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A Survey of Soils Irrigated with Arkansas River Water

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Research Project Technical Completion Report A-062-ARK

Arkansas Water Resources Research Center
University of Arkansas
Fayetteville, Arkansas 72701

Arkansas Water Resources Research Center

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United States Department of the Interior

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ABSTRACT

A SURVEY OF SOILS IRRIGATED WITH ARKANSAS RIVER WATER

Interest in the use of Arkansas River water for irrigation has increased recently as land adjacent to the river is converted to crop production and river water is considered as an alternative to depleted underground supplies. Since the Arkansas River can contain elevated concentrations of sodium chloride, this study was designed to determine if soil conditions adverse to crop growth were developing where river water has been used. The impact of river water on sites where river water was used as either the sole source for up to 3 years or as a supplement to another surface source for up to 20 years was evaluated. The mean surface and profile ESPs were both 3.7%, while parallel ECs for 1:2 soil: water extract were 183 and 163 umhos/cm, respectively. Mean surface and profile chloride concentrations were 32 and 50 ug/g, respectively. Mean saturated hydraulic conductivities were 0.015 cm/hr for the surface soil. No data were obtained which suggested that the use of the Arkansas River under the conditions described above was detrimental to soil physical or chemical properties. Periodic reevaluation of this conclusion is suggested at sites where direct use of Arkansas River water continues for an extended period of time.

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A SURVEY OF SOILS IRRIGATED WITH ARKANSAS RIVER WATER
Completion Report to the Office of Water Policy, Department of the Interior, Washington, D. C., March 1983
KEYWORDS--irrigation/ conductivity/ hydrogen ion concentration/saline water/ saline soils/ salinity/ salts/ soil physical properties/ sodium/ sodium chloride/ water quality

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I. INTRODUCTION

In recent years use of Arkansas River water for irrigation of agricultural crops has received increased attention. Irrigation of land adjacent to the river as well as water poor areas which might use river water transported by a network of canals are rapidly becoming a reality. A conservative estimate of the acreage potential next to the Arkansas River is 250,000 acres (S. L. Chapman, unpublished data). No estimate of irrigable acreage which might result from the development of a canal distribution system is available.

Certainly, water distribution is one factor which has limited the use of Arkansas water for irrigation. Yet, concern about the potential negative impact of the water on soil physical and chemical properties is more often cited as the major factor which has restricted use. Of primary concern has been a high salinity level due to sodium chloride at some time during the spring and summer of most years (United States Geological Survey, 1979-1982). During these high salinity periods the total salt concentration and sodium adsorption ratio are often more than double the values found during the rest of the year. As the sodium adsorption ratio of irrigation water increases, receiving soils tend to become sodic with attendant poor physical condition and at times, high pH (Reeve and Fireman, 1967). As total salt concentration (electrical conductivity) of irrigation water rises so does that of the soil being irrigated (Reeve and Fireman, 1967).

Over three decades ago it was recognized that use of the Arkansas

River for irrigation might lead to salinization of the soil (Kapp, 1948). Since that early warning, however, only one study directed specifically toward the Arkansas River and associated soils has been conducted (Hileman, 1974). Hileman (1974) brought cores of selected soil types to the laboratory and irrigated them with simulated river water. He concluded that: a) 7 of the 12 soil types could be irrigated with less than 6 inches of water per year, b) 2 of the 12 soil types could be furrow irrigated and c) none of the soils tested could be flood irrigated.

Other studies conducted in Arkansas have evaluated soil salinity (Hall and Thompson, 1962; Place and Keith, 1971) and rice plant response to salt (Hall and Thompson, 1962; Gilmour et al., 1977 Baser and Gilmour, 1982). The overall conclusion from these studies was that rice grown in Arkansas was very sensitive to moderate salinity levels in the seedling stage. This sensitivity is especially acute where chloride salts are dominant (Baser and Gilmour, 1983). Soybean response to salinity has shown that soybean seedlings are somewhat more tolerant than rice (J. Prasittikhet. 1977. Effect of salinity composition on soybean germination and subsequent seedling growth. M. S. Thesis. University of Arkansas).

Recently, salt and water balance models for an Arkansas soil have been updated and field verification of model output obtained (Gilmour et al., 1981). Salt losses via winter runoff in the latter were measured and were similar to those reported by Gilmour et al. (1976). The overall salt balance from these studies pointed out that well waters contributed more soluble salts to the soil than was removed in runoff and crop uptake. No published studies on the movement of salt within these soils is currently available for Arkansas.

The objective of this study was to measure key soil physical and chemical properties which could be altered by irrigation with Arkansas River water. These soil properties include soil pH, electrical conductivity, exchangeable sodium percentage and saturated hydraulic conductivity.

II. MATERIALS AND METHODS

Sites were located on rice-soybean farms adjacent to the Arkansas River. Sites were identified where Arkansas River water was the sole water source and where river water was mixed with surface water in a tributary to the river or overflow area. In the latter areas river water was not the sole irrigation water source. Where possible, control soils not irrigated with Arkansas River water were studied so as to provide a frame of reference for data collected at fields irrigated with Arkansas River water. Both surface and soil profile (core) samples were obtained at each site.

Soil Chemical Properties

Soil chemical properties evaluated included: pH; electrical conductivity; chloride, bicarbonate and sulfate concentrations; and exchangeable sodium percentage. A 1:2 soil: water extract was prepared and assayed for pH and electrical conductivity using pH and conductivity meters. After filtration to remove solids, the filtrate was analyzed for chloride with a Buchler-Cotlove chloridometer, sulfate by turbidometry and bicarbonate by titration with dilute acid. The remainder of the soil was dried, ground and extracted with 1N ammonium acetate (pH 7). Exchangeable sodium in the extract was analyzed by atomic absorption spectrophotometry and cation exchange capacity determined on the ammonium saturated soil sample using the semi-micro Kjeldahl technique. Standard methods (American Public Health Association, 1971; American Society of Agronomy, 1965; U. S. Salinity Laboratory Staff, 1954) were used throughout.

Soil Physical Properties

Soil physical properties evaluated included: particle size distribution, saturated hydraulic conductivity and water retention at -1/3 bar water potential. Soil cores collected in the field were assessed for infiltration capacity by the falling head method. Particle size distribution was evaluated using the hydrometer method. Water retention at -1/3 bar water potential was measured using pressure plate technique. Standard methods (American Society of Agronomy, 1965) were used.

III. RESULTS AND DISCUSSION

A total of 32 sites were selected along the Arkansas River in Desha, Faulkner, Jefferson and Perry counties. The descriptions of ten sites located far enough from the river to preclude sole use from the river are presented in Table 1a. At these sites river water was either mixed with another surface water or served as a water source only part of the year. The descriptions of twenty-two sites where river water was the sole irrigation water source are given in Table 1b. Maps of each site were made from soil surveys and are found in the Appendix. Tables 1a and b also show the soil series at each site and the years the soil had been irrigated by river water. Seven soil series (Coushatta, Desha, Gallion, Moreland, Norweed, Roxana and Perry) were identified in the study area. The term 'like' was used in Tables 1a and b to designate soils which appeared to be a series in the field but did not meet the textural range given for a horizon in the series. At sites where river water was the sole source of irrigation the maximum years of irrigation was 3, while at the other sites river water had been an irrigation supplement for up to 20 years.

Detailed soil chemical and physical data for profiles of each soil series are given in the Appendix Tables 1-14. These detailed data are summarized in Table 1. Properties of the surface soil (top 16cm) were similar to those of the entire profile for a majority of variables. Of particular interest were exchangeable sodium percentage (ESP), electrical conductivity ($EC_{1:2}$), chloride

Table 1a - Site descriptions for sites irrigated with Arkansas River water mixed with another surface source.

Site	County	Legal Description	Surface Water Source	Distance from River	Years Irrig	Soil Series
				km	yr	
1	Jefferson	R10W, T3S, Sec 3	unnamed	1.0	20	Desha like
2	Jefferson	R10W, T3S, Sec 3	unnamed	1.3	20	Desha like
3	Jefferson	R7W, T6S, Sec 11	Kings Bayou	1.6	0	Couchatta
4	Jefferson	R7W, T6S, Sec 11	Kings Bayou	2.0	3	Coushatta
5	Jefferson	R4W, T7S, Sec 4	Bayou Meto	3.3	7	Desha
6	Jefferson	R5W, T6S, Sec 36	Bayou Meto	7.9	0	Desha
7	Jefferson	R4W, T7S, Sec 15	Bayou Meto	0.6	?	Norwood
8	Desha	R3W, T9S, Sec 31	Silver Lake	1.3	2	Coushatta
9	Desha	R3W, T9S, Sec 31	Silver Lake	1.3	1	Coushatta like
10	Desha	R3W, T9S, Sec 30	Silver Lake	1.3	2	Coushatta

Table 1b - Site descriptions for sites irrigated with Arkansas River water alone.

Site	County	Legal Description	Surface Water Source	Distance from River	Years Irrig	Soil Series
				km	yr	
11	Faulkner	R14W, T4N, Sec 27	Arkansas River	0	1	Gallion
12	Faulkner	R14W, T4N, Sec 27	Arkansas River	0	1	Gallion like
13	Faulkner	R14W, T4N, Sec 27	Arkansas River	0	1	Roxana
14	Faulkner	R14W, T4N, Sec 27	Arkansas River	0	2	Moreland like
15	Faulkner	R14W, T4N, Sec 27	Arkansas River	0	2	Moreland
16	Faulkner	R14W, T4N, Sec 27	Arkansas River	0	2	Perry
17	Faulkner	R14W, T4N, Sec 27	Arkansas River	0	0	Perry like
18	Faulkner	R14W, T4N, Sec 26	Arkansas River	0	3	Moreland
19	Faulkner	R14W, T4N, Sec 26	Arkansas River	0	3	Moreland like
20	Faulkner	R14W, T4N, Sec 26	Arkansas River	0	3	Perry
21	Faulkner	R14W, T4N, Sec 26	Arkansas River	0	0	Gallion like

Table 1-b (cont'd) - Site descriptions for sites irrigated with Arkansas River water alone.

Site	Couney	Legal Description	Surface Water Source	Distance from River	Years Irrig	Soil Series
				km	yr	
22	Faulkner	R14W, T4N, Sec 26	Arkansas River	0	0	Gallion
23	Faulkner	R14W, T4N, Sec 26	Arkansas River	0	0	Gallion
24	Perry	R15W, T5N, Sec 10	Arkansas River	0	3	Moreland
25	Perry	R15W, T5N, Sec 10	Arkansas River	0	3	Gallion
26	Perry	R15W, T5N, Sec 9	Arkansas River	0	3	Moreland like
27	Perry	R15W, T5N, Sec 10	Arkansas River	0	3	Gallion
28	Perry	R15W, T5N, Sec 10	Arkansas River	0	3	Gallion
29	Perry	R15W, T5N, Sec 10	Arkansas River	0	0	Moreland like
30	Faulkner	R14W, T4N, Sec 26	Arkansas River	0	1	Moreland
31	Faulkner	R14W, T4N, Sec 26	Arkansas River	0	1	Perry like
32	Faulkner	R14W, T4N, Sec 27	Arkansas River	0	1	Perry

and saturated hydraulic conductivity (K_{sat}) as these variables reflected river water quality and soil productivity. The mean ESP of 3.7% for both the surface and profile samples was substantially less than 15% where sodic soils develop and physical properties deteriorate (Bresler et al., 1982). The mean $EC_{1:2}$s of the surface and profile samples were 183 and 163 umhos/cm, respectively. Assuming that the $EC_{1:2}$ was about one-fifth of an EC of the saturation extract, the $EC_{1:2}$ results were 2 to 5 times lower than needed for saline soil conditions (Bresler et al., 1982). Mean soil profile chloride concentrations were larger than surface concentrations which suggested that downward movement of chloride had occurred. Neither chloride concentration or $EC_{1:2}$ was large enough to affect rice crop growth (Baser and Gilmour, 1982). Mean unsaturated hydraulic conductivity was within the range found for soils cropped to rice (Gilmour et al., 1981). Insufficient K_{sat} data were collected to reach further conclusions. In total, the results presented in Table 2 suggested that soil chemical and physical properties have not been adversely affected by irrigation with Arkansas River water.

The fields in Faulkner and Perry counties (sites 11-32) were selected for more detailed evaluation as Arkansas River was the sole source of irrigation water and varying years of flooded rice irrigation were identifiable. The mean surface soil ESPs and $EC_{1:2}$s for different years of rice production at these sites are presented in Table 3. In both counties, the ESP increased from background levels of slightly less than 3% to about 5% where river water was used.

Table 2 - Summary of soil physical and chemical properties for the study area.

Variable	Units	Surface		Profile	
		Mean	Std Error	Mean	Std Error
Depth	cm	16	1	--	--
CEC	meq/100g	40.0	1.4	42.9	1.0
Sodium	meq/100g	1.4	0.1	1.5	0.1
ESP	%	3.7	0.2	3.7	0.2
EC 1:2	umhos/cm	183	9	163	7
pH	--	6.8	0.1	6.9	0.1
Chloride	ug/g	32	5	50	4
Bicarbonate	ug/g	219	20	202	15
Sulfate	ug/g	25	7	19	3
1/3 bar	g/g	0.31	0.01	0.33	0.01
Ksat	cm/hr	0.0115	0.003	--	--
Sand	%	11	1	9	1
Silt	%	48	2	47	1
Clay	%	41	2	44	1

Most of the increase appeared during the first year of irrigation.

Since ESP is related to irrigation water sodium adsorption ration (SAR_{iw}) as described by Rhoades (1972) an attempt was made to assess Arkansas River water for SAR_{iw} for the period 1978-81. U. S. Geological Survey (1978, 1979, 1980, 1981) data were used to compute SAR_{iw} given in Table 4. These SAR_{iw} data were, in turn, used to compute ESP values shown in Table 4 using Eq. 1 below.

$$ESP = SAR_{iw} (1 + (8.4 - pH_c)) \qquad (1)$$

where pH_c was related to the calcium and magnesium carbonate saturation of the water as described by Rhoades (1972). Computed ESP values were similar to actual results presented in Table 3 except for the prediction for April of 1979. These data supported the hypothesis that Arkansas River water has increased ESPS to values predicted using traditional methods such as Eq. 1. Yet, as discussed above ESPs were not near values found for sodic soils.

Surface soil $EC_{1:2}$ data presented in Table 3 revealed that use of river water has probably caused small increases in soil salinity. Similar data for the Arkansas River are given in Table 4. The mean EC of the river was 620 umhos/cm or about 3-6 times the soil $EC_{1:2}$ values. These electrical conductivities are much smaller than those of saline soils and waters (Bresler et al., 1982).

While the EC of the Arkansas River was not large enough to cause

Table 3 - Summary of ESP and $EC_{1:2}$ in surface soil for sites irrigated only with Arkansas River water.

Sites (s)	Flooded Rice Crops	ESP Mean	ESP Std Error	$EC_{1:2}$ Mean	$EC_{1:2}$ Std Error
		%		umhos/cm	
		Faulkner County			
17, 21-23	0	2.6	0.3	120	30
11-13	1	4.5	0.7	135	10
30-32	1	5.4	0.8	135	20
14-16	2	6.5	0.9	200	20
18-20	3	4.7	0.2	210	30
		Perry County			
29	0	2.9	-	60	-
24-28	3	4.9	0.7	105	25

Table 4 - Summary of Arkansas River water quality for 1978-81 growing seasons.

Year	Month	EC	Chloride	SAR	ESP*
		umhos/cm	mg/l		%
1978	April	408	47	1.5	2.1
	May	346	45	-	-
	June	860	160	-	-
	July	648	150	2.8	4.5
	Aug.	761	150	-	-
	Sept.	696	150	-	-
1979	April	430	77	0.3	0.4
	May	353	64	-	-
	June	504	88	-	-
	July	711	120	-	-
	Aug.	472	77	-	-
	Sept.	510	89	-	-
1980	April	480	91	2.4	3.2
	May	739	150	-	-
	June	1030	220	-	-
	July	-	270	3.7	5.6
	Aug.	1010	200	-	-
	Sept.	-	190	-	-
1981	April	-	46	-	-
	May	-	52	-	-
	June	-	-	-	-
	July	-	220	-	-
	Aug.	-	140	-	-
	Sept.	-	17	-	-

*Computed using Eq. 1.

saline soils to develop over the 3 year period of irrigation at the Faulkner and Perry county sites, caution should be taken where the river water is used for an extended period. This caution is recommended because: a) only 3 years of data were used for the conclusions of this study, b) chloride salts can be specifically toxic to crops, and c) high EC values in the river were correlated to high chloride concentrations. This latter point was illustrated by data in Table 4 where EC and chloride data followed a similar pattern. When a linear regression was attempted, Eq. 2 shown below was obtained.

$$EC = 150 + 4.0 * chloride \qquad (2)$$

where EC was Arkansas River water EC in umhos/cm and chloride was Arkansas River chloride in mg/l. The square of the correlation coeficient was 0.946.

IV. SUMMARY

It was the objective of this study to determine if irrigation with Arkansas River water has caused a deterioration in soil chemical and physical properties. Major conclusions were:

1. Increases in soil ESP were similar to those predicted using traditional equations and were not large enough to cause sodic soils.

2. Increases in soil EC and chloride were small and not large enough to cause saline soils.

3. No evidence of deterioration of soil physical properties was obtained.

4. Use of Arkansas River water as a sole irrigation source for an extended time should be accompanied by additional soil monitoring to assure that the conclusions presented here apply.

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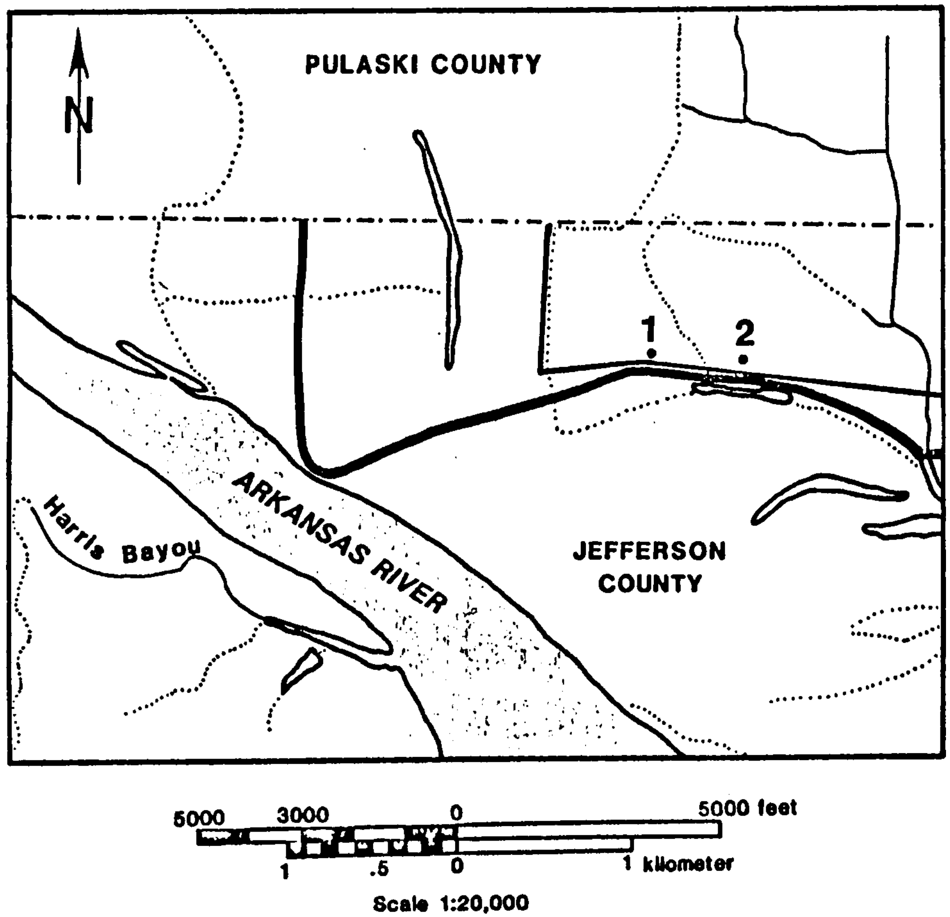
APPENDIX

Maps of Sites

Detailed Data

LEGEND

- COUNTY BOUNDARIES
- ROAD
- DRAINAGE
  - PERENNIAL, DOUBLE LINE
  - PERRENIAL, SINGLE LINE
  - INTERMITIENT
  - DRAINAGE AND/OR IRRIGATION
- WATER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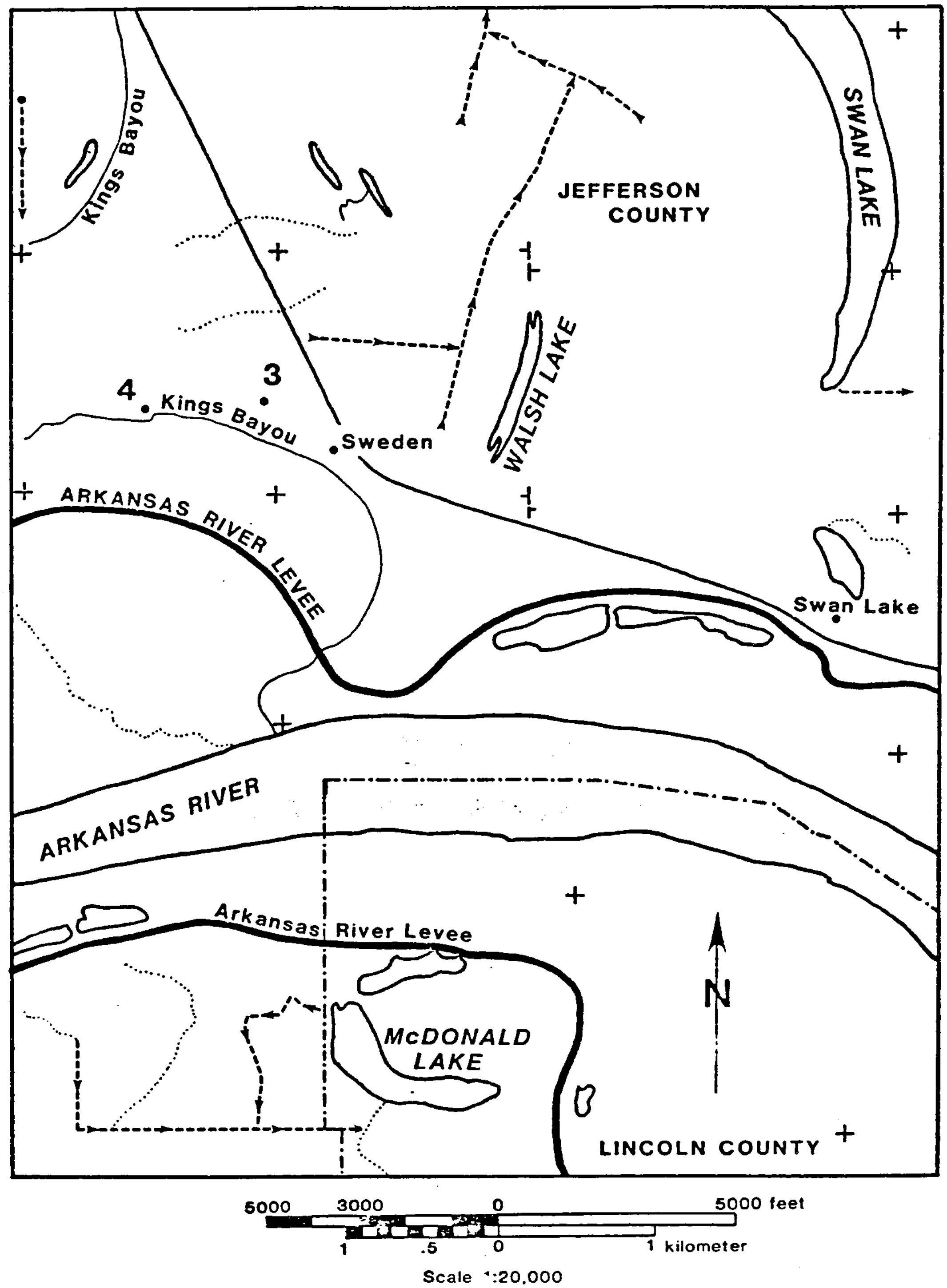
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SWAN LAKE
WALSH LAKE
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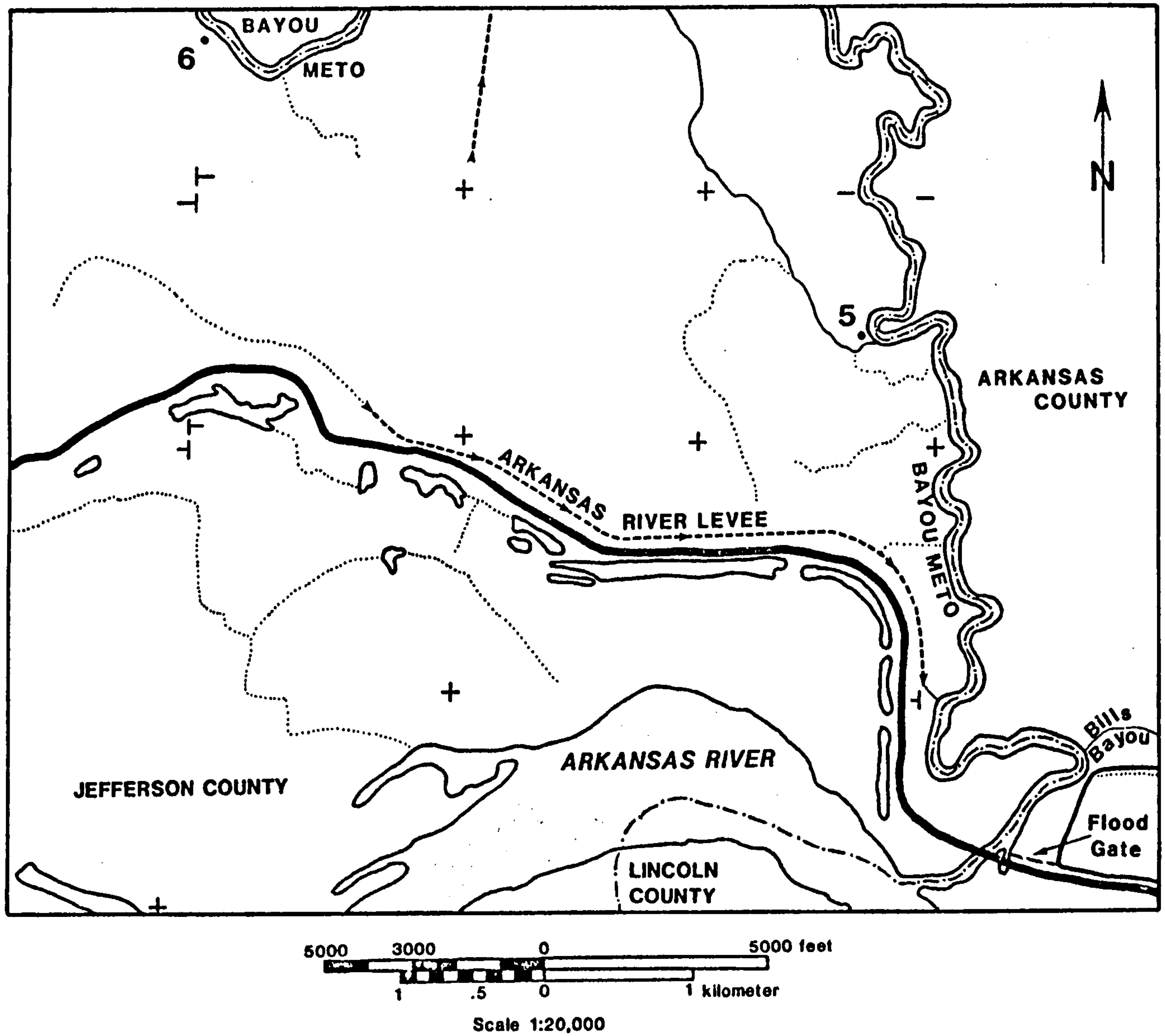
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ARKANSAS
COUNTY
ARKANSAS
RIVER LEVEE
BAYOU METO
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ARKANSAS RIVER
JEFFERSON COUNTY
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COUNTY
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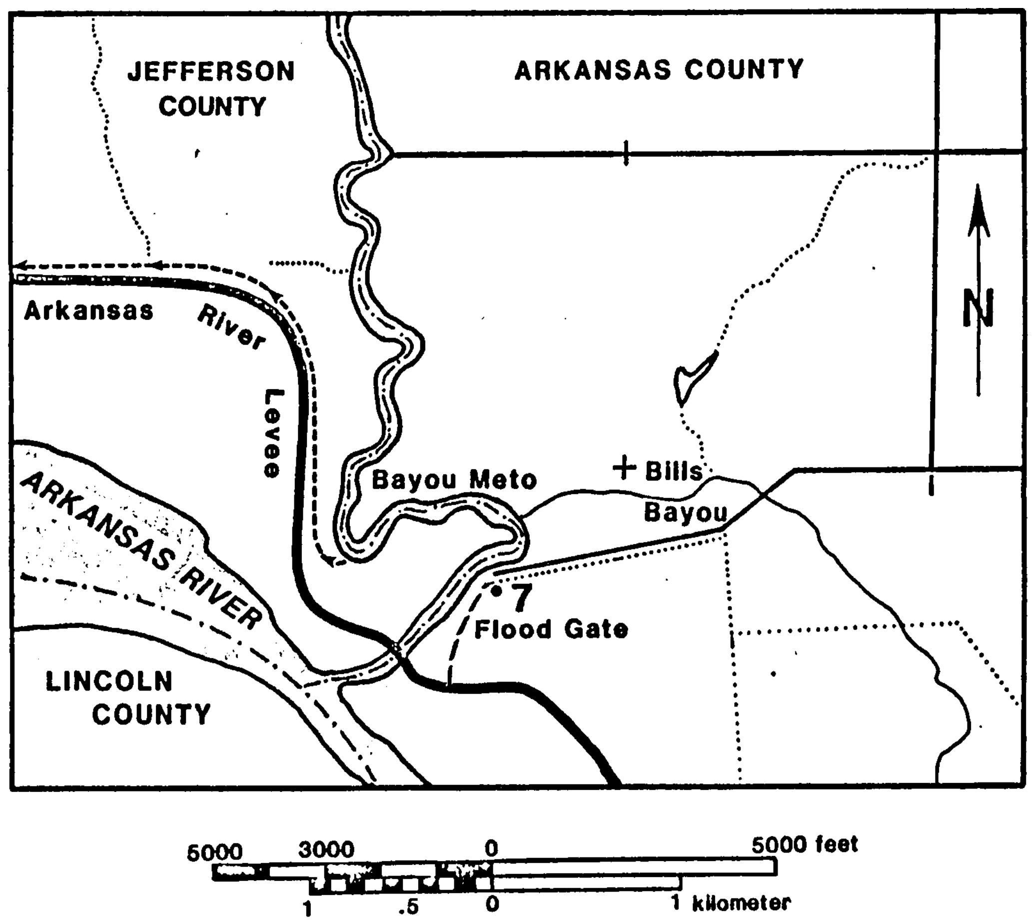

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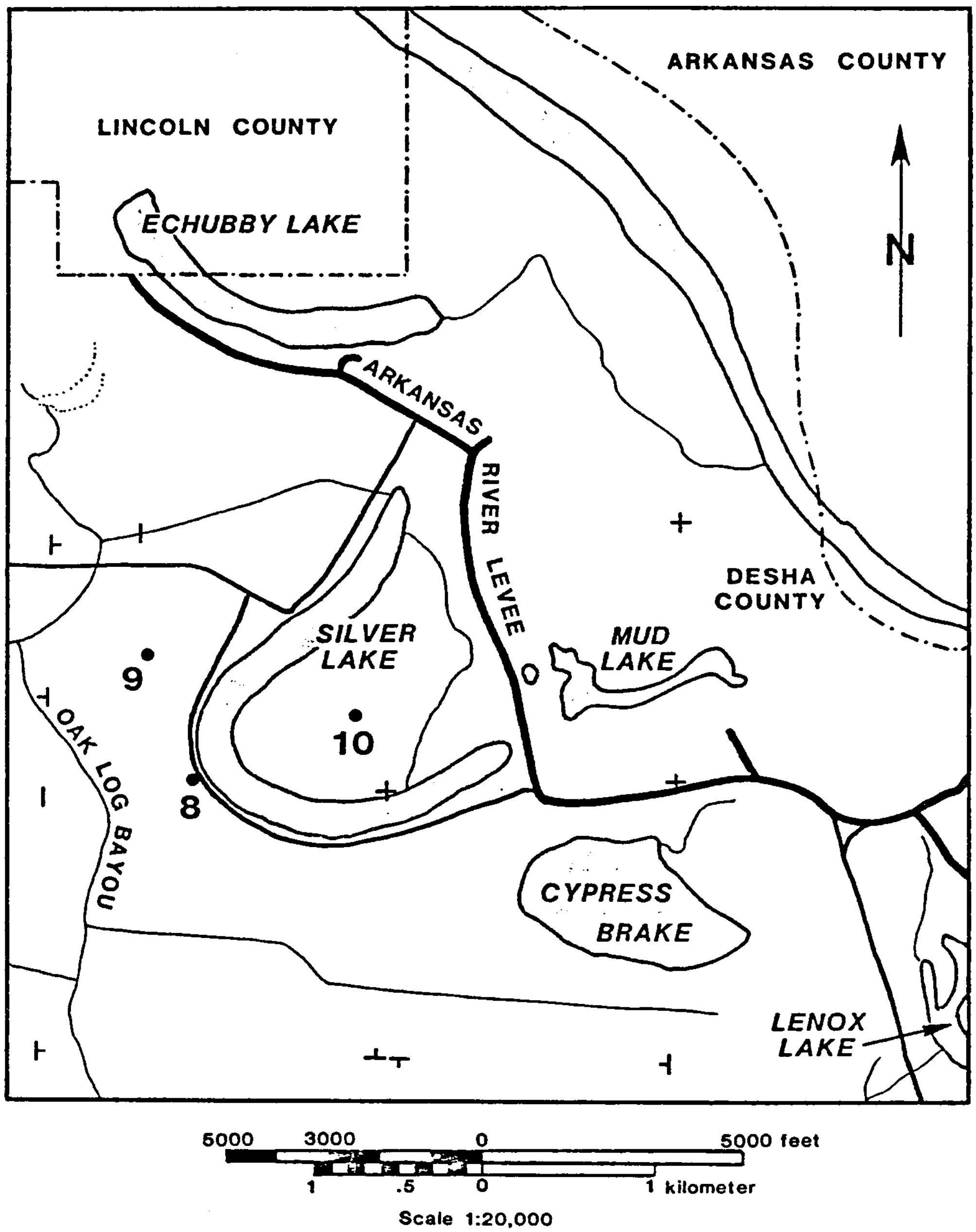
ARKANSAS COUNTY
LINCOLN COUNTY
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ECHUBBY LAKE
ARKANSAS
RIVER LEVEE
DESHA
COUNTY
MUD
LAKE
SILVER
LAKE
9
10
8
OAK LOG BAYOU
CYPRESS
BRAKE
LENOX
LAKE
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3000
0
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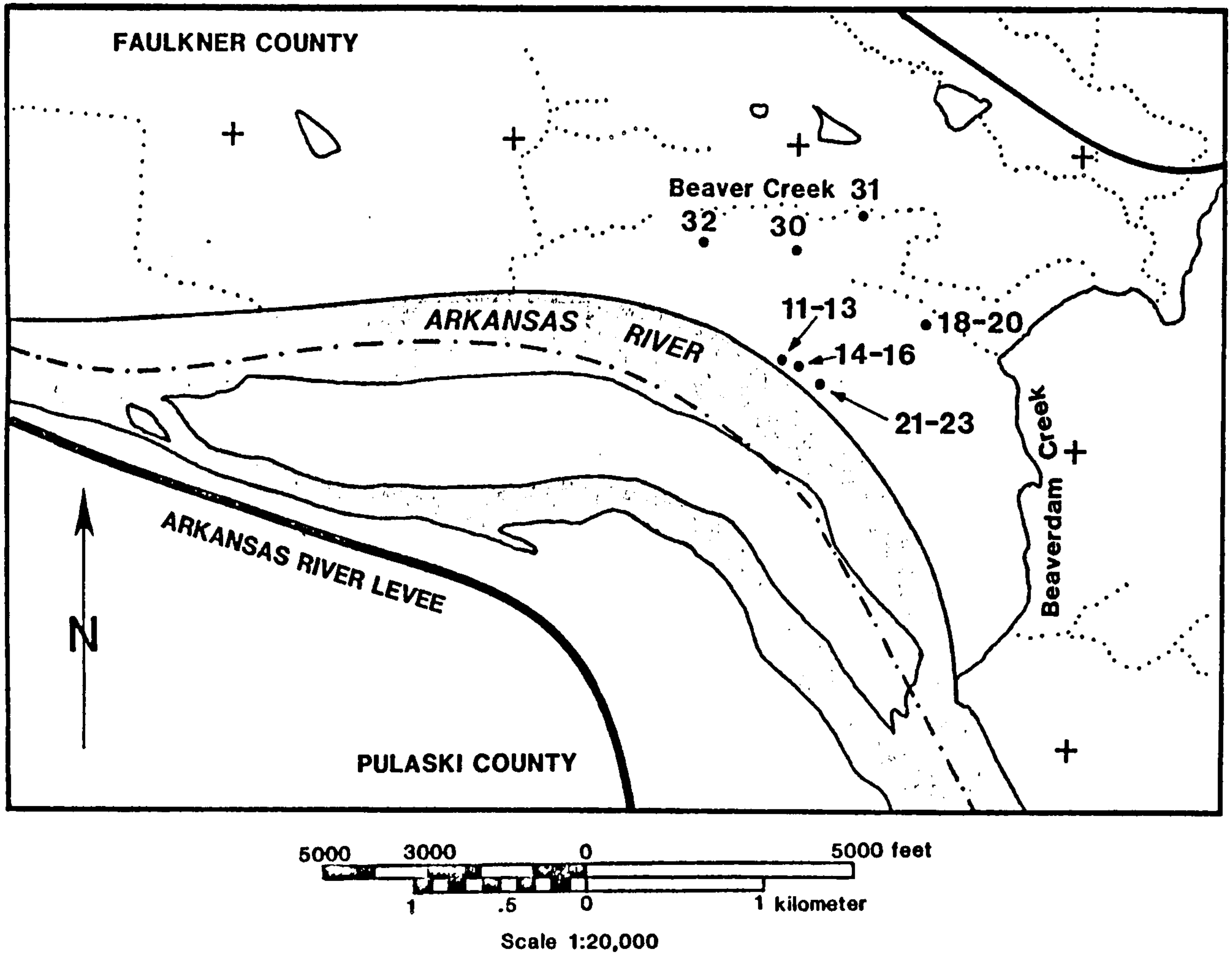
1 kilometer
Scale 1:20,000



FAULKNER COUNTY
Beaver Creek 31
32
30
ARKANSAS RIVER
11-13
14-16
18-20
21-23
Beaverdam Creek
ARKANSAS RIVER LEVEE
N
PULASKI COUNTY
5000 3000 0 5000 feet
1 .5 0 1 kilometer
Scale 1:20,000

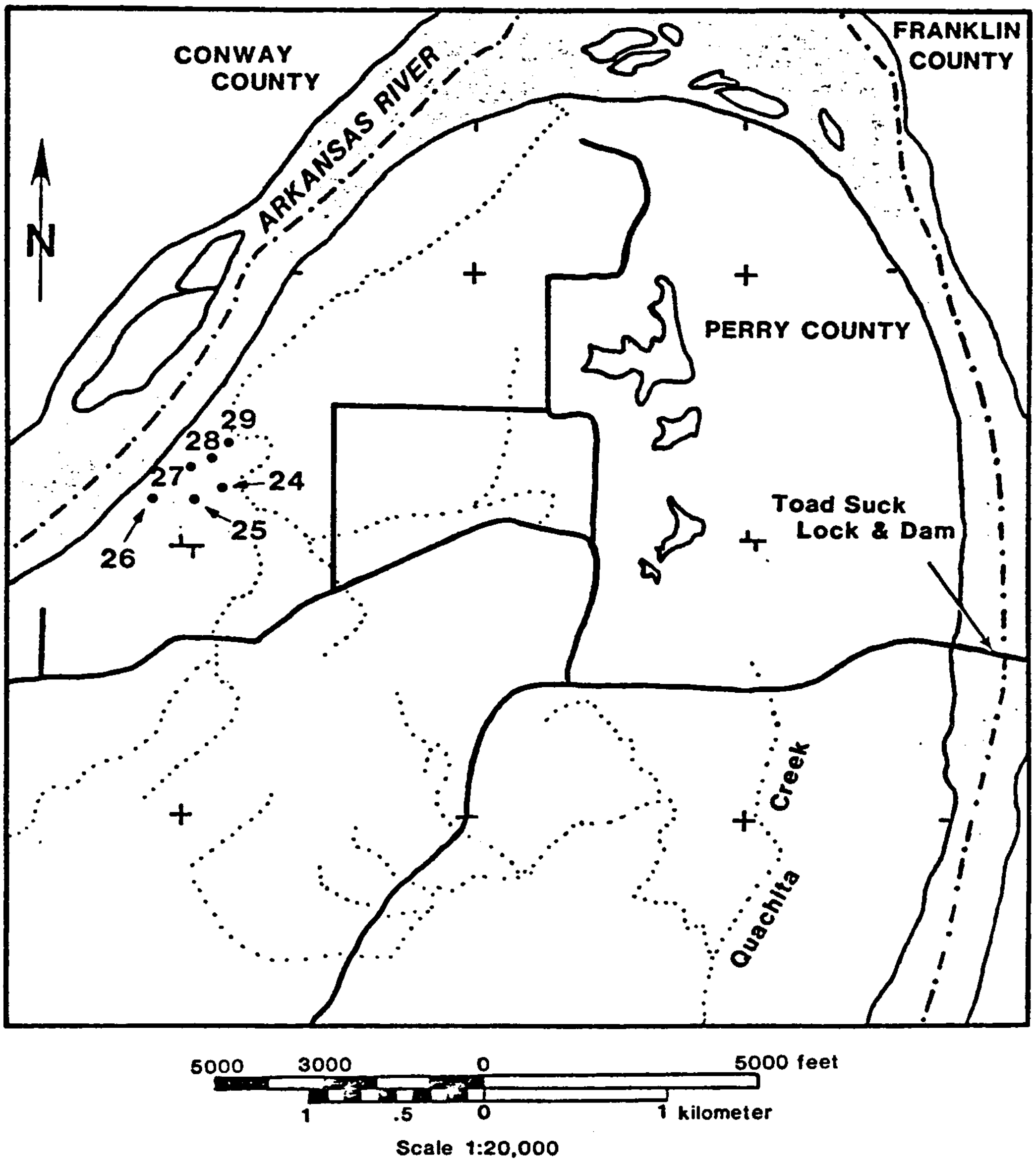

CONWAY
COUNTY
FRANKLIN
COUNTY
ARKANSAS RIVER
N
PERRY COUNTY
29
28
27
24
25
26
Toad Suck
Lock & Dam
Creek
Quachita
5000
3000
0
5000 feet
1
.5
0
1 kilometer
Scale 1:20,000

Table 5

Horizon depths.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	DEPTH, cm			DEPTH, cm			DEPTH, cm			DEPTH, cm			DEPTH, cm			DEPTH, cm			DEPTH, cm		
SERIES	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
COUSHATTA	10	15	1	2	37	1	2	66	5	3	121	5	1	130	.	.	.	.	18	47	11
COUSHATTALIKE	15	15	0	3	52	10	3	97	16	1	124	.	.	.	.	.	.	.	22	36	8
DESHA	16	15	0	2	44	11	2	91	25	2	137	5	.	.	.	.	.	.	22	35	9
DESHALIKE	4	16	1	2	56	15	2	86	8	2	103	11	2	135	8	.	.	.	12	69	14
GALLION	9	19	2	6	45	4	6	74	9	5	105	12	3	103	9	1	122	.	30	62	7
GALLIONLIKE	2	19	1	2	42	11	2	55	14	2	84	30	1	102	.	1	147	.	10	65	14
MORELAND	5	18	2	5	52	6	4	93	7	2	109	5	1	117	.	.	.	.	17	62	9
MORELANDLIKE	4	16	2	4	51	4	4	81	6	3	108	7	.	.	.	.	.	.	15	61	9
NORWOOD	5	16	1	1	71	.	1	122	.	.	.	.	.	.	.	.	.	.	7	39	16
PERRY	5	17	2	2	33	0	3	76	13	3	113	12	.	.	.	.	.	.	13	55	12
PERRYLIKE	2	19	1	2	48	15	2	88	9	2	130	3	.	.	.	.	.	.	8	71	16
ROXANA	1	20	.	1	79	.	1	112	.	.	.	.	.	.	.	.	.	.	3	70	27
SERIES TOTAL	78	16	0	32	49	2	32	83	4	25	112	4	8	116	6	2	135	13	177	54	3

Table 6

Cation exchange capacities (CEC) of soils.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	CEC, meq/100g			CEC, meq/100g			CEC, meq/100g			CEC, meq/100g			CEC, meq/100g			CEC, meq/100g			CEC, meq/100g		
SERIES	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
COUSHATTA	10	29.5	3.1	2	34.1	4.6	2	33.1	4.5	3	31.2	1.6	1	16.7	.	.	.	.	18	30.0	2.0
COUSHATTALIKE	15	41.0	1.8	3	45.1	11.5	3	35.3	9.0	1	51.7	.	.	.	.	.	.	.	22	41.3	2.2
DESHA	16	49.1	2.0	2	56.8	0.3	2	57.2	0.3	2	56.9	0.4	.	.	.	.	.	.	22	51.3	1.6
DESHALIKE	4	55.9	0.6	2	56.9	0.2	2	57.8	0.0	2	57.2	0.2	2	57.8	0.6	.	.	.	12	56.9	0.3
GALLION	9	27.6	3.5	6	28.5	2.3	6	40.2	3.1	5	42.1	7.9	3	45.3	2.1	1	34.7	.	30	34.7	2.2
GALLIONLIKE	2	27.9	11.2	2	42.3	9.4	2	28.5	4.1	2	49.6	2.0	1	45.5	.	1	35.0	.	10	37.7	3.7
MORELAND	5	43.7	5.7	5	44.8	3.3	4	50.8	4.7	2	57.8	4.3	1	63.0	.	.	.	.	17	48.5	2.5
MORELANDLIKE	4	43.6	6.1	4	50.6	7.5	4	54.5	6.5	3	46.4	12.6	.	.	.	.	.	.	15	48.9	3.7
NORWOOD	5	26.6	0.4	1	49.1	.	1	26.4	.	.	.	.	.	.	.	.	.	.	7	29.8	3.2
PERRY	5	48.6	6.8	2	58.0	2.5	3	55.3	1.7	3	59.5	2.4	.	.	.	.	.	.	13	54.1	2.8
PERRYLIKE	2	47.5	3.9	2	44.8	0.8	2	50.1	0.3	2	55.0	3.3	.	.	.	.	.	.	8	49.4	1.8
ROXANA	1	31.7	.	1	16.7	.	1	9.0	.	.	.	.	.	.	.	.	.	.	3	19.1	6.7
SERIES TOTAL	78	40.0	1.4	32	43.3	2.4	32	44.5	2.5	25	49.1	2.7	8	47.1	5.1	2	34.8	0.2	177	42.9	1.0

Table 7

Exchangeable sodium concentrations of soils.

	HORIZON 1			HORIZON 2			HORIZON 3			HORIZON 4			HORIZON 5			HORIZON 6			HORIZON TOTAL		
	SODIUM, meq/100g			SODIUM, meq/100g			SODIUM, meq/100g			SODIUM, meq/100g			SODIUM, meq/100g			SODIUM, meq/100g			SODIUM, meq/100g		
SERIES	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
COUSHATTA	10	1.1	0.1	2	0.5	0.3	2	0.6	0.2	3	0.7	0.3	1	0.5	.	.	.	.	18	0.9	0.1
COUSHATTALIKE	15	1.3	0.1	3	0.5	0.1	3	0.4	0.1	1	0.6	.	.	.	.	.	.	.	22	1.0	0.1
DESHA	16	1.4	0.2	2	0.7	0.1	2	1.1	0.3	2	1.4	0.0	.	.	.	.	.	.	22	1.3	0.1
DESHALIKE	4	1.2	0.2	2	1.0	0.4	2	1.1	0.0	2	1.3	0.1	2	1.4	0.1	.	.	.	12	1.2	0.1
GALLION	9	0.9	0.2	6	1.0	0.3	6	1.3	0.3	5	1.4	0.3	3	2.0	0.8	1	0.8	.	30	1.2	0.1
GALLIONLIKE	2	1.0	0.3	2	1.1	0.2	2	0.9	0.3	2	0.8	0.1	1	0.9	.	1	1.2	.	10	1.0	0.1
MORELAND	5	2.5	0.2	5	1.9	0.4	4	2.5	0.8	2	1.7	0.1	1	1.7	.	.	.	.	17	2.2	0.2
MORELANDLIKE	4	2.1	0.2	4	3.3	0.5	4	2.6	0.5	3	2.3	1.1	.	.	.	.	.	.	15	2.6	0.3
NORWOOD	5	0.8	0.1	1	1.3	.	1	0.4	.	.	.	.	.	.	.	.	.	.	7	0.8	0.1
PERRY	5	2.4	0.1	2	2.3	0.3	3	2.2	0.7	3	3.2	0.6	.	.	.	.	.	.	13	2.5	0.2
PERRYLIKE	2	2.0	0.4	2	1.0	0.0	2	0.8	0.2	2	2.6	0.3	.	.	.	.	.	.	8	1.6	0.3
ROXANA	1	1.7	.	1	1.7	.	1	3.3	.	.	.	.	.	.	.	.	.	.	3	2.2	0.5
SERIES TOTAL	78	1.4	0.1	32	1.5	0.2	32	1.5	0.2	25	1.7	0.2	8	1.5	0.3	2	1.0	0.2	177	1.5	0.1

Table 8

Exchangeable sodium percentages of soils.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	ESP, %			ESP, %			ESP, %			ESP, %			ESP, %			ESP, %			ESP, %		
	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
SERIES																					
COUSHATTA	10	4.0	0.5	2	1.4	0.6	2	1.8	0.3	3	2.3	1.1	1	2.8	.	.	.	.	18	3.1	0.4
COUSHATTALIKE	15	3.2	0.4	3	1.2	0.2	3	1.2	0.3	1	1.1	.	.	.	.	.	.	.	22	2.6	0.3
DESHA	16	2.9	0.5	2	1.3	0.1	2	1.9	0.6	2	2.5	0.0	.	.	.	.	.	.	22	2.6	0.4
DESHALIKE	4	2.2	0.4	2	1.8	0.7	2	1.9	0.1	2	2.3	0.2	2	2.5	0.0	.	.	.	12	2.2	0.2
GALLION	9	3.2	0.5	6	3.4	0.8	6	3.3	0.8	5	3.4	0.9	3	4.5	1.9	1	2.3	.	30	3.4	0.3
GALLIONLIKE	2	4.0	0.7	2	2.8	1.1	2	3.5	1.4	2	1.6	0.1	1	2.0	.	1	3.4	.	10	2.9	0.4
MORELAND	5	5.8	0.4	5	4.5	1.3	4	4.8	1.6	2	3.0	0.4	1	2.7	.	.	.	.	17	4.7	0.5
MORELANDLIKE	4	5.1	0.8	4	6.5	0.8	4	4.7	0.4	3	4.6	0.9	.	.	.	.	.	.	15	5.3	0.4
NORWOOD	5	2.9	0.5	1	2.7	.	1	1.4	.	.	.	.	.	.	.	.	.	.	7	2.7	0.4
PERRY	5	5.3	0.8	2	4.0	0.3	3	4.0	1.3	3	5.4	0.8	.	.	.	.	.	.	13	4.8	0.5
PERRYLIKE	2	4.3	1.2	2	2.3	0.2	2	1.6	0.4	2	4.8	0.9	.	.	.	.	.	.	8	3.3	0.6
ROXANA	1	5.4	.	1	10.0	.	1	37.0	.	.	.	.	.	.	.	.	.	.	3	17.5	9.9
SERIES TOTAL	78	3.7	0.2	32	3.5	0.4	32	4.2	1.1	25	3.3	0.4	8	3.3	0.7	2	2.8	0.6	177	3.7	0.2

Table 9

Electrical conductivities of 1:2 soil-water extracts.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	EC1:2, umhos/cm			EC1:2, umhos/cm			EC1:2, umhos/cm			EC1:2, umhos/cm			EC1:2, umhos/cm			EC1:2, umhos/cm			EC1:2, umhos/cm		
SERIES	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
COUSHATTA	10	137	15	2	113	33	2	160	40	3	155	43	1	120	.	.	.	.	18	139	11
COUSHATTALIKE	15	197	15	3	147	35	3	120	3	1	165	.	.	.	.	.	.	.	22	178	13
DESHA	16	258	18	2	300	60	2	290	10	2	380	20	.	.	.	.	.	.	22	275	16
DESHALIKE	4	233	26	2	290	70	2	310	50	2	230	10	2	335	95	.	.	.	12	272	22
GALLION	9	90	16	6	62	15	6	66	13	5	71	13	3	112	7	1	95	.	30	79	7
GALLIONLIKE	2	105	15	2	100	25	2	113	28	2	140	45	1	175	.	1	175	.	10	127	13
MORELAND	5	170	10	5	130	12	4	146	32	2	138	13	1	110	.	.	.	.	17	145	9
MORELANDLIKE	4	135	34	4	95	24	4	171	43	3	230	135	.	.	.	.	.	.	15	153	30
NORWOOD	5	217	44	1	175	.	1	75	.	.	.	.	.	.	.	.	.	.	7	191	36
PERRY	5	201	32	2	90	35	3	107	13	3	215	88	.	.	.	.	.	.	13	165	26
PERRYLIKE	2	158	13	2	138	63	2	105	60	2	103	48	.	.	.	.	.	.	8	126	21
ROXANA	1	125	.	1	70	.	1	95	.	.	.	.	.	.	.	.	.	.	3	97	16
SERIES TOTAL	78	183	9	32	130	14	32	140	15	25	172	24	8	176	40	2	135	40	177	163	7

Table 10

Soil pHs.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	pH			pH			pH			pH			pH			pH			pH		
	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
SERIES																					
COUSHATTA	10	6.8	0.1	2	6.9	0.3	2	6.7	0.1	3	7.2	0.3	1	7.1	.	.	.	.	18	6.9	0.1
COUSHATTALIKE	15	6.7	0.1	3	7.2	0.5	3	7.4	0.7	1	6.9	.	.	.	.	.	.	.	22	6.9	0.1
DESHA	16	7.2	0.1	2	7.1	0.4	2	7.1	0.3	2	7.0	0.4	.	.	.	.	.	.	22	7.2	0.1
DESHALIKE	4	7.0	0.2	2	7.4	0.1	2	7.4	0.1	2	7.6	0.0	2	7.7	0.0	.	.	.	12	7.4	0.1
GALLION	9	6.4	0.2	6	6.7	0.3	6	6.6	0.3	5	6.6	0.4	3	6.5	0.8	1	7.8	.	30	6.6	0.1
GALLIONLIKE	2	7.5	0.0	2	7.7	0.1	2	7.8	0.2	2	7.8	0.3	1	7.8	.	1	7.8	.	10	7.7	0.1
MORELAND	5	6.4	0.4	5	6.8	0.3	4	6.7	0.3	2	6.8	0.6	1	6.5	.	.	.	.	17	6.7	0.2
MORELANDLIKE	4	6.1	0.5	4	6.8	0.3	4	6.8	0.4	3	7.0	0.6	.	.	.	.	.	.	15	6.7	0.2
NORWOOD	5	7.3	0.2	1	8.2	.	1	6.5	.	.	.	.	.	.	.	.	.	.	7	7.3	0.2
PERRY	5	6.7	0.3	2	6.2	0.0	3	6.4	0.4	3	6.8	0.5	.	.	.	.	.	.	13	6.6	0.2
PERRYLIKE	2	7.3	0.0	2	7.1	0.4	2	6.9	0.3	2	7.1	0.2	.	.	.	.	.	.	8	7.1	0.1
ROXANA	1	6.6	.	1	8.3	.	1	8.5	.	.	.	.	.	.	.	.	.	.	3	7.8	0.6
SERIES TOTAL	78	6.8	0.1	32	7.0	0.1	32	6.9	0.1	25	7.0	0.1	8	7.0	0.3	2	7.8	0.0	177	6.9	0.1

Table 11

Chloride concentrations of soils.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	CHLORIDE, ug/g			CHLORIDE, ug/g			CHLORIDE, ug/g			CHLORIDE, ug/g			CHLORIDE, ug/g			CHLORIDE, ug/g			CHLORIDE, ug/g		
	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
SERIES																					
COUSHATTA	2	37	5	2	46	20	2	60	25	3	66	14	1	61	.	.	.	.	10	54	7
COUSHATTALIKE	3	23	6	3	28	8	3	39	6	1	52	.	.	.	.	.	.	.	10	32	4
DESHA	2	18	3	2	30	5	2	47	2	2	81	10	.	.	.	.	.	.	8	44	9
DESHALIKE	2	43	13	2	46	9	2	68	19	2	78	14	2	67	25	.	.	.	10	60	7
GALLION	3	18	4	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	3	18	4
GALLIONLIKE	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.
MORELAND	1	28	.	0	.	.	0	.	.	0	.	.	0	.	.	.	.	.	1	28	.
MORELANDLIKE	0	.	.	0	.	.	1	102	.	1	164	.	.	.	.	.	.	.	2	133	31
NORWOOD	1	29	.	1	22	.	1	21	.	.	.	.	.	.	.	.	.	.	3	24	3
PERRY	2	68	8	0	.	.	0	.	.	1	130	.	.	.	.	.	.	.	3	89	21
PERRYLIKE	0	.	.	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	0	.	.
ROXANA	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.
SERIES TOTAL	16	32	5	10	35	5	11	54	8	10	86	12	3	65	15	0	.	.	50	50	4

Table 12

Bicarbonate concentrations of soils.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	BICARBONATE, ug/g			BICARBONATE, ug/g			BICARBONATE, ug/g			BICARBONATE, ug/g			BICARBONATE, ug/g			BICARBONATE, ug/g			BICARBONATE, ug/g		
	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
SERIES																					
COUSHATTA	2	260	37	2	124	74	2	161	62	3	149	57	1	99	.	.	.	.	10	164	27
COUSHATTALIKE	3	265	33	2	186	37	3	182	41	1	149	.	.	.	.	.	.	.	9	207	22
DESHA	2	335	37	1	496	.	0	.	.	0	.	.	.	.	.	.	.	.	3	389	58
DESHALIKE	2	198	0	2	223	74	1	149	.	1	298	.	1	149	.	.	.	.	7	205	25
GALLION	3	124	25	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	3	124	25
GALLIONLIKE	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.
MORELAND	1	198	.	0	.	.	0	.	.	0	.	.	0	.	.	.	.	.	1	198	.
MORELANDLIKE	0	.	.	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	0	.	.
NORWOOD	1	149	.	1	223	.	1	223	.	.	.	.	.	.	.	.	.	.	3	198	25
PERRY	2	199	50	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	2	199	50
PERRYLIKE	0	.	.	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	0	.	.
ROXANA	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.
SERIES TOTAL	16	219	20	8	223	47	7	177	23	5	179	43	2	124	25	0	.	.	38	202	15

Table 13

Sulfate concentrations of soils.

	HORIZON 1			HORIZON 2			HORIZON 3			HORIZON 4			HORIZON 5			HORIZON 6			HORIZON TOTAL		
	SULFATE, ug/g			SULFATE, ug/g			SULFATE, ug/g			SULFATE, ug/g			SULFATE, ug/g			SULFATE, ug/g			SULFATE, ug/g		
SERIES	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
COUSHATTA	2	6	6	2	0	0	2	4	4	3	12	6	1	0	.	.	.	.	10	6	2
COUSHATTALIKE	3	0	0	2	12	12	3	12	12	1	12	.	.	.	.	.	.	.	9	8	4
DESHA	2	12	12	1	40	.	0	.	.	0	.	.	.	.	.	.	.	.	3	21	12
DESHALIKE	2	32	16	2	35	5	1	36	.	1	40	.	1	30	.	.	.	.	7	34	4
GALLION	3	34	11	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	3	34	11
GALLIONLIKE	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0	.	.
MORELAND	1	80	.	0	.	.	0	.	.	0	.	.	0	.	.	.	.	.	1	80	.
MORELANDLIKE	0	.	.	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	0	.	.
NORWOOD	1	20	.	1	0	.	1	0	.	.	.	.	.	.	.	.	.	.	3	7	7
PERRY	2	46	26	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	2	46	26
PERRYLIKE	0	.	.	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	0	.	.
ROXANA	0	.	.	0	.	.	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.
SERIES TOTAL	16	25	7	8	17	7	7	11	6	5	18	7	2	15	15	0	.	.	38	19	3

Table 14

One-third bar water contents of soils.

SERIES	Horizon 1: 1/3 BAR MOISTURE, g/g N	Horizon 1: MEAN	Horizon 1: STD ERROR	Horizon 2: 1/3 BAR MOISTURE, g/g N	Horizon 2: MEAN	Horizon 2: STD ERROR	Horizon 3: 1/3 BAR MOISTURE, g/g N	Horizon 3: MEAN	Horizon 3: STD ERROR	Horizon 4: 1/3 BAR MOISTURE, g/g N	Horizon 4: MEAN	Horizon 4: STD ERROR	Horizon 5: 1/3 BAR MOISTURE, g/g N	Horizon 5: MEAN	Horizon 5: STD ERROR	Horizon 6: 1/3 BAR MOISTURE, g/g N	Horizon 6: MEAN	Horizon 6: STD ERROR	HORIZON TOTAL: 1/3 BAR MOISTURE, g/g N	HORIZON TOTAL: MEAN	HORIZON TOTAL: STD ERROR
COUSHATTA	10	0.24	0.02	2	0.21	0.07	2	0.20	0.05	3	0.20	0.03	1	0.05	.	.	.	.	18	0.22	0.02
COUSHATTALIKE	15	0.32	0.02	3	0.31	0.08	3	0.23	0.08	1	0.30	.	.	.	.	.	.	.	22	0.30	0.02
DESHA	16	0.37	0.01	2	0.42	0.00	2	0.44	0.01	2	0.46	0.07	.	.	.	.	.	.	22	0.39	0.01
DESHALIKE	4	0.40	0.02	2	0.45	0.01	2	0.50	0.00	2	0.46	0.00	2	0.51	0.05	.	.	.	12	0.46	0.02
GALLION	9	0.22	0.03	6	0.25	0.03	6	0.32	0.01	5	0.31	0.03	3	0.37	0.03	1	0.32	.	30	0.28	0.01
GALLIONLIKE	2	0.21	0.11	2	0.34	0.07	2	0.24	0.03	2	0.39	0.03	1	0.34	.	1	0.31	.	10	0.30	0.03
MORELAND	5	0.34	0.03	5	0.35	0.02	4	0.38	0.03	2	0.43	0.03	1	0.48	.	.	.	.	17	0.37	0.01
MORELANDLIKE	4	0.34	0.04	4	0.41	0.06	4	0.42	0.04	3	0.35	0.11	.	.	.	.	.	.	15	0.38	0.03
NORWOOD	5	0.22	0.02	1	0.28	.	1	0.13	.	.	.	.	.	.	.	.	.	.	7	0.21	0.02
PERRY	5	0.37	0.04	2	0.45	0.02	3	0.45	0.03	3	0.47	0.02	.	.	.	.	.	.	13	0.42	0.02
PERRYLIKE	2	0.35	0.03	2	0.33	0.01	2	0.38	0.01	2	0.44	0.02	.	.	.	.	.	.	8	0.38	0.02
ROXANA	1	0.30	.	1	0.14	.	1	0.05	.	.	.	.	.	.	.	.	.	.	3	0.16	0.07
SERIES TOTAL	78	0.31	0.01	32	0.33	0.02	32	0.34	0.02	25	0.37	0.02	8	0.37	0.05	2	0.31	0.00	177	0.33	0.01

Table 15

Sand contents of soils.

SERIES	Horizon 1 SAND, % N	Horizon 1 SAND, % MEAN	Horizon 1 SAND, % STD ERROR	Horizon 2 SAND, % N	Horizon 2 SAND, % MEAN	Horizon 2 SAND, % STD ERROR	Horizon 3 SAND, % N	Horizon 3 SAND, % MEAN	Horizon 3 SAND, % STD ERROR	Horizon 4 SAND, % N	Horizon 4 SAND, % MEAN	Horizon 4 SAND, % STD ERROR	Horizon 5 SAND, % N	Horizon 5 SAND, % MEAN	Horizon 5 SAND, % STD ERROR	Horizon 6 SAND, % N	Horizon 6 SAND, % MEAN	Horizon 6 SAND, % STD ERROR	HORIZON TOTAL SAND, % N	HORIZON TOTAL SAND, % MEAN	HORIZON TOTAL SAND, % STD ERROR
COUSHATTA	10	23	4	2	10	1	2	1	1	3	12	9	1	6	.	.	.	.	18	16	3
COUSHATTALIKE	15	8	2	3	2	1	3	4	2	1	3	.	.	.	.	.	.	.	22	7	2
DESHA	16	6	1	2	4	3	2	12	6	2	2	0	.	.	.	.	.	.	22	6	1
DESHALIKE	4	9	4	2	1	1	2	6	4	2	2	1	2	13	4	.	.	.	12	7	2
GALLION	9	21	7	6	12	5	6	5	1	5	6	2	3	7	3	1	2	.	30	11	3
GALLIONLIKE	2	3	1	2	9	5	2	8	4	2	2	1	1	3	.	1	6	.	10	5	1
MORELAND	5	9	6	5	2	1	4	2	1	2	2	0	1	1	.	.	.	.	17	4	2
MORELANDLIKE	4	3	1	4	2	1	4	8	4	3	7	4	.	.	.	.	.	.	15	5	1
NORWOOD	5	8	3	1	1	.	1	72	.	.	.	.	.	.	.	.	.	.	7	16	10
PERRY	5	7	3	2	5	5	3	1	0	3	4	2	.	.	.	.	.	.	13	5	1
PERRYLIKE	2	12	6	2	15	12	2	6	1	2	1	0	.	.	.	.	.	.	8	3	3
ROXANA	1	4	.	1	37	.	1	72	.	.	.	.	.	.	.	.	.	.	3	38	20
SERIES TOTAL	78	11	1	32	7	2	32	9	3	25	5	1	8	7	2	2	4	2	177	9	1

Table 16

Silt contents of soils.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	SILT, %			SILT, %			SILT, %			SILT, %			SILT, %			SILT, %			SILT, %		
SERIES	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
COUSHATTA	10	51	3	2	71	0	2	29	7	3	58	11	1	41	.	.	.	.	18	52	4
COUSHATTALIKE	15	43	3	3	31	5	3	55	6	1	56	.	.	.	.	.	.	.	22	44	3
DESHA	16	43	4	2	24	1	2	59	3	2	38	1	.	.	.	.	.	.	22	42	3
DESHALIKE	4	57	10	2	40	17	2	28	2	2	49	19	2	55	5	.	.	.	12	48	5
GALLION	9	58	8	6	59	6	6	57	5	5	64	4	3	54	6	1	68	.	30	59	3
GALLIONLIKE	2	61	1	2	40	3	2	28	18	2	43	6	1	56	.	1	48	.	10	45	5
MORELAND	5	46	7	5	43	4	4	43	6	2	51	2	1	30	.	.	.	.	17	44	3
MORELANDLIKE	4	41	7	4	46	8	4	49	8	3	55	17	.	.	.	.	.	.	15	47	5
NORWOOD	5	51	3	1	24	.	1	26	.	.	.	.	.	.	.	.	.	.	7	44	5
PERRY	5	41	7	2	25	2	3	31	6	3	31	6	.	.	.	.	.	.	13	34	4
PERRYLIKE	2	47	3	2	45	19	2	75	5	2	27	1	.	.	.	.	.	.	8	48	8
ROXANA	1	73	.	1	51	.	1	26	.	.	.	.	.	.	.	.	.	.	3	50	13
SERIES TOTAL	78	48	2	32	44	3	32	46	3	25	49	4	8	50	4	2	58	10	177	47	1

Table 17

Clay contents of soils.

	HORIZON																		HORIZON TOTAL		
	1			2			3			4			5			6					
	CLAY, %			CLAY, %			CLAY, %			CLAY, %			CLAY, %			CLAY, %			CLAY, %		
	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR	N	MEAN	STD ERROR
SERIES																					
COUSHATTA	10	26	3	2	19	1	2	69	6	3	30	14	1	54	.	.	.	.	18	32	4
COUSHATTALIKE	15	49	3	3	67	6	3	40	8	1	42	.	.	.	.	.	.	.	22	50	3
DESHA	16	51	3	2	72	4	2	29	8	2	60	2	.	.	.	.	.	.	22	52	3
DESHALIKE	4	34	13	2	59	18	2	65	2	2	49	20	2	31	1	.	.	.	12	46	6
GALLION	9	21	2	6	29	3	6	38	5	5	30	3	3	38	4	1	30	.	30	30	2
GALLIONLIKE	2	37	0	2	51	8	2	64	14	2	54	7	1	42	.	1	46	.	10	50	4
MORELAND	5	45	6	5	55	4	4	55	6	2	47	2	1	68	.	.	.	.	17	52	3
MORELANDLIKE	4	56	8	4	52	9	4	44	11	3	37	19	.	.	.	.	.	.	15	48	5
NORWOOD	5	40	2	1	75	.	1	2	.	.	.	.	.	.	.	.	.	.	7	40	8
PERRY	5	52	9	2	70	7	3	68	6	3	65	7	.	.	.	.	.	.	13	61	4
PERRYLIKE	2	41	9	2	41	7	2	19	4	2	72	1	.	.	.	.	.	.	8	43	8
ROXANA	1	24	.	1	12	.	1	2	.	.	.	.	.	.	.	.	.	.	3	13	6
SERIES TOTAL	79	41	2	32	49	4	32	45	4	25	46	4	8	43	5	2	38	8	177	44	1

Table 18

Saturated hydraulic conductivities of soils.

Site	Saturated Hydraulic Conductivity	
	Mean	Std Error
	cm/hr	
1	0.0115	0.0116
2	0.0018	0.0004
3	0.0043	0.0012
4	0.0010	0.0002
5	0.0028	0.0010
7	0.0150	0.0027
8	0.0111	0.0009
9	0.0230	0.0113
10	0.0049	0.0009
11-13	0.0079	0.0013
14-16	0.0009	0.0001
18-20	0.0214	0.0215
21-23	0.0228	0.0017
25, 27, 28	0.0415	0.0076
24, 26	0.0021	0.0003

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1	Printing and Binding of completion report for J. T. Gilmour entitled "A Survey of Soils Irrigated With Arkansas River Water".			140.0

881033

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