EROSION SURVEY No. 21

Erosion and RELATED LAND USE CONDITIONS

on the

West Tauy Creek Demonstration Project

Kansas

by R. G. DUNMIRE
Junior Soil Surveyor
Physical Surveys Division, Soil Conservation Service

ITED STATES DEPARTMENT OF AGRICULTURE
IL CONSERVATION SERVICE • WASHINGTON • 1940

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Field survey by R. G. Dunmire, G. B. Killinger, M. P. Rogers, and M. H. Wertzberger

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CONTENTS

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Introduction

SOIL EROSION has caused severe damage on one-eighth of the land in the typical area in eastern Kansas described in this publication. Two-fifths of the same area has been moderately eroded. This destruction of irreplaceable land has taken place during less than a century of agricultural occupation and cropping.

The drainage basin of West Tauy Creek near Ottawa, Kans., was selected in 1935 for a demonstration of practical methods for control of erosion and conservation of soil (fig. 1). The project is representative of a large area of prairie soils, developed for the most part on sandstones, shales, and limestone, which comprises approximately 6 million acres in western Missouri and eastern Kansas. It is easily accessible to more than 2 million persons who live within 100 miles, chiefly in urban centers.

One of the first activities of the project was a survey of the land, including mapping the type of soil, slope, kind and degree of erosion, and present use. This survey yielded accurate knowledge of the physical capabilities of the land, field by field. Soil conservation technicians, with this survey at hand, talked with individual farmers about their farms, their type of farming, and also their wishes and preferences for different farming methods. Together, they devised for each farm a plan that would build up and maintain the soil, reduce erosion, and at the same time satisfy the farmer and give him returns for his investment and labor. Not all farmers, of course, found it possible to enter into cooperative agreements to follow such plans, but after the project had been in operation for 2 years, 79 cooperative agreements had been completed calling for conservation practices on 12,718 acres, or about 45 percent of the land in the watershed.

Soil conservation practices have been demonstrated in Kansas on four other projects, on a larger number of work areas of the Civilian Conservation Corps, and on one or more demonstration farms in each county. The first project of this kind in the State was established near Mankato, in Jewell County, in 1934.

Kansas farmers are now permitted by State law to organize self-governed soil conservation districts that operate under the direction of elected supervisors. A district, when fully organized, may utilize technicians of the Soil Conservation Service and other public agencies in carrying out a program of good land use and soil conservation. In March 1940, eleven districts in Kansas were cooperating actively with the United States Department of Agriculture, and one other had been organized and was ready to enter into such cooperation.

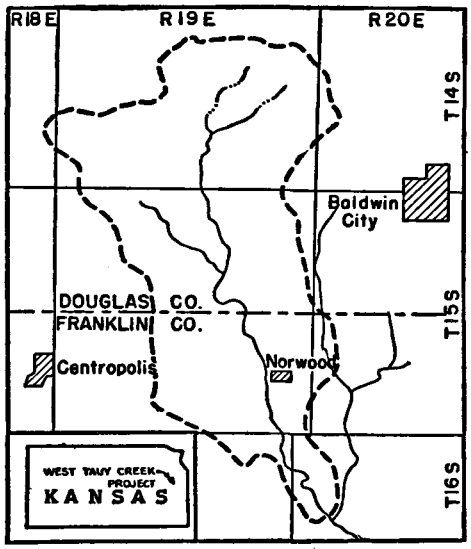


Figure 1.—Sketch map showing location of West Tauy Creek project.

This bulletin contains a discussion of the physical capability of the land and of the practices that are needed to preserve and improve the soil. Accompanying the bulletin, to furnish an exact physical basis for any necessary adjustments in land use or in farming practices, is a set of eight maps that cover the entire project area. These maps, on a scale of 1,320 feet to the inch (4 inches to the mile), show the land-capability classes in colors. They also show by brown symbols the physical factors that enter into the classification of capability, namely, soil type,

slope class, and kind and degree of erosion. The present land use is shown by gray symbols.

Complete sets of the maps are not distributed with every copy of the bulletin, but they may be seen at local offices of the Soil Conservation Service in Kansas, and in principal libraries throughout the State and elsewhere.

Using the Land in West Tauy Watershed

Classes of Land According to Use Capability

THE PHYSICAL survey is a detailed inventory of land in the project. The type of soil, slope of the land, type and degree of existing erosion, and the present land use were mapped carefully, as described elsewhere in this report (pp. 18–19). Each of these factors has significance in studies of the land, its present capability for use, and its past and present rate of deterioration through erosion and other causes. Each of them influences the practices that must be used to make the land produce returns in the form of agricultural products of any kind.

Use of land for farming invariably makes it subject to soil erosion or soil depletion. To permit the choice of practices and measures that will check these destructive processes on land that is capable of use for ordinary tillage, to permit ready recognition of land that for any reason is not suitable for usual tillage, and to guide the selection of pasture-management and woodland-management practices on all classes of land, the land is classified according to its capability for use.

Five classes of land according to use capability have been recognized in the project. Three are suitable for the usual crops with the first requiring no special practices other than good farming methods, the second requiring special practices of some kind, and the third requiring complex or intensive practices; the fourth is suitable for only infrequent or restricted cropping; and the fifth is not suitable for any cropping whatever that necessitates tillage of the soil.

Class I is suitable for cultivation without special practices. Land in this class will produce at least moderate yields of one or more crops without danger of significant erosion. It is by definition physically suitable for cultivation, although it may have at present a cover of grass or even trees. In the West Tauy project, it must lie on slopes of less than 2 percent, except on two soils of the flood plains where slopes slightly more than 2 percent are also placed in class I; and it must not already be affected by more than slight erosion. Land in class I, in common with all farm land, does require replenishment of those nutrient elements that are removed in crops or by leaching, rotation of crops, necessary tillage practices, and other measures that are necessary to control diseases and pests and to maintain good soil structure. These are not considered special practices in the classification of land according to use capability.

Land in class I is not necessarily the most productive in the project. Some land in class II, having a slope sufficient to require special erosion-control practices may be fully as productive at the present time as any land in class I. Class I does include all land that can be cultivated safely and permanently without any special practices. It occupies 5,487 acres, or 20.2 percent of the project.

Class II is suitable for cultivation if some simple practices are employed. These necessary practices are for the most part simple measures to control run-off water and soil erosion, such as contour tillage, strip cropping, and occasional use of diversion terraces. Much of the land also needs lime and phosphate fertilizer. All the land in class II is gently sloping, that is, has slopes of less than 5 percent, and most of it is only slightly eroded. There are 5,598 acres, amounting to 20.6 percent of the land in the project.

Land in class III is suitable for cultivation, but the growing of ordinary crops requires careful and intensive application of the best-known practices for soil-erosion control and soil maintenance. Slopes are less than 8 percent, and the present degree of erosion

ranges from slight to moderate. There are 9,618 acres, or 35.5 percent of the project, in class III. The intensive practices that are needed to use this land safely and to control erosion include contour tillage, strip cropping, terraces, and diversion ditches; establishment of terrace outlets; and the control and stabilization of gullies and drainageways. Usually a combination of two or more of these practices is required. Much of the land in class III is only moderately productive and needs intensive or special soil-improving practices such as the use of lime for alfalfa and sweetclover, and phosphate fertilizer for alfalfa, clovers, and wheat.

Class IV is unsuitable for continuous cultivation to the usual crop rotation that includes 1 or 2 years of corn. It consists chiefly of shallow soils that are slightly eroded, and moderately sloping areas that have been affected by moderate erosion. Only 3.5 percent of the project falls in this class.

Class V is not suitable for any cultivation but may be utilized for grazing or (in very few areas on this project) for woodland. One stony soil falls wholly within class V, and the class includes all steep or severely eroded areas, and areas of shallow soils that are moderately eroded. There are 5,474 acres of such land, amounting to 20.2 percent of the project.

Influence of Physical Factors on Use Capability of Land

Each parcel of land is classified definitely according to its capability on the basis of information obtained on the physical survey. The use-capability classes make possible ready selection of the land suitable for cultivation and the statement, in general terms, of practices necessary to control erosion and maintain the land in each class under feasible methods of use. Further details regarding the selection and use of different cropping systems and practices can be specified by referring to soil groups, erosion groups, and slope classes. As a basis for a discussion of erosion-control and farming practices, a brief summary of the factors shown by the physical survey—the soil groups, erosion groups, slope classes, and present land use—is given in the following section. For actual development of a farm plan involving selection of a cropping system, choice of crops, location of terraces and strip cropping, selection of treatment to be used in gullies, and other soil-saving and soil-using measures, complete and precise information regarding the soil types, erosion and slope classes, and present land use is required. This complete information is shown on the printed maps and is discussed fully in this bulletin on pages 18–22.

The classification according to use capability of each soil type as affected by different classes of erosion and as it occurs on different slope classes is shown in table 1.

Groups of Soils

Fifteen different soil types and phases were mapped on the project. Each of these has individual characteristics, but for many purposes the soils may be considered in six groups. Each group has several characteristics in common.

Group 1 consists of the Bates sandy or loamy soils. These soils have brownish-gray sandy or loamy surface soils and grayish-brown, brown, or yellowish-brown loam or sandy clay loam subsoils. They are underlain by sandstone.

Group 2 is made up of Bates soils that are heavy in texture, the Bates silt loam and a mixture of shallow soils designated as the Bates-Collinsville complex. These soils resemble those of group 1 but contain more clay and are therefore less permeable to water. They are underlain by shale or fine-grained sandstone.

Group 3 consists of the Summit and Sogn soils, Summit silty clay loam and Sogn stony silty clay loam. They are dark grayish-brown to black in the surface soil and have subsoils that are hard when dry and very sticky when wet. They are underlain by yellowish-brown to olive-gray plastic silty clay.

Group 4 is composed of the Labette and Newtonia soils. They are also heavy soils, and they are characterized by dark-red or reddish-brown surface soils and reddish or reddish-brown sub-

TABLE 1.—*Soil types, slope classes, and erosion classes making up each land-capability class*

Soil group and type	Slope [1] and erosion [2] characterizing class—				
	I (green) [3]	II (yellow) [3]	III (red) [3]	IV (blue) [3]	V (orange) [3]
1. Bates soils, light textured:					
Bates fine sand			A: 27 B: 3, 37.	BB: 3	C: 3.
Bates fine sandy loam, shallow phase.				A: 2 B: 2, 27, Θ.	B: 3, 37, 4, 47. BB: 2, 3, 37, 4, 47, 48, Θ. C: 3, 37, 4, 47, 48, Θ. D: 3, 37, 4, 47, Θ.
Bates loam	A: 2, Θ	A: 27, 3 B: 2, Θ.	B: 27, 3, 37 BB: 2, 27, 3, Θ.	BB: 37 C: 2, Θ.	B: 4, 47. BB: 4, 47, 48. C: 3, 37, 4, 47. D: 3, 4.
2. Bates soils, heavy textured:					
Bates silt loam	A: 1, 2, Θ	A: 3 B: 2, 27, Θ.	B: 3, 37 BB: 2, 3, 37, Θ.	B: 38 BB: 38. C: 2.	B: 4, 47, 48. BB: 4, 47, 48. C: 3, 37, 38, 4, 47. D: 3, 47.
Bates-Collinsville complex.				A: 2 B: 2, Θ.	B: 3, 37, 4, 47. BB: 3, 37, 4, 47, Θ. C: 3, 4, 47. D: 3, 37, 4, 47.
3. Summit and Sogn soils:					
Summit silty clay loam	A: 1, 2, Θ	A: 27, 3 B: 1, 2, Θ.	B: 27, 3, 37 BB: 2, 27, 3, 37, Θ.	B: 38, 4 C: 2.	B: 47, 48. BB: 38, 4, 47, 48. C: 3, 37, 4, 47. D: 3.
Summit silty clay loam, shallow phase.				A: 1, 2, Θ B: 2, Θ.	B: 27, 3, 37, 4, 47. BB: 2, 27, 3, 37, 4, 47, 48, Θ. C: 2, 3, 37, 4, 47, Θ. D: 3, 4, 47.
Sogn stony silty clay loam.					B: 2, 27, 3, 4, 47, Θ. BB: 2, 27, 3, 4, 47. C: 2, 3, 4. D: 4.
4. Labette and Newtonia soils:					
Labette silty clay loam	A: 1, 2, Θ	A: 3 B: 2, 27, Θ.	B: 3, 37 BB: 2, 3, Θ.		B: 4, 47. BB: 4, 47.
Labette-Newtonia silty clay loams.	A: 1	A: 2, 3 B: 2, 27, Θ.	B: 2, 27, Θ BB: 2, Θ.	B: 3, 37 BB: 3, 37.	B: 38, 4, 47. BB: 4, 47. C: 3, 37, Θ.
5. Parsons-Woodson silty clay loams.	A: 1, 2, Θ	B: 1, 2, 27, Θ	B: 3, 37 BB: 2, 3, 37.	B: 38	B: 4, 47. BB: 47.
6. Verdigris, Lightning, and Neosho soils:					
Lightning silt loam, terrace phase.		A: 2, 27, Θ B: 2, 27, Θ.			
Neosho silt loam	A: 1, 2, Θ B: 2.	B: 27			
Verdigris silt loam	A: 1, 2, 27, Θ				
Verdigris silty clay loam.	B: 2.				

[1] Slope symbols: A, less than 2 percent; B, 2–5; BB, 5–8; C, 8–12; and D, 12 percent and over.
[2] Erosion symbols are explained in detail on p. 19 and in the legend on the maps accompanying this bulletin. 2, 3, and 4 indicate progressive degrees of sheet erosion; 7 and 8, occasional and frequent gullies, respectively; 1, no apparent erosion; and Θ undifferentiated erosion.
[3] Color distinguishing class area on the maps accompanying this bulletin.

soils. They have developed on limestone.

Group 5 contains only one soil complex, the Parsons-Woodson silty clay loams. These soils have a stiff, impervious, clay subsoil (claypan) immediately beneath the surface soil.

Group 6 contains the Verdigris, Lightning, and Neosho soils, all of which occur on flood plains along streams.

Soils of the project area are discussed in greater detail on pages 19–21.

EROSION CLASSES AND GROUPS

Ten different classes of erosion were mapped, designated by the symbols given on page 19. The erosion classes, which include no apparent erosion, undifferentiated erosion and various degrees and combinations of sheet and gully erosion, have been grouped according to severity into no apparent, slight, moderate, severe, and very severe erosion.

Slope Classes

The degree of slope influences greatly the speed and cutting power of running water, and therefore its erosive action on any soil. In order to evaluate as well as possible the slope factor for classifying land according to use capability on the project, these five classes of slope were established and mapped: A, less than 2 percent; B, 2 to 5; BB, 5 to 8; C, 8 to 12; and D, 12 percent or more. As is shown in table 1, all D slopes are in class V; a few C slopes are in class IV, and none are in the classes suitable for cropland; BB slopes cannot be classified higher than III, nor B slopes higher than II. On Bates loam, for example, B slopes affected by only slight sheet erosion are classified as II. Gullied areas or moderately eroded areas on the same soil and slope are classified as III, and severely eroded areas, although on B slope, are in class V, because they are not suitable for any cultivation.

Present Land Use

Present use does not enter directly into the classification of land according to use capability, but since it is also mapped on the physical survey it is mentioned briefly here. Five classes were mapped, cropland (54.1 percent of the project), idle land (0.7 percent), pasture (33.9 percent), woodland (8.3 percent), and an additional class (3.0 percent) that included many farmsteads and areas that could not otherwise be classified.

Choosing Practices to Fit the Land

The map showing use-capability classes shows clearly on every farm the land which is suitable and that which is unsuitable for cultivation. Land in class V is unsuitable for cultivation because of unfavorable characteristics of some kind but may as a rule be used for grazing, for woodland, or for wildlife developments. The choice that is made within these limits depends largely on the farmers' needs and preferences, but it is guided also by such factors as the slope, type of soil, stoniness, degree of erosion, and water supply.

Class IV for one reason or another is unsuitable for safe and permanent cultivation. Land in this class may be used safely, however, for many forms of limited or occasional cultivation that do not involve the growing of intertilled crops. Class III, on the other hand, may be used safely for any of the common crops if the necessary safeguards and special practices are followed. In the actual farm organization, however, it may be advisable to use much of the class III land, and even some of class II for pasture, permanent hay, or woodland. Use of class I for these purposes that involve permanent vegetation will be more infrequent, but might be advisable in some instances. If good land of class I is occupied by a stand of growing timber, for example, the needs of the farm might be best served by leaving this wood lot and adopting the practices necessary to continue growing crops on some other land of class III that is already clear.

A general outline is given in table 2 of the practices that are necessary to use land in each class for purposes to which it is suited. In using these recommendations two facts should be emphasized: That if the broad limitations of use specified in the definitions of any land-capability class are exceeded, practices and measures in addition to those ordinarily considered practicable are required to make the land usable or to insure its permanence; and that within the limitations contained in the classification, countless choices are possible to fit the system of farming, the economy of the individual farm and the preferences of the individual farmer. A dairy farm and a general farm, for example, may require very different crop rotations and fertilizing practices.

Land of class I, which makes up 20.2 percent of the project, is subject to little erosion and needs only the application of ordinary good practices of farm management to keep it suitable for cultivation. Although few limitations in cropping are necessary to control erosion on these lands, crop rotations and fertilizing practices are needed to maintain fertility and good physical condi-

TABLE 2.—*Farming and conservation practices recommended, according to capability of land for use*

Land-capability class	Practices recommended for—						
	Cropland			Pasture		Woodland	
	Rotations [1]	Fertilizers or amendments	Supporting practices	Management	Supporting practices	Management	Supporting practices
I (green)[2]	1. R–R–S (C)–C–S–S. 2. R–R–S (C)–C. 3. R–R–S–S–A–A–A–A.	Farm manure. Lime and phosphate for alfalfa and clovers. Phosphate for wheat.	Incorporation of crop residues in soil. Utilization of stubble and crop residue for fall and winter cover.	Deferred and rotated grazing. Prevention of burning. Use of supplementary pasture and feed crops.		Protection from fire and grazing. Removal of dead and diseased trees.	Fencing of woodland.
II (yellow)[2]	1. R–R–S (C)–C–S–C. 2. R–R–S– (C)–C. 3. R–R–S–S–A–A–A–A.	Farm manure. Lime for sweet clover and alfalfa. Phosphate fertilizer for alfalfa, clover, and wheat.	Contour tillage, strip cropping, occasional use of diversion terraces where outlets are feasible. Special drainage furrows or diversions on Lightning and Neosho soils.	do	Diversion terraces to dispose of run-off from higher areas.	do	Do.
III (red)[2]	1. S (L) 2. R–S (C)–C–S–S. 3. S–S–S– (C)–C. 4. R–S–S–A–A–A–A.	Farm manure. Lime for alfalfa and sweetclover. Phosphate fertilizer for alfalfa, sweetclover, and wheat.	Contour tillage, strip cropping. Gradient terraces and diversion terraces. Perennial buffer strips. Permanent grassed outlets and waterways. Use of temporary and permanent structures for gully control. Use of permanent strips of alfalfa and bromegrass.	do	Control of gullies by fencing and planting to suitable grass, trees or shrubs, or by permitting natural revegetation. Pasture terraces or diversion terraces. Nitrogen and phosphate fertilizer for establishment of grass seedings.	do	Fencing of woodland. Contour planting. Use of contour furrows in some locations. Diversion terraces if necessary, to handle run-off from higher areas.
IV (blue)[2]	1. S (L) 2. A–A–A–A–S (H)–H. 3. S (C)–C–H. (No row crops.)	do	Contour tillage. Use of terraces, especially diversion terraces, wherever possible. Permanent hay strips. Grassed outlets and waterways. Seeding of gullies wherever feasible. Removal of stones from shallow soils if economical.	do	Control of gullies by fencing and planting to suitable grass, trees, or shrubs, or if feasible by natural revegetation. Use of nitrogen and phosphate when seeding.	do	Fencing of woodland. Contour planting. Use of diversion terraces if necessary to dispose of run-off from higher areas.
V (orange)[2]	None			do	Use of nitrogen and phosphate when seeding.	do	

[1] R=row crops; S=small grain; C=sweet clover; L=lespedeza; A=alfalfa; H=grass hay; ( )=seeded in small grain. Sorghums are recommended for feed crops in preference to corn.
[2] Color distinguishing class area on the maps accompanying this bulletin.

tion of the soil. The rotation commonly recommended consists of corn or sorghum 2 years, followed by small grain, with sweetclover seeded in the grain and allowed to remain the following year. This 4-year rotation may be extended by 2 additional years of small grain, as shown in table 2. Another rotation for soils that are well supplied with lime consists of 2 years each of row crops and small grain followed by alfalfa for several years. Whatever the rotation that is used, farm manure should be applied to the extent that it is available. Crop residues and stubble should be utilized to furnish protection for the soil in winter and turned under to aid in maintaining the supply of organic matter.

Land in class II requires special practices for safe and permanent cultivation. It is a little more extensive than land in class I and occupies 20.6 percent of the project. Special practices that are needed include the use of contour tillage, strip cropping, diversion ditches, or other fairly simple practices. Strip cropping and contour tillage are shown in figure 2. Lime and fertilizer are needed more urgently and must be applied more frequently than on class I land. Lime is recommended for alfalfa and sweetclover. Phosphate is needed on many areas of the Bates soils.

Most of the upland soils that are in class II have slopes of less than 5 percent and have been affected by slight erosion. Tillage across the slope, on or near the exact contour, is an essential practice on nearly all of this land. The planting of alternate strips of close-growing and cultivated crops is a simple and effective method of controlling run-off and erosion. Care is necessary regarding the width and spacing of strips on the heavy Parsons and Summit soils, and also on the Bates soils, which, although more permeable than the heavy soils, are also more erodible. If suitable outlets can be established, diversion terraces are useful, especially in handling run-off from adjoining lands. Diversion terraces in combination with contour tillage or strip cropping prove effective on all the upland soils.

Some of the Lightning and Neosho soils of the flood plains have poor surface drainage and require the use of special dead furrows and sometimes of diversion terraces along adjacent uplands to remove excess water.

Class III requires the most difficult and carefully applied practices that can be used under ordinary, present-day farming conditions. Land in this class may be on slopes up to 8 percent provided it is not more than moderately eroded. It occupies 35.5 percent of the project, or 9,618 acres.

No crop rotation recommended for class III includes row crops for 2 years in succession, and all of them make use of sweetclover, alfalfa, or lespedeza. Small grain, usually winter wheat, may be grown safely for 1 or 2 years in each rotation. Usually a legume is seeded in the grain in the spring. A mixture of bromegrass and alfalfa makes excellent cover for permanent erosion-resisting strips and is also a good source of hay.

Farm manure, lime, and fertilizer are needed, especially on the soils already affected by moderate erosion. Lime is needed for alfalfa and sweetclover on most of the soils, and phosphate will give good results on alfalfa, lespedeza, and wheat.

Supporting practices that may be required on different sites are numerous. Contour tillage and contour strip cropping are of first importance. On many fields terraces are needed to intercept run-off water and lead it off gradually. Terraces having a variable grade of 0.2 to 0.4 percent throughout most of their length and 0.5 percent in the last 100 feet at the outlet end have shown favorable results (fig. 3, *B*). Diversion terraces that are higher and not nearly so wide as the usual field terraces may be constructed in a few suitable locations to remove water that comes from higher adjacent land. Terraces of any type must be provided with suitable protected outlets that will dispose of surplus water safely. The most desirable practice is to empty the terraces into a well-vegetated pasture or meadow or into a grassed natural waterway or meadow strip. If none of these is suitably located, a specially constructed

286506°—41——2

Kans-5322; Kans-810

Figure 2.—A, Strip cropping. Wheat is alternated with strips of a mixture of alfalfa and bromegrass. These are to be maintained as permanent meadow strips. *B*, Contour farming. An effort to reclaim a severely eroded field.

Kans-5265; Kans-5324

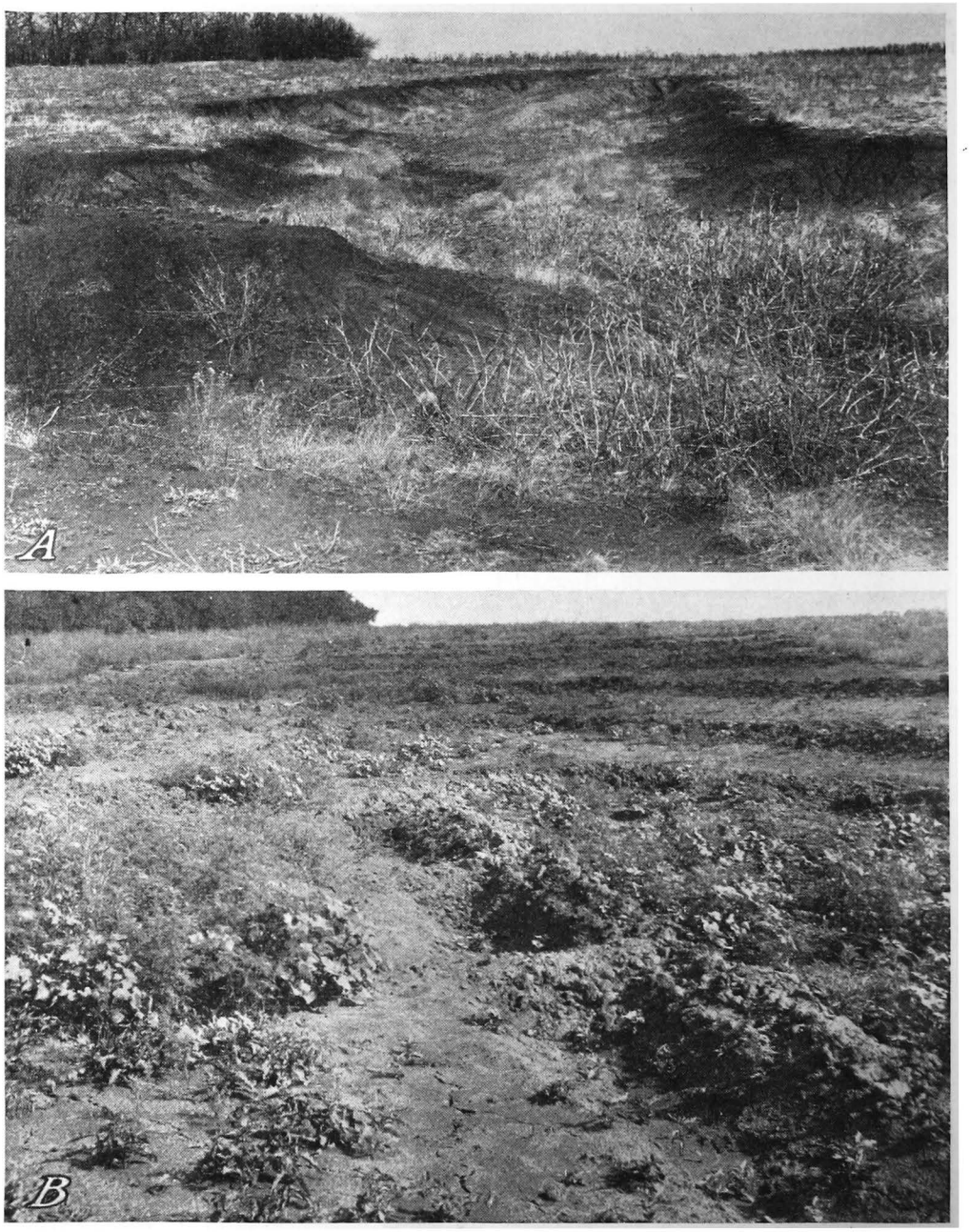
Figure 3.—*A*, **Gullies were started by run-off from a heavy rain soon after this field was planted to alfalfa. A good stand of alfalfa now stabilizes the space between gullies.** *B*, **Harvesting wheat with a combine on a terraced field.**

channel, protected by suitable sod-forming vegetation, must be used.

Every system of terraces should be reinforced with strip cropping and contour tillage. Buffer strips of perennial vegetation may sometimes be utilized as permanent markers of strip boundaries as well as a source of hay.

Stabilization of gullies and prevention of further gully erosion is needed on many areas of the Bates, Summit, and Labette soils (fig. 3, *A*). In cultivated fields that are to be terraced, most of the gullies can be filled without difficulty. Most noncrossable gullies can be plowed in or graded before terraces are constructed. Severely gullied areas should be planted to trees, shrubs, or grass or allowed to revegetate naturally, and should be fenced to exclude stock if necessary.

It is apparent that the use of class III land for cultivated crops calls for continuous use of appropriate soil-conserving and soil-building measures. For many of these the services of a



Kans-632-A; Kans. 632-B

Figure 4.—A, A deep gully before treatment. *B,* The same gully after treatment. After filling the gully, the sides were contour-ridged and planted to grass. Contour furrows in the pasture help to keep water out of the gully and prevent further erosion.

skilled conservation technician are essential. Few farm operators are in a position to lay out a system of terraces or strip cropping, a diversion terrace, or a grassed outlet channel. Many of these and other practices must be selected and applied according to the physical conditions and economic requirements of the individual farm. There are, however, numerous practices, even on class III land, that can be applied by the farmer before a soil conservation technician is able to visit his farm and work out the full set of practices and recommendations. Use of manure, fertilizers, and lime, and the addition of organic matter to the soil are needed on all the land and will help to conserve the soil. Small natural waterways can be left in sod to prevent scouring of channels. The need for many other practices will be evident to the farm operator who is aware of his soil losses and wants to stop them.

Class IV is suitable for only limited cropping, which in this locality means no row crops and also extreme care to see that the land is not left unprotected any longer or any oftener than is necessary in preparation for grain crops. Some slopes up to 12 percent are in this class, but for the most part it consists of gentler slopes that have shallow soils or are at least moderately eroded. It comprises only 3.5 percent of the project, or 948 acres.

Row crops are not recommended on class IV, but small grains may be grown in suitable rotations that include legumes and grasses. Long-term hay is more generally suitable. All the practices described under class III may be used on some locations, but they should be applied only if the probable return appears to justify the cost of the treatment. Many of the shallow soils are rather stony, and removal of stones from some fields may be practicable.

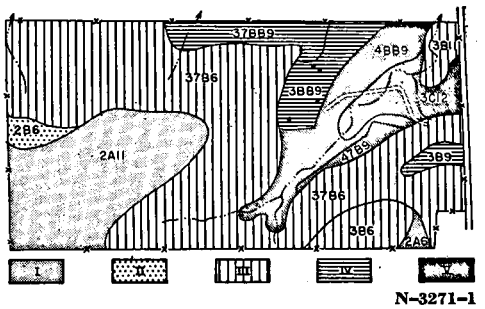
Class V, which comprises 5,474 acres, or 20.2 percent of the project, is not

Kans-5762

Figure 5.—**The pasture on the right has been overgrazed. The field on the left is a protected, native meadow.**

suitable for any cultivation. It consists of all severely eroded land, all steep land, moderately eroded areas of shallow soils on gentle slopes, and all the Summit stony silty clay loam, shallow phase. Nearly all of this land can be utilized for pasture.

It is extremely difficult to establish pasture grasses on present cropland of class V, and it may be impossible unless



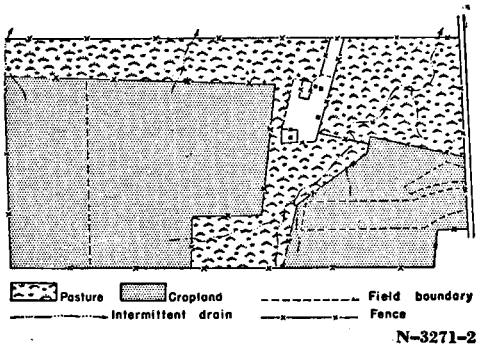
N-3271-1

Figure 6.—**Land-capability map of a farm of 79 acres. Class I is suitable for cultivation without special practices, class II with simple practices, and class III with complex or intensive practices. Class IV is suitable for only limited cultivation, and class V is not suitable for cultivation. Symbols show the detailed mapping of erosion-slope-soil type. Erosion symbols are: 2, slight; 3, moderate; 37, moderate with occasional gullies; 4, severe; 47, severe with occasional gullies. Slope: A, less than 2 percent; B, 2 to 5; BB, 5 to 8; and C, 8 to 12. Soil types: 6, Labette silty clay loam; 9, Newtonia silty clay loam; 11, Summit silty clay loam; 12, Summit silty clay loam, shallow phase. Soil types 6 and 9 are in soil groups 4; 11 and 12 are in soil group 3.**

the distribution of rainfall is favorable during the first season. Incorporation of crop residues and the use of fertilizer will aid somewhat. On the shallow, sandy, or stony soils the native tall grasses are most likely to be successful. The heavier soils, especially those developed on limestone, are suitable for the tame grasses.

Proper management of grazing land, especially on class V but also on any of the other classes of land, requires adjustment of the numbers of livestock and proper seasonal use and distribution. Proper grazing management in this locality includes also such use as is necessary of supplementary pasture and feed crops, mowing to reduce the competition of annual and perennial weeds, and control of gullies by diversion of water and revegetation, with fencing if necessary (fig. 4). Grazing should be deferred in the spring until the grass has attained sufficient growth, and should be controlled so as to maintain a vigorous, erosion-resistant stand of grass at all times (fig. 5). Burning of pastures is not recommended.

Woodland on all classes of land should be protected from fire and should not be grazed. Dead and diseased timber and undesirable trees should be removed, if possible, for use as posts, fuel, or other products. Contour furrows or diversion terraces may be useful to protect some of the woodlands.



N-3271-2

Figure 7.—**Land use, when surveyed, of the farm shown in figure 6.**

New plantings should be on the contour. More than half of the present woodland is on the Verdigris, Lightning, and Neosho soils of the flood plains.

Use of the physical survey in developing complete conservation measures on a farm in the project is shown by figures 6, 7, and 8. Figure 6 is the physical survey of a 79-acre farm. Class I land occupies 15 acres, class II, 3 acres, and class III, 43 acres, making 61 acres that are suitable for cropping. There are 6 acres of class IV land and 12 acres of class V.

Land use before the conservation plan was adopted is shown in figure 7. There were 47 acres of cropland, and 30 acres of pasture, with the remaining 2 acres taken up in farmstead. Hay, corn, and wheat were the principal crops grown.

The plan for conservation farming is shown in figure 8. Field 1 is now pro-

tected by a system of terraces that will intercept run-off water and allow it to flow gently into outlet ditches that are kept permanently in sod. Two of the terraces in field 1c empty directly into the pasture. Field 1a has been seeded to bromegrass and alfalfa, and will be maintained in permanent hay, in order to carry the water away safely from the longest outlet channel. Fields 1b, 1c, 1d, and 1e will be farmed in strips and will be used for corn, oats, wheat, and clover grown in rotations adjusted to give the necessary acreage of each crop.

Field 3a has been reseeded and will remain in permanent hay. Fields 3d

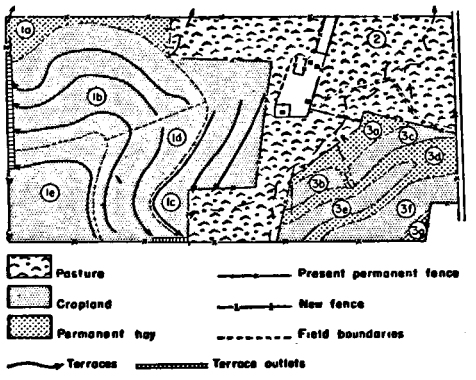


Figure 8.—**Conservation practices installed on the farm shown in figures 6 and 7. Practices include strip cropping, terracing, establishment of vegetated outlets for terraces, and retirement of some cropland, in addition to good soil-building measures.**

and 3g are permanent strips of alfalfa and bromegrass hay laid out on the contour in order to break the slope and help to prevent erosion. The remaining strips in this field will be used for a regular rotation that includes corn, oats, and wheat.

General Aspects of the Land Inventory

The foregoing sections give the principles of the classification of land according to use capability, and the use of the physical inventory, along with other information, in selecting and applying practices for good use and conservation of the land. Data from the survey also permit general consideration of the land resources of the project, in order to determine what adjustments, if any, are necessary in use of land, and the nature of possible changes that can be made within the limits of the physical capability of the land for use.

The acreage of each class of land according to use capability, by soil groups, is shown in table 3. In the project as a whole, 40.8 percent is in classes I and II, and 20.2 percent is in class V. The Verdigris, Lightning, and Neosho soils are all in classes I and II. The largest percentages of class V land are in soil groups 1, 2, and 3, the Bates and Summit soils. In this connection, it should be pointed out that although 29 percent of the Parsons-Woodson soil is class I land, it possesses a stiff, impervious subsoil (claypan) and is not suitable for as wide a range of crops nor is it as productive for corn or sorghum as some of the other upland soils. Some of the flood-plain soils also are imperfectly drained and are not suitable for all crops.

The use capability of each class of present land use is shown in table 4. This table reveals some significant facts about the land in the project. Present cropland (at the time of the survey) that is in class V amounts to 2,858 acres, or 18.9 percent of all cropland. An additional 2.6 percent of the present cropland is in class IV, making 21.5 percent of the land now cultivated that is not suitable for full cultivation. The retirement of this land and its utilization for pasture or hay should not be difficult for the project as a whole, since there are 4,331 acres of present pasture that fall in classes I and II. There is also a large acreage of woodland in classes I and II, owing no doubt to the tendency to use prairie lands for cultivation rather than the timbered bottoms. Most of this land will be more useful if it is left in timber rather than cleared, despite the fact that it is suitable for cultivation. Without clearing any timberland, there appears to be ample land to maintain the present acreage of crops, or

TABLE 3.—*Capability of land for use, by soil groups*

Soil group	Acreage and proportion in land-capability class—										Total
	I (green)[1]		II (yellow)[1]		III (red)[1]		IV (blue)[1]		V (orange)[1]		
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*
1. Bates soils, light textured	59	1.5	571	14.7	1,600	41.1	150	3.9	1,510	38.8	3,890
2. Bates soils, heavy textured	152	2.5	1,835	29.7	2,793	45.3	78	1.3	1,310	21.2	6,168
3. Summit and Sogn soils	1,150	15.0	1,185	15.4	2,645	34.5	325	4.2	2,372	30.9	7,677
4. Newtonia and Labette soils	776	19.8	590	15.2	1,953	49.9	388	9.9	203	5.2	3,910
5. Parsons-Woodson silty clay loams	630	29.0	828	38.1	627	28.9	7	0.3	79	3.7	2,171
6. Verdigris, Lightning, and Neosho soils	2,720	82.2	589	17.8	0	-------	0	-------	0	-------	3,309
Entire project[2]	5,487	20.2	5,598	20.6	9,618	35.5	948	3.5	5,474	20.2	[2] 27,125

[1] Color distinguishing class area on maps accompanying this bulletin.
[2] This does not include farmyards.

even to increase the acreage of cropland if that should be desirable.

The necessary adjustments on individual farms, in order to carry on farming operations within the limits set by the use capability of the land, might be more difficult. If a farm does not contain enough land of classes I, II, and III to meet its requirement for cultivated crops, there are two or three possible lines of action. One would be to buy or lease more land, or to exchange for a larger or more suitable holding elsewhere. Another would be to change to a less intensive system of farming, which probably would not be possible unless the farm were a large one. A third possibility, one which is not recommended, would be to use some of the land of class IV or class V for crops, using all possible precautions but recognizing that it is not suitable for cultivation and that any such use is a temporary measure only. Only by using the land within the limitations of its physical capability can a permanent system of farming be established and maintained.

Description of the Area

THE PROJECT consists of the drainage basin of West Tauy Creek, which rises in the southern part of Douglas County in eastern Kansas and flows southward, joining East Tauy Creek at a point about 3½ miles northeast of Ottawa. Tauy Creek enters Marais des Cygnes River 6 miles east of Ottawa. West Tauy Creek is mentioned in some of the early records as Ottawa Creek. The area is roughly triangular in shape, about 10 miles long from north to south and about 6 miles wide on the north end (fig. 1, p. 1). It contains 27,968 acres, or about 43.7 square miles.

The drainage basin is characterized by gently undulating divides, numerous small V-shaped valleys in the upper

TABLE 4.—*Capability of land for use, by land use*

Land use class	Acreage and proportion in land-capability class—										Total
	I (green)[1]		II (yellow)[1]		III (red)[1]		IV (blue)[1]		V (orange)[1]		
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*
Cropland	3,059	20.2	2,032	13.5	6,776	44.8	394	2.6	2,858	18.9	15,119
Idle land	23	12.2	17	9.0	75	39.7	15	7.9	59	31.2	189
Pasture	1,103	11.6	3,228	34.1	2,550	26.9	513	5.4	2,088	22.0	9,482
Woodland	1,302	55.8	321	13.7	217	9.3	26	1.1	469	20.1	2,335
Entire project[2]	5,487	20.2	5,598	20.6	9,618	35.5	948	3.5	5,474	20.2	[2] 27,125

[1] Color distinguishing class area on maps accompanying this bulletin.
[2] This does not include farmyards.

part, and a broad, V-shaped, alluvial valley that contains the major stream. The altitude ranges from about 891 feet above sea level near Ottawa to about 1,000 feet at the north end of the project.

The upper branches of West Tauy Creek and its tributaries are intermittent streams, but drainage from springs and hillside seepage is sufficient in normal seasons to form a continuous stream several miles above the junction with Tauy Creek. Near the junction there is a rock outcrop in the stream bed that creates a natural dam and impounds water that is from 3 to 8 feet deep for about three-fourths of a mile upstream, even during the driest seasons.

Native vegetation in this part of Kansas was principally prairie grasses with trees (oak and hickory) along the streams. Grasslands were dominated by big bluestem (*Andropogon furcatus*), with some little bluestem (*A. scoparius*), side-oats grama (*Bouteloua curtipendula*), Indian grass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). Sloughgrass (*Beckmannia syzigachne*) grew generally in the low, moist places. These prairie grasses have now been almost entirely replaced in pastures by Kentucky bluegrass and other grasses, many of which have little grazing value. On native meadows most of the original species have remained, although the total cover may be somewhat thinner than it was under virgin conditions.

Annual grasses that grow throughout the area are downy brome, little barley, triple-awn grass, barnyard grass, crabgrass, and witchgrass. Common weeds are sandbur, ironweed, pigweed, croton-weed, vervain, wild lettuce, common ragweed, and sunflower.

Original timber on the flood plains consisted largely of hickory, walnut, and oak. Hackberry, black cherry, ash, elm, dogwood, post oak, scrub oak, and blackjack oak grew on some of the alluvial plains but more commonly on adjacent uplands. Much of the better timber has been logged, cut for fuel, or cleared for the growing of crops, and existing woodlots contain chiefly the less valuable species. Post oak, scrub oak, and blackjack oak have occupied some of the sandy upland soils, and some areas of heavier soils in the southern part of the project.

Population of the project area is probably between 1,300 and 1,500. There are no towns in the area, although Norwood and Worden are small community and trading centers. Ottawa, Lawrence, and Baldwin are marketing points for surplus farm products. Kansas City is 58 miles away. Many farmers haul livestock by truck to the markets there.

Some coal is mined in the area, furnishing an occupation for a few persons during the winter months. Nearly all of the coal mined is used locally. A few of the residents are wage-earners in nearby towns, and a number obtain additional income from practice of a trade during slack farming seasons.

Numerous schools and colleges are easily accessible.

Transportation facilities are unusually good. Paved highways cross the project both north and south and east and west. A network of improved and gravel roads gives ready access to all parts of the project. A branch of the Atchison, Topeka, and Santa Fe R. R. joins the main lines at Ottawa and Lawrence. The entire community has telephone and daily rural mail service.

The climate is continental and is characterized by hot summers, and generally mild winters, although temperatures as low as −28° F. have been recorded. The highest temperature on record is 114°.

Annual precipitation as recorded ranges from 22.56 to 58.35 inches, with an average of 35.69. The annual fall of snow ranges from 1.2 to 23.5 inches, but as a rule the ground is not covered with snow for more than a few days at a time because of the sunshine and warm south winds. About 70 percent of the rainfall comes ordinarily during the period April to September, which is the time when moisture is needed for growing crops.

Crops may be damaged by drought in July or August, despite the high average rainfall for these months. High evaporation and unfavorable distribution make the rainfall less effective than it

would be in many other areas. Records of evaporation from 1925 to 1930 indicated that an average of 45.5 inches were lost from a free water surface during the 7 months, April to October, inclusive.

The prevailing wind is from the south in every month except February, and in that month from the north.

The average frost-free season is 178 days, from April 18 to October 13, but frost-free season has ranged from 149 to 209 days. Frost seldom causes any damage in the fall, as most crops mature by the middle of September. Freezing weather sometimes occurs following a period of warm weather in the spring and causes damage to fruit and early vegetables.

More detailed records of temperature and precipitation at Ottawa, compiled from records and publications of the United States Weather Bureau, are given in table 5.

Agriculture

THE INDIANS, many of whom entered the region between 1825 and 1832, were the first farmers in this part of Kansas. Each tribe cultivated small tracts of land, growing melons, beans, and Indian corn. The project area was part of the Shawnee reservation, which was not opened to white settlers until 1854.

Early pioneers settled chiefly along the streams and on the margins between wooded and prairie land. Corn was the most important crop, and oats, tobacco, broomcorn, castor-beans, and millet were cultivated to some extent. Political disorders interfered somewhat with the development. The crops that were grown barely provided an existence from one harvest to another.

A severe drought in 1860 brought unusual hardships, and caused many settlers to return to the East. Others

TABLE 5.—*Normal and extreme monthly, seasonal, and annual temperature and precipitation at Ottawa, Franklin County, Kans.*[1]

[Elevation, 891 feet]

Month	Temperature [2]			Precipitation [3]					
	Mean	Absolute maximum	Absolute minimum	Mean	Least on record	Greatest on record	Greatest in any 24-hour period	Average days with 0.01 inch or more	Average [4] snowfall
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
December	32.8	70	−10	1.18	0.14	3.00	1.60	6	2.7
January	30.1	73	−19	1.26	.03	4.76	1.70	6	3.6
February	33.1	83	−28	1.33	.02	4.81	2.26	6	3.5
Winter	32.0	83	−28	3.77	.92	7.79	2.26	18	9.8
March	44.6	93	−4	2.29	.14	5.98	2.51	7	2.8
April	54.8	96	11	3.03	1.06	8.54	2.28	9	.7
May	64.5	100	21	5.04	1.45	11.86	4.06	12	.0
Spring	54.6	100	−4	10.36	4.93	20.11	4.06	28	3.5
June	73.7	106	40	4.94	.26	12.49	5.03	10	.0
July	78.8	114	48	3.67	.07	11.76	5.77	5	.0
August	77.8	113	42	3.84	.36	9.41	3.40	8	.0
Summer	76.8	114	40	12.45	1.03	29.11	5.77	23	.0
September	69.8	107	27	4.32	.42	10.43	5.72	8	.0
October	57.8	94	16	2.75	.24	7.66	3.68	8	.0
November	44.5	85	1	2.04	.02	10.75	6.95	6	1.6
Fall	57.4	107	1	9.11	3.09	17.33	6.95	22	1.6
Year	55.2	114	−28	35.69	22.56	58.35	6.95	91	14.9

[1] U. S. Weather Bureau records.
[2] 41-year record.
[3] 43-year record.
[4] 12-year record.

came after the end of the war in 1865, and a stabilized agriculture began to develop. Flax, tobacco, hemp, millet, buckwheat, rice, castor-beans, and broomcorn were all grown at one time or another but have been almost wholly discarded. Hard red winter wheat was introduced about 1885 and became an important crop. Legumes and grasses came into use about 1900 and, more recently, alfalfa, soybeans, and sweetclover have been widely used. Sudan grass and grain and forage sorghums are valuable as feed crops.

The census of 1880 reports 66,986 acres of corn in Douglas County. There were 8,531 acres of oats, 23,871 of wheat, and 26,470 of hay. By 1890, the acreage of corn had increased slightly, oats had nearly doubled, wheat had decreased to 18,758 acres, and hay had increased about a half. Franklin County had in 1880, 63,803 acres of corn, 5,397 of oats, 7,460 of wheat, and 22,653 of hay. By 1890 the distribution had changed to 102,783 acres of corn, 11,313 of oats, 3,393 of wheat, and 44,439 of hay.

Present-day farming depends largely on livestock and livestock products. Of the 1,852 farms in Douglas County reported by the Census of 1930, 624 were classified as animal-specialty farms, 528 as general, 201 as dairy, and 114 as poultry farms. Principal crops grown in the same county in 1929 were corn, 57,464; wheat, 29,319, and hay, 21,285 acres. There were 111,813 acres of pasture, of which 22,021 were reported as woodland pasture.

Corn is grown on both uplands and bottom lands. Yields on many upland fields have declined somewhat, due in part to soil erosion and soil depletion. Corn is seldom grown more than 2 years in succession on the uplands, but may be grown for 4 or 5 years on alluvial land without any noticeable decrease in yields. It is used primarily as feed for cattle, hogs, sheep, poultry, and work animals.

Wheat is grown primarily as a cash grain crop, on all soils in the project. Hard red winter wheats predominate in the uplands, and soft red winter wheats are more commonly grown on the bottom lands. Binders are used principally for harvesting, although a number of combines are owned or rented. Most of the grain is sold on the local market immediately after threshing, but some of it is stored. Oats, the third crop in total acreage, is grown primarily as feed for work animals and to some extent as a nurse crop.

Sorghums have been widely used to replace or supplement the corn crop for grain and forage, especially in dry years. Soybeans and cowpeas are grown to a small extent, primarily for soil improvement and for hay, but also as a seed crop. Millet, rye, and barley are grown, but the total acreage devoted to them is small.

Alfalfa, native grasses, timothy, and red clover are the principal hay crops. Alfalfa requires lime and phosphate for best results. Stands are left for several years or as long as they will produce profitable yields. As a rule, three or four cuttings are obtained each season. Prairie-grass meadows are still a dependable source of hay on some of the farms. Sweetclover is grown on only a small acreage, but its use is increasing. Its vigorous root system penetrates some of the stiff subsoils and helps make them permeable to moisture.

Garden crops are grown for home use, but there is very little commercial gardening.

The 223 farms in the project average 125.4 acres in size. Fifty percent are operated by owners, 49 percent by tenants, and 1 percent by managers. The percentage of tenancy has increased rather consistently since about 1900. Most of the tenant farms are rented on a share basis with cash rent for hay or pasture land.

Many practices current at the time the project was established were detrimental to soil conservation. Nearly half the farms were operated by tenants, who as a rule are forced by financial circumstances to farm for immediate returns and neglect some soil-improving practices that they would like to follow. Crops, especially corn, were planted without regard to the slope. Corn as a rule was checkrowed and cultivated in two directions. This practice made the intro-

duction of contour farming difficult, but many soon became convinced of the merits of the new practice. Since about half of the annual precipitation comes during May, June, July, and August, while cornland is clean-cultivated, the manner of cultivation has a tremendous effect on soil erosion. Drainageways as a rule were cultivated in order to obtain long rows, with consequent gullying in the channels and sheet erosion on nearby slopes.

Liming was recognized as a necessary practice but was not followed by many of the farmers. Very little commercial fertilizer was used before 1937, although trials have shown that wheat responds to superphosphate or to a 2–12–2 fertilizer.[1] Fertilizers of high analysis are recommended in preference to the lower grades. An application of 35 to 50 pounds per acre of double superphosphate is recommended at seeding time for wheat. A similar application of phosphate will usually help in obtaining a good stand of alfalfa.

Carrying capacity of pastures was greatly reduced between 1930 and 1937 as a result of drought and overgrazing. Necessary reductions in livestock reduced the supply of barnyard manure, which in turn has made the maintenance of soil fertility more difficult.

The Conservation Survey

Methods and Definitions

FIELD MAPPING was done on aerial photographs having a scale of approximately 8 inches to the mile, or 660 feet to the inch. The survey showed soil types, slope classes, erosion classes expressing the type and degree of soil erosion that has occurred, and the present land use. On the maps that accompany this bulletin, land-capability classes are shown in colors; brown boundary lines and symbols show erosion classes, slope classes, and soil types; and land use at the time of the survey is shown in gray, using symbols to designate pasture, woodland, and idle land. Roads, houses, and other features of the base map are shown in black and drainage is in blue.

Use of the physical survey in classifying land according to use capability has been presented and discussed on pages 2–3. In this section there is given a record of each of the conditions mapped, the symbols that were used, the acreage of each major separation of soil types, slope classes, erosion classes or groups, and classes of present land use shown in relation to the other three factors, and a discussion of the results of the survey.

Soils were mapped according to the standards of the Division of Soil Survey, Bureau of Plant Industry. Fifteen distinct types or complexes were mapped. They are described on pages 19–21.

Slope classes are established in order to give recognition to the slope factor in classifying land according to its use capability. A slopes are those less than 2 percent; B slopes are from 2 to 5; BB, 5 to 8; C, 8 to 12; and D, 12 percent and over.

Five classes of present land use were mapped. Cropland includes all land that is cultivated regularly. Grassland includes chiefly pasture, but also some native meadows that are cut for hay. Idle land is land not having a cover of trees or grass and not occupied by crops at the time of the survey. Woodland is land of which at least 40 percent is covered by the spread of trees. An additional class, designated as farmyards, includes some of the larger farmsteads and other areas that could not otherwise be classified.

The type and degree of erosion were mapped and evaluated to obtain information on the rate and present stage of this phase of soil deterioration. Both sheet and gully erosion were mapped. Sheet erosion is the removal of a more or less uniform layer of soil, largely through the formation of tiny rills and channels that are smoothed out by cultivation. Gully erosion is the formation of definite channels that are not obliterated by cultivation. The degree of sheet erosion was estimated by comparing the present topsoil (the surface soil to plow depth or the A horizon, whichever is deeper) with that which existed before cultivation was begun.

[1] The figures refer to percentages, respectively, of nitrogen, phosphoric acid, and potash.

Soils that had never been disturbed by cultivation were examined, and this furnished an indication of the original depth of the surface layers on similar soils and slopes.

The following symbols were used to designate the type and degree of erosion:

Sheet erosion:
- 2. Less than 25 percent of topsoil removed.
- 3. 25 to 75 percent of topsoil removed.
- 4. 75 percent or more of topsoil removed, or all topsoil and some subsoil removed.

Gully erosion:
- 7. Occasional gullies: More than 100 feet apart.
- 8. Frequent gullies: Occurring less than 100 feet apart, but including less than 75 percent of area delineated.
- ○. Indicates gullies too deep to be crossed with tillage implements, as ⑦ or ⑧.

Miscellaneous:
- 1. No apparent erosion.
- Θ. Undifferentiated erosion.

Erosion classes were designated by sheet-erosion or miscellaneous symbols, or by combinations of sheet-erosion and gully symbols. Ten different erosion classes were mapped, as shown in table 6. The table also shows the grouping of these classes to give more concise expression of the severity of erosion.

TABLE 6.—*Acreage and percentage of each erosion group and class*

Erosion group and class	Area	
	Acres	*Percent*
No apparent erosion:		
1	1,326	4.7
Slight erosion:		
2	9,869	35.3
27	1,191	4.3
Θ	843	3.0
Total	11,903	42.6
Moderate erosion:		
3	6,466	23.1
37	4,524	16.2
Total	10,990	39.3
Severe erosion:		
38	131	0.5
4	1,078	3.8
Total	1,209	4.3
Very severe erosion:		
47	2,279	8.2
48	261	0.9
Total	2,540	9.1
Total	27,968	100.0

Soils

Soils of the project are for the most part dark and heavy textured. The area is underlain by sandstones, shales, and limestones of the Lawrence and Oread formations of the Pennsylvanian period. On these rocks a variety of soils have developed including the Bates soils on sandstones, the Summit, Labette, and Newtonia soils on shales and limestones, and the Parsons soils on heavy shales. Materials washed from the uplands and deposited in valleys have developed into the Neosho soils on second bottoms or terraces, and into the Lightning and Verdigris soils on the present flood plains.

Fifteen soil separations, belonging to ten series, were mapped in the project. These may be placed for convenience in 6 groups, brief descriptions of which are given here. Characteristics of the various soil series are given in table 7, which also gives the acreage and percentages of each soil type.

Group 1 includes the loam, fine sand, and fine sandy loam, shallow phase, of the Bates soils. These soils have grayish-brown or brownish-gray surface layers and friable, brownish-yellow, fine sandy loam subsoils. Sandstone bedrock occurs commonly at about 30 inches but is nearer to the surface in the shallow phase. The soils are well drained and moderately fertile. In dry seasons, corn is more successful on them than on soils having finer-textured subsoils. The Bates soils are suitable for a wide range of crops.

Group 2 includes Bates silt loam and the Bates-Collinsville complex. The soils of this group resemble those of group 1 but have more clay and occur as a rule on gentler slopes. Collinsville soils are shallower and more stony than the Bates.

Group 3 includes Summit silty clay loam and its shallow phase, and Sogn stony silty clay loam. These soils are darker and have finer-textured subsoils than the Bates soils. They occur on gently undulating to rolling surfaces. They are strong and very productive but are a little more difficult to work than the more sandy Bates soils because

TABLE 7.—*Characteristics of soil series and acreage of each soil type mapped*

Soil group and series	Soil type	Area		Description of soil profile		Parent or underlying material	Relief	Natural drainage		Distribution in project	Dominant land-capability class
				Surface soil	Subsoil			Surface	Internal		
		Acres	*Pct.*								
1. Bates soils, light textured.	Fine sand	27	0.1	Grayish brown or brownish gray. Crumb structure. Medium or slightly acid. 8 to 12 inches.	Brown friable loam to clay loam or sandy clay. May be splotched with red or gray. Medium or slightly acid. 10 to 15 inches.	Disintegrated sandstone merging into hard rock.	Undulating to gently rolling.	Good	Good	Chiefly in southern two-thirds of project.	III.
	Fine sandy loam, shallow phase.	667	2.4								
	Loam	3,329	11.9								
	Total	4,023	14.4								
2. Bates soils, heavy textured:											
Bates	Silt loam	6,201	22.3								
Bates-Collinsville.	Complex	173	.6								
	Total	6,374	22.9								
3. Summit and Sogn soils:											
Summit	Silty clay loam	5,954	21.2	Dark grayish brown to black. Granular. 12 to 15 inches. Shallow phase, 3 to 6 inches.	Dark-brown to olive-brown compact silty clay. 15 to 20 inches. Coarse irregular structure.	Yellowish-brown to olive-brown plastic silty clay. Rests on limestone at about 6 feet.	Gently sloping.	do	Fair		III, V.
	Silty clay loam, shallow phase.	1,746	6.2								
Sogn	Stony silty clay loam.	185	.7	Dark grayish brown. 2 to 3 inches. Stony.	Grayish-brown silty clay. Stony.	Limestone and shale at 10 to 12 inches.	do	do	Good		V.
	Total	7,885	28.1								
4. Labette and Newtonia soils:											
Labette	Silty clay loam	3,233	11.6	Dark grayish brown. Friable. Granular. 10 to 12 inches.	Reddish brown or chocolate brown.	Limestone and calcareous shale.	Undulating or very gently rolling.	do	do	Upper ridges in northern third of project.	III.
Labette-Newtonia.	Silty clay loams	869	3.1	Light reddish gray to reddish brown. Loose. Granular. 5 to 8 inches.	Brownish-red or dark-red friable silty clay or clay. About 25 inches.	Limestone	Undulating or gently rolling.	do	do	Northern third of project.	III.
	Total	4,102	14.7								
5. Parsons-Woodson soil.	Silty clay loams	2,248	8.0	Dark brown to grayish black. Granular. 7 to 10 inches.	Heavy, stiff, dark grayish-brown clay. About 20 inches.	Moderately friable light gray clay. Grades into shales or sandy shales.	Gently undulating.	Slow	Slow	Southern two-thirds of project.	II.
6. Verdigris, Lightning, and Neosho soils:											
Neosho	Silt loam	72	.3	Light brown. 6 inches.	Light-gray floury silt loam. 8 to 15 inches. Rests on claypan layer of dark-brown or dark-gray, dense clay.	Grayish-brown, massive clay.	Nearly level	Imperfect.	Imperfect.	On stream terraces.	I.
Lightning	Silt loam, terrace phase.	601	2.1	Grayish-brown or dark gray silt loam. 10 to 12 inches.	Mottled dark-brown waxy silty clay. About 30 inches.	Grayish-brown or olive-brown clay.	do	do	Poor	On low terraces just above streams.	I.
Verdigris	Silt loam	1,656	5.9	Dark brown to black. Friable. Granular. 8 to 10 inches.	Yellowish-brown friable silt loam. 35 inches or more.	Variable	do	do	Good	Flood plains	I.
	Silty clay loam	1,007	3.6								
	Total	3,336	11.9								
	Total	27,968	100.0								

of their higher clay content. Sogn soils are very shallow soils on limestone.

Group 4 includes the Labette and Newtonia soils, which have dark-brown and reddish-brown surface layers respectively and which rest on limestone or calcareous shale. These soils have more friable subsoils than the Summit soils. They are productive and are suitable for all of the common crops.

Group 5 includes a single soil complex, the Parsons-Woodson silty clay loams. These soils have dark-brown to grayish-black surface layers that overlie stiff clay subsoils through which water moves slowly The subsoils have poor internal drainage and restrict the development of roots. Corn is likely to be severely damaged by drought, but small grains and grasses that have shallower root systems commonly give satisfactory yields.

Group 6 includes the soils on the bottom lands and terraces. The Verdigris soils, which are on present flood plains, have rather open, friable subsoils and fairly good internal drainage. They are among the best soils in the project for the production of corn and alfalfa. The Lightning soils, also on the flood plains, have imperfect to poor drainage and are suitable mainly for pasture and for native hay production. The Neosho soils occupy terraces. They have sticky, clay subsoils, poor underdrainage, and are suited chiefly for hay or pasture land but also for growing wheat, corn, alfalfa, and sorghums.

Slope classes on the different soil groups are set out in table 8. The Bates and Summit soils occur on a wide range of slopes and include nearly all the C and D slopes in the project. The Labette, Newtonia, and Parsons-Woodson soils are chiefly on A and B slopes, and the soils of group 6 are almost wholly on A slopes.

Erosion

Erosion has been active on all the upland soils. The soils are fine-textured and slowly permeable. Rainfall is sometimes very intense. For example, 5 inches in 3 hours and 33 minutes were recorded at Kansas City on July 8 and 9, 1926. Such rains cause enormous run-off and erosion on unprotected slopes. Erosion caused by a single rain on a newly plowed field is shown in figure 9.

Severe or very severe water erosion has affected 13.4 percent of the project, an area of 3,749 acres. There is no significant wind erosion, although local duststorms may occur during dry summers. Numerous filled ponds and accumulations of soil material on lower slopes furnish evidence of active erosion. These deposits, coming chiefly from severely eroded areas, have damaged fertile soils and the crops growing on them, and expensive installations of culverts and ditches along highways.

Moderate erosion has affected 10,990 acres, which amount to 39.3 percent of the land. This is the land that is critical at the present time with respect to erosion. Use of this land according to its physical capability, including the necessary erosion-control practices, can preserve it indefinitely. Further neglect will permit much or even all of it to attain the severely eroded stage within a few years.

Slight erosion was mapped on 11,903 acres, or 42.6 percent of the land. This is still good land, but it is susceptible

TABLE 8.—*Distribution of the slope classes in each soil group*

Soil group	A slopes (less than 2 percent)		B slopes (2–5 percent)		BB slopes (5–8 percent)		C slopes (8–12 percent)		D slopes (12 percent and over)		Total
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*
1. Bates soils, light textured	85	2.1	2,639	65.6	818	20.3	354	8.8	127	3.2	4,023
2. Bates soils, heavy textured	175	2.7	5,245	82.3	685	10.7	246	3.9	23	.4	6,374
3. Summit and Sogn soils	1,299	16.5	4,572	58.0	1,396	17.7	528	6.7	90	1.1	7,885
4. Labette and Newtonia soils	837	20.4	3,123	76.2	132	3.2	10	.2	0	-------	4,102
5. Parsons-Woodson silty clay loams	666	29.6	1,514	67.4	68	3.0	0	-------	0	-------	2,248
6. Verdigris, Lightning, and Neosho soils	3,269	98.0	67	2.0	0	-------	0	-------	0	-------	3,336
Entire project	6,331	22.6	17,160	61.4	3,099	11.1	1,138	4.1	240	.8	27,968

to destruction by erosion and needs erosion-control measures. Only 1,326 acres were mapped as not affected by erosion.

Relation of Erosion to Soil Types, Slopes, and Present Land Use

The Bates and Summit soils account for nearly all the severe and very severe erosion mapped in the project, as shown in table 9. Bates soils are the most susceptible to erosion (fig. 10). They have stiff clay subsoils that, although they are granular, do not permit rapid movement of water. The coarse-textured soils are eroded more severely than the silty clay loams. Labette and Newtonia soils are more granular and friable than the Summit soils, and therefore slightly less erodible, although the subsoils become dispersed in water rather easily. Shallow bedrock in the Newtonia soils prevents formation of deep gullies.

Moderate erosion has affected 40 percent or more of all soil groups except 5 and 6, which lie almost wholly on A and B slopes. Slight erosion is dominant on the soils of groups 5 and 6, intermediate on the Summit and on the Newtonia and Labette soils (groups 3 and 4), and somewhat less extensive on the Bates soils (groups 1 and 2).

Erosion is more closely related in many instances with slope and cover than with the type of soil. In general, an increase in slope means increased run-off and also increased velocity of run-off, both of which lead to increased erosion. Many erosion-control measures have as their object a modification of the effects of slope or cover, such as construction of terraces to intercept the flow of water or strip cropping to check the velocity of run-off.

The relation of slope to existing erosion is shown in table 10 and is brought out more clearly, since the influence of cover is eliminated, in table 11, which shows only cropland. A slopes on cropland are slightly eroded on 98.9 percent of their area, whereas the C slopes are severely and very severely eroded on 85.2 percent of their cropped

Kans-5118

Figure 9.—**Erosion caused in a newly plowed field by a single rain.**

Kans-5106

Figure 10.—**This gully in Bates silty clay loam has cut through surface soil and subsoil to the underlying rock. Bates soils are highly susceptible to erosion.**

areas. The area of D slopes in cropland is only 7 acres, all severely eroded.

Present land use is largely determined by soil and slope, except where erosion has already caused abandonment or only partial use of fields that were formerly productive. Present use of the different soil groups is shown by table 12. The Newtonia and Labette, and the Parsons-Woodson soils are occupied by the highest percentage of cropland, and the terrace and bottom-

TABLE 9.—*Distribution of the erosion groups in each soil group*

Erosion group	Bates soils, light textured		Bates soils, heavy textured		Summit and Sogn soils		Newtonia and Labette soils		Parsons-Woodson silty clay loams		Verdigris, Lightning, and Neosho soils		Entire project	
	Acres	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*
No apparent erosion	0	.....	2	(1)	126	1.6	75	1.8	16	0.7	1,107	33.2	1,326	4.7
Slight erosion	910	22.6	2,264	35.5	3,247	41.2	1,732	42.2	1,521	67.7	2,229	66.8	11,903	42.6
Moderate erosion	2,137	53.1	2,955	46.5	3,175	40.3	2,098	51.2	625	27.8	0	.....	10,990	39.3
Severe erosion	281	7.0	341	5.3	474	6.0	94	2.3	19	.8	0	.....	1,209	4.3
Very severe erosion	695	17.3	812	12.7	863	10.9	103	2.5	67	3.0	0	.....	2,540	9.1
Total	4,023	100.0	6,374	100.0	7,885	100.0	4,102	100.0	2,248	100.0	3,336	100.0	27,968	100.0

[1] Less than 0.1 percent.

land soils of group 6 by the least, having crops on less than 35 percent of their area. More than half of the entire project, however, is in crops of one kind or another.

Table 13 shows that there is no serious misuse of steeply sloping land. There are 142 acres of C and D slopes in cultivation, comprising 11.9 percent of the C slopes and 2.9 percent of the D slopes. As has already been pointed out in the discussion of land capability, conservation farming can be accomplished on most of the project and also in the surrounding land, by adopting soil-saving and soil-building practices without any wholesale adjustments in land use.

TABLE 10.—*Distribution of the erosion groups in each slope class*

Erosion group	A slopes (less than 2 percent)		B slopes (2–5 percent)		BB slopes (5–8 percent)		C slopes (8–12 percent)		D slopes (12 percent and over)		Entire project	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
No apparent erosion	1,322	20.9	4	(1)	0	-------	0	-------	0	-------	1,326	4.7
Slight erosion	4,963	78.4	6,361	37.1	518	16.7	60	5.3	1	0.4	11,903	42.6
Moderate erosion	46	.7	8,830	51.5	1,302	42.1	701	61.6	111	46.3	10,990	39.3
Severe erosion	0	-------	543	3.2	395	12.7	175	15.4	96	40.0	1,209	4.3
Very severe erosion	0	-------	1,422	8.2	884	28.5	202	17.7	32	13.3	2,540	9.1
Total	6,331	100.0	17,160	100.0	3,099	100.0	1,138	100.0	240	100.0	27,968	100.0

[1] Less than 0.1 percent.

TABLE 11.—*Distribution of the erosion groups in each slope class for cropland*

Erosion group	A slopes (less than 2 percent)		B slopes (2–5 percent)		BB slopes (5–8 percent)		C slopes (8–12 percent)		D slopes (12 percent and over)		All cropland	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Slight erosion	3,498	98.9	1,669	16.4	0	-------	1	0.7	0	-------	5,168	34.2
Moderate erosion	40	1.1	6,815	66.8	377	30.3	19	14.1	0	-------	7,251	48.0
Severe erosion	0	-------	413	4.1	281	22.5	62	45.9	7	100.0	763	5.0
Very severe erosion	0	-------	1,296	12.7	588	47.2	53	39.3	0	-------	1,937	12.8
Total	3,538	100.0	10,193	100.0	1,246	100.0	135	100.0	7	100.0	15,119	100.0

TABLE 12.—*Distribution of the land use classes in each soil group*

Land use class	Bates soils, light textured		Bates soils, heavy textured		Summit and Sogn soils		Newtonia and Labette soils		Parsons-Woodson silty clay loams		Verdigris, Lightning, and Neosho soils		Entire project	
	Acres	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*	*Acres*	*Pct.*
Cropland	1,904	47.3	3,376	53.0	4,413	56.0	2,809	68.5	1,469	65.4	1,148	34.4	15,119	54.1
Idle land	39	1.0	60	.9	59	.7	1	(1)	11	.5	19	.6	189	.7
Pasture	1,480	36.8	2,269	35.6	3,121	39.6	1,086	26.5	677	30.1	849	25.5	9,482	33.9
Woodland	467	11.6	463	7.3	84	1.1	14	.3	14	.6	1,293	38.7	2,335	8.3
Farmyards	133	3.3	206	3.2	208	2.6	192	4.7	77	3.4	27	.8	843	3.0
Total	4,023	100.0	6,374	100.0	7,885	100.0	4,102	100.0	2,248	100.0	3,336	100.0	27,968	100.0

[1] Less than 0.1 percent.

TABLE 13.—*Distribution of the land use classes in each slope class*

Land use class	A slopes (less than 2 percent)		B slopes (2–5 percent)		BB slopes (5–8 percent)		C slopes (8–12 percent)		D slopes (12 percent and over)		Entire project	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Cropland	3,538	55.8	10,193	59.4	1,246	40.2	135	11.9	7	2.9	15,119	54.1
Idle land	29	.5	117	.7	24	.8	16	1.4	3	1.2	189	.7
Pasture	1,295	20.5	5,834	34.0	1,608	51.9	659	57.9	86	35.8	9,482	33.9
Woodland	1,301	20.5	440	2.6	152	4.9	299	26.3	143	59.7	2,335	8.3
Farmyards	168	2.7	576	3.3	69	2.2	29	2.5	1	.4	843	3.0
Total	6,331	100.0	17,160	100.0	3,099	100.0	1,138	100.0	240	100.0	27,968	100.0

TABLE 14.—*Distribution of the erosion groups in each land use class*

Erosion group	Cropland		Idle land		Pasture		Woodland		Farmyards		Entire project	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
No apparent erosion	0		0		267	2.8	1,059	45.4	0		1,326	4.7
Slight erosion	5,168	34.2	47	24.9	5,195	54.8	650	27.8	843	100.0	11,903	42.6
Moderate erosion	7,251	48.0	87	46.0	3,108	32.8	544	23.3	0		10,990	39.3
Severe erosion	763	5.0	33	17.5	348	3.7	65	2.8	0		1,209	4.3
Very severe erosion	1,937	12.8	22	11.6	564	5.9	17	.7	0		2,540	9.1
Total	15,119	100.0	189	100.0	9,482	100.0	2,335	100.0	843	100.0	27,968	100.0

The effect of present land use on erosion is shown conclusively in table 14. All of the cropland is at least slightly eroded even on A slopes, and nearly 18 percent of it is severely or very severely eroded. Idle land has 29.1 percent of its area affected by severe and very severe erosion, but the acreage is small. Slight erosion predominates on pastures, but there is some severe erosion, indicating either destructive grazing practices or the retirement of eroded cropland to pasture. Nearly half of the woodland (which is largely on soil group 6) is unaffected by erosion, and the acreage of severe erosion on woodland is very small. Table 14 shows, and it has been proved repeatedly, that a good cover of vegetation protects the soil.

Summary

THIRTEEN PERCENT of the land drained by West Tauy Creek in eastern Kansas has been severely or very severely eroded, and 39 percent more has been moderately eroded. Most of this land was brought under cultivation less than a century ago.

Seventy-six percent of the land is suitable for crops. Over two-thirds of this area, however, is in classes II and III and requires special practices if it is to be cultivated safely and permanently. Since only 54 percent of the project is now used for crops, no reduction of the total acreage of cropland is required to use the land according to its capability. Slightly more than 21 percent of the present cropland, however, is too steep, too severely eroded, or otherwise unsuitable for safe cropping. To attain conservation farming, this area of approximately one-fifth of the land cropped at the time of the survey must be retired from cultivation and protected by permanent vegetation.

Practices to control water and save soil, which are needed on two-thirds of the land that is suitable for crops, include strip cropping, contour tillage, some terracing, diversion of water from gullies, and some strips of perennial hay or other vegetation. All cropland needs rotation of crops and numerous soil-building measures such as application of farm manure, lime, and phosphate, and the growing of legume crops. Usually, the lands of classes II and III need more lime and fertilizer than those of class I.

All these practices may be seen in operation on the West Tauy demonstration project, which is located just north of Ottawa, in Douglas and Franklin Counties, in eastern Kansas.

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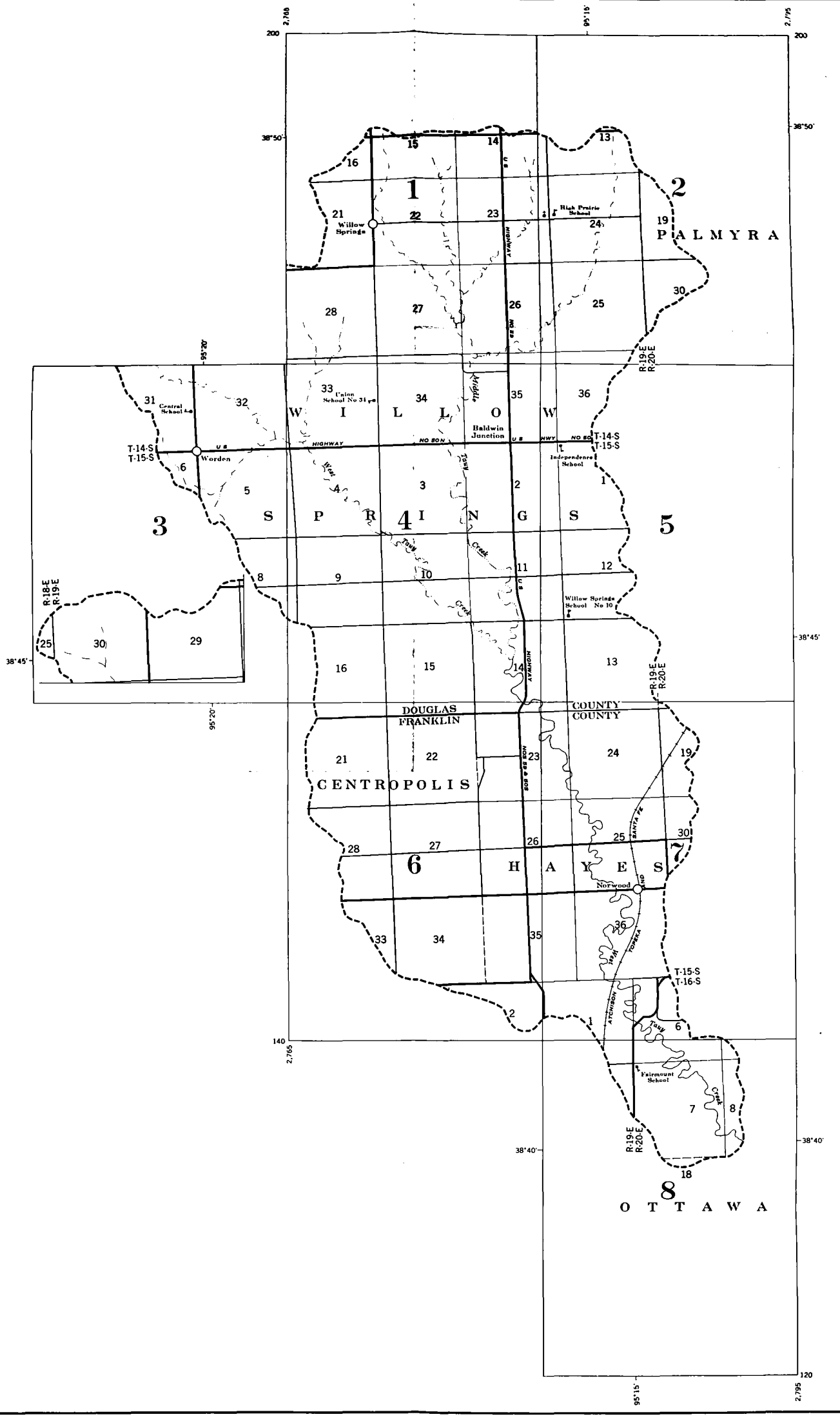
KANSAS
EROSION AND LAND-USE CONDITIONS

INDEX
WEST TAUY CREEK PROJECT
KAN-8



1 ¼ 0 1 2 3 Miles

5000 0 5000 10000 15000 Feet

- Surfaced roads
- Dirt roads
- Railroads
- Section line
- U S township lines
- Civil township lines
- Project boundary