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Technical Report

UTILITY OF REMOTELY SENSED DATA FOR IDENTIFICATION OF SOIL CONSERVATION PRACTICES

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16. ABSTRACT

This report discusses a variety of remotely sensed data sources that may have utility in the identification of conservation practices and related linear features. Test sites were evaluated in Alabama, Kansas, Mississippi, and Oklahoma using one or more of a variety of remotely sensed data sources, including color infrared photography (CIR), Landsat Thematic Mapper (TM) data, and aircraft-acquired Thermal Infrared Multispectral Scanner (TIMS) data. Both visual examination and computer-implemented enhancement procedures were used to identify conservation practices and other linear features. For the Kansas, Mississippi, and Oklahoma test sites, photo interpretations of CIR identified up to 24 of the 109 conservation practices from a matrix derived from the SCS National Handbook of Conservation Practices. The conservation practice matrix was modified to predict the possibility of identifying the 109 practices at various photographic scales based on the observed results as well as photo interpreter experience. Some practices were successfully identified in TM data through visual identification, but a number of existing practices were of such size and shape that the resolution of the TM could not detect them with great accuracy. A series of computer-automated decorrelation and filtering procedures served to enhance the conservation practices in TM data with only fair success. However, features such as field boundaries, roads, water bodies, and the Urban/Ag interface were easily differentiated. Similar enhancement techniques applied to 5-meter and 10-meter TIMS data proved much more useful in delineating terraces, grass waterways, and drainage ditches as well as the features mentioned above, due partly to improved resolution and partly to thermally influenced moisture conditions. Spatially oriented data such as those derived from remotely sensed data offer some promise in the inventory and monitoring of conservation practices as well as in supplying parameter data for a variety of computer-implemented agricultural models.

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Section I

INTRODUCTION

In recent years there has been a resurgence of concern for soil conservation. This concern has been recognized by actions taken on behalf of the public through such legislative mandates as the Soil and Water Conservation Act of 1977 and the requirement for a National Resources Inventory (NRI) every five years. The 1982 NRI indicated that erosion exceeded the tolerance (T) limit on 44% of all cropland. In 14 MLRA's (Major Land Resource Areas), for which 30% or more of all rural land is cultivated, average annual erosion even exceeded 10 tons (Lee, 1984). In addition, almost all pasture land and forest are at the tolerance limit.

In order to gather the necessary data for inventory and monitoring programs, like the NRI, quickly and at a detailed scale for the nation, new procedures for data acquisition and analysis are needed. Remote sensing, whether it is the application of traditional photo interpretation methods on aerial photography or the utilization of more sophisticated computer image processing techniques with satellite-acquired data, could facilitate the analysis of the necessarily large quantities of data for such comprehensive studies.

The goal of the Conservation Practice Inventory project, conducted under the AgRISTARS banner, was to determine the feasibility of utilizing different remotely sensed data for the identification and inventory of existing soil conservation practices. Data base technology, by incorporating digital soils and topographic data with the remotely sensed data, was also evaluated in this project. The work presented in this report is a summary of these efforts, some of which are presented in more detail in symposium and journal articles.

Section II

APPROACH

A. Site Descriptions

Various degrees of study were conducted on test sites in Alabama and Colorado and selected watersheds from the Rural Clean Water Program (RCWP) in Mississippi, Oklahoma, Kansas, Illinois, and Idaho. These sites were chosen due to the wide range in conservation practices used to combat water and/or wind erosion. These sites also covered a wide variety of climatic conditions, soil types, geomorphology, and topography and exhibited significant erosion rates according to the USDA Soil Conservation Service (SCS). The Alabama, Mississippi, Kansas, and Oklahoma test sites are the focus of the work presented in this report (Figure 1).

B. Data Sources

A number of different types of remotely sensed data are evaluated in this report, including high and low resolution color infrared (CIR) photography, Landsat Thematic Mapper (TM) data, and Thermal Infrared Multispectral Scanner (TIMS) data. Visual photo interpretive techniques and computer image enhancement techniques were used to highlight and identify conservation practices. For some of the test sites, conservation practices identified from remotely sensed data were further integrated with digitized soil survey and topographic data to determine those areas where certain conservation practices may be needed.

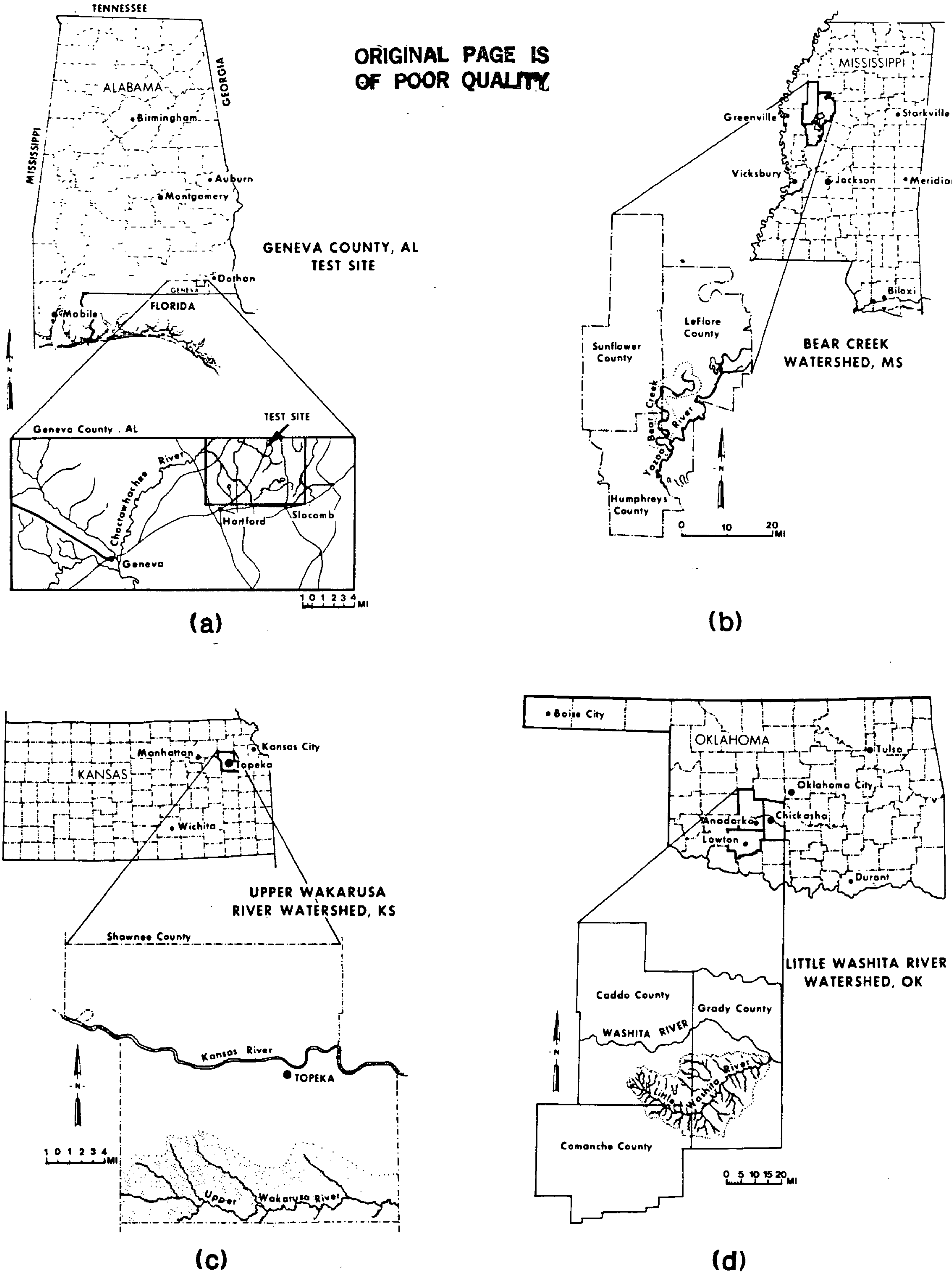

Figure 1. Conservation Practice Inventory Test Site Locations

Section III

CONSERVATION PRACTICE MATRIX SHEET DEVELOPMENT

Manual photo interpretation of aerial photography has long been a valuable tool of remote sensing for a multitude of disciplines in agriculture, natural resources, urban planning, military applications, etc. (Carroll, 1973; Manual of Photogrammetry, 1980; Manual of Photographic Interpretation, 1960). Aerial photos can be used to study soil erosion (Frazier, et al., 1983; and Welch, et al., 1984) and to monitor changes in soil management which may affect cropland erosion (Stephens, et al., 1982). Morgan, et al. (1980), used air photo analysis of erosion control practices for input to the Universal Soil Loss Equation.

Despite the application, a number of parameters about the object(s) or phenomena being photo-interpreted must be known. Among the most important of these parameters are the spatial dimensions, the spectral characteristics, and the temporal variations. Often, supporting ground information is also needed in addition to the experience of the photo-interpreter. All these factors must be considered in order to determine the likelihood that an object or phenomenon may be identified.

As a first phase of the Conservation Practice Inventory project, a photo interpretive matrix of the USDA Soil Conservation Service recognized conservation practices (USDA-SCS, 1977) was developed based on the format for the U.S. Army Engineer Topographic Laboratories (USAETL) Military Geographic Information Remote Sensor Matrix (Vogel, et al., 1972). The matrix takes into account the factors discussed above and includes the kind of photography (color, CIR, B/W) or sensor type (Landsat Thematic Mapper or Multispectral

Scanner), interpreter's skill level (novice or experienced), an indication of additional ancillary data needed, and a listing of photographic scale or sensor resolution for which each practice may be identified. The 22-page matrix is included in the Appendix, and a sample page from it is shown in Figure 2. Other factors which were inherent in formulating the matrix include object (conservation practice) resolution, object contrast with its surroundings, object contrast with other practices, and spectral characteristics of the camera or scanner.

One of the problems in identifying conservation practices is that many of them are indistinguishable from similar practices that do not meet the criteria for a conservation practice, a definition for which is "a technique or measure used to meet a specific need in planning and carrying out soil and water conservation programs for which standards and specifications have been developed." Consequently, it often becomes necessary to make a judgment on the intent for establishing the practice. Four common practices that do not qualify as conservation practices are access roads, bedding, fencing, and ponds when these practices are established to serve a management need without regard to conservation needs.

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Table A-1. Conservation Practices Photo-Interpretive Matrix

Interpreter Experience Level A - Novice
B - Experienced

Photo Type Desirability Level 1 - most
2 - acceptable
3 - least

Supporting Data
R - required
D - desired
- - not necessary

Practice Identification
0 - actually observed
P - predicted

APPROXIMATE MINIMUM DETECT. SIZE*: .5, 1, 2, 5, 8, 10, 15, 20, 25, 30 (in feet); -, -, 1, 2, 3, 4, 5, 7, 8, 10 (in meters)

CODE	PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	PHOTOGRAPHY SCALE: .5K	1K	5K	10K	15K	20K	30K	40K	50K	60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
560	Access Road	A	1	1	2	3	P	P	P	P	P	P	P	P	P	P	P	D	-	R	Constructed as part of a conservation program, min. width 10 ft. one way, 15 ft. two way. Provide access to farms, fields, etc. from county, state, or township highway to such enterprises.
310	Bedding	A	1	1	2	3	P	P	P									R	R	D	Elevating surface of flat land into broad, low ridges separated by shallow, dead parallel furrows. Used in poorly drained areas and nearly flat areas having slowly permeable soils.
314	Brush Management	B	1	1	2	3	P	P	P	P	P	P						D	D	D	Managing brushland by burning, chemical, biological or mechanical means to improve plant cover, habitat values, etc.
322	Channel Vegetation	B	1	1	2	2	P	P	P	P	P	P	0	P	P	P	0	R	R	-	Planting of grasses etc. to maintain channel banks, berms, spoil and associated areas; applies to Codes 400, 404, 582, 584, 580, and 607-B.

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Figure 2. Sample Page from Conservation Practices Matrix

Section IV

PHOTO INTERPRETATION FOR CONSERVATION PRACTICES

In order to evaluate and modify the conservation practice matrix, aerial photography was acquired for a number of the test sites at two photographic scales (~1:80,000 and 1:30,000). Each photographic set was photo interpreted from the smallest scale to the largest, with a sufficient length of time between interpretations to prevent biasing subsequent interpretations by prior knowledge of existing practices. Conservation practices were identified on the photography and transferred to 7.5-minute quad maps, which were planimetered to determine areal or linear extent. Tables 1 through 6 illustrate the type and extent or number of each practice photo-interpreted at high and low altitudes for three test sites in Oklahoma, Kansas, and Mississippi.

The summary of conservation practices for the Little Washita River watershed in Oklahoma can be found in Table 1, with a detailed breakdown by map quad in Table 2. Diversions and windbreaks are dominant practices in this test site compared to the other two sites, one each in Kansas and Mississippi. Windbreaks are especially important in the western portion of the watershed where soil erosion by wind is more severe than by water. Twenty-six times as many feet of diversions were identified in low altitude versus high altitude photography. Likewise, six times as many feet of dikes, five times as many sediment basins, and three times as many ponds were identified in low altitude photography versus high altitude photography. Windbreaks appeared to be as easily identified in either resolution photography. Perhaps the long linear nature of windbreaks along with their high spectral contrast to their surroundings explains this occurrence. Similarly, the decreased spatial dimension and apparent lack of high spectral contrast of hillside ditches and open

Table 1. Summary of Conservation Practices for Entire Little Washita River Watershed, OK

Code	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	26	122
356	Dike (Feet)	10,000	61,000
362	Diversion (Feet)	7,000	182,300
378	Pond (Quantity)	83	246
380	Farmstead/Feed Lot Windbreak (Acres)	20	20
392	Field Windbreak (Feet)	14,100	14,100
412	Grassed Waterway/Outlet (Acres)	258.22	423.57
423	Hillside Ditch (Feet)	-	1,000
582	Open Channel (Feet)	-	2,000
584	Stream Channel Stabilization (Feet)	-	1,000
587	Structure for Water Control (Quantity)	23	50
600	Terrace (Acres)	12,921.51	20,396.22

Table 2. Summary of Conservation Practices for Little Washita River Watershed, OK, by Individual 1:24,000 Maps

MAP: ROCKY FORD

Code	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	-	39
356	Dike (Feet)	-	7,000
362	Diversion (Feet)	-	7,300
378	Pond (Quantity)	8	112
412	Grassed Waterway/Outlet (Acres)	-	12.04
582	Open Channel (Feet)	-	3,000
587	Structure for Water Control (Quantity)	-	13
600	Terrace (Acres)	1425.95	3,487.55

MAP: LAVERTY

Code	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	-	20
362	Diversion (Feet)	-	34,500
378	Pond (Quantity)	7	46
392	Field Windbreak (Feet)	5,000	5,000
412	Grassed Waterway (Acres)	-	60.51
423	Hillside Ditch (Feet)	-	1,000
582	Open Channel (Feet)	-	2,000
584	Stream Channel Stabilization (Feet)	-	1,000
587	Structure for Water Control (Quantity)	-	12
600	Terrace (Acres)	5,657.23	6,049.93

Table 2. (Continued)

MAP: FLETCHER

Codes	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	8	22
362	Diversion (Feet)	3,000	27,000
378	Pond (Quantity)	22	23
412	Grassed Waterway/Outlet (Acres)	18.97	18.97
587	Structure for Water Control (Quantity)	8	8
600	Terrace (Acres)	2,302.44	2,677.72

MAP: RUSH SPRINGS NW

Code	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	-	61
356	Dike (Feet)	10,000	54,000
362	Diversion (Feet)	-	32,000
378	Pond (Quantity)	25	41
380	Farmstead/Feed Lot Windbreak (Acres)	20	20
392	Field Windbreak (Feet)	6,100	6,100
412	Grassed Waterway/Outlet (Acres)	195.28	209.57
587	Structure for Water Control (Quantity)	10	10
600	Terrace (Acres)	176.64	2,883.49

Table 2. (Continued)

MAP: RUSH SPRINGS SW

Code	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	2	2
362	Diversion (Feet)	2,000	67,000
378	Pond (Quantity)	3	5
392	Field Windbreak (Feet)	3,000	3,000
412	Grassed Waterway (Acres)	18.62	40.34
587	Structure for Water Control (Quantity)	2	2
600	Terrace (Acres)	485.13	545.10

MAP: RUSH SPRINGS NE

Code	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	-	12
362	Diversion (Feet)	-	7,500
378	Pond (Quantity)	2	2
412	Grassed Waterway/Outlet (Acres)	-	3.95
587	Structure for Water Control (Quantity)	-	2
600	Terrace (Acres)	132.57	342.43

Table 2. (Continued)

MAP: CYRIL

Code	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	14	22
362	Diversion (Feet)	2,000	5,000
378	Pond (Quantity)	9	10
412	Grassed Waterway/Outlet (Acres)	18.48	39.98
587	Structure for Water Control	3	3
600	Terrace (Acres)	2,251.25	2,769.97

MAP: APACHE

Code	Description	High Altitude Total	Low Altitude Total
350	Sediment Basin (Quantity)	2	4
362	Diversion (Feet)	-	2,000
378	Pond (Quantity)	7	7
412	Grassed Waterway/Outlet (Acres)	6.87	38.21
587	Structure for Water Control (Quantity)	-	-
600	Terrace (Acres)	1,490.30	1,640.03

channels may explain why these practices could be identified in low altitude photography but not in the high altitude photography.

Contour farming was the dominant conservation practice in the upper Wakarusa River watershed in Kansas (Tables 3 and 4). Similar to findings at the Oklahoma test site, 17 times as many feet of diversions were identified in low altitude photography as in high altitude photography. All other practices were found at nearly the same extent (two times the amount or less) in both photographic scales. An irrigation system/sprinkler, however, was only identified at the larger photographic scale (1:30,000).

Irrigation canals and ditches are dominant features in the Bear Creek watershed of Mississippi (Tables 5 and 6). Dikes, drainage ditches, and grassed waterways were identified at three, eight, and ten times the extent, respectively, in low altitude photography as in the high altitude photography. These practices are of such spatial and spectral characteristics that high resolution photography is necessary for their adequate identification.

Out of the 109 conservation practices listed in the matrix, 19 could not be determined through remote sensing because they exhibited very small spatial extent (e.g., mole drain) or were defined by managerial concepts rather than something physically visible (e.g., irrigation water management). Of the remaining 90 practices, only 27% (24 practices) were identifiable with little or no supporting data at the test sites studied. The remaining practices either could not be positively identified without further supporting data (e.g., windbreak renovation) or simply did not exist within the area of the study sites examined (e.g., spoil spreading).

Based on the knowledge gained from the photo-interpretation of the practices at the three test sites, the conservation practice matrix was modified

Table 3. Summary of Conservation Practices for Entire Upper Wakarusa River Watershed, KS

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	2,219.3	3,296.9
350	Sediment Basin (Quantity)	-	1
362	Diversion (Feet)	500	8,500
378	Pond (Quantity)	45	65
402	Dam/Floodwater Retarding (Feet)	12,350	12,850
412	Grassed Waterway/Outlet (Acres)	475.9	828.5
442	Irrigation System/Sprinkler (Acres)	-	133.5
587	Structure for Water Control (Quantity)	1	1
600	Terrace (Acres)	5,295.3	7,211.2

Table 4. Summary of Conservation Practices for Upper Wakarusa River Watershed, KS, by Individual 1:24,000 Maps

MAP: DOVER

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	419.8	508.1
378	Pond (Quantity)	17	17
412	Grassed Waterway/Outlet (Acres)	54.1	82.1
600	Terrace (Acres)	686.9	754.9

MAP: HARVEYVILLE

Code	Description	High Altitude Total	Low Altitude Total
378	Pond (Quantity)	8	8
412	Grassed Waterway/Outlet (Acres)	54.8	63.1
600	Terrace (Acres)	183.3	426.3

MAP: AUBURN

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	676.4	936.0
362	Diversion (Feet)	-	5,000
402	Dam/Floodwater Retarding (Feet)	7,050	7,050.0
412	Grassed Waterway/Outlet (Acres)	90.0	144.1
600	Terrace (Acres)	442.8	616.9

Table 4. (Continued)

MAP: BURLINGAME

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	277.9	355.9
350	Sediment Basin (Quantity)	-	1
362	Diversion (Feet)	-	2,000
378	Pond (Quantity)	2	16
402	Dam/Floodwater Retarding (Feet)	900	900
412	Grassed Waterway/Outlet (Acres)	35.1	41.6
600	Terrace (Acres)	496.1	496.1

MAP: KEENE

Code	Description	High Altitude Total	Low Altitude Total
378	Pond (Quantity)	-	1
412	Grassed Waterway/Outlet (Acres)	35.8	94.4
600	Terrace (Acres)	295.6	397.6

MAP: ESKRIDGE

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	-	28.5
412	Grassed Waterway/Outlet (Acres)	6.8	16.6
600	Terrace (Acres)	87.1	87.1

Table 4. (Continued)

MAP: WAKARUSA

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	114.4	143.7
362	Diversion (Feet)	500	500
378	Pond (Quantity)	12	12
402	Dam/Floodwater Retarding (Feet)	1,000	1,000
412	Grassed Waterway/Outlet (Acres)	35	58.6
600	Terrace (Acres)	856.1	1,151.5

MAP: CARBONDALE

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	236.9	265.6
402	Dam/Floodwater Retarding (Feet)	3,400	3,900
412	Grassed Waterway/Outlet (Acres)	135.8	247.0
587	Structure for Water Control (Quantity)	1	1
600	Terrace (Acres)	1,009.8	1,638.0

Table 4. (Continued)

MAP: RICHLAND

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	113.0	206.2
378	Pond (Quantity)	6	6
412	Grassed Waterway/Outlet (Acres)	10.0	47.9
442	Irrigation System/Sprinkler (Acres)	-	133.5
600	Terrace (Acres)	546.0	752.6

MAP: OVERBROOK

Code	Description	High Altitude Total	Low Altitude Total
330	Contour Farming (Acres)	380.9	852.8
362	Diversion (Feet)	-	1,000
378	Pond (Quantity)	-	5
412	Grassed Waterway/Outlet (Acres)	18.5	33.0
600	Terrace (Acres)	691.7	890.3

Table 5. Summary of Conservation Practices for Entire Bear Creek Watershed, MS

Code	Description	High Altitude Total	Low Altitude Total
320	Irrigation Canal or Lateral (Feet)	6,388.8	6,388.8
322	Channel Vegetation (Acres)	775.1	800.8
356	Dike (Feet)	6,494.4	20,169.6
378	Pond (Acres)	-	2.51
382	Fencing (Feet)	42,504.0	66,475.2
388	Irrigation Ditch (Feet)	21,542.0	21,542.4
392	Field Windbreak (Feet)	-	2,481.6
397	Fish Pond (Commercial) (Acres)	295.21	295.21
412	Grassed Waterway (Acres)	2.3	24.1
443	Subsurface & Surface Irrigation (Acres)	2,469.7	2,469.7
580	Stream Bank Protection (Acres)	46.42	50.02
607	Surface Drainage (Feet)	-	27,720.0
608	Main Ditch (Feet)	49,156.8	383,856.0

Table 6. Summary of Conservation Practices for Bear Creek Watershed, MS, by Individual 1:24,000 Maps

MAP: MOSSY LAKE, N.W.

Code	Description	High Altitude Total	Low Altitude Total
322	Channel Vegetation (Acres)	174.4	174.4
382	Fencing (Feet)	42,504.0	55,492.8
388	Irrigation Ditch (Feet)	21,542.0	21,542.4
440 C1	Subsurface and Surface Irrigation (Acres)	1,799.2	1,799.2
580	Stream Bank Protection (Acres)	46.4	46.4
607	Surface Drainage (Feet)	-	8,500.8
608	Main Ditch (Feet)	-	44,985.6

MAP: MOSSY LAKE, S.W.

Code	Description	High Altitude Total	Low Altitude Total
322	Channel Vegetation (Acres)	293.8	293.8
382	Fencing (Feet)	-	3,484.8
397	Fish Pond (Commercial) (Acres)	34.0	34.0
412	Grassed Waterway (Acres)	2.3	12.6
440 C1	Subsurface and Surface Irrigation (Acres)	425.75	425.75
607	Surface Drainage (Feet)	-	12,196.8
608	Main Ditch (Feet)	12,196.8	187,387.2

Table 6. (Continued)

MAP: MOSSY LAKE, N.E.

Code	Description	High Altitude Total	Low Altitude Total
322	Channel Vegetation (Acres)	251.4	286.3
378	Pond (Acres)	-	2.51
392	Field Windbreak (Feet)	-	2,481.6
397	Commercial Fish Pond (Acres)	65.1	65.1
607	Surface Drainage (Feet)	-	7,022.4
608	Main Ditch (Feet)	36,960.0	117,744.0

MAP: MILESTON, N.W.

Code	Description	High Altitude Total	Low Altitude Total
322	Channel Vegetation (Acres)	46.3	46.3
356	Dike (Feet)	6,494.4	20,169.6
608	Main Ditch (Feet)	-	10,507.2

MAP: INVERNESS

Code	Description	High Altitude Total	Low Altitude Total
322	Channel Vegetation (Acres)	9.21	-
382	Fencing (Feet)	-	7,497.6
397	Commercial Fish Pond (Acres)	196.0	196.0
580	Stream Bank Protection (Acres)	-	3.6
608	Main Ditch (Feet)	-	19,219.2

Table 6. (Continued)

MAP: MOORHEAD

Code	Description	High Altitude Total	Low Altitude Total
320	Irrigation Canal or Lateral (Feet)	6,388.8	6,388.8
412	Grassed Waterway (Acres)	-	11.5
440 C1	Subsurface and Surface Irrigation (Acres)	244.8	244.8
608	Main Ditch (Feet)	-	4,012.8

and expanded to include approximate scales at which the many practices may be identified. Since it was not practical to rigorously analyze each practice under each photo or sensor type and scale, the matrix is only to be viewed as a guideline based on an experienced evaluation. Keeping this in mind, the matrix indicates that about 26 practices of the 90 (approximately 29%) can be detected at the 1:80,000 scale; approximately 45% are identifiable at the 1:30,000 scale; over 70% are detectable at the 1:15,000 scale; and in excess of 90% could be identified at scales larger than 1:10,000.

The identified conservation practices from the photographic interpretations were digitized (Figure 3) and entered into a data base for integration with soils and topographic data so that relationships could be drawn between the location of a particular practice and soils and landscape features. Generally, the relationship between conservation practices and soils was quite similar to what was indicated in suitability tables found in the soil surveys. The relationship between conservation practices and topographic location also yielded expected results, such as terraces on gently to severely sloping areas and drainage ditches on relatively flat terrain. Table 7 describes some of these relationships. Based on these types of relationships established for a particular area, probability models can be developed to indicate those areas in need of conservation practices.

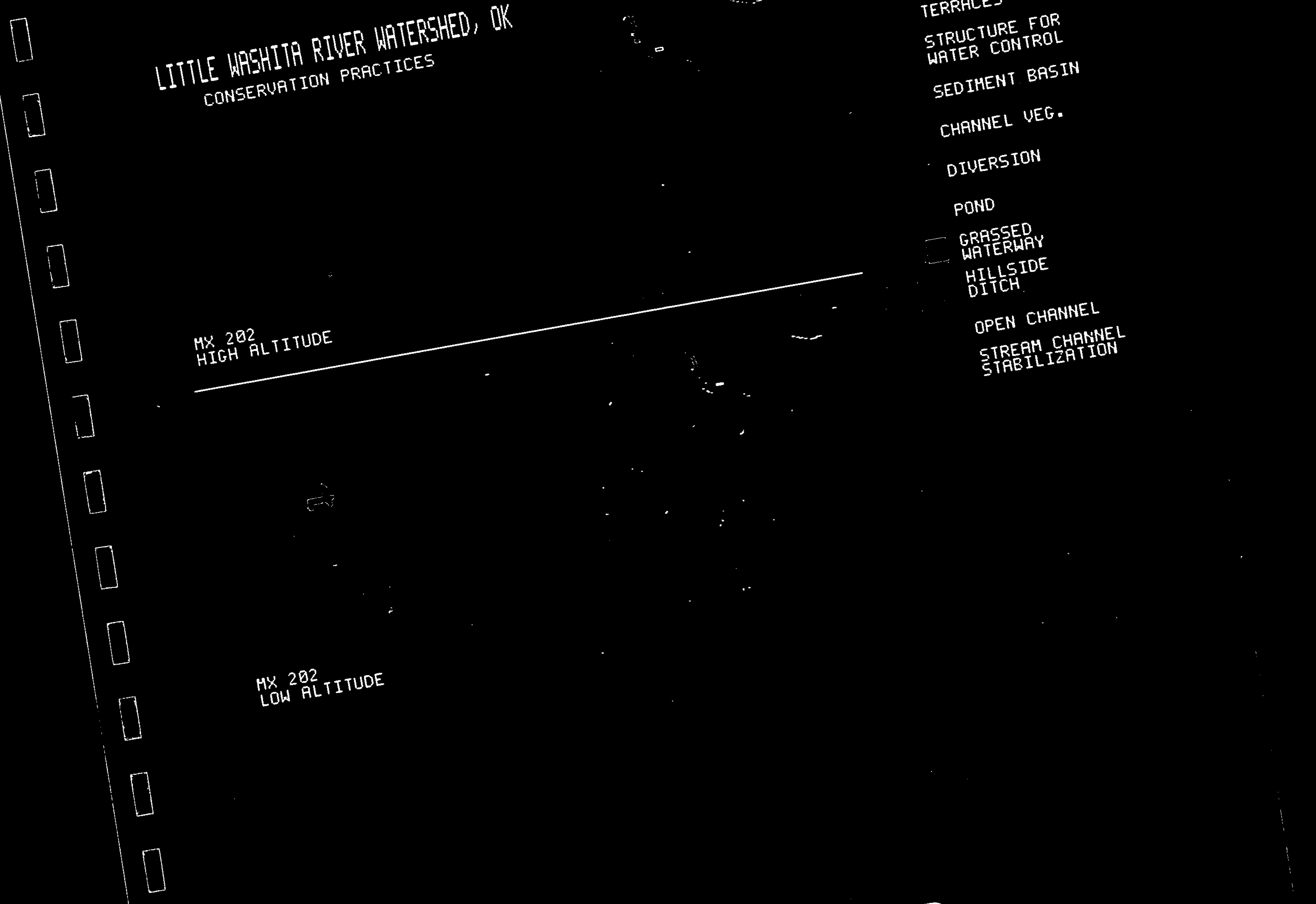


Figure 3. Digitized Conservation Practices from Photo-Interpretation of Little Washita River Watershed, Oklahoma

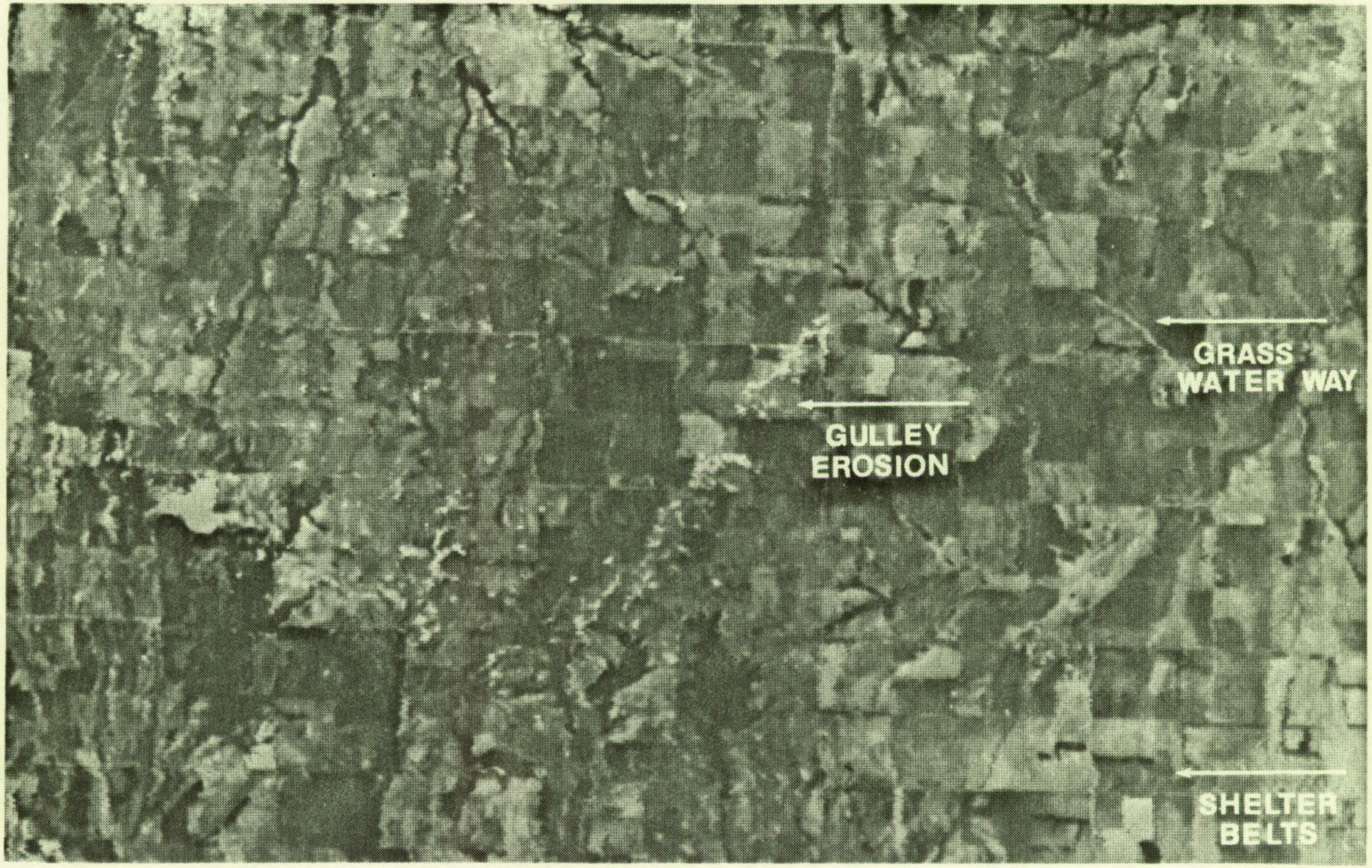
Table 7. Relationship Between Conservation Practices and Topographic Location

Conservation Practices	Topographic Location
Terraces	gentle to moderate slopes (2-8%) in cultivated areas.
Ponds	along drainage systems - for irrigation in cultivated areas; for livestock in pasture areas.
Grassed waterways	generally in areas with terraces.
Drainage ditches	relatively flat areas.
Sediment basins	along significant drainage systems, upstream from ponds.
Diversion	singular occurrences, often entering into sediment basins or ponds.
Windbreak	along field borders of broad flat to gently sloping areas in danger from wind erosion.
Center pivot irrigation	flat to gently sloping areas in need of irrigation.

Section V

IDENTIFICATION OF PRACTICES IN TM DATA

Some conservation practices were successfully detected in Thematic Mapper Simulator (Figure 4) and Thematic Mapper data (Figure 5) through visual interpretation. However, a number of existing practices are of such size and definition that these present sensors cannot detect them with great accuracy. In other situations, practices not thought to have the necessary spatial and spectral contrast to be identified (e.g., terraces) were sometimes detected due to temporary or unusual changes in contrast. In terraces, for example, such changes could be attributed to differential snow accumulations, excessive bare soil due to erosion along terraces in a vegetated field, or left-over vegetation along terrace crests in an otherwise plowed field.



THEMATIC MAPPER SIMULATOR-BAND 2-FEB. 19, 1981
LITTLE WASHITA RIVER WATERSHED - OKLAHOMA

Figure 4. Conservation Practice Visual Identification in TMS Data

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COLOR PHOTOGRAPH

Figure 5. Conservation Practice Visual Identification in TM Data

Section VI

ENHANCEMENT OF PRACTICES IN TM DATA

Following the photo interpretation and visual interpretation of TM data, special image enhancement techniques were employed in processing TM data with the hope of improving detection capabilities by highlighting patterns and properties of conservation practices. A number of studies have investigated image enhancement for purposes of cartographic feature extraction. Bajcsy and Tavakoli (1976) developed techniques to recognize roads from early satellite data. Others soon found that other linear features such as rivers could also be identified in the imagery (Montoto, 1977). Other investigators chose the improved resolution of digitized aerial photography to detect cartographic features. Fischler, et al. (1981), developed an approach based on line and edge detection operators and a knowledge of road characteristics. Benjamin and Gaydos (1984) developed a semi-automated process for the extraction of cartographic features through an initial clustering and classification of those features of interest and their subsequent refinement and vectorization.

Generally, these linear cartographic features develop when a material exhibits high spectral contrast with an adjacent material (often resulting in mixed pixels along the interface) in a patterned fashion. Finding the standard deviation of a group of pixels is a good way of defining and locating these areas of high spectral contrast. If these areas also exhibit a spatially linear pattern a filter can be employed to further delineate the features. Such was the approach used for this study.

By passing a matrix window (in this case a 7x7 window) through the data, pixel by pixel, the standard deviation of the clustered pixels in the window can be computed and that value assigned to the central pixel of the window (Module MCCS of the Earth Resources Laboratory Applications Software - Graham, et al., 1980). The process starts by clustering the center pixel (location 4,4) with the adjacent pixel that has the minimum distance in n-space, where n is the number of input data channels, from the center pixel. Each additional pixel clustered is the pixel adjacent to one or more of the previously clustered pixels having the minimum distance in n-space to the cluster mean. This pixel clustering continues until NPX (NPX is an input option of 10 in this study) pixels have been clustered. At the completion of clustering, the mean and standard deviation are multiplied by 8 and output for each channel.

This process is repeated for each pixel of the data set until an output file is derived with areas having high values (high standard deviations) between highly contrasting materials such as roads adjacent to vegetation, water bodies adjacent to soil, or two spectrally different crop types next to each other. Areas that are more spectrally homogeneous, such as within cultivated fields or water bodies, will exhibit a lower standard deviation.

Just as certain bands better classify different land covers and features, so too do these bands demonstrate higher spectral contrast by which these boundaries between land covers can be delineated. Roads, buildings, and subsequently, urban areas are defined best by the visible bands, especially the blue band (0.45-0.52 micrometer) (Figure 6, Image a). The images in Figure 6 depict the southern part of Topeka, KA, and surrounding farm land with the upper portion of the Wakarusa River cutting through the bottom of the images. The urban areas of the city and Forbes Air Force Base exhibit high standard deviation values due to the many interspersed streets and buildings (Figure 6b). Section lines, generally delimited by roads, are quite apparent. Many of the smaller dirt roads can likewise be identified, but not as clearly.

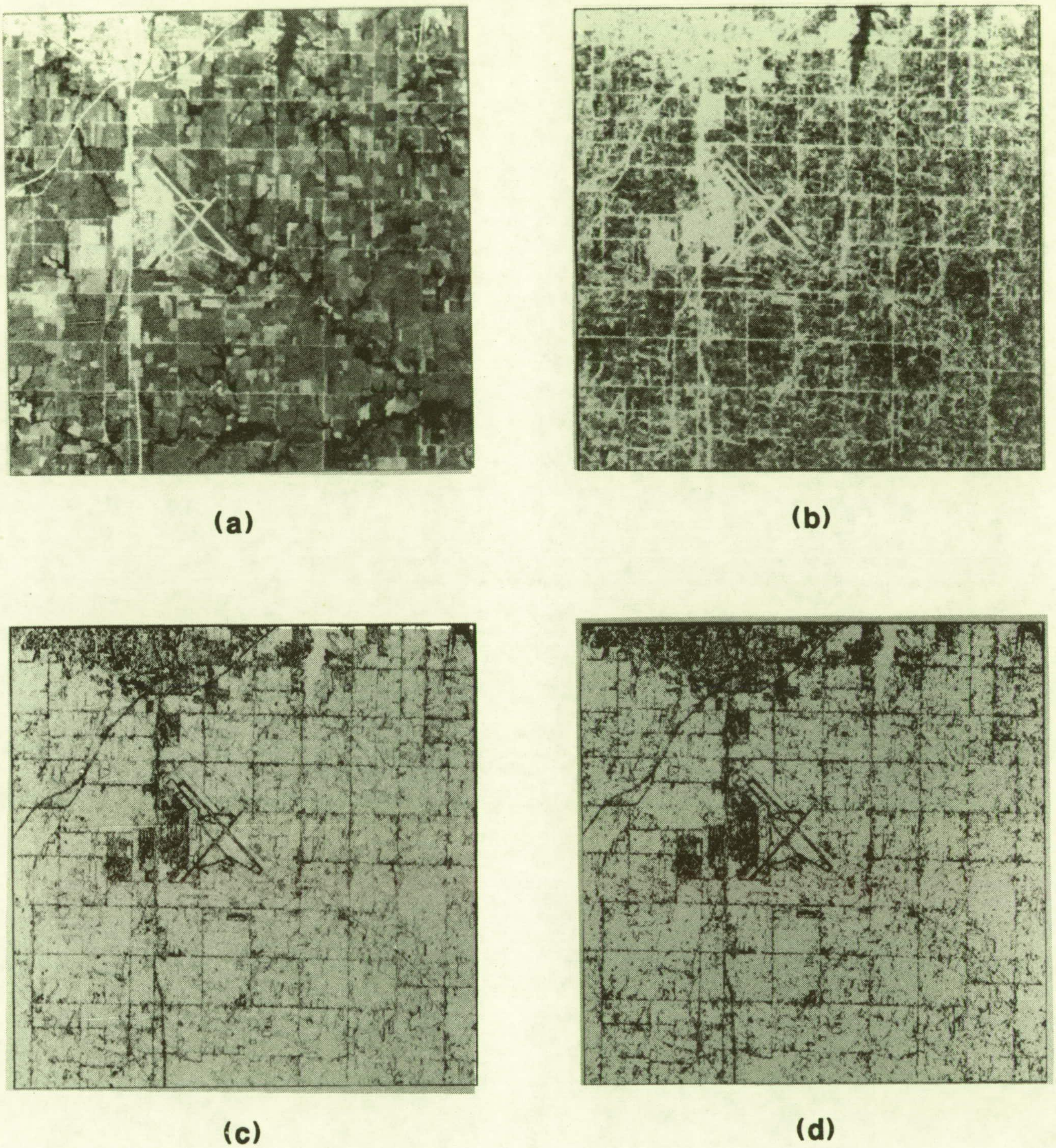

Figure 6. TM Band 1 from Topeka, Kansas

Further enhancement with a 3x3 window high-pass band filter (ELAS module FILT) can solidify the section line roads and highlight the dirt field roads better (Figure 6c). A "best cut" classification was developed by subjectively turning off (black) all the standard deviation values above a certain value which characterized linear features of significance and turning on (white) all the values below that minimum limit (Figure 6d).

Just as the blue band was good for delineating urban features, most agricultural field boundaries are delineated best in the near infrared (Band 4 - 0.76 to 0.90 micrometer) (Figure 7). Figure 8 illustrates a combination of both the standard deviation images derived from Band 1 and Band 4 in a color composite. Features exhibiting high standard deviations in Band 1 appear magenta in the new image while those features exhibiting high standard deviations in Band 4 appear green. By combining the two standard deviation images, the relationship between urban and agricultural boundaries can be viewed simultaneously.

Principal Component Analysis (Jenson & Waltz, 1979) has also shown promise as an enhancement technique. Figure 9 illustrates a composite of the first two principal components derived from the standard deviation data over a portion of the Little Washita River test site. Areas in white depict regions with low standard deviations in both components. Areas in black depict regions with high standard deviations in both components, while areas in grey illustrate those regions where standard deviations were high in only one of the first two components. By utilizing both the first and second principal component, an improved delineation of features is possible over the use of just one principal component. Details of this research in TM data enhancement are presented in an article by Pelletier (1984).

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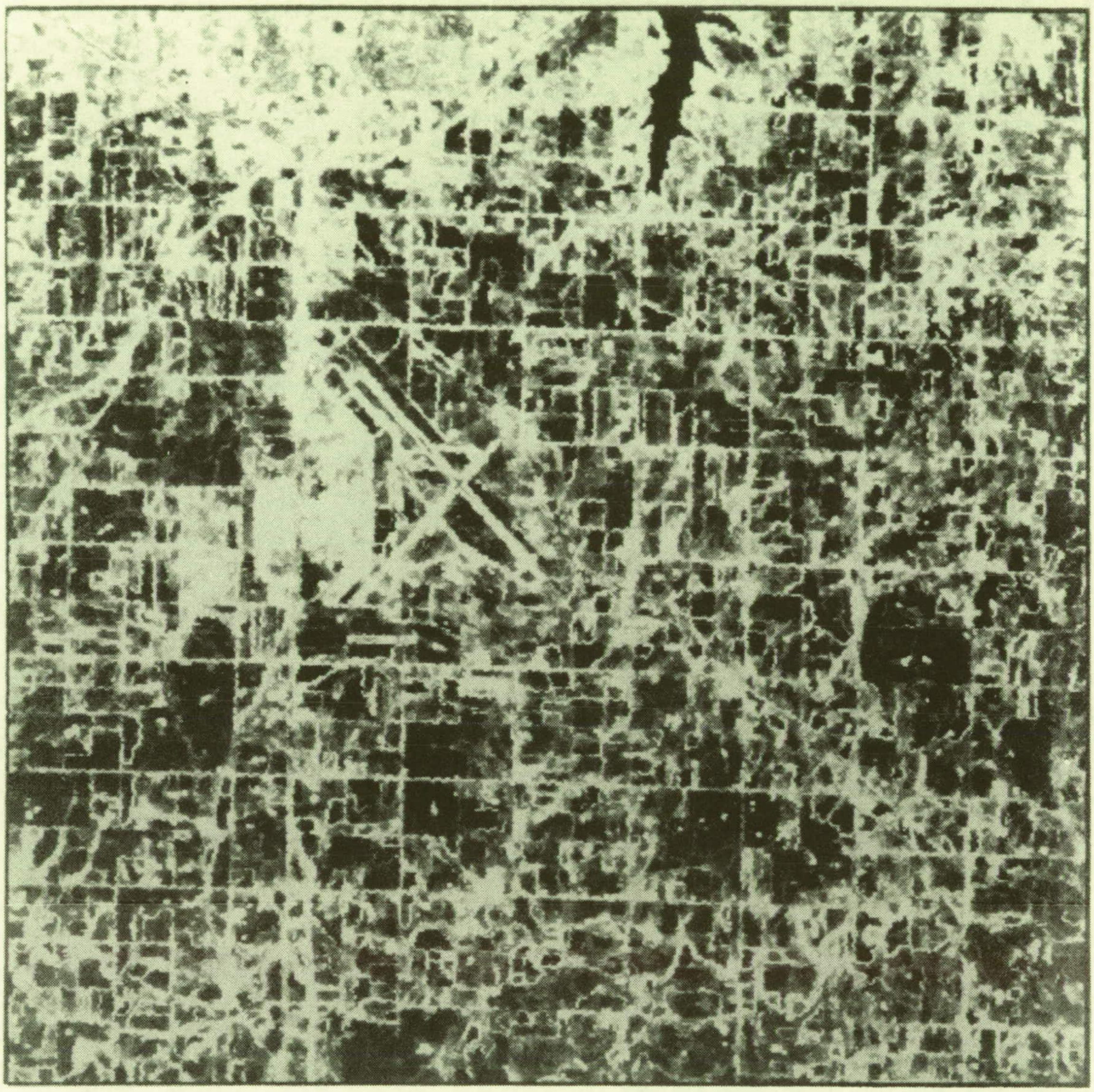


Figure 7. TM Band 4 Standard Deviation Image from Topeka, Kansas

Figure 8. Color Composite of Standard Deviations from TM Bands 1 (Magenta -- Man-Made) and 4 (Green -- Agriculture)

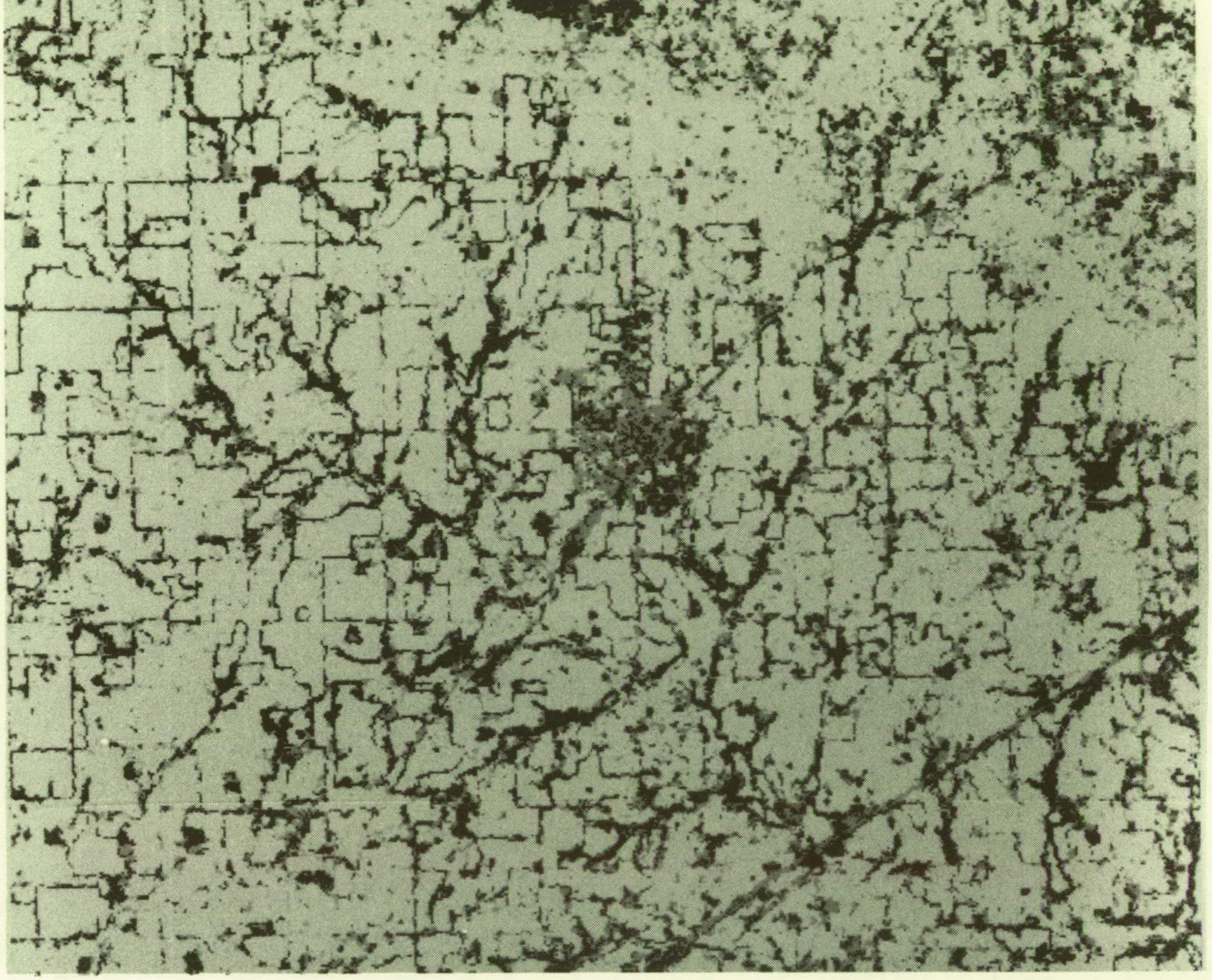


Figure 9. First and Second Principal Component Combination "Best Cut" Classification from TM Data for Headwater Region of Little Washita River Watershed in Oklahoma

Though these enhancement procedures were still unable to delineate conservation practices, such as terraces in this scene, they did delineate features of general cartographic importance. For those other practices nearing TM resolution, data acquisition season may be important for spectral contrast (e.g., a time of year when a grassed waterway is surrounded by a plowed field). Spectral variability within a mono-cultured field may sometimes be indicative of the presence of terraces but other factors such as weed infestations or disease could also be responsible. Unfortunately, with the enhancement procedures tried in this study, most conservation practices, if visible at all, were indistinguishable from the "noise" in the scene and therefore could not be delineated and extracted on an automated basis.

Section VII

ENHANCEMENT OF PRACTICES IN TIMS DATA

Although research in linear feature identification and cartographic extraction has met with some success and continues to be studied, most studies of this kind have been limited to the reflective portion of the spectrum. It is worthwhile to consider what information may be obtained from the thermal infrared region that is not available in the reflective region. Terrestrial surfaces including soil, water, vegetation, and man-made materials exhibit different thermal spectral responses (Buettner, 1965). These differences may be of aid in delineating features such as roads, vegetated fence rows, and water bodies when they display a sharp contrast with adjacent but different surface types. Variations in moisture content, texture, bulk density, and pore space, quite evident in bare fields, are, in large part, responsible for influencing the remotely sensed thermal spectral response of soil (Meyers and Heilman, 1968). These variations may be of further aid in delineating more subtle features such as terraces, drainage patterns, and erosion gullies.

In order to investigate the potential for thermal data in the identification of conservation practices, afternoon and predawn data of three spatial resolutions (5, 10, and 30 meters) were acquired over a highly agricultural area in southeast Alabama. All data were processed with ELAS using the same general procedures described for the processing of TM data in the previous section. The Thermal Infrared Multispectral Scanner (TIMS) has a spectral range of 8.2-12.2 micrometers covered by six bands (8.2-8.6, 8.6-9.0, 9.0-9.4, 9.4-10.2, 10.2-11.2, and 11.2-12.2 micrometers). The sensor has an Instantaneous Field of View (IFOV) of 2.5 milliradians, a total field of view of 76^{o}, and a ground resolvable temperature of approximately 0.2^{o}C depending on the band.

Figure 10 displays TIMS Bands 1, 3, 5, and 6, which illustrate the greatest across-band range of the six bands in spectral response. Of all individual bands, Band 5 exhibits the greatest within-band intensity range and least noise, which serves to highlight conservation practices and other linear features best. Erosional gullies appear bright in Bands 5 and 6 while they appear dark in Bands 1 and 3 due to the high quartz absorption of the Restrahlen bands in this spectral region. Terraces are also quite evident in all the bands due to a moisture differential in the soil (dry crests vs. moister troughs), altering spectral response either directly from the bare soil itself, or indirectly through a moisture stress type of effect on the vegetated canopy.

Due to the influence from multiple bands, the first principal component (PC1), in general, differentiates all surface features much better than any single band (Figure 11, Image a). Erosion gullies, however, stand out better in PC2 than PC1. Figure 11b illustrates the application of four different high-pass filters on the same segment of data. Filter B is quite similar to Filter A but B has a greater dynamic range by which features may be differentiated from noise. Filter C generates strong features; however, many are "noise." Filter D also enhances much noise. Figure 11c demonstrates Filter B applied to PC1 with a "best cut" classification of all filter values above "18." Figure 11d demonstrates Filter B similarly applied for a classification of all filter values above "10."

The afternoon data were acquired approximately two hours after solar noon at a time when surface soil temperature is at its maximum. The predawn data were acquired when surface soil temperature was at its minimum. Acquiring data at these two different times allows for the acquisition of different

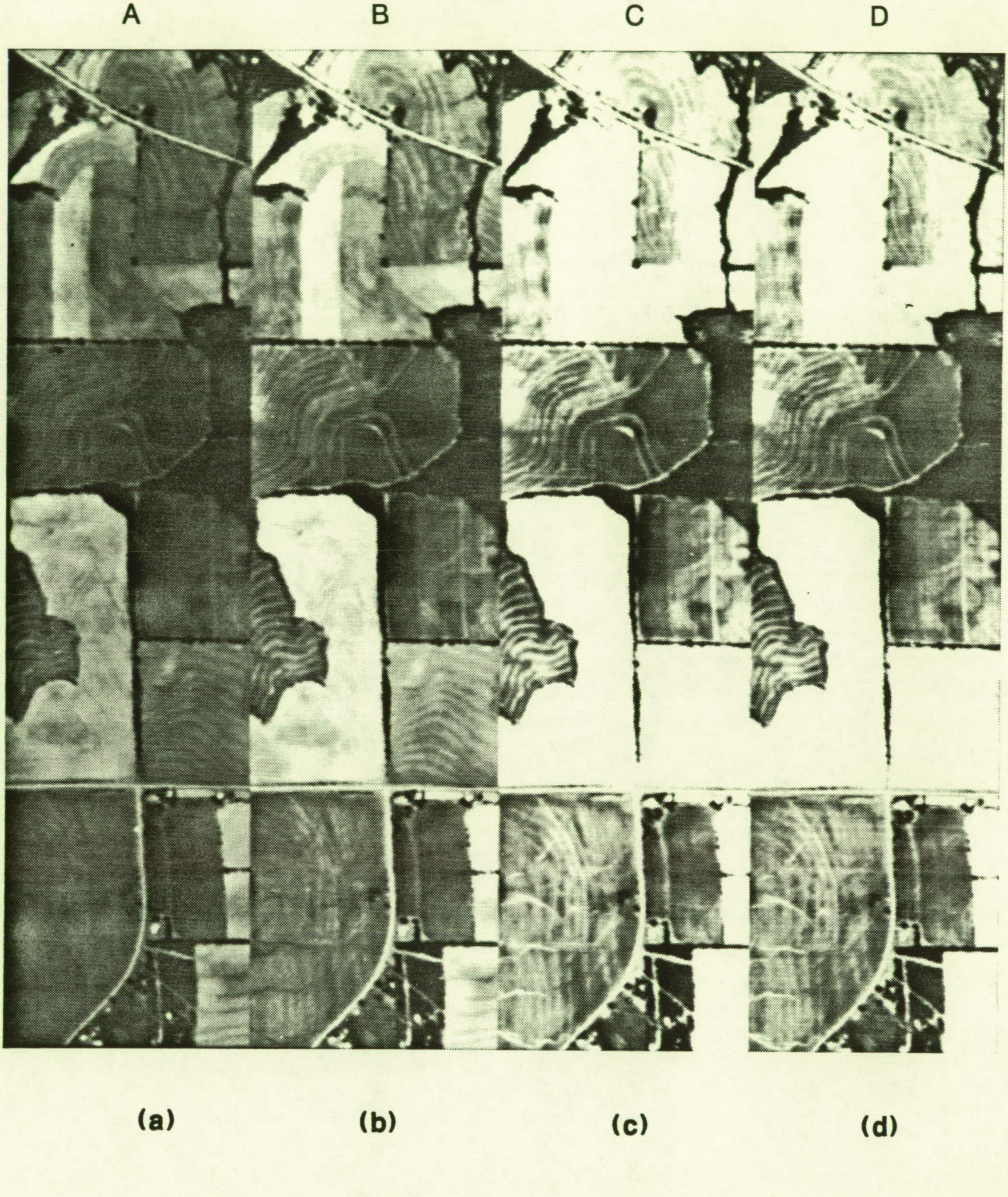
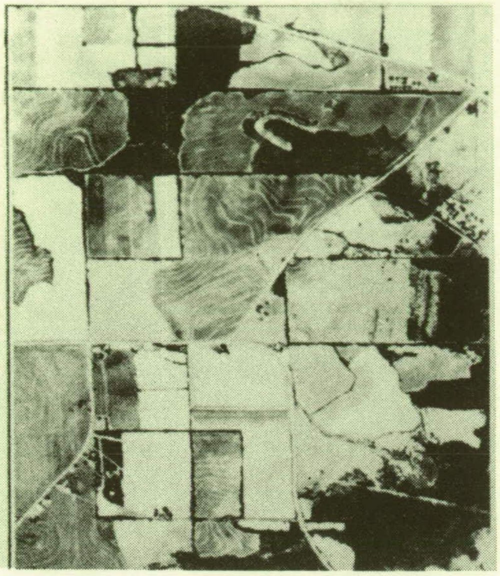
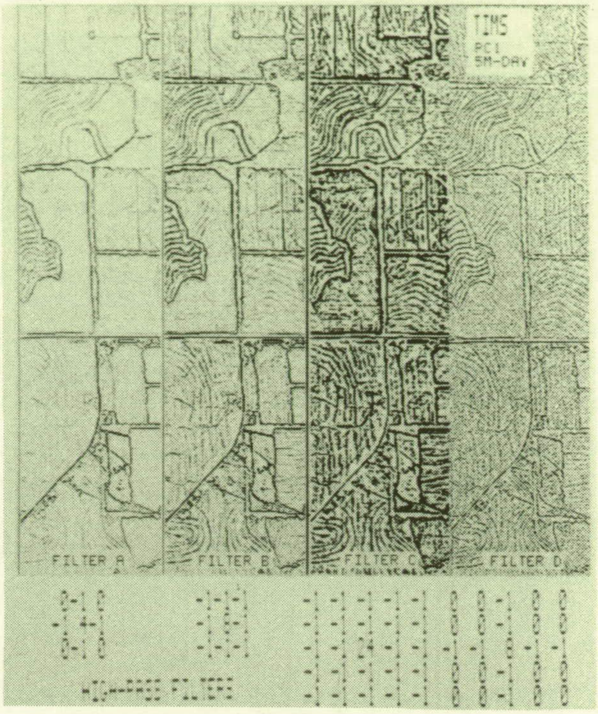


Figure 10. TIMS Raw 5-Meter Afternoon Data

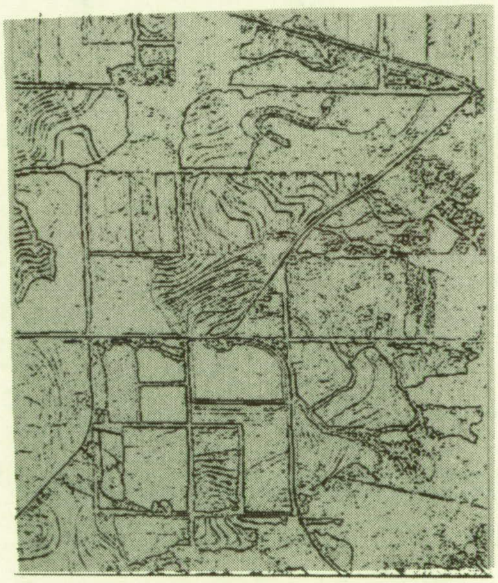


(a)



(b)

(c)



(d)

Figure 11. TIMS Data First Principal Component and Derivative Filtered Images

types of information as well. PC1 from the predawn data highlights those terraces which were only weakly identifiable in the day imagery (Figure 12, Image a). It also highlights roads and water bodies very well due to their comparative warmth. Figure 12c illustrates the extracted roads and water body boundaries from filtered data. Whereas roads, field boundaries, and terraces are enhanced at the same time during processing of the afternoon set, the roads and water bodies can be extracted separately in the predawn set. PC2 from the predawn set illustrates many of the same features that are highlighted in the afternoon PC2, notably the erosional gullies (Figure 12b). These gullies and other erosional areas can be extracted independently from the rest of the image. By overlaying the extracted roads, water body boundaries, and erosional features over the extracted classification from the afternoon set, the terraces and field boundaries can be extracted separately. That way only the features of interest can be further evaluated.

All of the TIMS data discussed thus far have been 5m in resolution. Almost all the features visible in the 5m data are maintained in the 10m data (Figure 13, Images a and c). Roads, field boundaries, and terraces are still quite distinguishable, although the overall image has lost some definition. The 30m data maintain only basic field outlines but have lost all definition of terraces, which generally have field spacings less than 30m (Figure 13b and d). Details of this research in linear feature enhancement from TIMS data are presented in an article by Pelletier (1985).

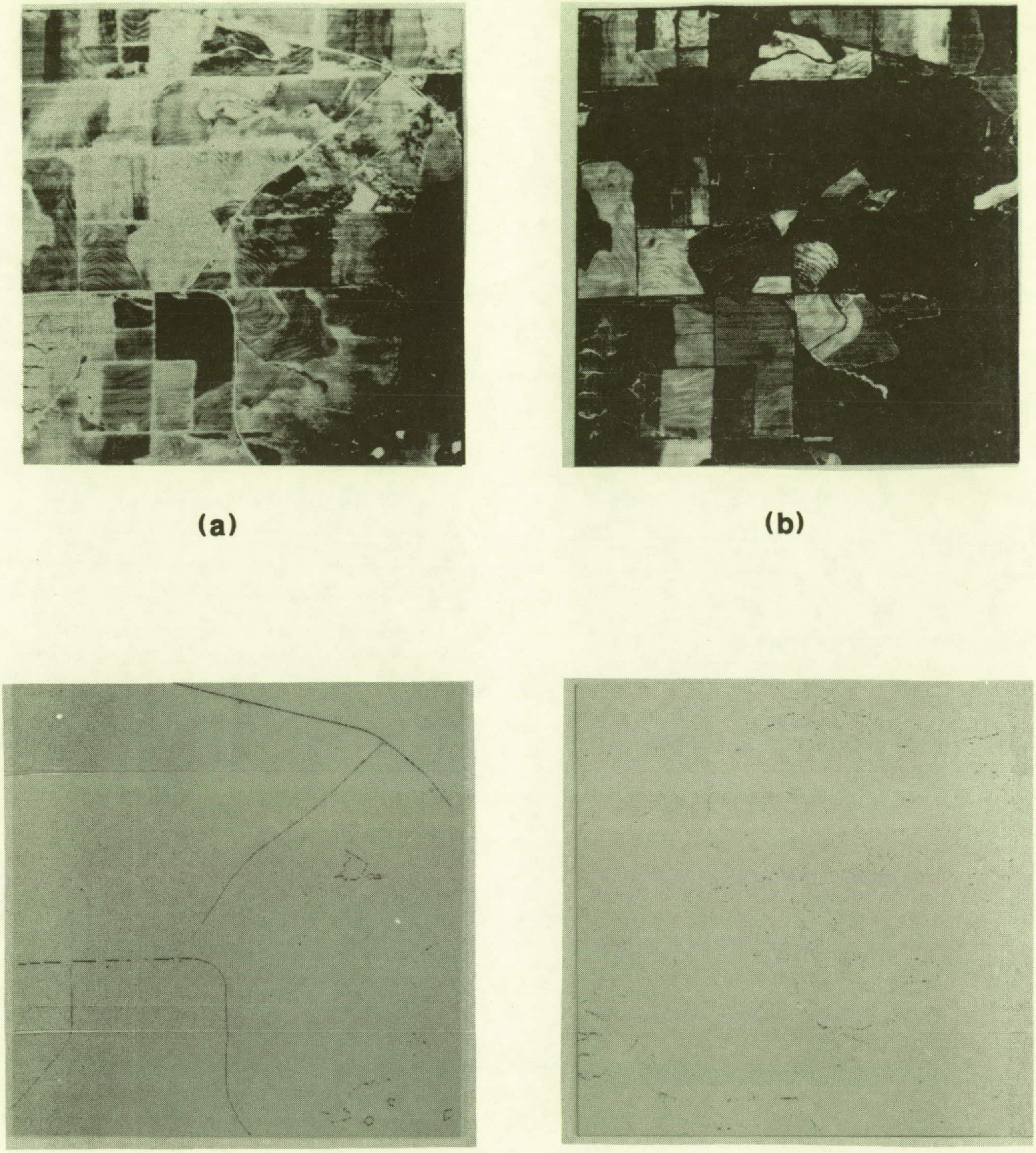


Figure 12. TIMS 5-Meter Predawn Data

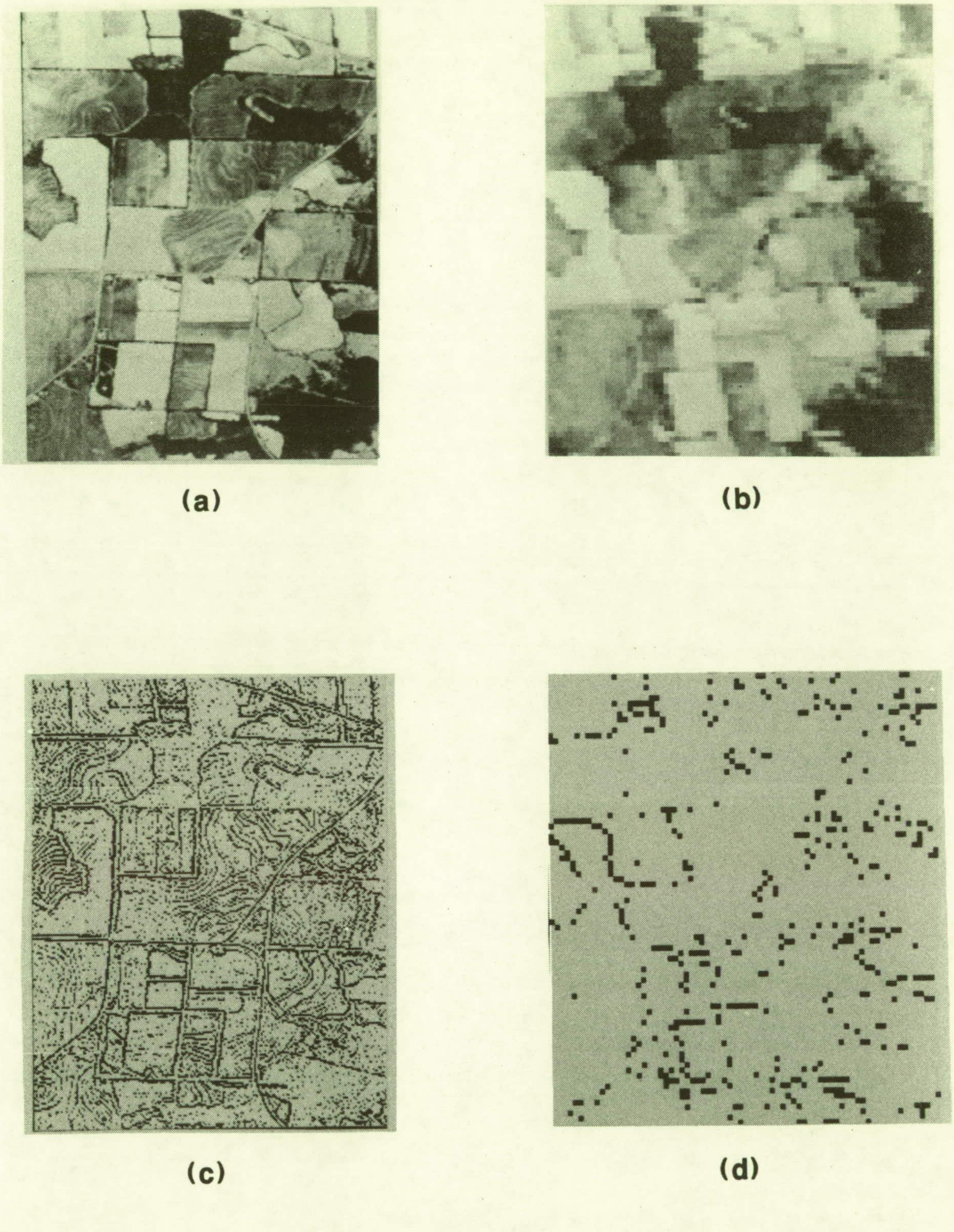


Figure 13. TIMS 10-Meter and 30-Meter Afternoon Data Comparison

Section VIII

SUMMARY AND DISCUSSION

The use of remotely sensed data shows promise in the identification of conservation practices. Color infrared aerial photography, especially at low altitudes (about 1:30,000 scale), was very useful in identifying conservation practices. Though not all 109 practices listed could be determined, approximately 24 of the most common and most important ones were located in the photography. Many more may also be identified with the aid of supporting ground data. Visual interpretation of TM data for conservation practices revealed the presence of a small number of them. Automated enhancement procedures did a good job of delineating roads, water bodies, and the urban/agriculture interface, but were unable to definitively distinguish and delineate conservation practices consistently in the TM data analyzed.

Thermal data from the TIMS at 5m showed great utility for identifying features such as terraces, drainage ditches, or grassed waterways due to contrast in thermal response by properties such as moisture content. TIMS data collected at 10m still exhibited a high level of utility but 30m TIMS data, much like 30m TM data, lost all definition of such small conservation features. Based on these findings from the very high resolution TIMS data and aerial photography studied, improved resolution of TM type reflective data (perhaps the 10m resolution of SPOT) should prove useful for the identification of conservation practices.

In addition to identification purposes for the National Resource Inventory, features derived from such data enhancement procedures of TM and thermal data can be used to update computerized USDA sampling frame units and to delineate man-induced slope breaks caused by terraces, ditches, roads, and hedgerows. The influence of these man-induced slope breaks, calculated in with natural landscape topography, could be important in determining more accurate slope values for soil erosion models than are presently available with many topographic models.

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APPENDIX

PHOTO INTERPRETIVE MATRIX
OF CONSERVATION PRACTICES

Table A-1. Conservation Practices Photo-Interpretive Matrix

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE	PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	.5K (.5 ft / - m)	1K (1 ft / - m)	5K (2 ft / 1 m)	10K (5 ft / 2 m)	15K (8 ft / 3 m)	20K (10 ft / 4 m)	30K (15 ft / 5 m)	40K (20 ft / 7 m)	50K (25 ft / 8 m)	60K (30 ft / 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
560	Access Road	A	1	1	2	3	P	P	P	P	P	P	P	P	P	P	P	D	-	R	Constructed as part of a conservation program, min. width 10 ft. one way, 15 ft. two way. Provide access to farms, fields, etc. from county, state, or township highway to such enterprises.
310	Bedding	A	1	1	2	3	P	P	P									R	R	D	Elevating surface of flat land into broad, low ridges separated by shallow, dead parallel furrows. Used in poorly drained areas and nearly flat areas having slowly permeable soils.
314	Brush Management	B	1	1	2	3	P	P	P	P	P	P						D	D	D	Managing brushland by burning, chemical, biological or mechanical means to improve plant cover, habitat values, etc.
322	Channel Vegetation	B	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	R	R	-	Planting of grasses etc. to maintain channel banks, berms, spoil and associated areas; applies to Codes 400, 404, 582, 584, 580, and 607-B.

Column groups: PHOTO TYPE (Color, Color IR, B&W Pan, B&W IR); APPROXIMATE MINIMUM DETECT. SIZE* (in feet / in meters) by PHOTOGRAPHY SCALE.

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

Interpreter Experience Level A - Novice; B - Experienced

Photo Type Desirability Level 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE	PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	PHOTOGRAPHY SCALE .5K (approx. min. detect. size* .5 ft / - m)	1K (1 ft / - m)	5K (2 ft / 1 m)	10K (5 ft / 2 m)	15K (8 ft / 3 m)	20K (10 ft / 4 m)	30K (15 ft / 5 m)	40K (20 ft / 7 m)	50K (25 ft / 8 m)	60K (30 ft / 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
324	Chiseling and Subsoiling	B	1	1	2	2	P	P	P									D	R	D	Loosening the soil without inverting to shatter restrictive layers below normal plow depth. Need to see in progress.
326	Clearing and Snagging	B	1	1	2	2	P	P	P	P	P	P						D	-	D	Removing snags, drifts, or other obstructions from a natural or excavated channel.
397	Commercial Fish Pond	A	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	-	-	R	A small body of water established to produce fisheries products for commercial purposes. Ponds in rice areas could be a problem without supporting data.
328	Conservation Cropping	B	1	1	2	2	P	P	P									-	R	D	Growing crops using a combination of cultural and management measures including rotations that contain grasses and legumes.

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE	PRACTICE	PHOTO TYPE: INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	APPROXIMATE MINIMUM DETECT. SIZE*: .5 ft / - m; PHOTOGRAPHY SCALE .5K	1 ft / - m; 1K	2 ft / 1 m; 5K	5 ft / 2 m; 10K	8 ft / 3 m; 15K	10 ft / 4 m; 20K	15 ft / 5 m; 30K	20 ft / 7 m; 40K	25 ft / 8 m; 50K	30 ft / 10 m; 60K	80K	STEREO SCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
329	Conservation Tillage	B	1	1	2	2	P	P	P									D	-	D	Non-inversion tillage that retains protecting residue mulch on surface. Includes no-tillage, strip tillage, stubble mulching. Need to see in operation.
330A	Contour Farming	A	1	1	1	2	P	P	P	P	P	P	O	P	P	P	O	R	D	-	Plowing, planting, cultivating done on the land contour.
330B	Contour Orchard	A	1	1	2	2	P	P	P	P	P	P	P	P	P	P		R	R	D	Planting orchards, vineyards, small fruits on the land contour.
340	Cover and Green Manure Crop	B	1	1	2	2	P	P	P	P								D	R	D	Close growing grasses, legumes, or small grain grown primarily for seasonal protection and soil improvement.
342	Critical Area Planting	B	1	1	2	2	P	P	P	P								R	R	D	Planting vegetation such as trees, shrubs, vines, grasses, legumes on highly erodible surfaces; eg., dams, levees, mine spoils, surface mines.

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE PRACTICE	PHOTO TYPE: INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	APPROXIMATE MINIMUM DETECT. SIZE*: .5 (in feet) / - (in meters) / .5K (PHOTOGRAPHY SCALE)	1 / - / 1K	2 / 1 / 5K	5 / 2 / 10K	8 / 3 / 15K	10 / 4 / 20K	15 / 5 / 30K	20 / 7 / 40K	25 / 8 / 50K	30 / 10 / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
344 Crop Residue Use	B	1	1	2	2	P	P	P									R	-	D	Use of plant residue to protect cultivated fields during critical erosion periods.
348 Dam, Diversion	B	1	1	2	2	P	P	P	P								R	-	-	Built to direct part or all the water from a waterway or stream into a different water course, stream, ditch, or water-spreading system. Does not apply to codes 362, 400, 402, or 410.
402 Dam, Floodwater Retarding	A	1	1	1	2	P	P	P	P	P	P	P	P	P	P	P	R	-	D	A single-purpose dam designed for temporary storage of floodwater and for its controlled release (spill-ways, conduit).
349 Dam, Multiple Purpose	A	1	1	2	2	P	P	P	P	P	P	P	P	P	P	P	R	-	D	Constructed across a natural stream that has designed reservoir storage capacity for two or more purposes; eg., floodwater retardation, municipal supply, recreation.

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

CODE	PRACTICE	PHOTO TYPE: INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	PHOTOGRAPHY SCALE .5K (.5 ft; - m)	1K (1 ft; - m)	5K (2 ft; 1 m)	10K (5 ft; 2 m)	15K (8 ft; 3 m)	20K (10 ft; 4 m)	30K (15 ft; 5 m)	40K (20 ft; 7 m)	50K (25 ft; 8 m)	60K (30 ft; 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
352	Deferred Grazing	B	1	1	2	2	P	P	P	P	P							R	R	R	Postponed grazing or resting grazing land for a prescribed period. Supporting data critical.
356	Dike	A	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	R	D	-	Constructed of earth or other suitable materials to protect land against overflow or inundation.
362	Diversion	A	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	R	-	-	A channel with a supporting ridge on the lower side constructed across slope to divert excess water from areas to sites where it can be used or disposed of safely.
462	Drainage Land Grading	B	1	1	2	2	P	P	P	P								R	-	R	Reshaping the surface of land to be drained to planned grades. Supporting documents critical.
365	Emergency Tillage	B	1	1	1	2	P	P	P	P								R	R	R	Roughening the soil surface to temporarily protect cultivated land against soil loss during high wind periods (listing, ridging, duck footing, or chiseling).

APPROXIMATE MINIMUM DETECT. SIZE* given in feet and in meters for each photography scale.

Interpreter Experience Level A - Novice
B - Experienced

Photo Type Desirability Level 1 - most
2 - acceptable
3 - least

Supporting Data
R - required
D - desired
- - not necessary

Practice Identification
O - actually observed
P - predicted

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

Interpreter Experience Level A - Novice
B - Experienced

Photo Type Desirability Level 1 - most
2 - acceptable
3 - least

Supporting Data
R - required
D - desired
- - not necessary

Practice Identification
0 - actually observed
P - predicted

CODE	PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	PHOTOGRAPHY SCALE .5K (APPROX. MIN. DETECT. SIZE* .5 ft / - m)	1K (1 ft / - m)	5K (2 ft / 1 m)	10K (5 ft / 2 m)	15K (8 ft / 3 m)	20K (10 ft / 4 m)	30K (15 ft / 5 m)	40K (20 ft / 7 m)	50K (25 ft / 8 m)	60K (30 ft / 10 m)	80K	STEREO SCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
380	Farmland and Feed Lot Windbreak	A	1	1	1	2	P	P	P	P	P	P	P	P	P	P	P	R	-	-	A belt of trees to protect soil resources, retain snow, prevent wind damage, provide livestock shelter.
382	Fencing	A	1	1	1	2	P	P	P	P	P	P	O	P	P	P	O	R	-	D	Enclosing or dividing an area with a suitable structure to serve as a barrier to livestock, big game, people.
386	Field Barrier	A	1	1	1	2	P	P	P	P	P							D	D	-	A strip of perennial vegetation planted at the edge of fields or by converting it from trees to herbaceous vegetation or shrub.
392	Field Windbreak	A	1	1	1	2	P	P	P	P	P	P	O	P	P	P	O	R	R	D	A strip of trees established in or adjacent to a field to reduce soil blowing, retain snow or protect crops, livestock, orchards.
394	Firebreak	A	1	1	2	2	P	P	P	P	P	P	P	P	P	P	P	R	-	R	A strip of bare land or fire retarding vegetation.

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Table A-1. (continued)

Interpreter Experience Level A - Novice
B - Experienced

Photo Type Desirability Level 1 - most
2 - acceptable
3 - least

Supporting Data
R - required
D - desired
- - not necessary

Practice Identification
O - actually observed
P - predicted

CODE	PRACTICE	PHOTO TYPE: INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	APPROXIMATE MINIMUM DETECT. SIZE* .5 (in feet) / - (in meters) / PHOTOGRAPHY SCALE .5K	1 / - / 1K	2 / 1 / 5K	5 / 2 / 10K	8 / 3 / 15K	10 / 4 / 20K	15 / 5 / 30K	20 / 7 / 40K	25 / 8 / 50K	30 / 10 / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
398	Fish Raceway	B	1	1	2	2	P	P	P									R	-	R	A channel with continuous water flow constructed to produce fish. Supporting data critical.
395	Fish Stream Improvement	B	1	1	2	2	P	P	P									R	R	R	Improving a stream channel to make a new fish habitat or to enhance existing habitat. Supporting data critical.
399	Fish Pond Management	B	1	2	2	2	P	P	P									R	-	R	Developing or improving impounded water to produce fish for domestic use or recreation. Supporting data critical.
400	Floodwater Diversion	A	1	1	2	2	P	P	P	P	P	P	P	P				R	-	D	A graded channel with supporting embankment or dike on lower side constructed on lowland subject to flood to divert floodwater.
404	Floodway	A	1	1	1	2	P	P	P	P	P	P	P	P	P	P	P	R	D	D	A channel, usually bounded by dikes, used to carry floodwater from a side drainage across a flood plain into a main stream.

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Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE	PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	APPROXIMATE MINIMUM DETECT. SIZE*: .5 ft / - m / Photography scale .5K	1 ft / - m / 1K	2 ft / 1 m / 5K	5 ft / 2 m / 10K	8 ft / 3 m / 15K	10 ft / 4 m / 20K	15 ft / 5 m / 30K	20 ft / 7 m / 40K	25 ft / 8 m / 50K	30 ft / 10 m / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
410	Grade Stabilization Structure	B	1	1	1	2	P	P	P	P								R	-	D	A structure to stabilize the grade or to control head cutting in natural or artificial channels, prevent the formation or advance of gully erosion; eg., earthen dam.
412	Grassed Waterway or Outlets	B	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	R	D	D	A natural or constructed waterway or outlet, shaped or graded and established in suitable vegetation for the safe disposal of runoff. Provides disposal in terraces, diversions, or natural concentrations.
411	Grasses and Legumes in Rotation	B	1	1	2	2	P	P	P	P	P							R	R	D	Establishing grasses and legumes or a mixture of them and maintaining the stand for a number of years to produce hay, silage, grazing. Supporting data critical.
548	Grazing Land, Mechanical Treatment	B	1	1	2	2	P	P	P	P								-	R	D	Renovating, contour furrowing, pitting, or chiseling native grazing mechanically.

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Table A-1. (continued)

CODE	PRACTICE	INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	.5K (.5 ft; - m)	1K (1 ft; - m)	5K (2 ft; 1 m)	10K (5 ft; 2 m)	15K (8 ft; 3 m)	20K (10 ft; 4 m)	30K (15 ft; 5 m)	40K (20 ft; 7 m)	50K (25 ft; 8 m)	60K (30 ft; 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
561	Heavy Use Protection Area	B	1	1	2	2	P	P	P	P	P	P						D	-	D	Protecting heavily used areas by establishing vegetative cover, by surfacing with suitable materials, or by installing suitable structures. Tourist centers, roadside parks, etc.
422	Hedgerow Planting	A	1	1	2	2	P	P	P	P	P	P	P	P	P	P	P	R	D	-	A living fence of shrubs or trees in, across, or around a field.
423	Hillside Ditch	A	1	1	2	2	P	P	P	P	P	P	O					R	-	R	A channel having a supporting ridge on the lower side constructed across the slope at definite vertical intervals and gradient.
320	Irrigation Canal or Lateral	A	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	D	D	D	A permanent irrigation canal or lateral constructed to convey water from source of supply to one or more farms.
388	Irrigation Field Ditch	A	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	R	-	-	A permanent irrigation ditch constructed to convey water from the source of supply to a field or fields in a farm distribution system.

Column heads: PHOTO TYPE (INTERP. LEVEL, COLOR, COLOR IR, B&W PAN, B&W IR); APPROXIMATE MINIMUM DETECT. SIZE* (in feet) / (in meters); PHOTOGRAPHY SCALE.

Interpreter Experience Level A - Novice
B - Experienced

Photo Type Desirability Level 1 - most
2 - acceptable
3 - least

Supporting Data
R - required
D - desired
- - not necessary

Practice Identification
O - actually observed
P - predicted

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

CODE	PRACTICE	INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	.5K (.5 ft; - m)	1K (1 ft; - m)	5K (2 ft; 1 m)	10K (5 ft; 2 m)	15K (8 ft; 3 m)	20K (10 ft; 4 m)	30K (15 ft; 5 m)	40K (20 ft; 7 m)	50K (25 ft; 8 m)	60K (30 ft; 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
464	Irrigation Land Leveling	B	1	1	2	1	P	P	P	P	P							D	R	R	Reshaping the surface of the land to be irrigated to planned grades. Essential to have engineer plans, seasonal data.
552	Irrigation Pit or Regulating Reservoir																				Unable to determine.
436	Irrigation Storage Reservoir	B	1	1	2	2	P	P	P	P	P	P	P					D	-	-	An irrigation structure made by constructing a dam.
440	Irrigation System, DRIP																				Unable to determine.
440B1	Irrigation System Sprinkler	B	1	1	2	2	P	P	P	P	P	P						R	R	D	A planned system in which all necessary facilities are installed for efficiently applying water by means of perforated pipes or nozzles operated under pressure.

Column groups: PHOTO TYPE (Interp. Level, Color, Color IR, B&W Pan, B&W IR); APPROXIMATE MINIMUM DETECT. SIZE* (in feet) / (in meters) / PHOTOGRAPHY SCALE.

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

Approximate minimum detect. size* is given in feet and in meters for each photography scale.

CODE	PRACTICE	INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	.5K (.5 ft; - m)	1K (1 ft; - m)	5K (2 ft; 1 m)	10K (5 ft; 2 m)	15K (8 ft; 3 m)	20K (10 ft; 4 m)	30K (15 ft; 5 m)	40K (20 ft; 7 m)	50K (25 ft; 8 m)	60K (30 ft; 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
443	Irrigation System Surface & Subsurface	A	1	1	1	2	P	P	P	P	P	P	O	P	P	P	O	D	D	D	A planned system where all necessary control structures have been installed for efficient distribution of water by furrows, borders, contour levees, contour ditches, or subsurface means. Unable to determine subsurface.
447	Irrigation System Tailwater Recovery	B	1	1	2	2	P	P	P	P								R	-	D	A facility to collect, store, and transport tailwater for reuse in farm distribution system, includes pick-up ditches, sumps, pits, pipelines. Return facilities difficult to detect.
430	Irrigation Water Conveyances	A	1	1	2	2	P	P	P	P	P	P	P	P				-	-	R	A system of ditches, pipelines for conveying water to areas of need. Unable to determine linings, types of pipelines, high vs. low pressure, underground.
449	Irrigation Water Management																				Unable to determine.

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Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	COLOR IR	B&W PAN	B&W IR	APPROXIMATE MINIMUM DETECT. SIZE*: .5 (in feet) / - (in meters) / PHOTOGRAPHY SCALE .5K	1 / - / 1K	2 / 1 / 5K	5 / 2 / 10K	8 / 3 / 15K	10 / 4 / 20K	15 / 5 / 30K	20 / 7 / 40K	25 / 8 / 50K	30 / 10 / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
460 Land Clearing	A	1	1	2	2	P	P	P	P	P	P	P	P				R	D	D	Removing trees, stumps, and other vegetation from wooded areas.
466 Land Smoothing	B	1	1	2	2	P	P	P	P								R	-	D	Removing irregularities on land surface by use of special equipment.
468 Lined Waterway	A	1	1	1	2	P	P	P	P	P	P						D	-	R	Waterway or outlet having an erosion resistant lining of concrete, stone.
472 Livestock Exclusion	A	1	1	2	2	P	P	P	P	P							-	-	D	A means of excluding livestock (fence). Not applicable to pastures/feed lots.
478 Minimum Tillage	A	1	1	1	2	P	P	P	P	P							-	D	D	Limiting the number of cultural operations to those properly timed and essential to produce a crop, prevent soil damage.
482 Mole Drain																				Unable to determine.

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Table A-1. (continued)

Interpreter Experience Level A - Novice
B - Experienced

Photo Type Desirability Level 1 - most
2 - acceptable
3 - least

Supporting Data
R - required
D - desired
- - not necessary

Practice Identification
0 - actually observed
P - predicted

CODE PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	APPROXIMATE MINIMUM DETECT. SIZE*: .5 ft / - m; PHOTOGRAPHY SCALE: .5K	1 ft / - m; 1K	2 ft / 1 m; 5K	5 ft / 2 m; 10K	8 ft / 3 m; 15K	10 ft / 4 m; 20K	15 ft / 5 m; 30K	20 ft / 7 m; 40K	25 ft / 8 m; 50K	30 ft / 10 m; 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
484 Mulching	B	1	1	2	2	P	P	P	P	P							-	-	R	Applying plant residue produced elsewhere to the soil surface; practically need to see operation in progress.
500 Obstruction Removal	A	1	1	2	2	P	P	P	P	P							-	-	D	Disposing of rock, stone, hedges, fence rows, and filling gullies, abandoned roads to facilitate layout of crops, land smoothing, etc.
582 Open Channel	A	1	1	1	2	P	P	P	P	P	P	O					D	-	-	Constructing or improving a channel, either natural or artificial, in which water flows freely.
510 Pasture and Hayland Mgmt.																				Unable to determine.
516 Pipeline																				Unable to determine.
556 Planned Grazing																				Unable to determine.

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Table A-1. (continued)

CODE	PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	APPROXIMATE MINIMUM DETECT. SIZE* .5 (in feet) / - (in meters) / PHOTOGRAPHY SCALE .5K	1 / - / 1K	2 / 1 / 5K	5 / 2 / 10K	8 / 3 / 15K	10 / 4 / 20K	15 / 5 / 30K	20 / 7 / 40K	25 / 8 / 50K	30 / 10 / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
378	Pond	A	1	1	2	1	P	P	P	P	P	P	O	P	P	P	O	D	-	-	A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.
521	Pond Sealing or Lining																				Unable to determine.
338	Prescribed Burning																				Unable to determine.
528	Proper Grazing	A	1	1	2	2	P	P	P	P	P							-	-	R	Grazing at an intensity that will maintain enough cover to protect soil and improve quantity and quality. Supporting data essential.
530	Proper Woodland Grazing	A	1	1	2	2	P	P	P	P	P							-	-	R	Grazing that will maintain adequate cover for soil protection and improve quality and quantity of trees & vegetation.
532	Pumped Well Drain																				Unable to determine.

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

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Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE	PRACTICE	PHOTO TYPE: INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	APPROXIMATE MINIMUM DETECT. SIZE* (in feet) / (in meters) / PHOTOGRAPHY SCALE: .5 / - / .5K	1 / - / 1K	2 / 1 / 5K	5 / 2 / 10K	8 / 3 / 15K	10 / 4 / 20K	15 / 5 / 30K	20 / 7 / 40K	25 / 8 / 50K	30 / 10 / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
533	Pumping Plant for Water Control	A	1	1	2	2	P	P	P	P	P	P	P	P	P	P	P	R	-	D	A facility to transfer water for a conservation need, removing excess surface or ground, filling ponds, ditches, or wetlands.
550	Range Seeding																				Unable to determine.
558	Reclamation of Surface	A	1	1	2	2	P	P	P	P	P	P	P					R	D	D	Restoration of mined lands to beneficial use, reduce erosion and sediment production.
562	Recreation Area Improvement	A	1	1	2	2	P	P	P	P	P							D	D	R	Establishing grasses, legumes, vines, shrubs, trees or selectively reducing stand density to improve an area.
566	Recreation Land Grading & Shading	A	1	1	2	2	P	P	P	P	P	P	P					R	-	R	Altering the land's surface to meet facility requirements.

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Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE	PRACTICE	INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	.5 ft / - m / .5K	1 ft / - m / 1K	2 ft / 1 m / 5K	5 ft / 2 m / 10K	8 ft / 3 m / 15K	10 ft / 4 m / 20K	15 ft / 5 m / 30K	20 ft / 7 m / 40K	25 ft / 8 m / 50K	30 ft / 10 m / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
568	Recreation Trail and Walkway	A	1	1	2	2	P	P	P	P	P							R	-	R	Pathways prepared especially for pedestrian, equestrian, and cycle travel. Supporting data essential.
554	Regulating Water in Drainage Systems	B	1	1	2	2	P	P	P	P	P	P	P					-	-	R	Controlling the removal of surface or subsurface runoff, through operation of control structures. Supporting data essential.
555	Rock Barrier	B	1	1	2	2	P	P	P	P	P							R	-	D	A rock retaining wall constructed across the slope to form and support a bench terrace to control water flow and erosion.
557	Row Arrangement	A	1	1	2	2	P	P	P	P	P	P						R	R	R	Establishing a system of rows of planned grades and lengths, primarily for erosion control and water management.
350	Sediment Basin	A	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	R	-	D	A basin constructed to collect and store debris or sediment.

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Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE PRACTICE	INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	.5K (.5 ft / - m)	1K (1 ft / - m)	5K (2 ft / 1 m)	10K (5 ft / 2 m)	15K (8 ft / 3 m)	20K (10 ft / 4 m)	30K (15 ft / 5 m)	40K (20 ft / 7 m)	50K (25 ft / 8 m)	60K (30 ft / 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
		PHOTO TYPE				APPROXIMATE MINIMUM DETECT. SIZE* (in feet) (in meters) / PHOTOGRAPHY SCALE														
572 Spoil Spreading	A	1	1	2	2	P	P	P	P	P	P						R	-	D	Disposing of excavated materials from irrigation canals or drainage ditches on adjacent land. Need to see in progress.
574 Spring Development	A	1	1	2	2	P	P	P	P								-	-	R	Improving by excavating, cleaning, capping, or providing collection and storage facilities.
575 Stock Trails and Walkways	A	1	1	2	2	P	P	P	P								R	-	R	A livestock trail or walkway constructed to improve grazing distribution and access to forage/water. Found in areas of steep slopes, rock outcrop, dense timber, rough lava, marsh.
580 Stream Bank Protection	A	1	1	1	2	P	P	P	P	P	P	O	P	P	P	O	R	R	-	Stabilizing and protecting banks of streams, lakes, estuaries, or excavated channels from scour and erosion by vegetative or structural means.

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Table A-1. (continued)

Interpreter Experience Level A - Novice
B - Experienced

Photo Type Desirability Level 1 - most
2 - acceptable
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Supporting Data
R - required
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Practice Identification
O - actually observed
P - predicted

CODE	PRACTICE	INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	Approx. min. detect. size*: .5 ft / - m; Photography scale: .5K	1 ft / - m; 1K	2 ft / 1 m; 5K	5 ft / 2 m; 10K	8 ft / 3 m; 15K	10 ft / 4 m; 20K	15 ft / 5 m; 30K	20 ft / 7 m; 40K	25 ft / 8 m; 50K	30 ft / 10 m; 60K	80K	STEREO SCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
584	Stream Channel Stabilization	A	1	1	1	2	P	P	P	P	P	P	O					R	-	R	Stabilizing the stream channel with suitable structures. Supporting data essential.
585	Stripcropping Contour, Field	A	1	1	1	2	P	P	P	P	P	P	P	P	P	P	P	D	D	-	Growing wind resistant crops arranged at angles to offset adverse wind effects.
587	Structure for Water Control	A	1	1	1	2	P	P	P	P	P	P	O	P	P	P	O	R	-	D	A structure in an irrigation, drainage, or other water management system that conveys water, controls rate of flow, or maintains desired water surface elevation.
344	Stubble Mulching	B	1	1	2	2	P	P	P	P								-	R	D	Managing plant residue on a year round basis. Harvesting, tilling, planting, and cultivation performed in such a way that protective amounts of vegetation remain on the surface.

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Table A-1. (continued)

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

CODE	PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	.5K (.5 ft; - m)	1K (1 ft; - m)	5K (2 ft; 1 m)	10K (5 ft; 2 m)	15K (8 ft; 3 m)	20K (10 ft; 4 m)	30K (15 ft; 5 m)	40K (20 ft; 7 m)	50K (25 ft; 8 m)	60K (30 ft; 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
606	Subsurface Drain																				Unable to determine.
607	Surface Drainage Field Ditch	A	1	1	2	2	P	P	P	P	P	P	O					D	-	-	A graded ditch for collecting excess water in a field.
608	Surface Drainage Main or Lateral	A	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	D	-	D	An open drainage ditch constructed to collect and dispose of excess waters from field ditches, subsurface drains.
600	Terrace	A	1	1	2	2	P	P	P	P	P	P	O	P	P	P	O	R	-	-	An earth embankment, channel, or a combination ridge and channel cut across the slope.
610	Toxic Salt Reduction																				Unable to determine.
612	Tree Planting	A	1	1	2	2	P	P	P	P								R	R	R	Setting tree seedlings or cuttings in the soil.
614	Trough or Tank	A	1	1	2	2	P	P	P	P	P	P						D	-	D	With needed devices for water control and disposal, installed to provide drinking water for livestock.

Columns .5K–80K: APPROXIMATE MINIMUM DETECT. SIZE* (in feet / in meters) and PHOTOGRAPHY SCALE.

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

CODE	PRACTICE	INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	.5K (.5 ft / - m)	1K (1 ft / - m)	5K (2 ft / 1 m)	10K (5 ft / 2 m)	15K (8 ft / 3 m)	20K (10 ft / 4 m)	30K (15 ft / 5 m)	40K (20 ft / 7 m)	50K (25 ft / 8 m)	60K (30 ft / 10 m)	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
630	Vertical Drain																				Unable to determine.
312	Waste Management	A	1	1	2	2	P	P	P	P								D	-	D	A planned system of managing liquid and solid waste, including runoff from concentrated waste areas, that does not degrade air, soil, or water resources.
425	Waste Storage Pond	A	1	1	1	2	P	P	P	P								D	-	D	Made by excavation or earth fill for temporary storage of animal or other agricultural waste.
359	Waste Treatment Lagoon	A	1	1	2	2	P	P	P	P	P	P	P	P	P	P	P	D	-	D	Made by excavation or earthfill for biological treatment of animal or other agricultural waste.
633	Waste Utilization																				Unable to determine.
640	Water Spreading	A	1	1	2	2	P	P	P	P								R	-	R	Diverting runoff from natural channels or gullies by means of dams, dikes, or ditches and spreading over relatively flat areas.

Column groups: PHOTO TYPE (Color, Color IR, B&W Pan, B&W IR); PHOTOGRAPHY SCALE (.5K–80K), with APPROXIMATE MINIMUM DETECT. SIZE* (in feet) and (in meters) given for each scale.

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

CODE	PRACTICE	INTERP. LEVEL	COLOR	COLOR IR	B&W PAN	B&W IR	.5 ft / - m / .5K	1 ft / - m / 1K	2 ft / 1 m / 5K	5 ft / 2 m / 10K	8 ft / 3 m / 15K	10 ft / 4 m / 20K	15 ft / 5 m / 30K	20 ft / 7 m / 40K	25 ft / 8 m / 50K	30 ft / 10 m / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
642	Well	A	1	1	2	1	P	P	P	P								-	-	R	Constructed or impounded to provide water for irrigation, livestock, or recreation. Supporting data essential.
645	Wildlife Upland Habitat Management																				Unable to determine.
648	Wildlife Watering Facility																				Unable to determine.
644	Wildlife Wetland Habitat Management	B	1	1	2	2	P	P	P	P											Unable to determine.
650	Windbreak Renovation	B	1	1	2	2	P	P	P	P	P							R	D	D	Widening, partial replanting and replacing selected trees and shrubs for improvement.
652	Woodland, Direct Seeding																				Unable to determine.
654	Woodland, Improved Harvesting	A	1	1	2	2	P	P	P	P	P	P	P					R	D	D	Systematically removing some of the merchantable trees from an immature stand or all of the trees from a designated area.

Column groups: PHOTO TYPE (Color, Color IR, B&W Pan, B&W IR); APPROXIMATE MINIMUM DETECT. SIZE* (in feet / in meters); PHOTOGRAPHY SCALE.

Interpreter Experience Level: A - Novice; B - Experienced

Photo Type Desirability Level: 1 - most; 2 - acceptable; 3 - least

Supporting Data: R - required; D - desired; - - not necessary

Practice Identification: O - actually observed; P - predicted

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.

Table A-1. (continued)

Interpreter Experience Level: A - Novice, B - Experienced

Photo Type Desirability Level: 1 - most, 2 - acceptable, 3 - least

Supporting Data: R - required, D - desired, - - not necessary

Practice Identification: O - actually observed, P - predicted

CODE	PRACTICE	INTERP. LEVEL	PHOTO TYPE: COLOR	PHOTO TYPE: COLOR IR	PHOTO TYPE: B&W PAN	PHOTO TYPE: B&W IR	APPROXIMATE MINIMUM DETECT. SIZE* .5 ft (- m) / PHOTOGRAPHY SCALE .5K	1 ft (- m) / 1K	2 ft (1 m) / 5K	5 ft (2 m) / 10K	8 ft (3 m) / 15K	10 ft (4 m) / 20K	15 ft (5 m) / 30K	20 ft (7 m) / 40K	25 ft (8 m) / 50K	30 ft (10 m) / 60K	80K	STEREOSCOPY	SEASONAL DATA	SUPPORTING DATA	REMARKS (DESCRIPTIVES & CHARACTERISTICS)
666	Woodland, Improvement	A	1	1	2	2	P	P	P	P								R	D	D	Removing unmerchantable or unwanted trees, shrubs, or vines from wooded areas. Supporting data essential.
660	Woodland Pruning																				Unable to determine.
490	Woodland Site Preparation	A	1	1	2	2	P	P	P	P	P	P						D	D	R	Treating areas to encourage natural seeding of desirable trees or to permit reforestation by planting or direct seeding. Supporting data essential.

*Minimum detectable size equals approximately one half the size of an object which can be detected at that specified photographic scale.