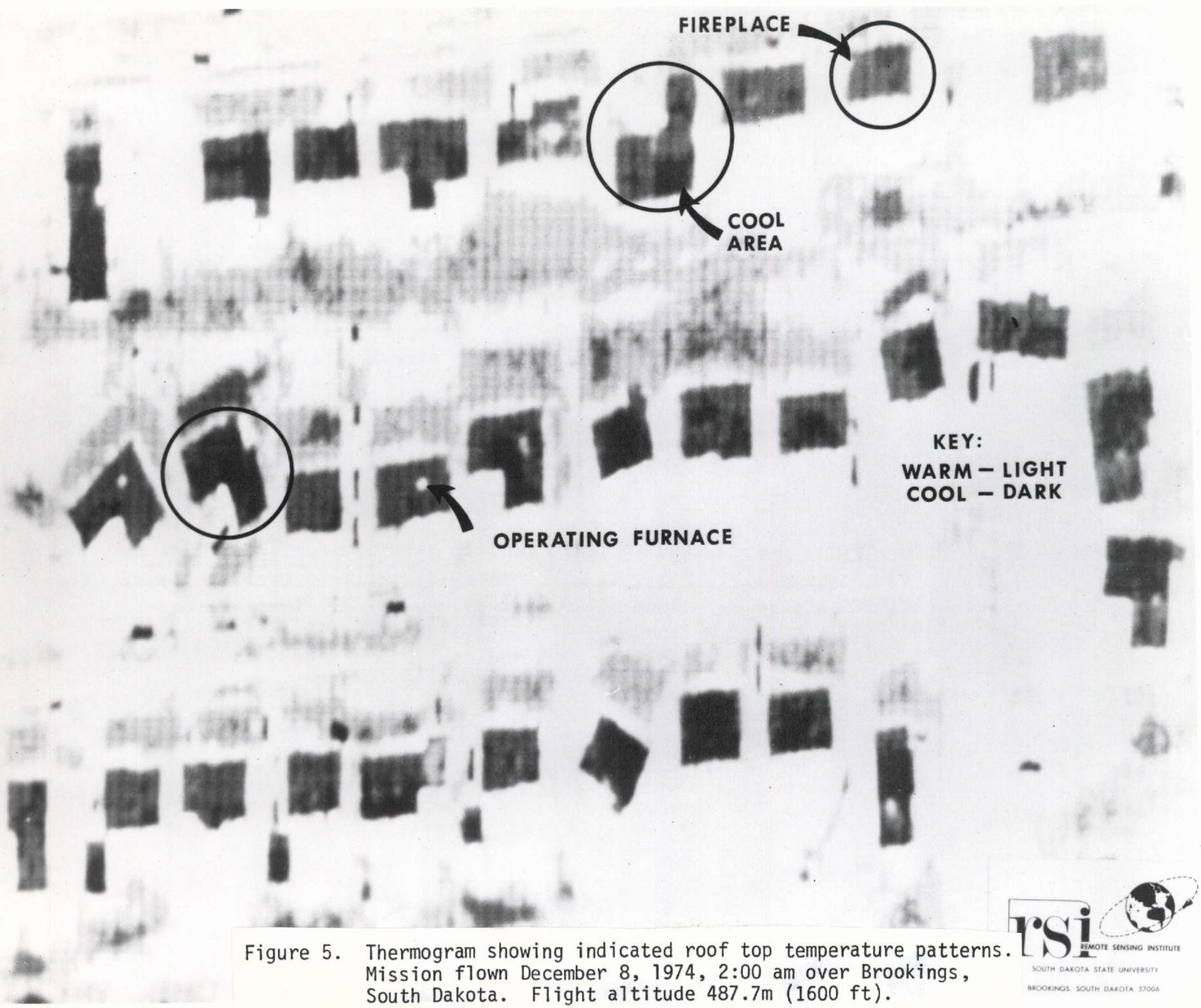


Figure 5. Thermogram showing indicated roof top temperature patterns. Mission flown December 8, 1974, 2:00 am over Brookings, South Dakota. Flight altitude 487.7m (1600 ft).

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SOUTH DAKOTA STATE UNIVERSITY
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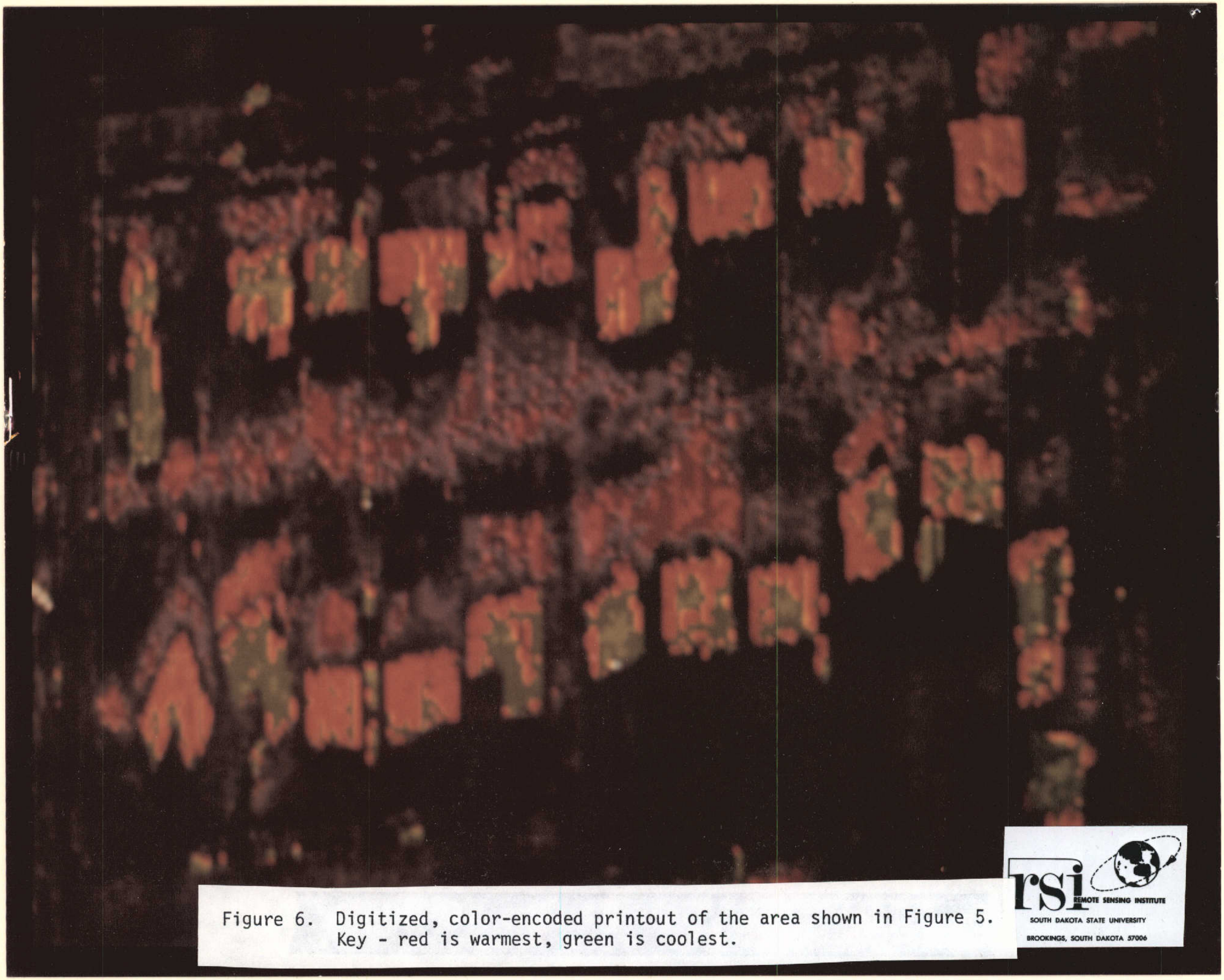

Figure 6. Digitized, color-encoded printout of the area shown in Figure 5. Key - red is warmest, green is coolest.

Cengas, the natural gas operation of Central Telephone and Utilities, was briefed on the potential for remote sensing detection of energy losses from homes and businesses, and subsequently contracted with the Remote Sensing Institute to collect thermal imagery for the cities of Sioux Falls, South Dakota; and Lincoln, Norfolk, Columbus, and Beatrice, Nebraska. Cengas intends to make the data available to individual property owners so they will be able to determine if their home is adequately insulated.

The interest of the gas company in the project is in conservation of energy, which may result in proper insulation of buildings. This in turn can enhance the gas industry's ability to serve existing and future customers as well as support national energy objectives. A news release which was given to the press, television, and radio is enclosed as Appendix B.

BICENTENNIAL ACTIVITIES

PARK AND RECREATION AREA PLANNING

Coordination meetings have been held between RSI personnel, Frank Shideler, SDSU Bicentennial representative and Arnold Stenseth and Mark Young of the South Dakota Bicentennial Commission. Programs were discussed which suggested ways that remote sensing techniques could be an aid to the planning and promotion of certain Bicentennial projects. Les Helgeland, State Chairman of the Bicentennial Commission also met with RSI personnel and later authored a resolution to the SDBC endorsing the Bicentennial effort of the NASA RSI Bicentennial project. A letter from Mr. Helgeland endorsing the proposed activities is indicated in Appendix D.

The various communities in the state have moved slowly on this effort, orginally because of lack of funding by the national commission and then by the onset of winter. Sioux Falls, however, has moved ahead, due to efforts of the Sioux Falls Park and Recreation people.

The news clipping in Appendix D describes the Bicentennial Parkway that is being planned with the cooperative efforts of the Bicentennial Commission in Sioux Falls, other local groups and RSI. The City Commission budgeted $311,000 of revenue-sharing funds for land acquisition of riverfront property.

Remote sensing imagery has been provided to the Sioux Falls Park and Recreation Department for use in planning activities. Geographers from SDSU, cooperatively with RSI, have worked with members of the Parks Department in planning activities. Because of teaching commitments of geographers, a detailed report has not been completed but will be as soon as the spring term of school is ended.

AGRICULTURAL MAP OF SOUTH DAKOTA

This proposed activity is intended to provide a map of South Dakota from LANDSAT imagery showing agricultural activities and special noteworthly agricultural sites for use by South Dakotans and visitors in a major effort to stress importance of the state's major industry. Funding for this map was originally to have been provided jointly by NASA-RSI, and the Bicentennial Commission. A recent development is that the agricultural map is being sponsored and partly funded by the SDSU Gamma Sigma Delta organization and they will solicit the the remainder of the funding from other groups.

SOUTH DAKOTA BICENTENNIAL PROJECT
Remote Sensing Institute - NASA

Agricultural Map of South Dakota

Use/Audience

The Main objective of an Agricultural Map of South Dakota would be to provide a promotional-educational overview of agriculture in this state that would be of interest or assistance to tourists and tourism groups as well as to provide an informative item for state residents. As such, the agricultural map(s) would be tied in with the Bicentennial year celebration.

Distribution

Distribution would mainly be through tourist information centers, Chambers of Commerce, agribusiness, and county Extension offices. The extent of distribution would depend upon possible interest by state highway and tourism officials, Bicentennial officials, and others. It would be one source of information for telling the story of agriculture.

Funding

Part of the funding would be through the Remote Sensing Institute at South Dakota State University which has approval by NASA to initiate some materials on remote sensing that would be of wide, popular use. It is possible that additional funding might be obtained through the South Dakota Bicentennial Commission, the SDSU Bicentennial Committee, highway or tourism groups. The first printing would be somewhat of a pilot effort to establish the potential and use of an agricultural map.

Map Details

The map would be approximately 25x19 inches in size, folded into (probably) a 6x9 carry-along size. The back of the map would consist of an ERTS mosaic of South Dakota which would include county lines and names. Three main highways east-west and north-south would be superimposed on the ERTS mosaic. These highways would be the major guidelines for identifying agricultural highlights.

The other side of the map would be in line form in two or three colors plus black, the basic outlines to be taken from ERTS imagery. This would include the same highways marked on the ERTS mosaic plus numbered or lettered references to agricultural highlights, practices, and types which would include crops and livestock and areas in which specific types of agriculture are prominent. Other items of interest might be agricultural research sites, agricultural agency locations, virgin prairie areas, special geographical features, soils, events in agriculture of historical or other significance, places along highways where these or other items could be readily viewed. When some of these aspects are not on a highway, the reference material would refer to mileage, town, or other point that would aid in finding these areas. (NOTE: these items listed above only touch on the possibilities and are not intended to be limiting).

(more)

Around the edges of the map would be a few photos of agricultural implements or methods so that a person riding along a highway could determine what is happening in a particular area at a particular time (harvesting, planting, etc.). It may be that these photos would not be available for the first edition of the map.

Each county (through the county Extension agent) would be asked to list five major items specific to that county such as largest county in area, smallest in population, top county in production of certain crops, site of certain point of interest, etc., etc. The top three of these ~~kk~~ items would be ~~kisa~~ listed for the county in a special reference guide appearing in connection with the map.

The above are intended mainly as examples.

Preparation

Remote sensing imagery would be a responsibility of RSI which would draw on resources in various sections of SDSU, for example, plant science and Fred Westin for aid in mapping and crop area designations; geography as an aid in mapping; Ag Info for compiling data and information.

Timing

The first map -- "South Dakota Agricultural Map 1975" -- should be published no later than March 1, 1975. It would be "pilot" in nature and if a success, another map implementing new material and ideas could be made from the same basic material as a "South Dakota Bicentennial Agricultural Map 1976." Depedding upon success of the idea, it might be necessary to expand such a map into several sections, either by quartering the state or by complete state maps showing various phases of agriculture.

Initial printing would be 10,000 copies. It would be anticipated that other organizations might want reprints which would be available at a pre-determined cost. It probably would be impractical to insert imprints of the name of the organization but a blank area could be incorporated into the design so that names could be rubber stamped into this space.

Who Does It?

Compiling the data and coordination would be a function of the Agricultural Information office (with suitable office credit on the map). Technical details and actual mapping would be furnished through Remote Sensing Institute and its resources. The Information office would be responsible for layout and readying the final material for the print lab.

If it is decided that the Agricultural Information Office will be unable to provide this assistance, I feel that the concept is valid enough to merit at least an attempt of a "pilot" map and would volunteer my time to do this part outside of office hours.

Frank J. Shideler

LITERATURE CITED

Anderson, J.R., E.E. Hardy, and J.T. Roach. 1971. A Land-Use Classification System for Use with Remote-Sensor Data. Geological Survey Circular 671.

Benson, Lawrence A., Charles J. Frazee, and V. I. Myers, "Land Classification of the Lake Dakota Plain in South Dakota with Remote Sensing Methods." Interim Technical Report, SDSU-RSI-73-13, August, 1973.

Brink, A.B.A., J.A. Mabbutt, R. Webster, and P.H.T. Beckett. 1966. "Report of the Working Group on Land Classification and Data Storage. Mil. Eng. Expt. Estab. Christchurch, England. Mexe Report 940.

Christian, C.S., and G. A. Stewart. 1968. "Methodology of Integrated Surveys." Proc. Toulouse Conference. UNESCO, Paris. P. 233-280.

Frazee, C.J., V.I. Myers, and F.C. Westin. 1972. "Density Slicing Techniques for Soil Survey." Soil Sci. Soc. Amer. Proc. 36:693-695.

Frazee, C.J., P.H. Rahn, F.C. Westin, and V.I. Myers. 1974. "Use of ERTS-1 Imagery for Land Evaluation in Pennington County, South Dakota," Proceedings, Ninth International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan. pp 549-568.

Webster, R. and R.H.T. Beckett. 1970. "Terrain Classification and Evaluation Using Air Photography: A Review of Recent Work at Oxford." Photogrammetria 26: 51-75.

APPENDIX A

Hot Springs, S. Dak.
20 Sept 74

Mr. Victor I. Myers
Remote Sensing Institute
Brookings, South Dakota

Dear Mr. Myers;

I have had the pleasure of working with Dr. Chas. Frazee over the past several months on the reappraisal of Pennington County using Remote Sensing Material.

To me it is fantastic as to the accuracy of these highlevel photos, and the use that can be made of them, in the appraisal of rural land.

With the information that your institute can provide, and the cost estimates being what they are, I can see no reason why other counties should not be taking advantage of this service for valuing land for assessment, in compliance with the 1970 Ag valuation law, rather than waiting several years for a soil survey to be made.

As a member of the field staff of the Department of Revenue, I would personally recommend that other counties, especially here in the West River Area, look into the use of Remote Sensing for the evaluation of land for Assessment purposes.

I hope that I will be able to spend much more time in this field in the months to come.

Sincerely yours

Melvin T. Norton
Area Appraiser
Dept. of Revenue
Hot Springs, S. Dak.

USE OF ERTS-1 IMAGERY FOR LAND EVALUATION IN PENNINGTON COUNTY, SOUTH DAKOTA[1]

by

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ABSTRACT

Color composite transparencies, single band transparencies, and enlargement prints were interpreted to produce a soilscape map for an area of 400,000 hectares (1,000,000 acres) in Pennington County, South Dakota. Areas with similar photographic characteristics were delineated on mylar over a color composite using a light table and a three power magnifying glass. For field checking, the overlay was transferred to 1:250,000 scale topographic maps. The field checking consisted of a resource team of soils, geology, and range science specialists traversing the major roads in the area to examine and describe the dominant soils, geologic materials, and vegetation for each interpreted area.

The color composite transparency was adequate for locating most of the boundaries between the soilscape areas. The time necessary to map and field check the general soils for 400,000 hectares using ERTS-1 imagery was four to six weeks. The soilscape map plus land sales data were used to prepare a land value map of Pennington County.

INTRODUCTION

The role of soil surveys in land use planning has been demonstrated in urban areas in the eastern United States (ASA, 1966). The suitability of soils for various land uses, such as housing, recreational areas, cropland, industrial areas, and irrigation is routinely interpreted by soil scientists of the National Cooperative Soil Survey. In less populated areas the necessary soil maps are frequently not available or may be outdated. Usually data on other resources, such as vegetation and geology, are not included with the soil maps. A natural resource map combining soil, geologic, and vegetative data would be helpful to land use planners.

The launch of ERTS-1 (Earth Resources Technology Satellite) on July 23, 1972, provided the soil scientists with a new tool for making resource inventories. The ERTS-1 image, covering

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more than 3,200,000 hectares (8 million acres) surveys a region through one perspective. Information about the earth's surface is collected in four bands of the electromagnetic spectrum at 18-day intervals.

Several scientists reported on the utility of ERTS-1 images for making soil maps at the Symposium on Significant Results Obtained from the Earth Resources Technology Satellite-1 held on May 5-9, 1973, at Goddard Space Flight Center (NASA, 1973). Two pertinent references from that conference are of interest to this study.

Westin and Myers (1973) studied the usefulness of ERTS-1 imagery in western South Dakota for identifying soil associations. Both color composites at 1:1,000,000 scale and enlarged prints at 1:500,000 and 1:250,000 were interpreted using visual techniques. Soil association boundaries were corrected and new soil associations discovered.

Baumgardner, Kristof, and Harrison (1973) used ERTS-1 imagery to map soil resources in Lynn County, Texas. They used computer compatible tapes with interactive machine processing to produce a general soil map.

The planning districts in South Dakota are in various stages of preparing general land use plans for county areas. The role of the ERTS-1 satellite imagery in providing natural resource and land use data for planning purposes has not been evaluated in an operational situation in South Dakota. The objective of this study is to use ERTS-1 imagery to inventory the soils, geology and vegetation of eastern Pennington County.

DESCRIPTION OF STUDY AREA

The study area is located in extreme western South Dakota (Figure 1). Pennington County was selected as the study area because the variety of soils and land uses are representative of counties in western South Dakota which do not have modern soil surveys. Pennington County covers 711,500 hectares (1,778,700 acres). The Black Hills National Forest, Buffalo Gap National Grasslands, and Badlands National Monument comprise most of the 280,100 hectares (700,300 acres) of public land in the county. Approximately 12% of the land is cropped. Alfalfa and wheat are the major crops. Native mid- to short-grass rangeland comprises about 45% of the private land.

Pennington County lies in the Great Plains Province, with the eastern two-thirds of the county in the Missouri Plateau section and the western one-third in the Black Hills section (Fenneman, 1931). The climate is semiarid and continental with large variation in seasonal temperatures and precipitation. The soils in this area are developed from nearly horizontal Cretaceous and Tertiary sedimentary rocks, terrace deposits, or alluvial deposits.

The major geomorphic areas include:

1. White River Badlands
2. Tablelands
3. Shale Plains and Breaks
4. Terraces
5. Cuestas
6. Flood Plains

The current soil association map is shown in Figure 2.

PROCEDURES

The ERTS-1 multispectral scanner records electromagnetic energy from the earth's surface in four bands as follows: band 4 (green) .5-.6 μm; band 5 (red) .6-.7 μm; band 6 (infrared) .7-.8 μm; and band 7 (infrared) .8-1.1 μm. The scanner imagery is received at the Remote Sensing Institute in the form of 9-inch positive transparencies at a scale of 1:1,000,000. Transparencies of each of the bands are received for each ERTS-1 overpass which are at 18 day intervals. The ERTS-1 imagery available for Pennington County was evaluated and transparencies from three dates were selected for further analysis (Table 1). Color transparency composites at 1:1,000,000 scale were made from bands 4, 5, and 7, and enlargement negative prints at scales of 1:500,000 and 1:250,000 were made from bands 5 and 7 from the September 6 and October 12 imagery. The band 7 transparency for December 5, 1973, was enlarged to 1:250,000

The color composites, positive transparencies, and enlargement prints were viewed using a light table and a three power magnifying glass. The areas with similar photographic characteristics were delineated on mylar over the color composite of the September 6, 1972, image (Figure 3). This overlay was then placed over the other color composite and negative transparencies for additional interpretation. An initial legend for this map was drafted, based upon the existing soil and geologic information (Table 2).

For field checking, the ERTS-1 interpretation was transferred to the 1:250,000 USGS topographic map and 1:60,000 ASCS photo index map of Pennington County. The field checking consisted of reconnaissanceby a resource team to describe the soils, vegetation and geology for each map unit. The resource team consisted of a geologist from the South Dakota School of Mines and Technology, a range scientist from the USDA Soil Conservation Service, and a soil scientist from South Dakota State University. Following the field check the legend and map were finalized.

RESULTS AND DISCUSSION

SOILSCAPES

The major soil boundaries interpreted in the office by photo interpretation of the color composite transparencies, single band positive transparencies, and enlargement prints are shown in Figure 4. The legend for this map (Table 2) was developed using the existing soil and geologic data in conjunction with slope information interpreted from the snow-covered ERTS-1 imagery of December 5, 1972, (Figure 5).

The map interpreted in the office was transferred to USGS 1:250,000 scale topographic maps and to 1:60,000 scale photo index sheets of Pennington County. Each of the areas delineated in the office were checked in the field. For each area, the dominant soils, vegetation, and geologic materials were described as well as the surface features responsible for the reflectance patterns on the ERTS-1 imagery. Examination of the ERTS-1 imagery in the field revealed several additional boundaries between soilscape areas which could be easily interpreted. These additional areas were delineated and the soilscape map areas finalized (Figure 6). Descriptions of soils, geology, and land use along with suitability ratings for rangeland, cropland and ground water development were made (Table 3).

USEFULNESS OF ERTS-1 IMAGERY

The color composite transparencies were most useful for interpretation of boundaries between the soilscape areas. The interaction between the individual bands provided an additional characteristic for interpretation (Figure 7). Most of the boundaries of the soilscape areas were delineated very well on the ERTS-1 imagery (Figure 8). The delineations which could not be identified using ERTS-1 imagery were either too small or similar to adjoining areas. The boundaries between the soilscape areas were as easily interpreted at a scale of 1:1,000,000 as 1:250,000. Areas such as flood plains, which were too small to delineate using the color composite transparency at a scale of 1:1,000,000, could be mapped using the 1:250,000 enlargement prints.

The features or characteristics observable on the ERTS-1 color composite transparency which were used for interpreting the soilscape boundaries were tone, color, land use patterns, and drainage patterns. In Figure 7, the use of drainage pattern, color, and land use patterns to delineate soilscapes in northern Pennington County is illustrated. Drainage pattern was used in conjunction with color patterns to interpret the boundary between the steep shale breaks (B1) and hilly to steep sandstone breaks (C1). The steep shale breaks have yellowish-green hues and a pinnate drainage pattern, whereas the hilly to steep sandstone breaks have yellowish-red hues and a dendritic drainage pattern (Figure 7). Differences in color were utilized to draw the boundary between the undulating shale plains (B4) and the undulating to gently rolling sandstone uplands (C3). These two areas have similar land use patterns, but the reflectance from the soils developed from the olive-gray Pierre Shale is less than that from the soils developed from the grayish-brown Fox Hills Formation (Figure 7). Other soilscape areas which were identified by color were the hilly to very steep barren badlands (A1) and the alluvial areas having shallow water tables (D1). The A1 unit is associated with areas of high reflectance or a white color on the imagery (Figure 9). Naturally wet flood plains are recognized by an intense red color, related to high reflectance in the infrared bands (Figure 9).

Land use pattern was used to delineate the boundary between the undulating to gently rolling shale plains (B3) and the undulating shale plains (B4). These two areas have similar slopes, but the land use of the undulating to gently rolling shale plains is dominately rangeland, whereas the land use of the undulating shale plains is cropland (Figure 7). The geometric shapes and patterns of the cropland fields are the features used to distinguish between cropland and rangeland.

Differences within a particular land use pattern are useful indicators of soil conditions (Figure 9). Field size is larger where uniform soil areas occur. The field sizes of the land use pattern characteristic of the B8 unit (nearly level terraces) are larger than the fields of the A4 unit (nearly level to undulating tablelands). Intensity or continuity of the cropland land use pattern was used to separate the undulating to gently rolling terrace remnants (B6) from the nearly level to undulating terrace remnants (B7). The cropland land use pattern is nearly continuous on the B7 unit whereas in the B6 unit the land use pattern is a mixture of cropland and rangeland (Figure 10).

In summary, the features of ERTS-1 imagery most useful to this study were the synoptic view and multispectral imagery. The synoptic view provided by ERTS-1 imagery allowed large areas to be viewed and studied from the same perspective. Therefore, differences in reflectance patterns of noncontiguous areas are meaningful and can be used to delineate general soil areas (soilscapes). The multispectral feature of ERTS-1 imagery provides a new tool for studying soil differences. General soil areas have different multispectral characteristics as shown in Figures 7, 9 and 10.

COMPARISON WITH EXISTING SOIL ASSOCIATION MAP

More soil areas were delineated on the soilscapes map using the ERTS photography as described above than on the existing soil association map (Figure 2 and 6). Three reasons may be cited to explain this. First, the scale of the soilscape map is larger. The soilscape map is at a scale of 1:250,000 whereas the existing soil association map is at a scale of 1:500,000. Secondly, the field work provided additional information which was used to distinguish more areas. Thirdly, the use of the ERTS-1 imagery allowed further delineations of some of the large soil associations on the existing map.

The major differences between the two maps are in the areas with soils formed on the Fox Hills Formation, White River Sediments, and terraces overlying the Pierre Shale. The Ralph-Cabbart-Regent area (32) on the existing map (Figure 2) was divided into four parts (Figure 6) using slope and land use information. The Badlands area (69) was divided into three segments using color and color pattern interpretations (Figure 2 and 6). The Caputa soil association (36) on the existing map was separated into three parts utilizing differences in land use patterns (Figure 2 and 6).

RECOMMENDATIONS FOR USE OF ERTS-1 IMAGERY TO INTERPRET GENERAL SOIL MAPS

The ERTS-1 imagery gives soil scientists a new tool for interpreting general soil areas. The use of ERTS-1 imagery for preparing a general soils map has been discussed in this paper. Based upon this work the following recommendations are intended to give guidelines for use of ERTS-1 imagery to obtain soil information for areas where soils data are lacking.

The following materials are needed:

1. ERTS-1 imagery -- single band transparencies, color composite transparencies, preferably for more than one season.
2. Enlargement prints of ERTS-1 imagery -- scale to base maps, the 1:250,000 USGS topographic map series covers the entire U.S.
3. Existing soil and geologic information.
4. Topographic or other existing base maps.
5. Photo index maps for existing aircraft coverage -- useful for plotting boundaries interpreted on ERTS-1 imagery.

ERTS-1 imagery can be enlarged to 1:125,000 without loss of detail.

The production of a general soils map using ERTS-1 imagery can be separated into three major parts. The first part involves the following items:

1. Locating and evaluating existing ERTS-1 imagery.
2. Summarizing existing soils information.
3. Interpreting ERTS-1 imagery.
4. Drafting initial legend and map.
5. Transferring map to 1:250,000 topographic map for field checking.

This part involves from 1 to 1½ weeks time.

The second part is the field checking of the interpreted map. Boundaries interpreted in the office are verified. The soils, geologic material, and vegetation are described for each area on the map. The time needed to complete this part is dependent upon the size of the area. For an area similar in size to Pennington County (400,000 hectares or 1,000,000 acres) which has some soils information available, 2 to 3 weeks time is necessary for the field work.

The remaining part involves completing the project. The final map and legend have to be drafted and the report written. One to 2 weeks are needed for this work.

USE OF SOILSCAPE MAP IN PENNINGTON COUNTY

In South Dakota a law was passed in 1970 requiring that agricultural land be assessed for taxation according to the ability of the land to produce agricultural crops or native grass. A method based on soil inventory data and land sales was developed by Westin et al., 1974, for use by assessors in South Dakota. A value for each kind of soil limitation was calculated utilizing crop and grass yield data along with detailed soil inventory and land sales data. Soil inventory data necessary to use this method are not available for 41 of the 67 counties in South Dakota. General soils information must be used until the detailed soil survey is completed in those counties.

The soilscape map of Pennington County was interpreted to give the director of equalization general guidelines for land evaluation and to extrapolate land values of agricultural land (Figure 11). If the soilscape was used for cropland, the land capability rating was used. If the soilscape was used for rangeland, the range site grouping was used. The crop and/or grass yield rating was calculated for each soilscape and related to sale figures from 1967-1973 furnished by the director of equalization.

SUMMARY AND CONCLUSIONS

ERTS-1 imagery was evaluated for interpreting soils in Pennington County, South Dakota. Color composite transparencies, single band transparencies, and enlargement prints were used to interpret a soilscape map at a scale of 1:250,000.

Most of the soilscapes were delineated very well on the ERTS-1 color composite, which was the best imagery for interpreting boundaries between the soil areas. The features used for interpreting the soilscape boundaries were color, land use pattern, and drainage pattern. The dominant soil, geologic material, and vegetation were described by the natural resource team consisting of a soil scientist, geologist, and range scientist for each of the 21 soilscape areas.

Four to 6 weeks time was estimated to be necessary for using ERTS-1 imagery to map the general soil areas for 400,000 hectares (1 million acres). A land value map interpreted from the soilscape map and sale figures was used to illustrate practical application of the soilscape map.

LITERATURE CITED

1. American Society of Agronomy. 1966. Soil Surveys and Land Use Planning. Madison, Wis.
2. Baumgardner, M. F., S. F. Kristof, J. A. Harrison. 1973. Identification and Mapping of Soils, Vegetation, and Water Resources of Lynn County, Texas, by Computer Analysis of ERTS. Symposium on Significant Results Obtained from the Earth Resources Technology Satellite-1. NASA SP-327. Pages 213-221.
3. Fenneman, N. M. 1931. Physiography of Western United States. McGraw-Hill, New York.
4. NASA. 1973. Symposium on Significant Results Obtained from the Earth Resources Technology Satellite-1. NASA SP-327, Vol. 1: Sections A and B.
5. Westin, F. C. and D. L. Bannister. 1971. Soil Association Map of South Dakota, AES Info. Series No. 3. South Dakota State University, Brookings, SD.
6. Westin, F. C., M. Stout, D. L. Bannister, and C. J. Frazee. 1974. Soil Surveys for Land Evaluation in South Dakota. Submitted to Assessor's Journal.
7. Westin, F. C. and V. I. Myers. 1973. Identification of Soil Associations in Western South Dakota on ERTS-1 Imagery. Symposium on Significant Results Obtained from the Earth Resources Technology Satellite-1. NASA SP-327. Pages 965-972.

Table 1. ERTS-1 imagery of Pennington County, South Dakota used for interpretation of soils.

Date	Frame Identification	Color Composite	Positive Transparencies, Bands 4, 5, 6 & 7	Enlargement Prints of Bands 5 & 7: 1/500,000	Enlargement Prints of Bands 5 & 7: 1/250,000	Enlargements of Color Composite 1/250,000
September 6, 1972	1045-17063	x	X	x	x	
October 12, 1972	1081-17064	x	x	x	x	
December 5, 1972	1135-17078		x		x	
December 5, 1972	1135-17074		x		x	

Table 2. Legend for Preliminary Interpretation.

A. Soilscapes from White River Sediments

A1 -- Badland walls and basins, steep
A2 -- Badland uplands, nearly level to undulating

B. Soilscapes from Pierre Shale

B1 -- Shale Breaks, steep
B2 -- Shale Plains, gently rolling
B3 -- Shale Plains, undulating
B4 -- Terraces, nearly level
B5 -- Alluvium

C. Soilscapes from Fox Hills Formation

C1 -- Sandsone Breaks, Steep
C2 -- Sandstone Uplands, gently rolling
C3 -- Sandstone Uplands, nearly level

D. Soilscapes from Black Hills Footslope

D -- Uplands, gently rolling

Table 3. Soilscapes of Eastern Pennington County

Unit	Land Form	Geologic Material	Soil	Range Site	Land Use	LCS*	Ground Water**
A	Soilscapes from White River Sediments						
A1	Hilly to very steep barren badlands	Siltstone and shale	None	None	Non-Agricultural	8s	None to Poor
A2	Undulating to gently rolling uplands	0-5' of terrace alluvium over White River Sediments	Shallow to Moderately Deep Clayey Soils	Clayey-Shallow	Rangeland	4e-6s	Poor
A3	Nearly level to undulating badland basins	Clayey alluvial sediments	Shallow to Moderately Deep Clayey Soils	Clayey-Shallow	Rangeland	4e-6s	Poor
A4	Nearly level to undulating table lands	5-20' of terrace alluvium and aeolian deposits over White River Sediments	Deep Silty and Loamy Soils	Silty-Sandy	Cropland-Rangeland	3c-3e-4e	Fair
B	Soilscapes from Pierre Shale						
B1	Steep shale breaks	Pierre Shale	Shallow to Moderately Deep Clayey Soils and Shaleland	Shallow	Rangeland	7s-6e-8s	None to Poor
B2	Undulating to rolling sideslopes	Colluvium from Pierre Shale	Shallow, Moderately Deep to Deep Clayey Soils	Clayey	Rangeland	6e-4e 6s	Poor
B3	Undulating to gently rolling plains	Colluvium from Fox Hills Sandstone and Pierre Shale	Deep Clayey and Thin Claypan Soils	Clayey-Claypan	Rangeland	4e-6s	Fair to Good
B4	Undulating plains	Thick colluvium from Pierre Shale	Moderately Deep to Deep Clayey Soils	Clayey	Cropland	4e	Fair
B5	Undulating to rolling dissected terraces	5-10' of terrace alluvium over Pierre Shale	Moderately Deep to Deep Loamy Soils	Clayey-Thin Upland	Rangeland	4e-6e	Fair
B6	Undulating to gently rolling terrace remnants	5-10' of terrace alluvium over Pierre Shale or White River Sediments	Deep Loamy Soils	Clayey	Rangeland-Cropland	3e-4e	Fair

Table 3. Continued

Unit	Land Form	Geologic Material	Soil	Range Site	Land Use	LCS*	Ground Water**
B7	Nearly level to undulating terrace remnants	5-50' of terrace alluvium over Pierre Shale	Deep Loamy Soils	Clayey	Cropland	3c-3e	Fair
B8	Nearly level terraces	5-20' of terrace alluvium over Pierre Shale	Deep Silty and Loamy Soils	Silty-Clayey	Cropland	3c	Fair to Good
B9	Nearly level terraces	0-5' of terrace alluvium over Pierre Shale	Moderately Deep Loamy Soils	Silty	Rangeland	4s	Fair to Good
<u>C</u>	<u>Soilscapes from Fox Hills Formation</u>						
C1	Hilly to steep breaks	Fox Hills Sandstone and Shale	Shallow to Moderately Deep Loamy Soils	Shallow	Rangeland	7s	Fair
C2	Rolling uplands	Coluvium from Fox Hills Sandstone and Shale	Shallow, Moderately Deep to Deep Silty Soils	Silty-Shallow	Rangeland	6e-6s	Fair to Good
C3	Undulating to Gently rolling uplands	Colluvium from Fox Hills Sandstone and Shale	Deep Silty Soils	Silty	Cropland	3e-4e	Fair to Good
C4	Nearly level to undulating uplands	Colluvium from Fox Hills Sandstone and Shale	Deep Silty Soils	Silty	Cropland	3e-3c	Fair to Good
<u>D</u>	<u>Flood Plains</u>						
D1	Flood plains of Cheyenne and White Rivers	Sands and fine textured alluvium	Deep Clayey and Thin Sandy Soils	Clayey-Overflow	Rangeland-Hayland	4s-4e 6w	Excellent
D2	Flood plains of Rapid, Box Elder, and Spring Creeks	Medium textured alluvium	Deep Silty Clay Loam Soils	Overflow	Hayland	3c-6w	Excellent

Table 3. Continued

Unit	Land Form	Geologic Material	Soil	Range Site	Land Use	LCS*	Ground Water**
E	Soilscapes from Black Hills Footslopes						
E1	Rolling uplands	Colluvium from Carlisle, Greenhorn and Niobrara Formations	Moderately Deep Clayey and Loamy Soils	Thin Upland-Clayey	Rangeland	6e-4e	Fair to Poor
E2	Rolling uplands	Clayey colluvium and bedrock from Graneros Group	Shallow to Moderately Deep Clayey Soils	Shallow-Clayey	Rangeland	6s-6e	Fair to Poor

* LCS Land Capability Subclass
** Potential for development of household wells

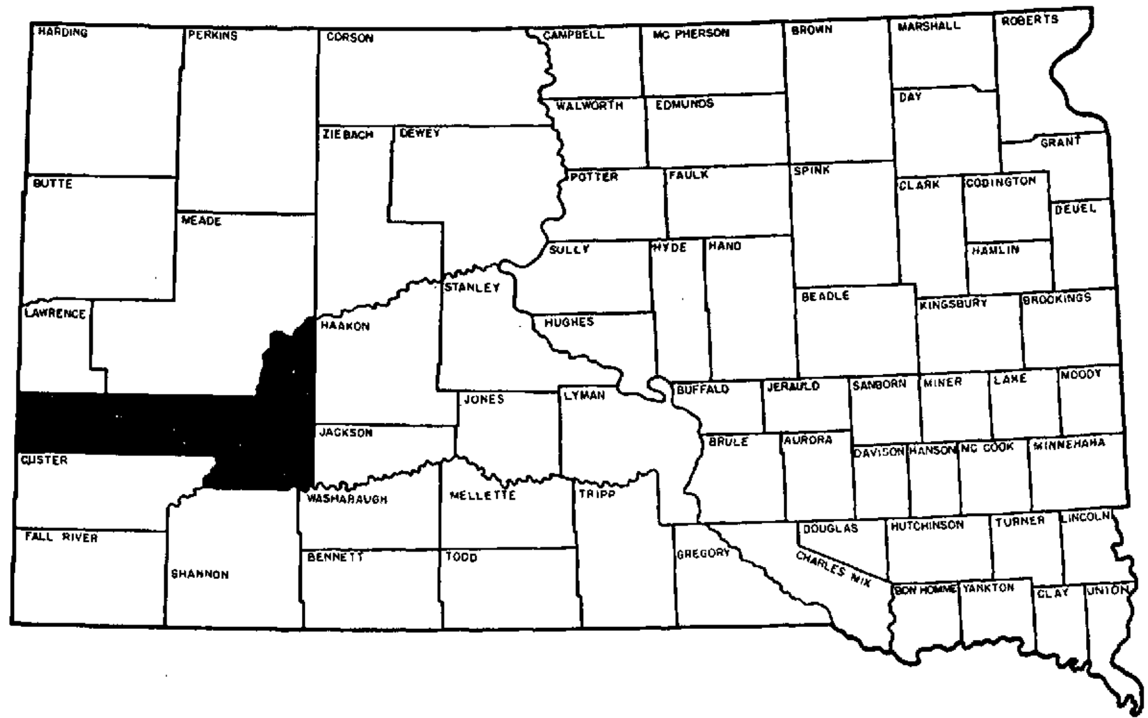


Figure 1. Location of Pennington County in South Dakota

Legend for Pennington County Soil Association Map

1 Rough Mountainous Land, pre-Cambrian
2 Rolling Limestone Plateau
4 Rough Mountainous Land, Limestone
5 Nevee-Spearfish
6 Spearfish-Nevee
7 Butche-Canyon
8 Canyon-Butche
32 Ralph-Cabbart-Regent
36 Caputa-Satanta
37 Ree
39 Satanta
43 Penrose-Minnequa
44 Pierre-Kyle
47 Pierre-Samsil
48 Grummit
50 Samsil-Lismas-Pierre
57 Valentine-Anselmo
60 Wanblee
62 Glenburg-Haverson
63 Haverson
64 Loamy alluvial land
65 Bankard-Kyle
69 Badlands

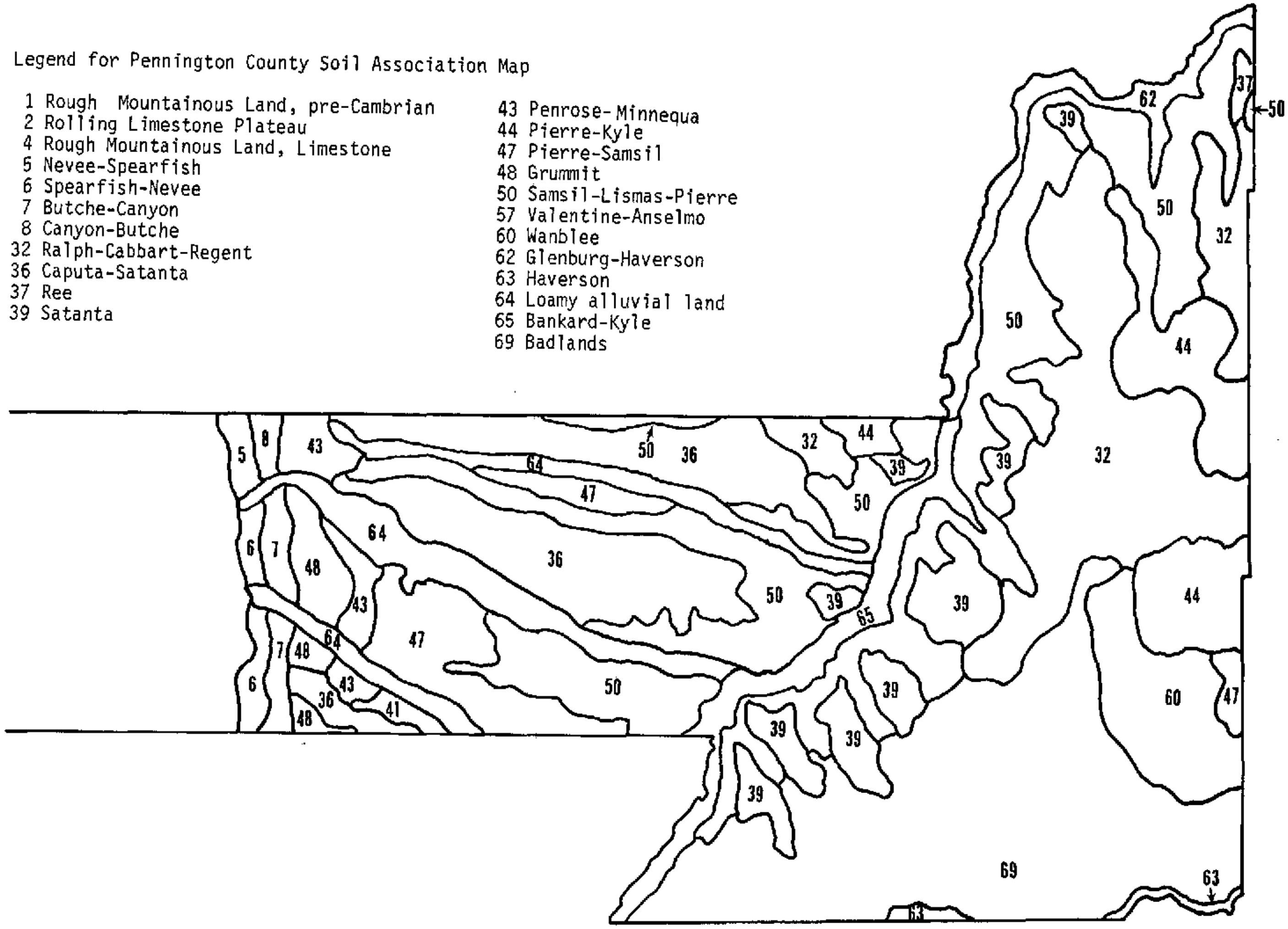


Figure 2. Current soil association map of eastern Pennington County (Westin and Bannister, 1971). Original scale = 1:500,000.

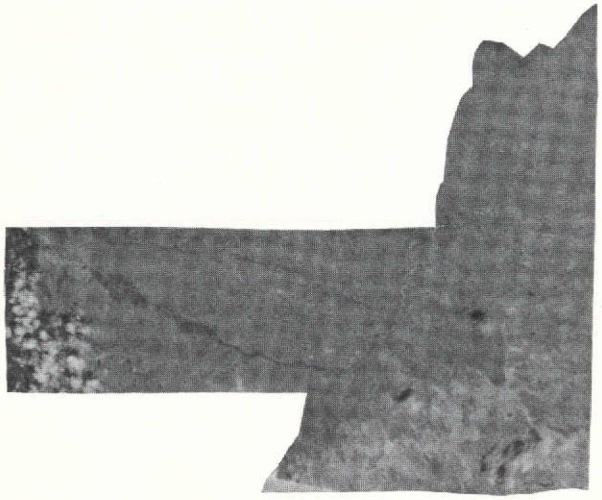


Figure 3. Contact print of color composite transparency. Bands 4, 5, and 7. September 6, 1972. 1045-17063. Scale - 1:1,000,000.

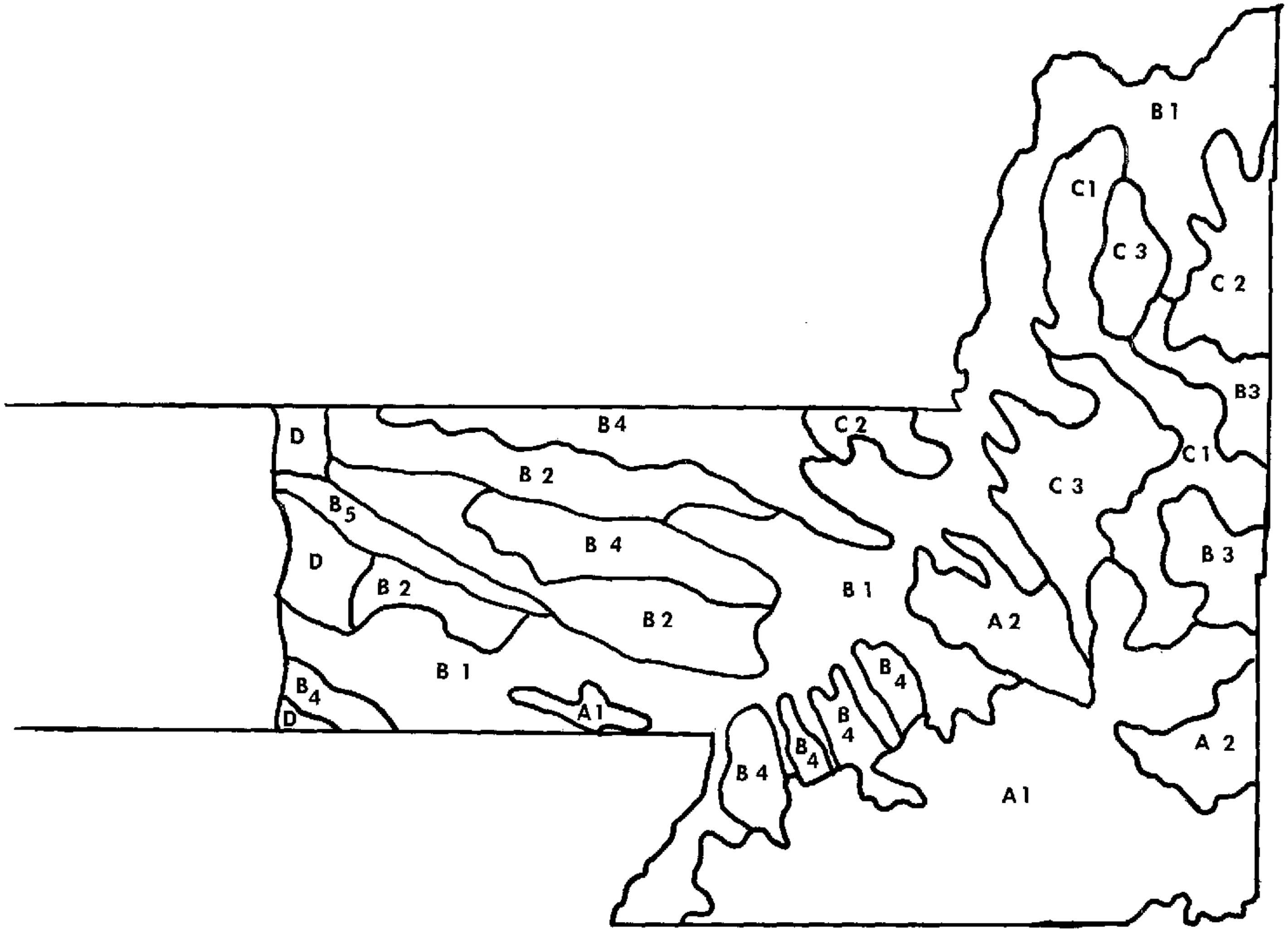


Figure 4. Preliminary interpretation of ERTS-1 imagery of eastern Pennington County, South Dakota.

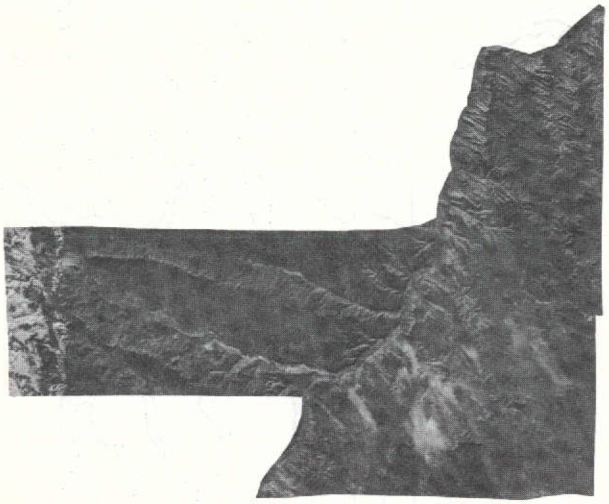


Figure 5. Snow-covered ERTS-1 image of Pennington County. Negative print. December 5, 1972. 1135-17072. Scale = 1:1,000,000.

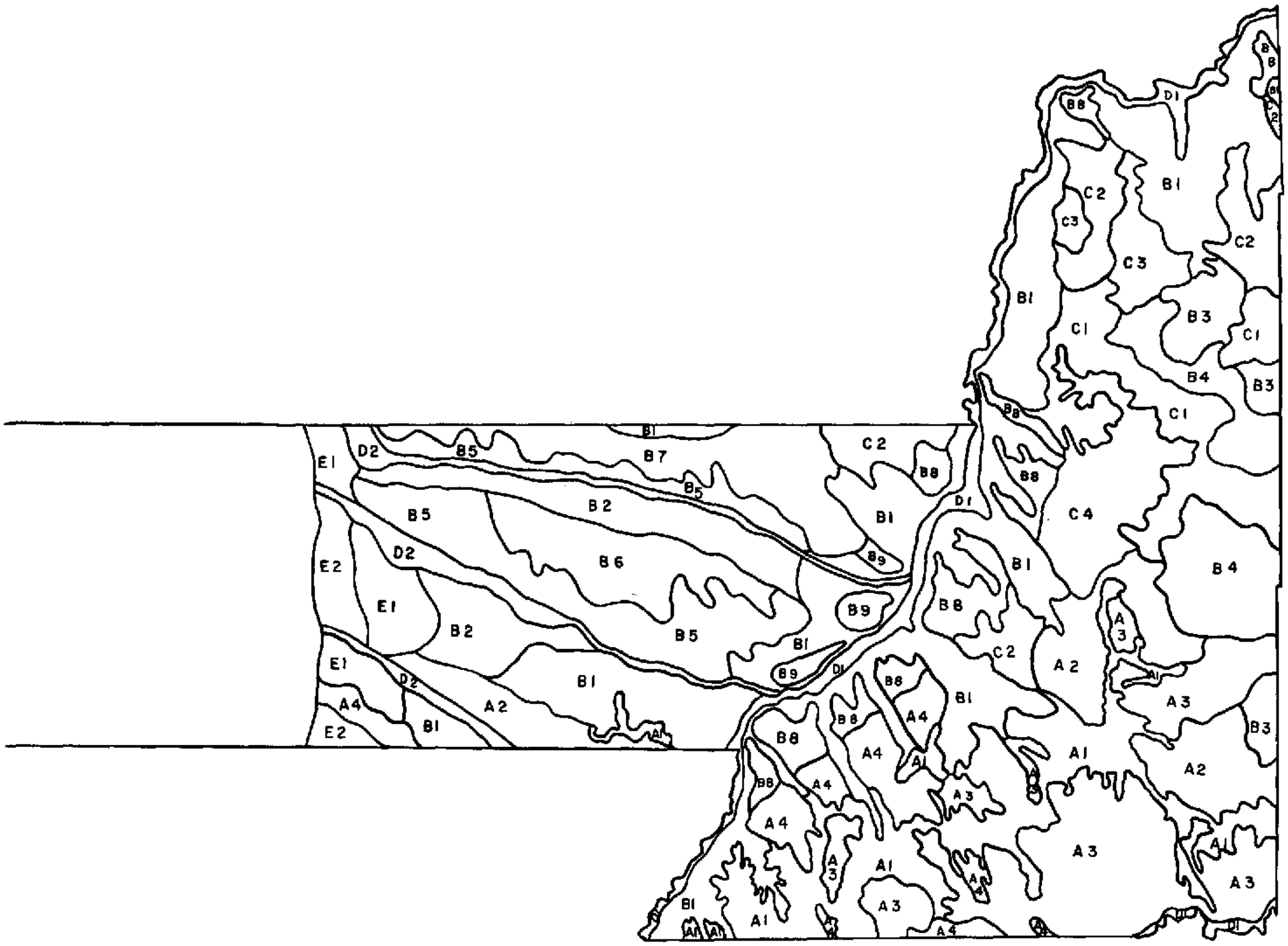
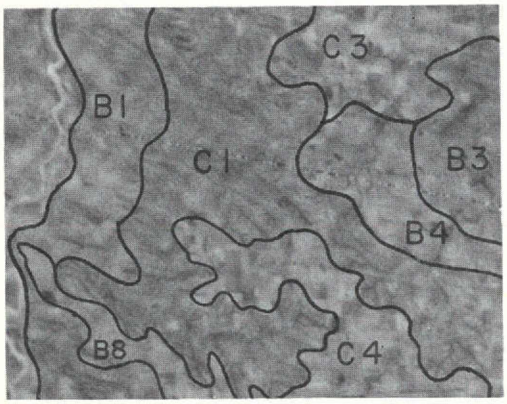


Figure 6. Soilscapes of eastern Pennington County.



Drainage Pattern--C1 was separated from B1 by change in drainage pattern and color. C1 has reddish colors and a dendritic drainage pattern. B1 has yellowish-green colors and a pinnate drainage pattern.

Color--The boundary between B4 and C3 was delineated by a color change. The fields in the B4 have lower reflectance.

Land Use--The B3 areas have a rangeland land use pattern. The B4 areas have a cropland pattern.

Figure 7. Use of drainage pattern, color and land use pattern features of ERTS-1 imagery to delineate soilscapes of northern Pennington County. Enlargement print of color composite. July 9, 1973. 1351-17064. Scale = 1:250,000.

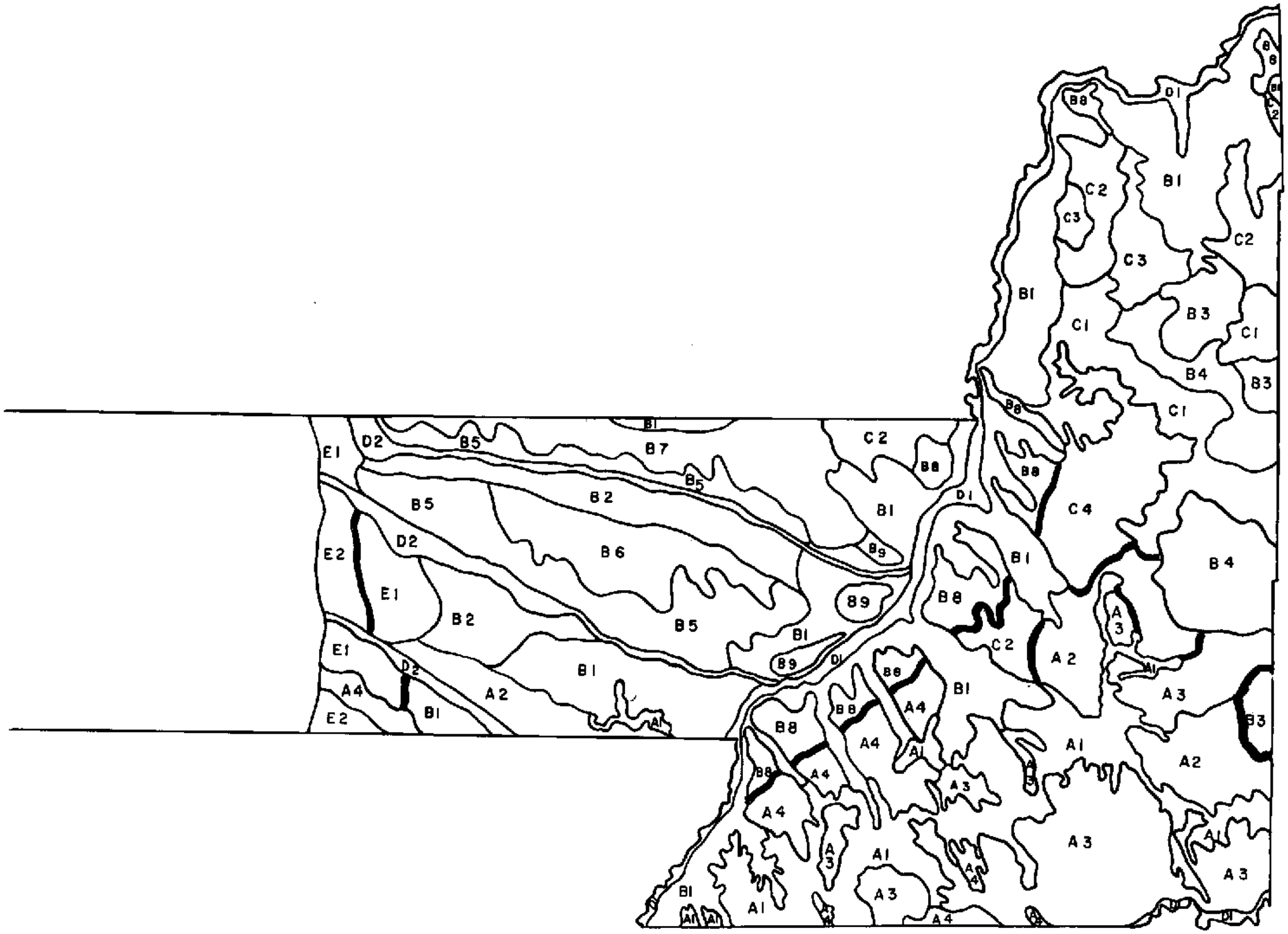
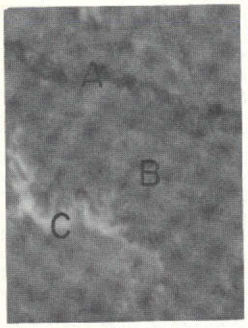
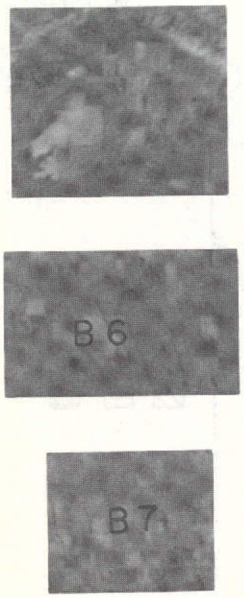


Figure 8. Usefulness of ERTS-1 imagery to delineate soilscape boundaries. Thick lines indicate boundaries not detected on ERTS-1 imagery.



Color	Soilscape
Red (A)	Flood Plain
Yellowish-Green (B)	Steep Shale Breaks
White (C)	Hilly to Steep Barren Badlands

Figure 9. Use of color to delineate soilscapes. Enlargement prints of color composite. July 9, 1973. 1351-17064. Scale = 1:1,000,000.



Field Size--Larger fields are indicative of uniform medium textured soils. These soils occur on level terraces next to the Cheyenne River.

Intensity of Field Pattern--The land use in B6 soilscape is nearly all cropland as indicated by the nearly continuous field pattern. The land use in B7 soilscape is a mixture of cropland and rangeland as indicated by the discontinuous field pattern.

Figure 10. Use of differences in cropland land use pattern to delineate soilscapes. Enlargement print of color composite. July 9, 1973. 1351-17064. Scale = 1:250,000.

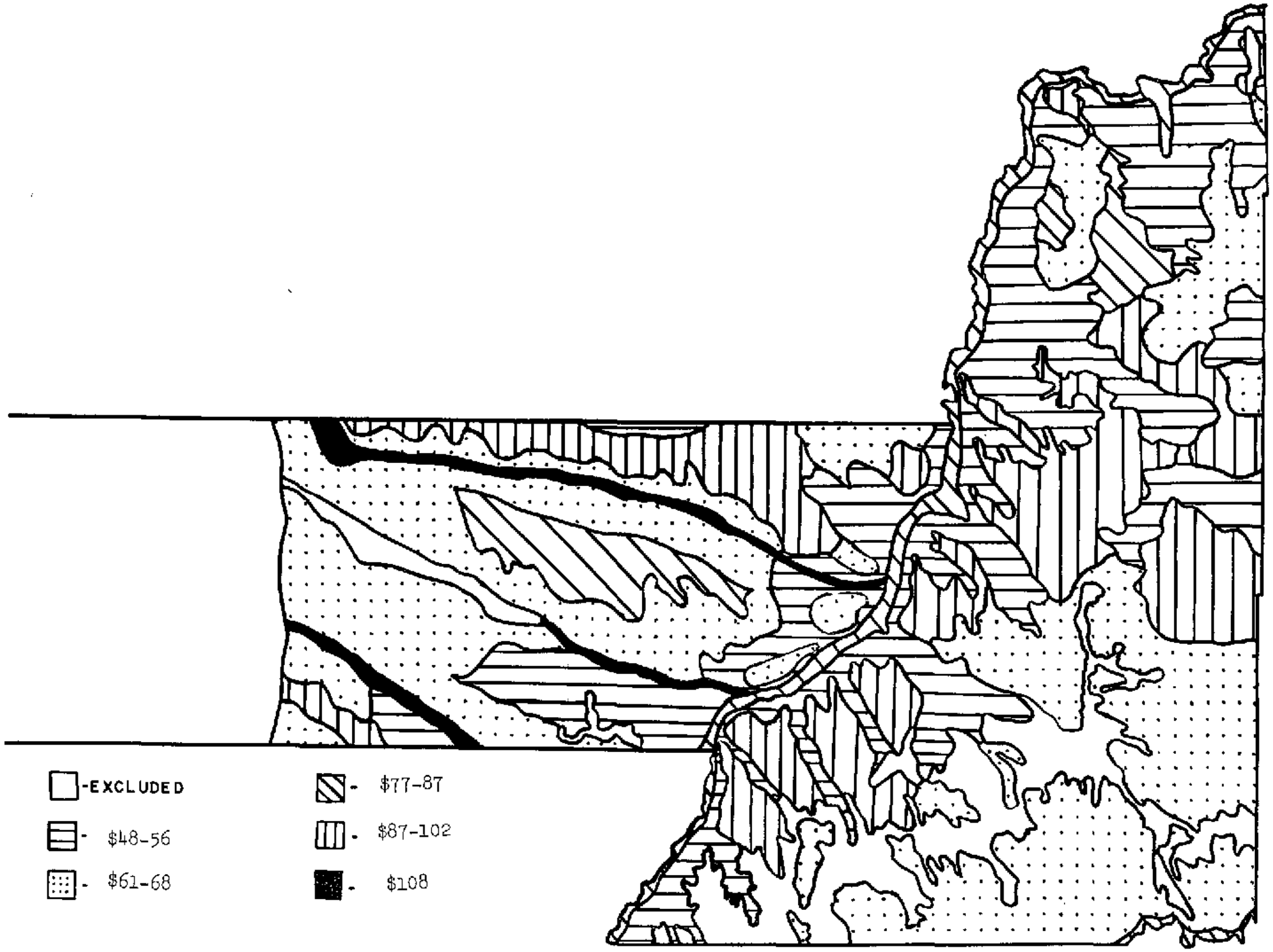


Figure 11. Land value map of eastern Pennington County.

APPENDIX B

INDEPENDENCE MALL WEST PHILADELPHIA, PA. 19105, U.S.A. TELEPHONE (215) 592-3000
CABLE ADDRESS: ROHMHAAS TELEX 845-247

B-1

ROHM AND HAAS COMPANY

February 13, 1975

Dr. Frederick C. Westin
Plant Science Department
South Dakota State University
Brookings, S. D. 57006

Dear Dr. Westin:

Recently I obtained a copy of the ERTS Mosaic of South Dakota (Soil Texture, Soil Slope, and Soil Test Results, AES Infor. Series No. 7). I consider this about the best soil profile for a state that I've seen in years. You and the others who assisted you in the preparation of the Mosaic are to be commended.

Do you know if other states have prepared similar soil mosaics? Or if other states cooperate, or intend to cooperate with the National Aeronautics and Space Administration to obtain data for such soil mosaics? Perhaps you could recommend a contact at NASA who is coordinating such activity or who is at least knowledgeable about the existance of similar activities covering other states.

We would find soil mosaics of this type very helpful in arranging tests for herbicide evaluations. These mosaics would be useful also in assessing areas for marketing herbicides where activity for weed control is dependent on soil type.

Any assistance you can provide will be most helpful.

Sincerely,

Charles F. Gordon

Charles F. Gordon
Marketing Research Analyst
Agricultural & Sanitary Chemicals Department

CFG/fc
cc: Mr. Leon J. Wrage
Mr. Paul L. Carson
Mr. Jack R. Smith

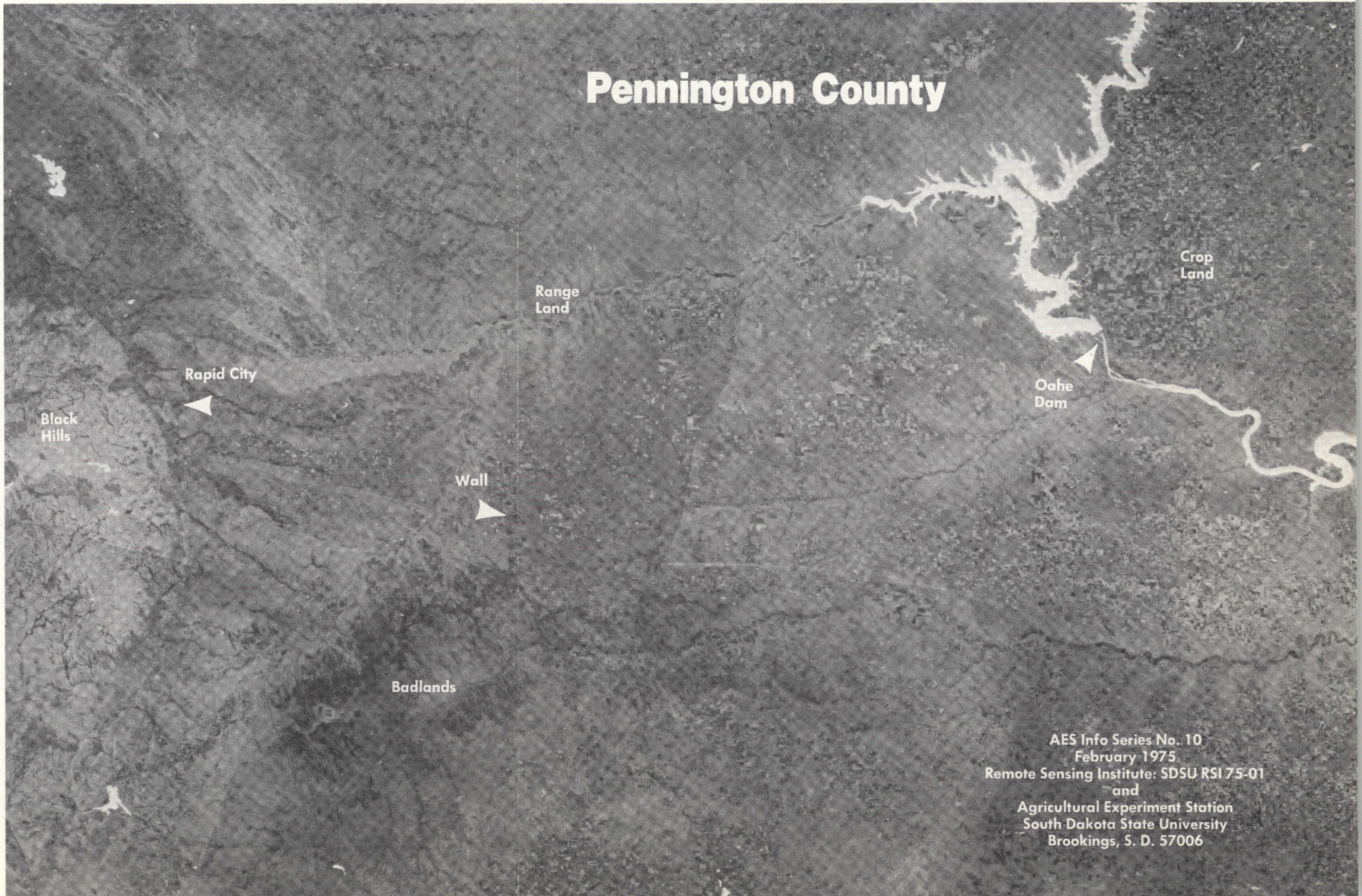
Land Use Data Interpreted from ERTS-1 Imagery

ERTS-1 Imagery

The ERTS-1 imagery used for the base map was prepared from four ERTS scenes taken in June and July 1973. The mosaic consists of negative prints from Band 7 (reflected infrared) of the Multispectral Scanner (MSS) of the ERTS-1 (Earth Resources Technology Satellite) satellite orbiting the earth at about 550 miles. The MSS records energy reflected by features of the earth's surface in four different spectral bands. Each ERTS scene covers approximately 8,000,000 acres. The ERTS-1 satellite provides complete coverage of South Dakota every 18 days.

On these negative prints of Band 7, water appears white, rangeland medium gray, pine trees light gray, and vigorously growing vegetation and badlands dark gray. Thus, land use can be interpreted from reflectance or reflectance patterns of the ERTS bands. This mosaic is at a scale of 1:500,000 (1 inch = 8 miles), but the imagery can be enlarged up to scales as large as 1:60,000 (1 inch = 1 mile). In addition, false color composites of the ERTS-1 bands can be prepared to aid in interpretation of land use, soil areas, and other features.

New technology now makes it feasible to acquire land use information rapidly and economically over large areas. To prepare a base map of Pennington County (1,780,000 acres) using conventional aerial photographs (scale of 1:20,000) would require 1,400 separate photographs costing an estimated $14,000. This ERTS base map was compiled using only four images or pictures costing $20. ERTS-1 prints are available at nominal cost from the EROS Data Center, Sioux Falls, South Dakota 57189.



AES Info Series No. 10
February 1975
Remote Sensing Institute: SDSU RSI 75-01
and
Agricultural Experiment Station
South Dakota State University
Brookings, S. D. 57006

How to Use ERTS-1 Imagery for Interpretation of Land Use Information

Each of the land use classes can be identified by particular tones (shades of gray) or tone patterns as recorded by the satellite and illustrated on the ERTS-1 imagery. Selection of the best image for study requires an understanding of the ground situation throughout the year and how this is recorded by the satellite. The use of color composites and multispectral information from more than one season of the year is normally better than using a single ERTS-1 image.

The following criteria were used to identify the various land use classes of Pennington County from the negative print of the Band 7 images.

1. Urban and Built-Up Land. Tone is different than surrounding areas and pattern may be symmetrical due to street layout. Supplemental information is needed to adequately map these areas.

2. Agricultural Land. Geometric shapes and patterns due to field boundaries are usually distinct. Areas used infrequently for hay may not show well defined boundaries.

3. Rangeland. Intermediate gray tones and a lack of well defined boundaries.

4. Forest Land. Light gray tones. Rangeland, burn areas, or other disturbances in forested areas are noted by darker tones.

5. Water. Distinctive white tones. Many stock ponds can be identified but are too small to map at 1:500,000 scale.

6. Barren Land. Dark gray tones.

Using criteria similar to above, an accuracy of 85% to 90% is obtainable with limited supplemental information from spot ground checks and existing land use information. Greater accuracy may be attained only at much higher costs.

This 1973 land use map for Pennington County, South Dakota was interpreted by Charles J. Frazee, assistant professor, Plant Science Department and Remote Sensing Institute, South Dakota State University. Funded in part by the State of South Dakota and National Aeronautics and Space Administration, Office of University Affairs. Grant No. 42-003-007.

Definitions of Land Use Classes*

*These definitions are based upon the publication: *A Land-Use Classification System for Use with Remote Sensor Data,* by Anderson, Hardy, and Roach, U. S. Geological Survey Circular 671, and are localized for Pennington County conditions.

1. Urban and Build-Up Land. Areas of intensive use with much of the land covered by structures. This category includes residential, commercial, industrial, mining, transportation, utility, recreational, and institutional areas. These areas may occur in cities, towns, villages, strip developments along highways, or as isolated units.

2. Agricultural Land. Areas used primarily for production of farm commodities. This category includes lands cultivated for crops or hay production.

3. Rangeland. Areas used primarily for grazing of livestock. This category includes the short grass rangelands as well as mountain meadows and valleys.

4. Forest Land. Areas covered by or influenced by trees. This category includes lands covered by both evergreen and deciduous trees. Also included are forest fire areas which potentially will revegetate with trees.

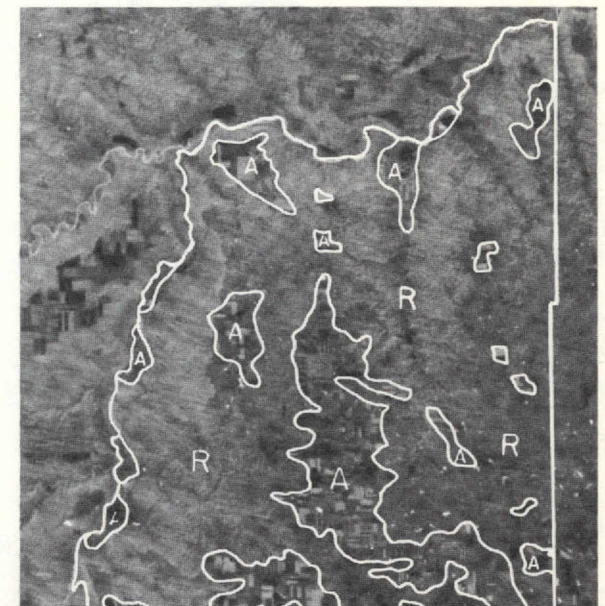
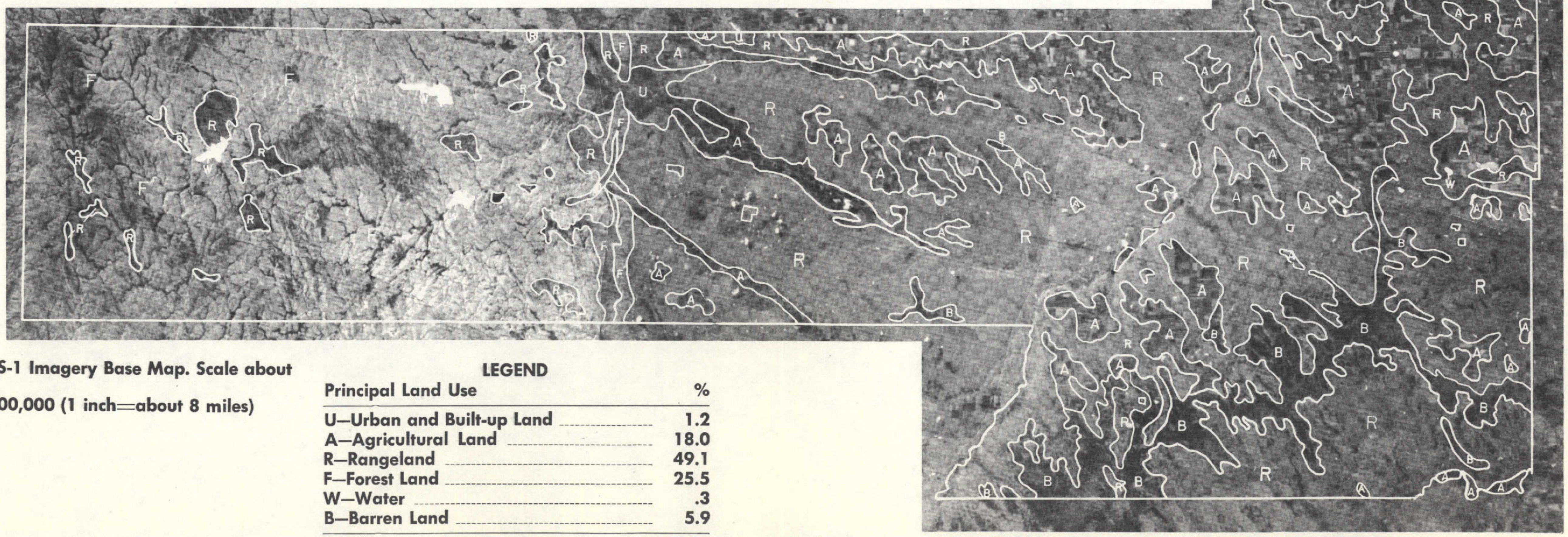
5. Water. Areas covered by water which are at least ⅛ mile wide and cover more than 40 acres. This category includes lakes, reservoirs, and large farm ponds.

6. Barren Land. Areas having limited ability to support life and little or no vegetation. This category includes bare exposed rock areas.

Use of Information

The growing need and concern for environmental resource planning dictates that general land use data are required for land use planners to make relevant planning decisions to ensure the economic future and an assured quality of life. Pending state and federal legislation require land use data to be collected in the land use planning process.

Changes in land use of an area can be monitored. For example, the amount and location of rangelands converted to wheatland in western South Dakota can be estimated by using suitable ERTS-1 images from different growing seasons.

ERTS-1 Imagery Base Map. Scale about 1:500,000 (1 inch=about 8 miles)

LEGEND

Principal Land Use	%
U—Urban and Built-up Land	1.2
A—Agricultural Land	18.0
R—Rangeland	49.1
F—Forest Land	25.5
W—Water	.3
B—Barren Land	5.9
Total	**100.0**

APPENDIX C

NEWS RELEASE
From: Central Telephone & Utilities Corporation
114 South Main Avenue
Sioux Falls, South Dakota 57101

Telephone: James R. Bjorklund
336-0530, Ext. 60

FOR IMMEDIATE RELEASE

Embarking on a pioneer conservation effort, Cengas today announced a thermal scanning project aimed at determining a major cause of heat loss in homes and other buildings in five Cengas-served communities.

Cengas, the natural gas operations of Central Telephone & Utilities, has contracted with the Remote Sensing Institute of South Dakota State University at Brookings to collect data through the use of an infra-red sensing technique. Lyle Fenstermaker, South Dakota Division Manager, said the company's research indicates that the Cengas project is apparently the first practical application of this technology for measurement of the surface temperature of roofs.

The project will be implemented in Sioux Falls and in Beatrice, Columbus, Lincoln, and Norfolk in Nebraska. The flights will be at night, Fenstermaker said, when weather conditions are suitable. A clear cold night with snow cover on the ground is the most desirable.

Fenstermaker said the Remote Sensing Institute will survey each of the five communities with equipment in a twin engine plane. The airplane will traverse the length of each community approximately every three blocks and fly at 1,600 feet above ground.

During the flights roof temperatures will be recorded on a magnetic tape. "The measurements are accurate to within ½ degree of the actual temperature," Fenstermaker said in noting the reliability of the measurements.

Through an electronic process, the recordings on the magnetic tape will be translated to photographic sheets of paper showing the outlines of buildings. Trained Cengas personnel will be able to decipher the material for property owners, Fenstermaker said.

Information gained from the thermal scanner project will be available to individual property owners, Fenstermaker noted. Individuals will be notified when information from the project is available. They may then contact Cengas to see the results of the survey of their home or business.

Through the proper application of the information gathered by Cengas, Fenstermaker said, property owners will be able to determine if their home is adequately insulated. Conservation resulting from the proper insulation of buildings can enhance the gas industry's ability to serve existing and future customers as well as support national energy objectives, Fenstermaker said.

"The thermal scanner project," Fenstermaker said, "is just one of the things that demonstrates Cengas support of federal energy conservation efforts."

He noted that Department of Commerce statistics indicate that over half of all energy is wasted. "We feel that the ultimate good of the public would be served," Fenstermaker said, "by helping the public identify the effectiveness of the insulation in their homes or businesses so that potential waste can be reduced."

Members of the Remote Sensing Institute's survey team will advise local authorities in each of the five communities in advance of the flights and the public will be notified through the news media.

During the flights, Cengas staff members will provide ground support by marking the routes with yellow guidance lights on Cengas vehicles.

The thermal scanner project is a joint program of Cengas' three divisions in its two-state service area. The five communities are headquarters for division and district offices of the company.

APPENDIX D

South Dakota Bicentennial Commission

April 22, 1974

Vic Myers, Director
Remote Sensing Institute
South Dakota State University
Brookings, S. D.

Dear Mr. Myers,

I have a letter from Frank Shideler of Brookings, a member of our S.D. Bicentennial Commission, in which he reported that you had expressed some interest in being a part of the Bicentennial program in South Dakota.

Certainly we as a commission are interested and I would look forward to an opportunity to meet with you and to discuss the role that NASA and Remote Sensing Institute might play in the bicentennial effort to make it more meaningful and interesting.

I had thought that possibly something of this nature might have been included in the excellent bicentennial proposal made by South Dakota State University which was approved by our Commission. I know that a reference was made to it.

As I understand Frank's proposal, it would seem that it might well qualify as a Designated Bicentennial Project which could be built around the Horizon Themessince it would be state-wide in scope and could serve in so many ways.

This letter is to assure you that our commission is interested. I would welcome the opportunity to sit down with you and with Frank some day and discuss it and possibly work out some details that could be presented to the full commission for its consideration.

Very sincerely,

Les Helgeland, Chairman
S.D. Bicentennial Commission
1003 Mulberry
Yankton, South Dakota 57078

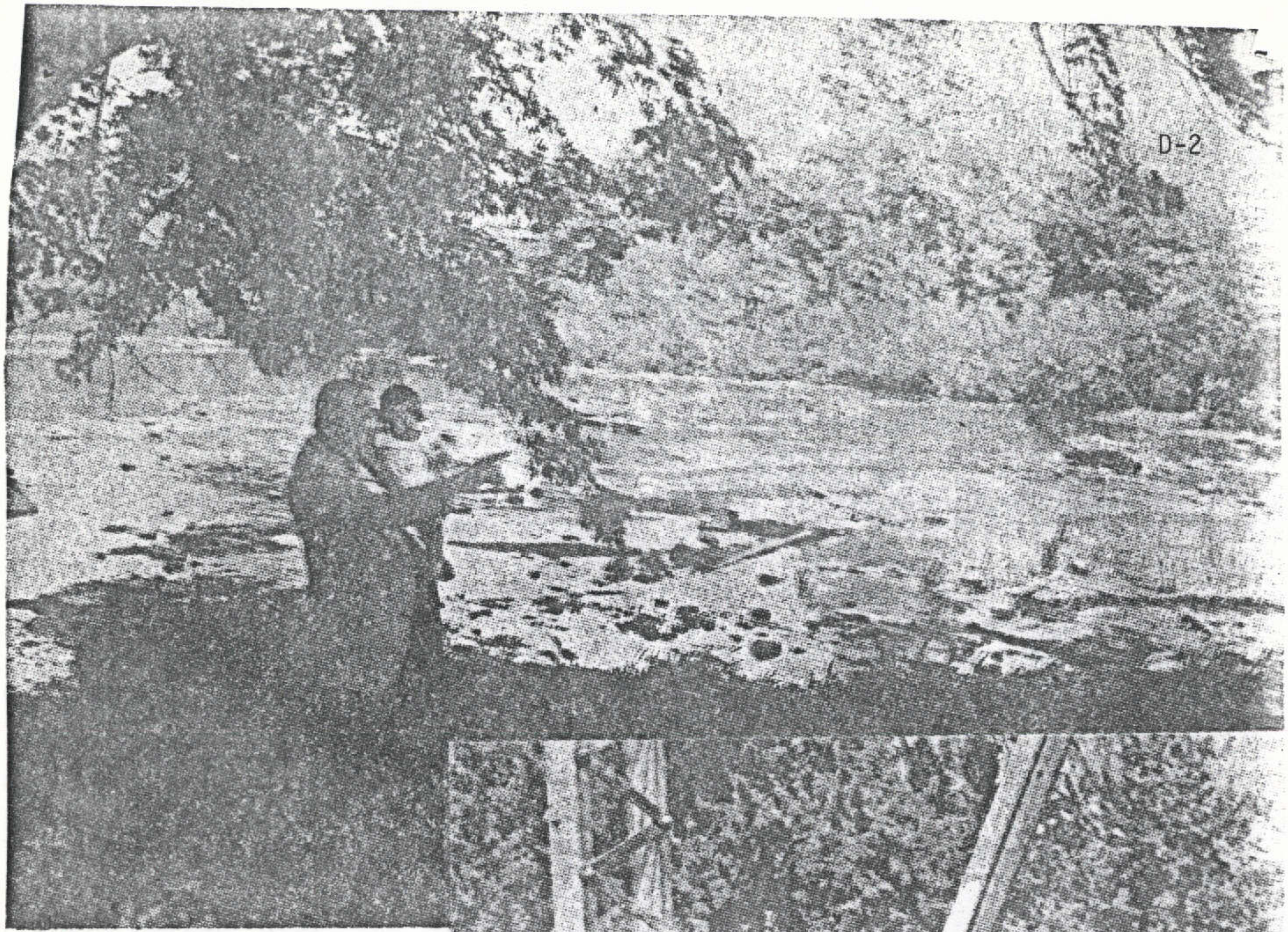
CC: Frank Shideler
Arnie STenseth

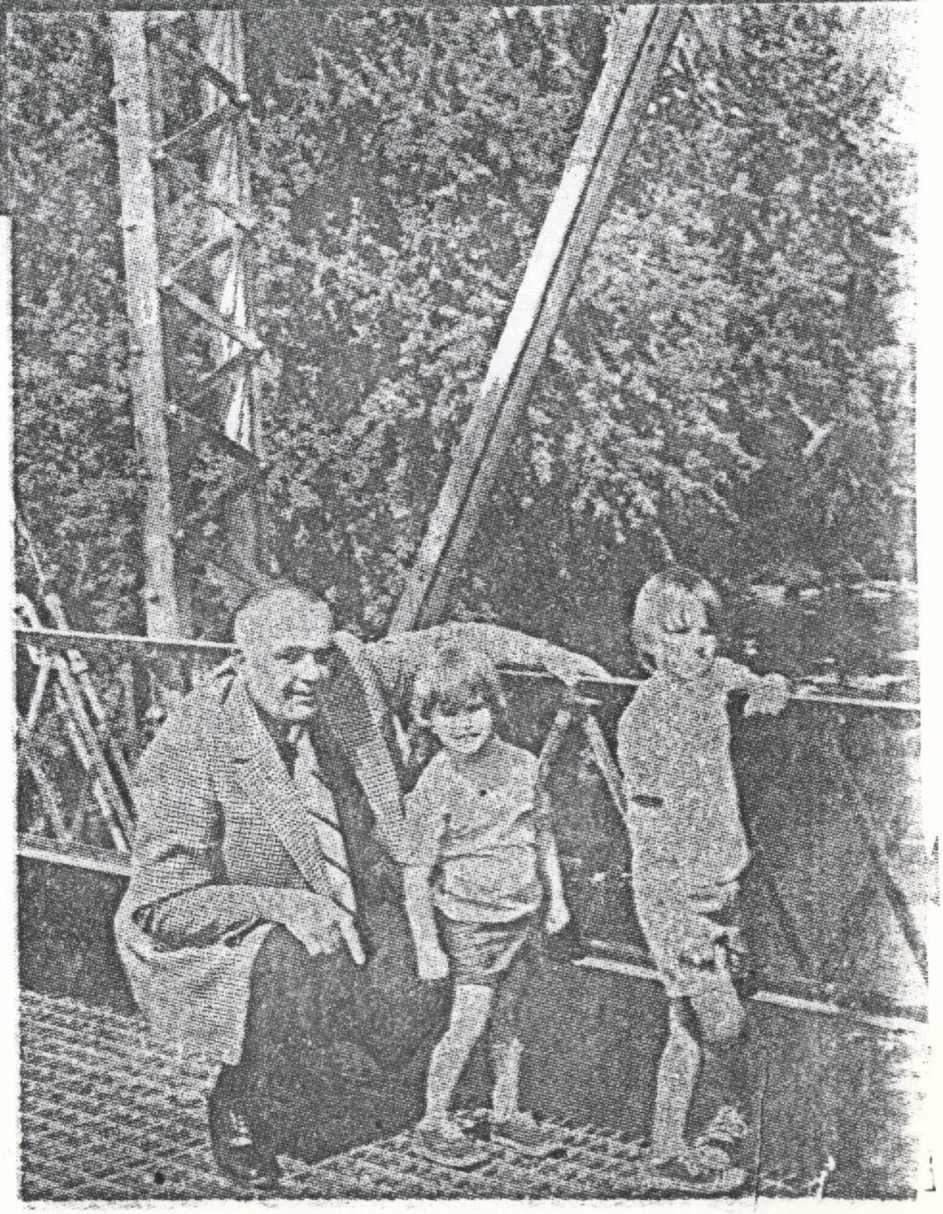
ORIGINAL PAGE IS
OF POOR QUALITY

South Dakota 1976

MT. RUSHMORE - SHRINE OF DEMOCRACY / USA BICENTENNIAL FOCAL POINT

STATE CAPITOL – PIERRE, SOUTH DAKOTA 57501 – 605-224-3224
LES HELGELAND – CHAIRMAN
ARNIE STENSETH – DIRECTOR





Looking Toward The Future

Kenneth Munro, Parks and Recreation Department director, hopes these three children will soon be enjoying a riverfront parkway along the Big Sioux River. In the top photograph, Munro is holding 15-month-old Meghan Knobe. In the background is a portion of the river that will be cleared as part of Bicentennial Parkway Project. Billed as one of the region's biggest undertakings, the park will follow the river as it meanders around Sioux Falls.

At the right, Munro poses on the old Yankton bridge with 3-year-old Michael Samp and Brian Knobe, 6. The bridge, which was constructed in the late 1800s, stands on the site of a ford that was used as part of a wagon trail to Yankton. Historically, the trail served as an exit for pioneers during an Indian invasion. Munro explained that the bridge will be retained as part of the Bicentennial Parkway.

Sioux Falls Declared 'Horizon City' For Bicentennial Celebration

Sioux Falls
ARGUS
LEADER

By KAY CARLSON
Women's News Editor

Have 200 years taken their toll on America?

Or has the durability that steered the pioneers through blizzards and droughts manifested itself in the 20th Century American?

The Bicentennial celebration may tell. Across the nation service clubs, schools, businesses and entire communities are nibbling at ways to become involved in the event.

Last week Sioux Falls joined their ranks. This city of an estimated 100,000 people has received its official state designation, "Horizon City." This means two things:

1. Community projects will be designed to offer a revival of community spirit and a new sense of values.
2. An improvement of the quality of life and an assurance of a better future for all mankind.

"The projects are being created for more than tourism," stated Mrs. Elizabeth Shreves, cochairperson of the Sioux Falls Bicentennial Commission. "It will be a year to celebrate the good things in this country."

The year 1976 will be one of celebration. Events are in the making for those 366 days. Already Sioux Falls has 17 official projects with over 20 more proposed. The Bicentennial Commission feels this is only a grain of sand on the beach. It is its dream to see every organization become involved. Interested groups may contact Mrs. Shreves or Dennis Sunderman, cochairperson for applications. Deadline is July, 1975. Others on the local committee include Mrs. William Robinson, Charles Rogness, the Rev. Martin Brokenleg, Mrs. Arthur Huseboe, Dr. Gary Olson, Dr. Harry William Farrell, Rollyn Samp, Dr. Leland Lillehaug, Burton Ode, Mrs. Orville Lonnenan, Laurie Thorson and Ray Loftesness.

"One of the biggest undertakings in the region is the Bicentennial Parkway. Plans call for a riverfront park to encompass the city," Mrs. Shreves said.

The City Commission has budgeted $311,000 of revenue-sharing funds for land acquisition of riverfront property. After the land is acquired, it is hoped that civic groups and organizations will help sponsor development and beautification of specific areas.

Freedom Train To Come

"On Aug. 8, five railroad cars from the Bicentennial Freedom Train will be in Sioux Falls for a trial run," Sunderman said. "Because we are the only city in South Dakota where the 20-car train will stop in 1976, the national committee will be taking this opportunity to prepare security and make plans."

The Freedom Train, which is sponsored by the American Freedom Train Foundation, will be a treasure house of American heritage. In its cars, citizens will discover the original Declaration of Independence, films on the space program, ethnic groups' contributions and many other items. Currently the train's schedule will allow it to be stationed in Sioux Falls for two days in Sept., 1976. It is estimated that 200,000 people will visit it.