

FINAL REPORT
SECTION 6
ENDANGERED SPECIES ACT



FEDERAL AID PROJECT E-27

STATUS SURVEY FOR THREE CANDIDATE AQUATIC
INVERTEBRATES IN THE ARBUCKLE MOUNTAINS

MAY 1, 1993 - DECEMBER 31, 1995

FINAL REPORT

STATE: Oklahoma

PROJECT NO: E-27

PROJECT TITLE: **Status survey for three candidate aquatic invertebrates in the Arbuckle Mountains.**

DATES: 1 May 1993 - 30 April 1994; 15 Sept. 1994 - 31 Dec. 1995

I. Objectives

- (1) To survey selected streams in the Arbuckle Uplift for Reisen's Hydropsychyche caddisfly (*Hydropsyche reiseni*) and the Little Riffle Beetle (*Dubiraphia parva*).
- (2) To survey caves and springs in the Arbuckle Mountains for the Oklahoma Cave Amphipod (*Allocrangonyx pellucidus*).
- (3) To record a legal description and potential threats to candidate invertebrate populations at each survey site.

II. Introduction

Although all three species are endemic to stream habitats in the Arbuckle Mountains, they each occupy different microhabitats within this larger habitat type.

Dubiraphia parva (Elmidae: Coleoptera) was described by Hilsenhoff (1973) from Buck Creek, Pontotoc County, Oklahoma. The species has also been collected from Rush Creek in Pontotoc County by Dr. Harley P. Brown, Curator Emeritus of Invertebrates at the Oklahoma Museum of Natural History and a renowned expert on riffle beetle systematics (Brown, 1976). *D. parva* may occur outside the Arbuckle Mountains, as indicated by C.B. Barr's (1982, *in litt.* Louisiana State Univ.; Barr and Chapin (1988)) records from Bushley Creek, Catahoula Parrish, Louisiana. Barr and Chapin (1988) reported the species with a question mark, due to unresolved taxonomic questions within the genus. It is possible that their records represent a similar, undescribed species. According to Dr. Brown (pers. com.) the species lives in submerged aquatic vegetation in small streams.

Reisen (1974, 1975) studied the spatial and temporal distributions of benthic macroinvertebrates of Honey Creek, Murray County, Oklahoma. This is the stream on which the popular Turner Fall's recreation area is located. *Hydropsyche reiseni* was considered to be a new species of caddisfly (Hydropsychidae: Trichoptera) discovered by Reisen during his work on Honey Creek and described by Denning (1975). The species occurred in a series of riffles along the stream and was present during all seasons. At the beginning of this study Honey Creek was the only known location of *H. reiseni*.

The type locality for *Allocrangonyx pellucidus* is Bird's Mill Spring, Pontotoc County, Oklahoma. The species was originally described from this site by Mackin (1935) as *Niphargus pellucidus*. Hubricht and Mackin (1940) reported a second location for the species in Murray County. Schellenberg (1936) was the first to describe *Allocrangonyx* as a distinct genus for the species *pellucidus*, and this usage was later adopted by Hubricht (1943). Holsinger's (1971) revisions incorporated new information on *A. pellucidus*, described a second species, and modified the genus description accordingly. Prior to this study, the species was known from the Wild Woman - Bitter Enders cave system and seeps and springs associated with those caves, and Coool Creek Cave (Holsinger, 1989). Although *A. pellucidus* has been taken from springs and seeps, it is thought to be largely a cavernicolous species (Holsinger, 1971). Many of the springs in the Arbuckles are fed directly from caves and solution channels and could easily afford exit to the surface following heavy rains. According to Harrel (1959, 1962) the species was common in Wild Woman Cave.

III. Methods

Above ground stream sampling for *Hydropsyche reiseni* and *Dubiraphia parva*

Areas to be sampled were defined by examining topographic maps of the entire Arbuckle region. Twenty-eight above-ground stream sites were sampled quantitatively and qualitatively for benthic invertebrates during June and July of 1993 (Table 1, Figure 1). Sampling was conducted by Dr. Geoffrey C. Carpenter and Diana Deblanc under the direction of Vaughn. Honey Creek and Buck Creek, the type localities for *Hydropsyche reiseni* and *Dubiraphia parva*, respectively, were sampled. Rush Creek, a locality where *D. parva* had been found in the past, was dry during this study and was not sampled.

Quantitative samples consisted of three replicate Surber samples taken at each location. Qualitative samples were taken by picking invertebrates by hand from all available microhabitats. At each sampling location, stream width, average depth, current velocity, water and air temperature, pH, and conductivity were measured. The substratum was described. Two replicate water samples were collected at each site. These were frozen, and then sent to a professional water quality laboratory where concentrations of the following 20 elements were determined: Al, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Si, Sr, Zn. When aquatic vascular plants were present, percent cover was estimated. The riparian area adjacent to each stream or spring site was described. Landuse in areas adjacent to sample locations was described, including an assessment of threats to the area (Appendix 1).

In all species of *Hydropsyche*, the larvae are riffle-dwellers which build nets on stones in areas of rapid flow and filter small food particles out of the water (Wiggins 1977). The adults are terrestrial. We sampled for both adults and larvae of *Hydropsyche*. Identification of aquatic insects to the species level can usually only be done with adult,

male forms (Merritt et al. 1984). However, the insect spends most of its life as a larva, and identification of species numbers, exact microhabitat, and threats to the species can only be determined by examining the distribution of the larvae. Larvae were quantitatively sampled by Surber net in 1993 (Merritt et al. 1984; see above). Adults were collected with light traps by Julian Hilliard under the direction of Vaughn in 1995 (Vaughn 1992, Merritt et al. 1984).

Both adults and larvae of the genus *Dubiraphia* occur in the same microhabitat. They prefer submerged vegetation but can also be found on decomposing wood (H.P. Brown, pers. com.). We searched both these microhabitats. Submerged vegetation was sampled quantitatively using a Surber net (see above). Vegetation samples were preserved in formalin in the field and then examined for the presence of *D. parva*. Wood and vegetation were also qualitatively searched for beetles in the field.

Cave stream sampling.

Allocrangonyx pellucidus can be collected in cave streams, and occasionally where those streams come to the surface as springs or seeps. Of the eleven known caves in the Arbuckles (Curtis 1959), only five are "wet" caves containing underground streams or springs: Mystic, Blue Hole, Wild Woman, and Bitter Enders caves, all in Murray county, and Coal Creek Cave in Pontotoc county. Historically, *A. pellucidus* had been found in the Wild Woman-Bitter Enders cave system and seeps emerging from those caves and in Coal Creek Cave. Mystic and Blue Hole caves had not been surveyed for amphipods prior to this study. We surveyed for *A. pellucidus* in Wild Woman Cave and Coal Creek Cave; accessible areas of Bitter Enders Cave and seeps associated with both Wild Woman and Bitter Enders caves were dry during this study and could not be sampled. We also sampled for *A. pellucidus* in the type locality, Bird's Mill Spring, as well as four other springs (Table 1). Therefore, two historical localities and six new localities were surveyed for this species.

All cave sampling was conducted by Bill and Beth Howard and Andy Harris (Tulsa Grotto members) during 1995. The Howards and Harris also sampled seeps near caves in Murray county. Springs (Table 1) were sampled opportunistically following rains by Vaughn. Amphipods were observed in caves and attempts were made to estimate their numbers. Mesh traps were set and baited with leaf-litter and left overnight. Limited voucher specimens were collected by hand and preserved in 70% ethanol.

Identification.

Riffle beetle identifications were made by Dr. Harley P. Brown, University of Oklahoma. Hydropsychid caddisfly adults were identified by Dr. Stephen Moulton, U.S. Geological Survey. Amphipods were identified by Vaughn and Katie Meier, Oklahoma Biological Survey. Planarians were identified by Professor Dr. Masahara Kawakatsu, Sapporo, Japan. All other macroinvertebrates collected were identified to the lowest taxonomic groups feasible by Vaughn or by Dr. Elizabeth Bergey, University of Wisconsin.

Voucher specimens are currently held in Vaughn's laboratory at the Oklahoma Biological Survey.

IV. Results and Discussion

The sampled streams and springs in the Arbuckles contain a diverse assemblage of benthic macroinvertebrates. A complete species list by site is included here as Table 2. These data will provide a baseline for monitoring these sites in the future. Water quality data is given in Table 3.

Hydropsyche reiseni

During the course of this study the species designation of *Hydropsyche reiseni* was revised. The species collected from Honey Creek and described as *H. reiseni* by Denning (1975), is now considered to be *Hydropsyche arinale* Ross (Moulton and Stewart 1996). Moulton and Stewart (1996) examined the holotype male (California Academy of Science type No. 16193) and 16 male paratypes of *H. reiseni* and found them to agree well with Ross' description of *H. arinale*. They also matched perfectly with other *H. arinale* collected from other locations throughout the Arbuckles, as well as the Ouachita uplands and the Ozark Plateau. Consequently, Moulton and Stewart (1996) have designated *H. reiseni* as a junior synonym.

In this study, hydropsychid caddisflies occurred at 19 of the 28 sites sampled (Table 2). Of these 19 sites, *H. arinale* occurred at 6/19 or 32% of the hydropsychid sites (Table 4). *H. arinale* was collected from Bridal Veil Falls of Honey Creek, Murray County (site 1), and two sites on Travertine Creek in Chickasa National Recreation Area, Murray County (site 7 and 8), both in the Washita River drainage. *H. arinale* was also collected from Slippery Falls on Pennington Creek (site 13; Washita drainage), and Rock Creek (site 14), and Delaware Creek (site 27), both within the Blue River drainage in Johnston County.

In the Arbuckle streams, the presence of *Hydropsyche arinale* was positively correlated with pH (Table 5). *H. arinale* only was found at more alkaline sites (Figure 2) characterized by travertine (CaCO₃) deposits. According to Dr. Stephen Moulton (pers. com.), an expert on Interior Highland caddisflies, this species also is associated with more alkaline streams in the Ozarks and Ouachitas.

Dubiraphia parva

Dubiraphia parva was collected from six sites. This species occurred at Bridal Veil Falls, Honey Creek (site 1), and Lick Creek Falls (site 2), both in Murray County. *D. parva* also occurred in Spring Creek (site 15), Pennington Creek (site 16), and Pecan Creek (site 26) in Johnston County, and Buck Creek (site 19) in Pontotoc County (Figure 1, Appendix 1). *D. parva* did not occur in the quantitative samples. The species was only found in the samples where vegetation or wood were searched by hand. Like *Hydropsyche arinale*, this species was also associated with more alkaline

streams (Table 5).

Allocrangonyx pellucidus

Locations of cave sites sampled are given in Appendix 2. This information is confidential and should not be distributed to outside parties except by special prior permission of the U.S. Fish and Wildlife Service or Oklahoma Department of Wildlife Conservation. This precaution is taken in order to protect the sensitive species that inhabit these caves.

Allocrangonyx pellucidus was found in Wild Woman and Coal Creek caves, both historical localities for this species. The species was abundant in these two caves. Exact numbers were very difficult to estimate because these species were not found in the leaf traps; estimates had to be made by visual observation. In both of these caves Howard reported seeing greater than 20 individuals in different "rooms" or stretches of the caves. He reported the species as occurring in densities of approximately three individuals in a nine square foot pool. The species appears to be reproducing in both caves, as both large and small individuals were observed in both of these localities. Three voucher specimens were collected from Coal Creek Cave and one voucher specimen was collected from Wild Woman Cave. Accessible areas of Bitter Enders Cave were dry during this study; this cave needs to be sampled.

Only three specimens total were observed in Mystic Cave. Because of these low numbers, a voucher specimen was not taken. However, the species is very distinctive and easy to recognize in the field without magnification. Specimens were also observed in a large spring four miles due south of Mystic Cave, but numbers were not estimated at this location. The species was not found in Blue Hole Cave (Figure 7).

A. pellucidus was not found in any of the following springs (Figure 1) that were sampled opportunistically after rains: Bird's Mill Spring (site 22), the type locality for this species, Cummins Spring (site 28), Buffalo Spring (site 9), Antelope Spring (site 10), Lowrance Spring (site 12).

V. Recommendations

Hydropsyche reiseni is now considered to be *Hydropsyche arinale* Ross (Moulton and Stewart 1996). *Hydropsyche arinale* occurs throughout the Interior Highlands and appears to be secure. This species does not need to be listed.

Dubiraphia parva occurs throughout the Arbuckles. While it has a limited distribution and is relatively rare compared to some other species of riffle beetles (Table 2), its existence within the Arbuckle Mountains appears to be secure at the present time. *D. parva* also may occur outside the Arbuckle Mountains. Dr. Cheryl B. Barr (1982, *in litt.* Louisiana State Univ.; Barr and Chapin (1988)) collected specimens that may belong to

this species from Bushley Creek, Catahoula Parrish, Louisiana (Ouachita River drainage), although this record may represent a new, undescribed species. Dr. Harley Brown (pers. com.) collected female specimens from two streams in Mississippi that he has suggested may also be *D. parva*; collection of males will be necessary to make this determination.

Dubiraphia parva should not be listed, but because of its limited distribution, it should be considered a sensitive species so that its status can be re-evaluated in the future. This opinion does not necessarily reflect that of the Oklahoma Department of Wildlife Conservation or the U.S. Fish and Wildlife Service. In addition, a species designation should be made for the specimens from Louisiana and Mississippi so that the true range extent for *D. parva* is known. If the specimens from Louisiana and Mississippi are indeed *D. parva*, then surveys for this species should be conducted in appropriate habitat in these states.

Allocrangonyx pellucidus is a cavernicolous species endemic to the Arbuckle Mountains. It has a very limited distribution. It is abundant in two caves (Wild Woman Cave and Coal Creek Cave), both of which are also historical locations, and there is a probable small population within a third cave system (Mystic Cave) which represents a previously unknown location for this species (Figure 2). Howard (pers. com.) believes that the large spring four miles south of Mystic Cave leads into a large, unexplored cave system. A voucher specimen(s) needs to be collected from Mystic Cave or the spring emerging from this cave, and the extent of this cave system needs to be documented and mapped. Accessible areas of an historical location, Bitter Enders Cave, were dry during this study. This cave needs to be surveyed. However, even if the species is present in Bitter Enders Cave, this would undoubtedly represent the same population as Wild Woman Cave (Figure 2) because these caves are so close together. Seeps associated with Wild Woman Cave that are historical localities for *A. pellucidus* were also dry during this study and not sampled, however this was unimportant since the species was observed in the cave itself.

The species no longer occurs at its type locality, Bird's Mill Spring, and was not found in any of the other springs not associated with caves that were sampled (Figure 1). Bird's Mill Spring has been altered substantially. This spring now serves as the major water supply for the city of Ada. The springhead is surrounded by many large turbines and a fence. A low water crossing has been built across the stream about 30 meters downstream from the springhead. The area is used as a swimming hole by local residents.

Thus, the distribution of *A. pellucidus* in the Arbuckle Mountains appears to be as follows: (1) A population in the Wild Woman - Bitter Enders cave system, Murray County; (2) a population in Coal Creek Cave, Pontotoc County, approximately 40 miles away from the Murray County system; and (3) a potential third, small population located halfway between the two known populations in Mystic Cave, Murray County (Figure 2).

The *A. pellucidus* population in Coal Creek Cave is relatively protected. This cave is on a nature preserve (Pontotoc Ridge) owned and under the stewardship of the Oklahoma Nature Conservancy. The Nature Conservancy is protecting the immediate watershed of Coal Creek. The population of *A. pellucidus* in the Wild Woman - Bitter Enders system should be considered threatened. These caves are on private land, but adjacent to (directly southwest) and in the same watershed (Honey Creek) as the popular Turner Falls recreation area, owned and operated by the City of Davis. Thousands of people swim in and hike and camp along Honey Creek each summer. In addition, the City of Davis has recently purchased land adjacent to the ranch on which the caves are located and plans to expand the park. The caves themselves are located on a private ranch. The landowner is concerned about liability with the park expansion and has recently threatened to fill the entrance to Wild Woman Cave. The potential population of *A. pellucidus* in Mystic Cave should also be considered threatened. Mystic Cave is connected to Blue Hole Cave, which is extremely polluted (Howard, pers. com.). The owner of Blue Hole Cave has been cited for excess dumping of chicken litter in the watershed above this cave. Because the caves are connected underground, poor water quality in Blue Hole Cave will eventually impact Mystic Cave.

Allocrangonyx pellucidus has a highly restricted distribution, only occurring in wet caves in the Arbuckle Mountains of central Oklahoma. One of two known populations of *A. pellucidus* is threatened, and a third potential population is also threatened. Based on this information, *A. pellucidus* should be considered for federal threatened status. This opinion does not necessarily reflect that of the Oklahoma Department of Wildlife Conservation or the U.S. Fish and Wildlife Service.

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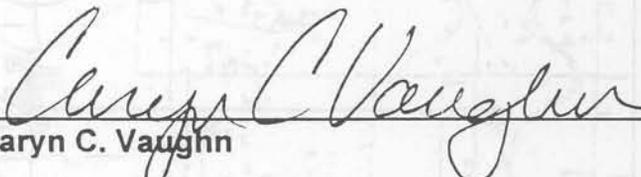
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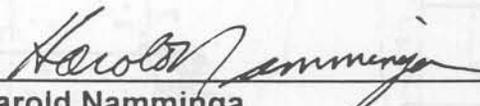
VII. Prepared by:


Caryn C. Vaughn

Oklahoma Natural Heritage Inventory
Oklahoma Biological Survey
University of Oklahoma

Date: 6/25 1996

Approved: Oklahoma Department of Wildlife Conservation

By: 
Harold Namminga
Federal Aid/Research Coordinator

Map, ardm. springs sites
Thu May 30 15:24:49 CDT 1996
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REGION 641300 77
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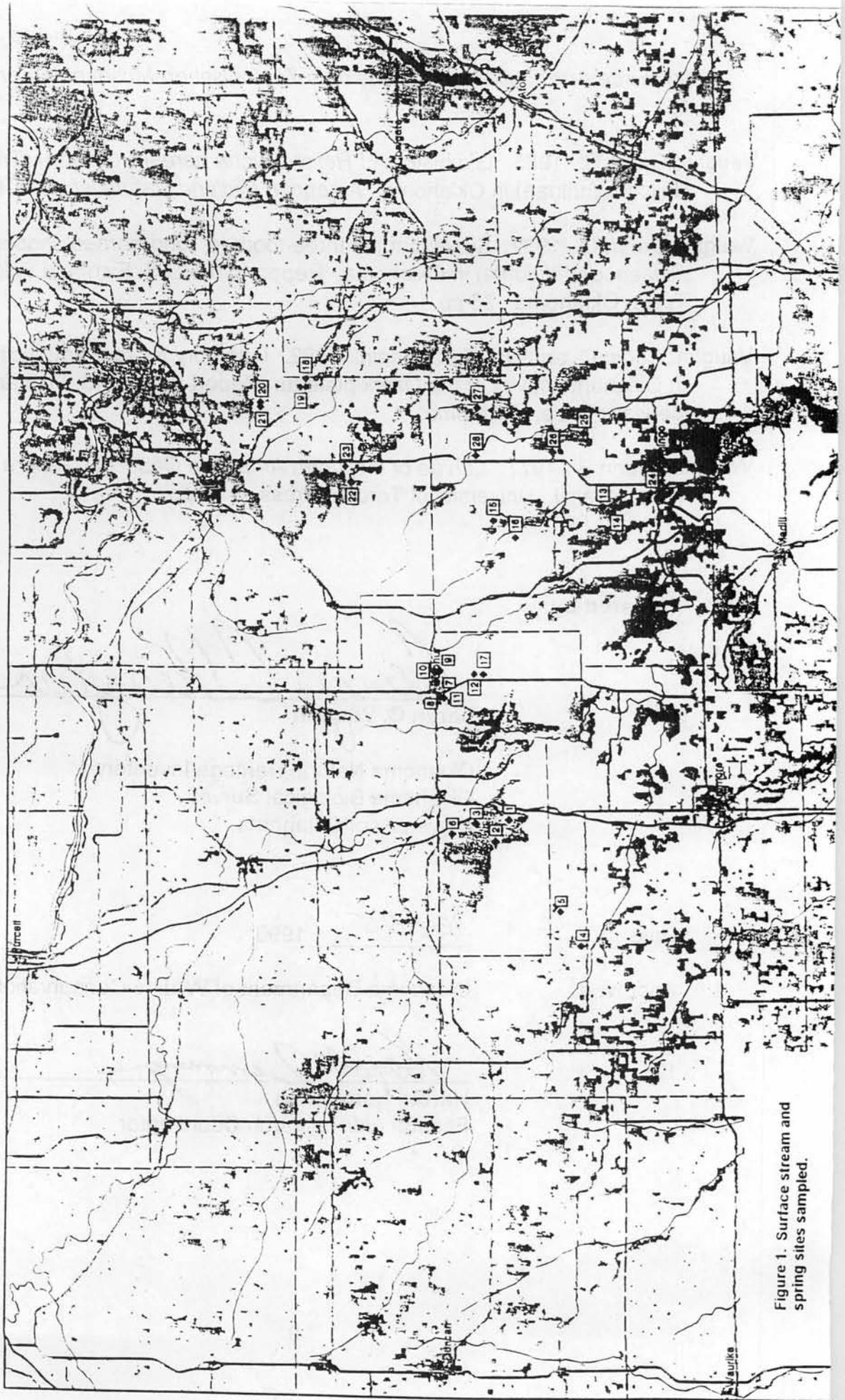


Figure 1. Surface stream and spring sites sampled.

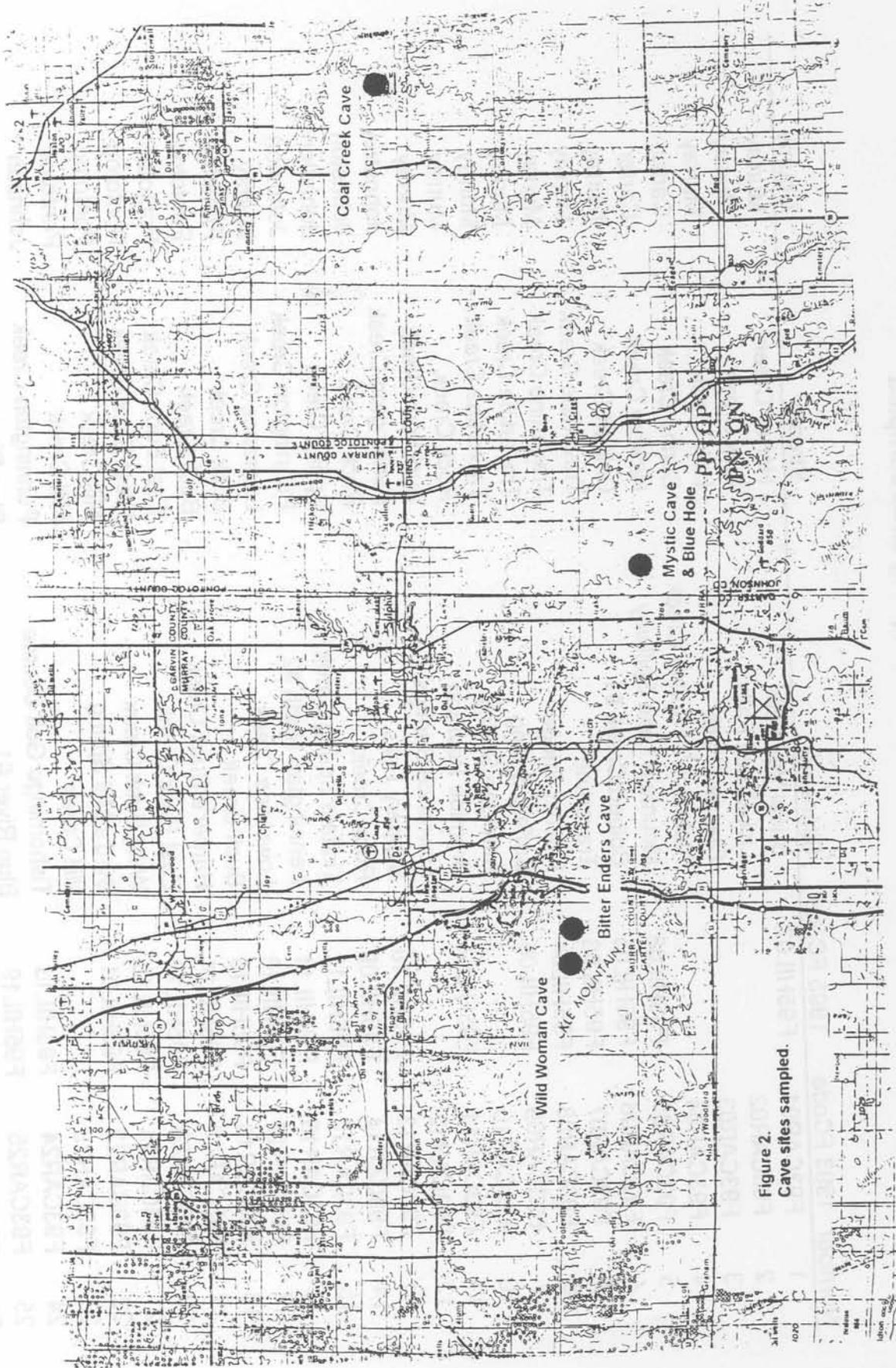


Figure 2.
Cave sites sampled.

Table 1. Surface stream and spring sites sampled.

Number	1993 FCode	1995 FCode	Sitename	Stream	County
1	F93CAR01	F95HIL02	Bridal Veil Falls	Honey Creek	Murray
2	F93CAR02		Lick Creek Falls	Lick Creek	Murray
3	F93CAR03		Classen Falls	Lick Creek	Murray
4	F93CAR04		"Johnson's" Spring Creek	Spring Creek	Carter
5	F93CAR05	F95HIL08	Mountain Lake Spillway	Hickory Creek	Carter
6	F93CAR06	F95HIL05	Colbert Creek #1	Colbert Creek	Murray
7	F93CAR07	F95HIL03	Travertine	Travertine Creek	Murray
8	F93CAR08	F95HIL04	Lincoln Bridge	Travertine Creek	Murray
9	F93CAR09	F95HIL06	Buffalo Spring	Travertine Creek	Murray
10	F93CAR10		Antelope Spring	Travertine Creek	Murray
11	F93CAR11	F95HIL07	Bromide Pavillion	Rock Creek	Murray
12	F93CAR12		Lowrance Springs	Buckhorn Creek	Murray
13	F93CAR13	F95HIL10	Slippery Falls	Pennington Creek	Johnston
14	F93CAR14	F95HIL09	Rock Creek	Rock Creek	Johnston
15	F93CAR15	F95HIL12	Tisdale Spring Creek	Spring Creek	Johnston
16	F93CAR16	F95HIL11	Pennington North #2	Pennington Creek	Johnston
17	F93CAR17	F95HIL16	Lowrance Creek	Lowrance Creek	Murray
18	F93CAR18	F95HIL15	Buck Creek	Buck Creek	Pontotoc
19	F93CAR19	F95HIL14	Harper's Buck Creek	Buck Creek	Pontotoc
20	F93CAR20	F95HIL17	East Buck Creek	East Buck Creek	Pontotoc
21	F93CAR21	F95HIL18	West Buck Creek	West Buck Creek	Pontotoc
22	F93CAR22	F95HIL01	Byrd's Mill Spring	Mill Creek	Pontotoc
23	F93CAR23		Mill Creek	Mill Creek	Pontotoc
24	F93CAR24	F95HIL13	Tishomingo Golf Course	Pennington Creek	Johnson
25	F93CAR25	F95HIL19	Blue River #1	Blue River	Johnston
26	F93CAR26	F95HIL20	Pecan Creek	Pecan Creek	Johnston
27	F93CAR27	F95HIL21	Delaware Creek	Delaware Creek	Johnston
28	F93CAR28		Cummin's Spring	Cummin's Spring	Johnston

Table 2. Species collected in surface streams and springs, by site.

			1	2	3	4	5	6	7
Cnidaria	Hydridae	<i>Hydra/Chlorhydra</i> sp.					X		
Turbellaria		<i>Dugesia</i> sp.	X	X	X	X	X	X	X
Nematoda									
Oligochaeta	Lumbriculidae								X
	Naidiade	<i>Nais</i> sp.		X			X		
		<i>Pristina</i> sp.							
	Tubificidae			X					
Hirudinea		unidentified							
	Erpobdellidae	nr <i>Dina</i> sp.							
	Glossiphonidae	<i>Placobdella multilineata</i>							
		<i>Placobdella ornata</i>					X		
MOLLUSKS									
Gastropoda	Lymnaeidae	<i>Stagnicola</i> sp.							
	Physidae	<i>Physella</i> sp.	X	X	X	X	X		X
	Planorbidae	<i>Gyraulus</i> sp.	X				X		
		<i>Menetus dilatatus</i>							
Bivalvia	Corbiculidae	<i>Corbicula fluminea</i>							
	Sphaeriidae	<i>Musculium</i> sp.					X		
CRUSTACEANS									
Isopoda		<i>Licercus garmani</i>					X		
		<i>Asellus</i> sp.							
Amphipoda		<i>Hyalella azteca</i>	X		X	X			
		<i>Gammarus lacustris</i>							
Decapoda	Cambaridae	unidentified		X		X			X
MITES									
Hydracarina	Lebertiidae	<i>Lebertia/Scutolebertia</i>		X					
	Limnesiidae	<i>Limnesia/Centrolimnesia</i>	X						
	Sperchonidae	<i>Spercon/Sperchonopsis</i>							

Table 2. Species collected in surface streams and springs, by site.

			1	2	3	4	5	6	7	
INSECTS										
Collembola		unidentified								
Plecoptera	Perlidae	<i>Neoperla</i> sp.				X				
		<i>Perlesta placida</i>				X				
Ephemeroptera	Baetidae	<i>Baetis</i> spp.	X	X	X	X	X	X	X	
		<i>Baetodes</i> sp.								
		<i>Callibaetis</i> sp.								
		<i>Dactylobaetis</i> sp.	X		X				X	
		<i>Heterocloeon</i> sp.								
		<i>Pseudocloeon</i> sp.			X	X	X		X	X
		<i>Caenis</i> sp.								
	Caenidae	Heptageniidae	<i>Heptagenia</i> sp.							
			<i>Stenacron</i> sp.				X	X		
			<i>Stenonema</i> sp.				X			X
			<i>Stenonema exiguum</i>							
			<i>Stenonema femoratum</i>			X	X		X	
			<i>Stenonema mediopunctatum</i>				X			
		Oligoneuridae	<i>Isonychia</i> sp.					X		
	Tricorythidae	<i>Tricorythodes</i> sp.	X		X					
Odonata	Calopterygidae	<i>Calopteryx</i> sp.								
		<i>Hetaerina</i> sp.								X
	Coenagrionidae	<i>Argia</i> sp.	X	X	X	X	X	X	X	X
		<i>Coenagrion/Enallagma</i>								
		<i>Enallagma</i> sp.								
		<i>Ischnura/Anomalagrion</i>								
			<i>Telebasis</i> sp.							
	Lestidae		<i>Archilestes</i> sp.							
	Aeschnidae	<i>Basiaeschna janata</i>								
		<i>Boyeria</i> sp.								
	Gomphidae	<i>Dromogomphus spinosus</i>	X							
		<i>Erpetogomphus</i> sp.								
		<i>Ophiogomphus</i> sp.								
	Libellulidae	<i>Brechmorhoga mendax</i>				X				
<i>Libellula</i> sp.										
Macromiidae		<i>Macromia</i> sp.								

Table 2. Species collected in surface streams and springs, by site.

			1	2	3	4	5	6	7	
Hemiptera	Belostomatidae	<i>Belostoma</i> sp.								
	Corixidae	<i>Trichocorixa</i> sp.								
	Gerridae	<i>Gerris</i> sp.		X						X
		<i>Rheumatobates</i>								
		<i>Trepobates</i>								
	Hebridae	<i>Hebrus</i> sp.								
		<i>Lipogomphus</i> sp.								
	Mesoveliidae	<i>Mesovelia</i> sp.								
	Saldidae	<i>Saluda</i> sp.								
	Veliidae	<i>Microvelia</i> sp.								
<i>Paravelia</i> sp.										
<i>Rhagovelia</i> sp.									X	
Orthoptera	Tetrigidae	unidentified								
Megaloptera	Corydalidae	<i>Corydalus</i> sp.			X					
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	X	X	X	X		X	X	
	Hydropsychidae	<i>Cheumatopsyche</i> sp.	X		X	X	X	X		
		<i>Hydropsyche</i> sp.	X					X	X	X
		<i>Smicridia</i> sp.								
	Hydroptilidae	unidentified		X						
		<i>Hydroptila</i> sp.		X	X	X	X	X	X	
		<i>Mayatrichia</i> sp.		X	XXX			X	X	
		<i>Neotrichia</i> sp.			X					
		<i>Ochrotrichia</i> sp.		X	X	X			X	X
	Leptoceridae	<i>Nectopsyche</i> sp.								
		<i>Oecetis</i> sp.		X		X				
	Philopotamidae	<i>Chimarra</i> sp.				X	X	X	X	
Polycentropodidae	<i>Nyctiophylax</i> sp.									
	<i>Polycentropus</i> sp.									
Lepidoptera	Pyralidae	<i>Petrophila</i> sp.								

Table 2. Species collected in surface streams and springs, by site.

			1	2	3	4	5	6	7
Coleoptera	Carabidae	Omophroninae							
		Dryopidae	<i>Helichus</i> sp.						
		Dytiscidae	<i>Acilius</i> sp.						
			<i>Agabus</i> sp.						X
			<i>Brachyvatus</i> sp.						
			<i>Hydroporus</i> sp.				X		
			<i>Laccophilus</i> sp.						
		Elmidae	<i>Stenelmis exigua</i>				X		
			<i>Stenelmis sexlineata</i>	X	X	X			
			<i>Stenelmis crenata</i>				X		
			<i>Stenelmis knobeli?</i>						
			<i>Stenelmis sexlineata</i>						
			<i>Stenelmis lignicola</i>						
			<i>Microcylloepus pusillus</i>	X	X	X			X
			<i>Microcylloepus pusillus weesei</i>						
			<i>Microcylloepus n. sp.</i>						
			<i>Dubiraphia minima</i>	X	X				
			<i>Dubiraphia parva</i>	X	X				
			<i>Dubiraphia vittata</i>	X					
			<i>Hexacylloepus ferrugineus</i>						
			<i>Hexacylloepus</i> sp.						
		Lutrochidae	<i>Lutrochus luteus</i>	X	X	X			
		Gyrinidae	<i>Dineutes</i> sp.						
			<i>Gyretes</i> sp.						
			<i>Gyrinus</i> sp.						
		Halipiidae	<i>Peltodytes</i> sp.						
		Hydrophilidae	<i>Anacaena</i> sp.						
			<i>Berosus</i> sp.						
			<i>Enochrus</i> sp.						X
			<i>Helochaeres</i> sp.						
			<i>Helocombus</i> sp.		X				X
		<i>Helophorus</i> sp.							
		<i>Hydrobius</i> sp.							
		<i>Hydrochus</i> sp.							
		<i>Laccobius</i> sp.							
		<i>Paracymus</i> sp.					X	X	
		<i>Tropisternis</i> sp.					X		
	Limnichidae	<i>Limnichus</i> sp.							
		<i>Lutrochus</i> sp.	X	X	X		X	X	
	Noteridae	<i>Suphisellus</i> sp.							
	Scirtidae	<i>Scirtes</i> sp.							

Table 2. Species collected in surface streams and springs, by site.

			1	2	3	4	5	6	7
Diptera	Athericidae	<i>Atherix</i> sp.	X	X					X
	Ceratopogonidae	<i>Atrichopogon</i> sp.							
		unidentified	X	X					
	Culicidae	<i>Anopheles</i> sp.							
		Dixidae	<i>Dixella</i> sp.						
		Empididae	<i>Hemerodromia</i> sp.						
			unid. (pupae)			X			
		Psychodidae	<i>Pericoma</i> sp.						
		Simuliidae	<i>Cnephia</i> sp.						X
			<i>Simulium</i> sp.	X	X	X		X	X
		Stratiomyidae	<i>Caloparyphus</i> sp.	X	X	X			X
			<i>Euparyphus</i> sp.	X	X	X			X
		Tabanidae	<i>Hybomitra</i> sp.?						
			<i>Tabanus</i> /Whit.		X	X	X		
		Tipulidae	<i>Tipula</i> sp.		X	X	X		X
		Chironomidae	unidentified	X	X	X		X	X
		Chironminae	<i>Chironomus</i> sp.						
			<i>Cryptochironomus</i> sp.						
			<i>Dicrotendipes</i> sp.	X					X
			<i>Polypedilum</i> sp.		X	X		X	X
			<i>Pseudochironomus</i>	X	X	X			
			<i>Tribelos</i> sp.						X
		Chir.-Tanytarsini	<i>Rheotanytarsus</i> sp.			X			
			<i>Tanytarsus</i> sp.						
		Orthocladinae	<i>Cardiocladius</i>					X	
			<i>Cricotopus</i> sp.	X	X	X		X	X
			<i>Eukefferiella</i>	X	X				X
		<i>Parametriocnemus</i> sp.?							
		<i>Rheocricotopus</i> sp.			X				
		<i>Thienemanniella</i> sp.					X	X	
	Tanypodinae	<i>Ablabesmyia</i> sp.	X						
		<i>Pentaneura</i> sp.				X		X	
		<i>Thienemannimyia</i> grp			X	X			

Table 2. Species collected in surface streams and springs, by site.

			8	9	10	11	12	13	14
Cnidaria	Hydridae	<i>Hydra/Chlorhydra</i> sp.							
Turbellaria		<i>Dugesia</i> sp.	X	X			X	X	
Nematoda						X	X		
Oligochaeta	Lumbriculidae						X		
	Naidiade	<i>Nais</i> sp. <i>Pristina</i> sp.				X			
Hirudinea	Tubificidae	unidentified					X		
	Erpobdellidae	nr <i>Dina</i> sp.							
	Glossiphonidae	<i>Placobdella multilineata</i> <i>Placobdella ornata</i>					X		
MOLLUSKS									
Gastropoda	Lymnaeidae	<i>Stagnicola</i> sp.							
	Physidae	<i>Physella</i> sp.			X				
	Planorbidae	<i>Gyraulus</i> sp. <i>Menetus dilatatus</i>							
Bivalvia	Corbiculidae	<i>Corbicula fluminea</i>				X		X	
	Sphaeriidae	<i>Musculium</i> sp.							
CRUSTACEANS									
Isopoda		<i>Licercus garmani</i>		X					
		<i>Asellus</i> sp.							
Amphipoda		<i>Hyalella azteca</i>		X	X		X		X
		<i>Gammarus lacustris</i>							
Decapoda	Cambaridae	unidentified			X	X	X		
MITES									
Hydracarina	Lebertiidae	<i>Lebertia/Scutolebertia</i>	X			X			
	Limnesiidae	<i>Limnesia/Centrolimnesia</i>							
	Sperchonidae	<i>Spercon/Sperchonopsis</i>							X

Table 2. Species collected in surface streams and springs, by site.

			8	9	10	11	12	13	14	
Hemiptera	Belostomatidae	<i>Belostoma</i> sp.								
	Corixidae	<i>Trichocorixa</i> sp.					X			
	Gerridae	<i>Gerris</i> sp.					X			
		<i>Rheumatobates</i>								X
		<i>Trepobates</i>								
	Hebridae	<i>Hebrus</i> sp.								
		<i>Lipogomphus</i> sp.								
	Mesoveliidae	<i>Mesovelia</i> sp.								
	Saldidae	<i>Saluda</i> sp.								
	Veliidae	<i>Microvelia</i> sp.			X		X	X		
<i>Paravelia</i> sp.					X					
<i>Rhagovelia</i> sp.						X		X	X	
Orthoptera	Tetrigidae	unidentified								
Megaloptera	Corydalidae	<i>Corydalus</i> sp.		X				X	X	
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	X	X		X		X	X	
	Hydropsychidae	<i>Cheumatopsyche</i> sp.				X		X	X	
		<i>Hydropsyche</i> sp.	X	X		X		X	X	
		<i>Smicridia</i> sp.							X	
		unidentified							X	
	Hydroptilidae	<i>Hydroptila</i> sp.				X			X	X
		<i>Mayatrichia</i> sp.							X	
		<i>Neotrichia</i> sp.								
		<i>Ochrotrichia</i> sp.	X	X		X				X
	Leptoceridae	<i>Nectopsyche</i> sp.				X	X	X		
		<i>Oecetis</i> sp.				X				X
Philopotamidae	<i>Chimarra</i> sp.							X	X	
Polycentropodidae	<i>Nyctiophylax</i> sp.									
	<i>Polycentropus</i> sp.									
Lepidoptera	Pyalidae	<i>Petrophila</i> sp.					X	X		

Table 2. Species collected in surface streams and springs, by site.

			8	9	10	11	12	13	14
Diptera	Athericidae	<i>Atherix</i> sp.						X	
	Ceratopogonidae	<i>Atrichopogon</i> sp.							
		unidentified		X					X
	Culicidae	<i>Anopheles</i> sp.							
	Dixidae	<i>Dixella</i> sp.		X			X		
	Empididae	<i>Hemerodromia</i> sp.		X		X			
		unid. (pupae)							
	Psychodidae	<i>Pericoma</i> sp.	X						
	Simuliidae	<i>Cnephia</i> sp.							
		<i>Simulium</i> sp.	X	X		X	X	X	X
	Stratiomyidae	<i>Caloparyphus</i> sp.							
		<i>Euparyphus</i> sp.	X			X	X		
	Tabanidae	<i>Hybomitra</i> sp.?						X	
		<i>Tabanus</i> /Whit.							
	Tipulidae	<i>Tipula</i> sp.		X		X	X	X	X
Chironomidae	pupae/tiny larvae	unidentified	X			X			X
	Chironminae	<i>Chironomus</i> sp.					X		
		<i>Cryptochironomus</i> sp.							
		<i>Dicrotendipes</i> sp.		X	X		X		X
		<i>Polypedilum</i> sp.				X			X
		<i>Pseudochironomus</i>		X	X			X	X
		<i>Tribelos</i> sp.					X		
	Chir.-Tanytarsini	<i>Rheotanytarsus</i> sp.				X	X		X
		<i>Tanytarsus</i> sp.		X					X
	Orthocladinae	<i>Cardiocladius</i>							
		<i>Cricotopus</i> sp.	X	X	X	X	X	X	X
		<i>Eukefferiella</i>	X			X	X	X	
		<i>Parametrioctenemus</i> sp.?	X	X					
		<i>Rheocricotopus</i> sp.				X			
		<i>Thienemanniella</i> sp.				X	X		
	Tanypodinae	<i>Ablabesmyia</i> sp.							
		<i>Pentaneura</i> sp.							
		<i>Thienemannimyia</i> grp							

Table 2. Species collected in surface streams and springs, by site.

			15	16	17	18	19	20	21
Cnidaria	Hydridae	<i>Hydra/Chlorhydra</i> sp.							
Turbellaria		<i>Dugesia</i> sp.	X	X					
Nematoda									
Oligochaeta	Lumbriculidae								
	Naidiade	<i>Nais</i> sp. <i>Pristina</i> sp.							
Hirudinea	Tubificidae							X	
		unidentified	X						
	Erpobdellidae	nr <i>Dina</i> sp.							
	Glossiphoniidae	<i>Placobdella multilineata</i> <i>Placobdella ornata</i>							
MOLLUSKS									
Gastropoda	Lymnaeidae	<i>Stagnicola</i> sp.						X	
	Physidae	<i>Physella</i> sp.	X						X
	Planorbidae	<i>Gyraulus</i> sp. <i>Menetus dilatatus</i>	X X						
Bivalvia	Corbiculidae	<i>Corbicula fluminea</i>							
	Sphaeriidae	<i>Musculium</i> sp.							
CRUSTACEANS									
Isopoda	unidentified	<i>Licercus garmani</i> <i>Asellus</i> sp.							
Amphipoda	unidentified	<i>Hyaella azteca</i>	X					X	X
		<i>Gammarus lacustris</i>							X
Decapoda	Cambaridae	unidentified					X		
MITES									
Hydracarina	Lebertiidae	<i>Lebertia/Scutolebertia</i>							
	Limnesiidae	<i>Limnesia/Centrolimnesia</i>							
	Sperchonidae	<i>Spercon/Sperchonopsis</i>							

Table 2. Species collected in surface streams and springs, by site.

			15	16	17	18	19	20	21
INSECTS									
Collembola		unidentified							
Plecoptera	Perlidae	<i>Neoperla</i> sp. <i>Perlesta placida</i>							
Ephemeroptera	Baetidae	<i>Baetis</i> spp. <i>Baetodes</i> sp. <i>Callibaetis</i> sp. <i>Dactylobaetis</i> sp. <i>Heterocloeon</i> sp. <i>Pseudocloeon</i> sp.	X	X	X	X		X	X
	Caenidae	<i>Caenis</i> sp.							
	Heptageniidae	<i>Heptagenia</i> sp. <i>Stenacron</i> sp. <i>Stenonema</i> sp. <i>Stenonema exiguum</i> <i>Stenonema femoratum</i> <i>Stenonema mediopunctatum</i>							
				X		X		X	X
			X	X			X		
						X	X	X	X
					X				X
	Oligoneuridae	<i>Isonychia</i> sp.	X		X	X			X
	Tricorythidae	<i>Tricorythodes</i> sp.	X		X	X	X		X
Odonata	Calopterygidae	<i>Calopteryx</i> sp. <i>Hetaerina</i> sp.							
			X		X		X		
	Coenagrionidae	<i>Argia</i> sp. <i>Coenagrion/Enallagma</i> <i>Enallagma</i> sp. <i>Ischnura/Anomalagrion</i> <i>Telebasis</i> sp.			X				
									X
			X						
	Lestidae	<i>Archilestes</i> sp.							
	Aeschnidae	<i>Basiaeschna janata</i> <i>Boyeria</i> sp.						X	
									X
	Gomphidae	<i>Dromogomphus spinosus</i> <i>Erpetogomphus</i> sp. <i>Ophiogomphus</i> sp.							
							X		
	Libellulidae	<i>Brechmorhoga mendax</i> <i>Libellula</i> sp.							
	Macromiidae	<i>Macromia</i> sp.							

Table 2. Species collected in surface streams and springs, by site.

			15	16	17	18	19	20	21
Hemiptera	Belostomatidae	<i>Belostoma</i> sp.				X			
	Corixidae	<i>Trichocorixa</i> sp.					X		
	Gerridae	<i>Gerris</i> sp.							X
		<i>Rheumatobates</i>							X
		<i>Trepobates</i>							
	Hebridae	<i>Hebrus</i> sp.					X		
		<i>Lipogomphus</i> sp.							
	Mesoveliidae	<i>Mesovelia</i> sp.	X				X		X
	Saldidae	<i>Saluda</i> sp.				X			
	Veliidae	<i>Microvelia</i> sp.					X		
<i>Paravelia</i> sp.									
<i>Rhagovelia</i> sp.				X	X	X	X		
Orthoptera	Tetrigidae	unidentified			X	X			
Megaloptera	Corydalidae	<i>Corydalus</i> sp.	X	X			X	X	X
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	X	X	X				
	Hydropsychidae	<i>Cheumatopsyche</i> sp.	X	X	X	X	X	X	X
		<i>Hydropsyche</i> sp.	X	X	X	X	X	X	X
		<i>Smicridia</i> sp. unidentified							
	Hydroptilidae	<i>Hydroptila</i> sp.		X	X				
		<i>Mayatrichia</i> sp.				X			
		<i>Neotrichia</i> sp.							
		<i>Ochrotrichia</i> sp.		X	X				
	Leptoceridae	<i>Nectopsyche</i> sp.						X	
		<i>Oecetis</i> sp.		X	X			X	
	Philopotamidae	<i>Chimarra</i> sp.	X	X					X
	Polycentropodidae	<i>Nyctiophylax</i> sp.							
<i>Polycentropus</i> sp.				X	X				
Lepidoptera	Pyralidae	<i>Petrophila</i> sp.				X			

Table 2. Species collected in surface streams and springs, by site.

			15	16	17	18	19	20	21	
Coleoptera	Carabidae	Omophroninae								
		Dryopidae					X			
		Dytiscidae	<i>Acilius</i> sp.							
			<i>Agabus</i> sp.							
			<i>Brachyvatus</i> sp.							
			<i>Hydroporus</i> sp.					X	X	
			<i>Laccophilus</i> sp.							
		Elmidae	<i>Stenelmis exigua</i>							
			<i>Stenelmis sexlineata</i>							
			<i>Stenelmis crenata</i>							
			<i>Stenelmis knobeli?</i>							
			<i>Stenelmis sexlineata</i>			X				
			<i>Stenelmis lignicola</i>					X	X	X
			<i>Microcyloopus pusillus</i>		X	X	X	X		
			<i>Microcyloopus pusillus weesei</i>							
			<i>Microcyloopus n. sp.</i>							
			<i>Dubiraphia minima</i>		X	X				
			<i>Dubiraphia parva</i>		X	X			X	
			<i>Dubiraphia vittata</i>							
			<i>Hexacyloopus ferrugineus</i>							
			<i>Hexacyloopus</i> sp.							X
		Lutrochidae	<i>Lutrochus luteus</i>		X		X			
		Gyrinidae	<i>Dineutes</i> sp.			X		X		X
			<i>Gyretes</i> sp.					X	X	
			<i>Gyrinus</i> sp.			X				
		Haliplidae	<i>Peltodytes</i> sp.							
			Hydrophilidae	<i>Anacaena</i> sp.						
		<i>Berosus</i> sp.			X				X	X
		<i>Enochrus</i> sp.			X				X	
		<i>Helochaeres</i> sp.								
	<i>Helocombus</i> sp.									
	<i>Helophorus</i> sp.					X	X		X	
	<i>Hydrobius</i> sp.									
	<i>Hydrochus</i> sp.							X	X	
	<i>Laccobius</i> sp.						X			
	<i>Paracymus</i> sp.			X		X		X	X	X
	<i>Tropisternis</i> sp.			X		X		X		
	Limnichidae	<i>Limnichus</i> sp.			X		X			X
		<i>Lutrochus</i> sp.		X		X				
	Noteridae	<i>Suphisellus</i> sp.								
	Scirtidae	<i>Scirtes</i> sp.		X		X				

Table 2. Species collected in surface streams and springs, by site.

			15	16	17	18	19	20	21
Diptera	Athericidae	<i>Atherix</i> sp.							
	Ceratopogonidae	<i>Atrichopogon</i> sp.							
		unidentified	X						X
	Culicidae	<i>Anopheles</i> sp.			X				
		Dixidae	<i>Dixella</i> sp.						
		Empididae	<i>Hemerodromia</i> sp.	X		X			
			unid. (pupae)						
		Psychodidae	<i>Pericoma</i> sp.						
		Simuliidae	<i>Cnephia</i> sp.						
			<i>Simulium</i> sp.	X	X	X			
		Stratiomyidae	<i>Caloparyphus</i> sp.			X			
			<i>Euparyphus</i> sp.						
		Tabanidae	<i>Hybomitra</i> sp.?						
			<i>Tabanus</i> /Whit.				X		
	Tipulidae	<i>Tipula</i> sp.	X		X				
Chironomidae	pupae/tiny larvae	unidentified			X				
	Chironminae	<i>Chironomus</i> sp.							
		<i>Cryptochironomus</i> sp.						X	
		<i>Dicrotendipes</i> sp.							
		<i>Polypedilum</i> sp.	X	X	X	X	X		
		<i>Pseudochironomus</i>	X						
		<i>Tribelos</i> sp.							
		Chir.-Tanytarsini	<i>Rheotanytarsus</i> sp.		X		X	X	X
			<i>Tanytarsus</i> sp.	X					
		Orthocladinae	<i>Cardiocladius</i>						
			<i>Cricotopus</i> sp.	X		X	X	X	
			<i>Eukefferiella</i>			X			
			<i>Parametricnemus</i> sp.?						
			<i>Rheocricotopus</i> sp.		X				
			<i>Thienemanniella</i> sp.						X
	Tanypodinae	<i>Ablabesmyia</i> sp.					X		
		<i>Pentaneura</i> sp.	X	X					
		<i>Thienemannimyia</i> grp				X			

Table 2. Species collected in surface streams and springs, by site.

			22	23	24	25	26	27	28
Cnidaria	Hydridae	<i>Hydra/Chlorhydra</i> sp.							
Turbellaria		<i>Dugesia</i> sp.	X	X	X	X	X	X	X
Nematoda									
Oligochaeta	Lumbriculidae								
	Naidiade	<i>Nais</i> sp.			X				
		<i>Pristina</i> sp.							X
	Tubificidae					X			X
Hirudinea		unidentified							
	Erpobdellidae	nr <i>Dina</i> sp.		X					X
	Glossiphoniidae	<i>Placobdella multilineata</i>							
		<i>Placobdella ornata</i>							
MOLLUSKS									
Gastropoda	Lymnaeidae	<i>Stagnicola</i> sp.					X		
	Physidae	<i>Physella</i> sp.		X			X	X	X
	Planorbidae	<i>Gyraulus</i> sp.		X					
		<i>Menetus dilatatus</i>							
Bivalvia	Corbiculidae	<i>Corbicula fluminea</i>			X	X			X
	Sphaeriidae	<i>Musculium</i> sp.							
CRUSTACEANS									
Isopoda		<i>Licercus garmani</i>							X
		<i>Asellus</i> sp.		X					
Amphipoda		<i>Hyalella azteca</i>					X		X
		<i>Gammarus lacustris</i>							X
Decapoda	Cambaridae	unidentified	X		X	X			X
MITES									
Hydracarina	Lebertiidae	<i>Lebertia/Scutolebertia</i>					X	X	X
	Limnesiidae	<i>Limnesia/Centrolimnesia</i>							
	Sperchonidae	<i>Spercon/Sperchonopsis</i>						X	

Table 2. Species collected in surface streams and springs, by site.

			22	23	24	25	26	27	28
INSECTS									
Collembola		unidentified							
Plecoptera	Perlidae	<i>Neoperla</i> sp.							
		<i>Perlesta placida</i>	X						
Ephemeroptera	Baetidae	<i>Baetis</i> spp.	X		X	X	X	X	
		<i>Baetodes</i> sp.		X					
		<i>Callibaetis</i> sp.	X				X		
		<i>Dactylobaetis</i> sp.							X
		<i>Heterocloeon</i> sp.			X	X			
		<i>Pseudocloeon</i> sp.							
		Caenidae	<i>Caenis</i> sp.			X			
	Heptageniidae	<i>Heptagenia</i> sp.							
		<i>Stenacron</i> sp.				X	X		
		<i>Stenonema</i> sp.			X				
		<i>Stenonema exiguum</i>							X
		<i>Stenonema femoratum</i>						X	X
		<i>Stenonema mediopunctatum</i>	X			X	X		
Oligoneuridae	<i>Isonychia</i> sp.			X	X	X			
Tricorythidae	<i>Tricorythodes</i> sp.		X	X	X	X			
Odonata	Calopterygidae	<i>Calopteryx</i> sp.							
		<i>Hetaerina</i> sp.			X	X	X		X
	Coenagrionidae	<i>Argia</i> sp.	X			X			X
		<i>Coenagrion/Enallagma</i>							
		<i>Enallagma</i> sp.					X		
		<i>Ischnura/Anomalagrion</i>							X
		<i>Telebasis</i> sp.							
	Lestidae	<i>Archilestes</i> sp.	X						
	Aeschnidae	<i>Basiaeschna janata</i>							
		<i>Boyeria</i> sp.				X	X		
	Gomphidae	<i>Dromogomphus spinosus</i>							
		<i>Erpetogomphus</i> sp.			X				
		<i>Ophiogomphus</i> sp.							
	Libellulidae	<i>Brechmorhoga mendax</i>							
		<i>Libellula</i> sp.							X
	Macromiidae	<i>Macromia</i> sp.			X				

Table 2. Species collected in surface streams and springs, by site.

			22	23	24	25	26	27	28	
Hemiptera	Belostomatidae	<i>Belostoma</i> sp.								
	Corixidae	<i>Trichocorixa</i> sp.	X							
	Gerridae	<i>Gerris</i> sp.	X	X						X
		<i>Rheumatobates</i>						X		
		<i>Trepobates</i>						X	X	
	Hebridae	<i>Hebrus</i> sp.						X		
		<i>Lipogomphus</i> sp.		X						
	Mesoveliidae	<i>Mesovelia</i> sp.						X	X	
	Saldidae	<i>Saluda</i> sp.								
	Veliidae	<i>Microvelia</i> sp.	X	X	X					
		<i>Paravelia</i> sp.								X
<i>Rhagovelia</i> sp.			X	X	X	X	X		X	
Orthoptera	Tetrigidae	unidentified								
Megaloptera	Corydalidae	<i>Corydalus</i> sp.		X	X	X	X			
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	X		X	X	X		X	
	Hydropsychidae	<i>Cheumatopsyche</i> sp.	X		X	X	X	X		
		<i>Hydropsyche</i> sp.	X		X	X	X	X		
		<i>Smicridia</i> sp.			X	X				
			unidentified							
	Hydroptilidae	<i>Hydroptila</i> sp.		X	X			X		
		<i>Mayatrichia</i> sp.			X				X	
		<i>Neotrichia</i> sp.								
			<i>Ochrotrichia</i> sp.	X	X	X				X
	Leptoceridae	<i>Nectopsyche</i> sp.				X				
		<i>Oecetis</i> sp.				X				
Philopotamidae	<i>Chimarra</i> sp.			X	X	X	X			
Polycentropodid	<i>Nyctiophylax</i> sp.						X			
	<i>Polycentropus</i> sp.									
Lepidoptera	Pyralidae	<i>Petrophila</i> sp.				X	X	X		

Table 2. Species collected in surface streams and springs, by site.

			22	23	24	25	26	27	28
Coleoptera	Carabidae	Omophroninae					X		
	Dryopidae	<i>Helichus</i> sp.			X				
	Dytiscidae	<i>Acilius</i> sp.							X
			<i>Agabus</i> sp.						
			<i>Brachyvatus</i> sp.			X			
			<i>Hydroporus</i> sp.						
			<i>Laccophilus</i> sp.						X
	Elmidae	<i>Stenelmis exigua</i>							
		<i>Stenelmis sexlineata</i>							
		<i>Stenelmis crenata</i>					X		
		<i>Stenelmis knobeli?</i>							
		<i>Stenelmis sexlineata</i>					X		
		<i>Stenelmis lignicola</i>							
		<i>Microcyloopus pusillus</i>		X	X	X	X	X	
		<i>Microcyloopus pusillus weesei</i>	X						
		<i>Microcyloopus n. sp.</i>	X						
		<i>Dubiraphia minima</i>							
		<i>Dubiraphia parva</i>					X		
		<i>Dubiraphia vittata</i>							
		<i>Hexacycloopus ferrugineus</i>		X	X				
		<i>Hexacycloopus</i> sp.							
	Lutrochidae	<i>Lutrochus luteus</i>		X	X	X			X
	Gyrinidae	<i>Dineutes</i> sp.							
		<i>Gyretes</i> sp.							
		<i>Gyrinus</i> sp.							
	Haliplidae	<i>Peltodytes</i> sp.			X	X			X
	Hydrophilidae	<i>Anacaena</i> sp.							
		<i>Berosus</i> sp.		X			X	X	
		<i>Enochrus</i> sp.		X	X		X		
		<i>Helochaeres</i> sp.							
		<i>Helocombus</i> sp.							X
		<i>Helophorus</i> sp.					X		
		<i>Hydrobius</i> sp.					X		
	<i>Hydrochus</i> sp.			X					
	<i>Laccobius</i> sp.								
	<i>Paracymus</i> sp.	X	X	X	X	X	X	X	
	<i>Tropisternis</i> sp.					X			
Limnichidae	<i>Limnichus</i> sp.	X	X						
	<i>Lutrochus</i> sp.		X	X	X	X	X	X	
Noteridae	<i>Suphisellus</i> sp.					X			
Scirtidae	<i>Scirtes</i> sp.					X			

Table 2. Species collected in surface streams and springs, by site.

			22	23	24	25	26	27	28		
Diptera	Athericidae	<i>Atherix</i> sp.			X	X			X		
	Ceratopogonida	<i>Atrichopogon</i> sp.					X				
		unidentified					X	X			
	Culicidae	<i>Anopheles</i> sp.	X								
	Dixidae	<i>Dixella</i> sp.									
	Empididae	<i>Hemerodromia</i> sp.							X		
		unid. (pupae)				X					
	Psychodidae	<i>Pericoma</i> sp.									
	Simuliidae	<i>Cnephia</i> sp.									
		<i>Simulium</i> sp.			X	X	X			X	
	Stratiomyidae	<i>Caloparyphus</i> sp.			X		X		X	X	
		<i>Euparyphus</i> sp.		X	X				X		
	Tabanidae	<i>Hybomitra</i> sp.?									
		<i>Tabanus</i> /Whit.									
	Tipulidae	<i>Tipula</i> sp.	X	X	X		X			X	
	Chironomidae	pupae/tiny larva	unidentified			X			X		
		Chironminae	<i>Chironomus</i> sp.								
			<i>Cryptochironomus</i> sp.								
			<i>Dicotendipes</i> sp.								
<i>Polypedilum</i> sp.						X			X		
<i>Pseudochironomus</i>							X	X	X		
<i>Tribelos</i> sp.											
Chir.-Tanytarsini		<i>Rheotanytarsus</i> sp.									
		<i>Tanytarsus</i> sp.				X					
Orthocladinae		<i>Cardiocladius</i>									
		<i>Cricotopus</i> sp.		X	X	X	X	X		X	
		<i>Eukefferiella</i>		X				X		X	
		<i>Parametriocnemus</i> sp.?									
	<i>Rheocricotopus</i> sp.										
	<i>Thienemanniella</i> sp.										
Tanypodinae	<i>Ablabesmyia</i> sp.										
	<i>Pentaneura</i> sp.										
	<i>Thienemannimyia</i> grp				X			X			

Table 3. Water quality data for surface sites, by site.

SITE	Date	Time	Air Temp.	Water Temp.	pH	Cond. (umho)	D.O. (mg/l)	Avg. Depth (cm)	Min. Depth (cm)	Max. Depth (cm)	Average Flow (m/s)	Flow C.V.
1	03-Jun-93	1330	26.7	24	8.20	42	8.5-9.0	65	10	100	0.100	61.237
2	04-Jun-93	1200	23.9-26.7	20.5	7.90	41	9	5	1	10	0.184	102.081
3	04-Jun-93	1450	23.9-26.7	25	7.90	41		10	1	20	0.184	102.081
4	07-Jun-93	1130	26	20.5	7.49	41	5.9	6	2	10	0.176	65.723
5	07-Jun-93	1500	28	24.5	8.17	25	7.5	22.5	5	40	0.480	45.166
6	09-Jun-93	1015	27	19.5	7.74	41	7.4	10	2	40	0.278	118.252
7	09-Jun-93	1430	25.5	18.5	8.02	39	8.2	25	7	66	0.376	23.079
8	9&10Jun9	1730	29	19.5	7.79	49	8.2	8	4	27	0.640	35.971
9	10-Jun-93	1015	21.5	17.9	7.22	51	2	15	7	40	1.080	27.311
10	10-Jun-93	1223	30	18	7.24	50	1.8	15	5	25	0.780	42.906
11	10-Jun-93	1613	31	24	8.18	45	7.5	20	10	40	0.990	28.211
12	11-Jun-93	1230	21	18	7.31	42	4.7	30	10	40	0.110	89.072
13	08-Jul-93	1100	32.8	26	8.10	49	10.2	5	1	20	0.960	55.761
14	08-Jul-93	1315	32.8	31	8.42	29	11.4	15	25	5	0.062	119.833
15	08-Jul-93	1530	32.8	28.5	8.03	42	10.8	10	5	20	0.130	91.179
16	09-Jul-93	1030	32.8	23.5	8.13	45	8.4	11	4	20	0.432	25.060
17	09-Jul-93	1415	32.2	22.2	7.92	40	10.4	16	12	28	0.980	49.149
18	12-Jul-93	1124	33.9	23	7.88	38	6.4	9	4	20	0.068	146.469
19	12-Jul-93	1300	33.9	31	8.38	31	9.2	14	8	25	0.124	127.077
20	12-Jul-93	1430	33.9	31	7.70	28	6.4	12	6	28	0.012	69.722
21	12-Jul-93	1600	33.9	34	7.74	38	9.4	12	8	15	0.004	136.931
22	13-Jul-93	1245	26.7	17.5	7.40	38	9.4	8	4	12	1.334	16.153
23	13-Jul-93	1510	28.9	20.8	7.93	38	9.7	8	2	25	0.342	54.796
24	14-Jul-93	1230	31	26	8.43		8.4	15	8	29	0.600	52.374
25	14-Jul-93	1505	31	24	8.13		9.4	13	10	30	0.696	23.904
26	15-Jul-93	1045	31	26	8.12		7.6	5	4	8	0.070	52.489
27	15-Jul-93	1400	33	30	8.36		11.2	6	5	9	0.030	47.140
28	15-Jul-93	1545	34	18	7.32		7.4	9	7	15	0.366	34.593

Table 3. Water quality data for surface sites, by site.

SITE	Element Concentrations (ppm)													
	Al	Ba	Ca	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	Si	Sr
1														
2														
3														
4	0.081	0.064	69.403	0.013	0.031	2.263	5.295	0.016	5.740	0.000	0.000	0.000	0.234	0.157
5	0.000	0.017	26.709	0.014	0.000	1.074	2.468	0.006	0.751	0.000	0.000	0.000	0.000	0.150
6	0.024	0.043	50.451	0.020	0.000	1.244	8.201	0.000	3.329	0.005	0.000	0.000	1.091	0.242
7	0.047	0.044	24.287	0.000	0.000	1.432	10.450	0.000	0.834	0.000	0.000	0.000	0.609	0.022
8	0.048	0.072	40.803	0.000	0.000	0.848	16.537	0.000	4.062	0.000	0.000	0.000	1.427	0.087
9	0.101	0.040	31.698	0.003	0.046	0.632	16.180	0.006	1.180	0.000	0.000	0.000	0.771	0.027
10														
11	0.368	0.063	43.616	0.000	0.307	1.947	12.206	0.060	14.504	0.000	0.000	0.000	1.022	0.265
12	0.402	0.029	22.459	0.005	0.256	1.466	10.684	0.000	2.418	0.000	0.000	0.014	0.737	0.054
13	0.168	0.020	27.195	0.004	0.092	0.734	16.822	0.012	1.211	0.000	0.000	0.000	0.800	0.024
14	0.111	0.024	20.708	0.002	0.050	1.072	11.370	0.006	4.272	0.000	0.000	0.000	0.559	0.036
15	0.181	0.042	45.394	0.002	0.079	1.027	25.484	0.014	1.849	0.000	0.000	0.000	1.400	0.033
16	0.169	0.024	31.322	0.002	0.112	0.526	17.676	0.037	1.095	0.000	0.000	0.006	0.640	0.024
17	0.205	0.044	42.601	0.002	0.110	1.238	21.652	0.006	4.759	0.000	0.000	0.000	1.623	0.088
18	0.202	0.030	35.057	0.002	0.203	2.188	12.039	0.131	14.601	0.001	0.000	0.000	0.400	0.076
19	0.232	0.037	45.064	0.002	0.214	1.785	13.362	0.070	18.483	0.002	0.000	0.000	0.746	0.100
20	0.289	0.022	26.942	0.002	0.496	2.001	10.603	0.232	5.480	0.003	0.010	0.000	0.498	0.045
21	0.224	0.023	33.620	0.002	0.336	1.834	11.289	0.338	6.535	0.004	0.000	0.000	0.487	0.061
22	0.120	0.023	35.164	0.008	0.046	1.852	18.073	0.006	1.563	0.004	0.027	0.000	1.251	0.049
23	0.109	0.020	29.807	0.002	0.046	1.588	16.837	0.006	1.407	0.000	0.000	0.000	0.896	0.041
24	0.133	0.026	29.099	0.002	0.046	1.337	20.755	0.007	1.557	0.006	0.000	0.000	1.339	0.029
25	0.176	0.027	29.345	0.003	0.075	1.222	19.489	0.006	1.366	0.013	0.000	0.000	1.051	0.030
26	0.160	0.032	35.185	0.002	0.066	1.395	21.801	0.016	1.564	0.014	0.000	0.006	0.848	0.029
27	0.096	0.018	23.507	0.002	0.046	1.803	12.445	0.012	4.577	0.009	0.000	0.000	0.400	0.080
28	0.109	0.019	29.984	0.002	0.046	2.091	16.366	0.006	1.127	0.007	0.000	0.000	0.741	0.024

Table 4. Caddisfly species found at each site.

SPECIES	1	6	7	8	9	11	13	14	15	16	17	18	19	20	21	24	25	26	27
<i>Ceratopsyche morosa</i>			X		X				X		X								
<i>Cerotonina calcea</i>																X			
<i>Cheumatopsyche campyla</i>			X	X				X				X			X			X	X
<i>Cheumatopsyche lasia</i>						X													
<i>Cheumatopsyche pasella</i>												X	X						
<i>Cheumatopsyche pettiti</i>		X	X	X	X	X		X		X	X	X	X	X					
<i>Chimarra feria</i>		X																	
<i>Chimarra obscura</i>									X	X				X		X			X
<i>Helicopsyche borealis</i>	X	X	X	X	X	X	X	X	X		X	X				X	X		X
<i>Helicopsyche piroa</i>						X				X									
<i>Hydropsyche arinale</i>	X		X	X			X	X											X
<i>Hydropsyche bidens</i>															X				
<i>Hydropsyche orris</i>	X					X	X				X	X						X	X
<i>Hydropsyche scalaris</i>			X			X	X	X								X	X	X	X
<i>Hydropsyche simulans</i>												X	X						
<i>Hydroptila armata</i>									X										
<i>Hydroptila melia</i>																	X		
<i>Hydroptila waubesiana</i>															X				
<i>Nectopsyche diarina</i>					X	X			X		X						X		
<i>Ochrotrichia stylata</i>									X										
<i>Oecetis avara</i>	X	X		X		X	X	X	X	X	X					X	X	X	X
<i>Oecetis cinerascens</i>										X				X					
<i>Oecetis ditissa</i>																			
<i>Oecetis inconspicua</i>	X			X				X										X	X
<i>Paranyctiophylax affinis</i>			X															X	
<i>Polycentropus centralis</i>	X																		
<i>Polycentropus crassicornis</i>			X																
<i>Potamyia flava</i>	X	X										X			X	X		X	
<i>Psychomyia flavida</i>										X									
<i>Smicridea fasciatella</i>								X								X	X		

Table 5. Pearson correlation coefficients (with probabilities in italics) for water quality parameters with the presence and absence of *H. arinale* and *D. parva*. Bonferroni corrected p value is 0.002 for 0.05.

	wt	pH	cond	ad	mnd	mxd	af	fcv	hr	dp
Water temperataure (wt)	1.000 <i>0.000</i>									
pH	0.575 <i>0.004</i>	1.000 <i>0.000</i>								
Conductivity (cond)	-0.526 <i>0.010</i>	-0.424 <i>0.044</i>	1.000 <i>0.000</i>							
Average depth (ad)	-0.036 <i>0.871</i>	0.176 <i>0.421</i>	-0.047 <i>0.831</i>	1.000 <i>0.000</i>						
Minimum depth (mnd)	0.352 <i>0.100</i>	0.317 <i>0.141</i>	-0.328 <i>0.127</i>	0.376 <i>0.077</i>	1.000 <i>0.000</i>					
Maximum depth (mxd)	-0.218 <i>0.317</i>	0.120 <i>0.586</i>	0.096 <i>0.661</i>	0.882 <i><0.001</i>	0.098 <i>0.658</i>	1.000 <i>0.000</i>				
Average flow (af)	-0.487 <i>0.018</i>	-0.287 <i>0.184</i>	0.469 <i>0.024</i>	-0.156 <i>0.477</i>	-0.103 <i>0.640</i>	-0.027 <i>0.904</i>	1.000 <i>0.000</i>			
Flow coefficient of variation (fcv)	0.534 <i>0.009</i>	0.212 <i>0.331</i>	-0.368 <i>0.084</i>	-0.136 <i>0.537</i>	0.137 <i>0.534</i>	-0.286 <i>0.186</i>	-0.724 <i><0.001</i>	1.000 <i>0.000</i>		
Hydropsyche arinale (hr)	0.043 <i>0.845</i>	0.366 <i>0.055</i>	0.115 <i>0.600</i>	0.356 <i>0.095</i>	0.330 <i>0.125</i>	0.373 <i>0.079</i>	0.001 <i>0.998</i>	-0.159 <i>0.469</i>	1.000 <i>0.000</i>	
Durbiraphia parva (dp)	0.231 <i>0.290</i>	0.419 <i>0.046</i>	0.005 <i>0.980</i>	0.245 <i>0.260</i>	-0.064 <i>0.772</i>	0.147 <i>0.502</i>	-0.313 <i>0.146</i>	0.139 <i>0.146</i>	-0.022 <i>0.920</i>	1.000 <i>0.000</i>

APPENDIX 1: Surface stream and spring sites sampled.

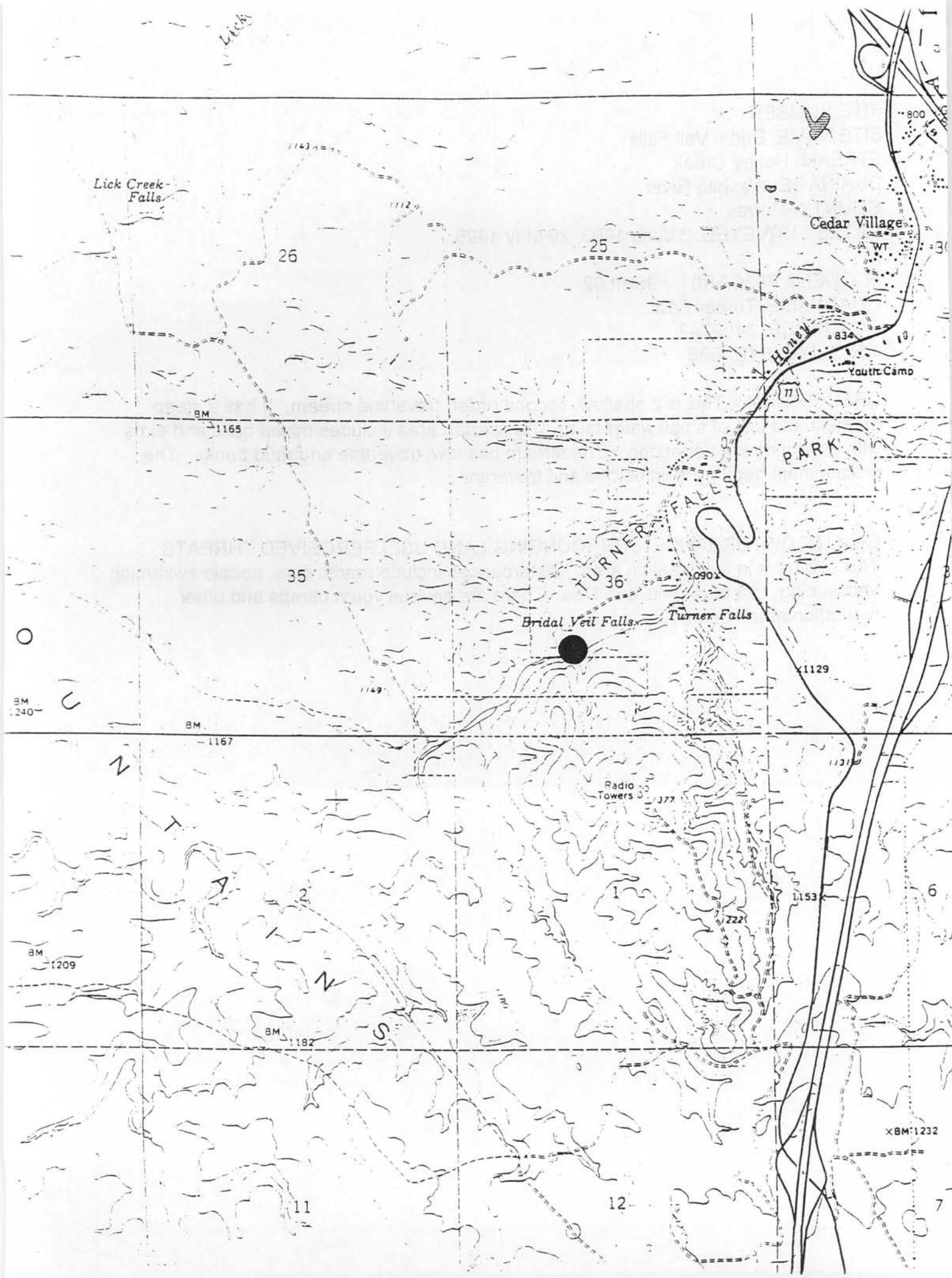
SITE NUMBER: 1
SITE NAME: Bridal Veil Falls
STREAM: Honey Creek
DRAINAGE: Washita River
COUNTY: Murray
DATES SURVEYED: 3 June 1993, 29 May 1995

FCODE(s): F93CAR01, F95HIL02
QUADNAME: Turner Falls
QUADCODE: 3409742
T,R,S: T1S, R1E, S36

DESCRIPTION: This is a shallow, second order, travertine stream. It has a steep gradient and lots of small water falls. The riparian area includes mixed oaks and elms with a semi-dense understory. The stream has low, travertine and mud banks. The predominant geology is limestone and travertine.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:

This stream is in a recreation area. Disturbances include roads, cars, people swimming and wading, campers, pets and fires. There are several youth camps and other recreation areas nearby.

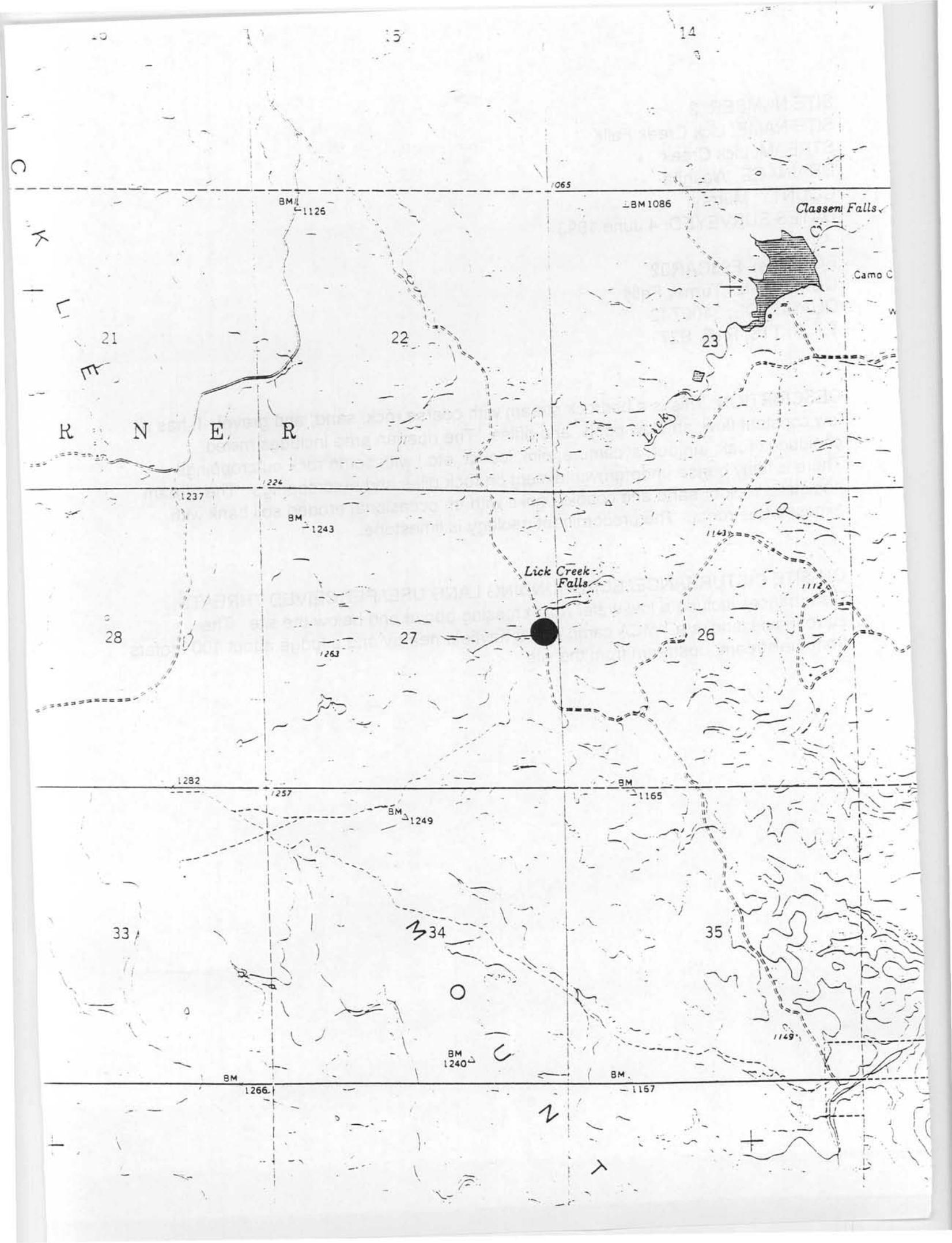


SITE NUMBER: 2
SITE NAME: Lick Creek Falls
STREAM: Lick Creek
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 4 June 1993

FCODE(s): F93CAR02
QUADNAME: Turner Falls
QUADCODE: 3409742
T,R,S: T1S, R1E, S27

DESCRIPTION: This is a bedrock stream with coarse rock, sand, and gravel. It has a low constant flow, shallow pools, and riffles. The riparian area includes mixed deciduous (oak, juniper, sycamore, elm, locust, etc.) with some rock outcroppings. There is fairly dense undergrowth except on rock piles and outcroppings. The stream has steep rock or sand and cobble banks with an occasional eroded soil bank with exposed tree roots. The predominant geology is limestone.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances include a low-water road crossing above and below the site. The surrounding land is a YMCA camp with a hayfield nearby and a lodge about 100 meters from the stream, upstream from the site.



Classen Falls

Lick Creek Falls

R N E R

BM 1086

BM 1126

BM 1243

22

23

21

28

27

26

33

34

35

BM 1240

BM 1157

BM 1266

1149

1143

1112

1263

1237

1282

1257

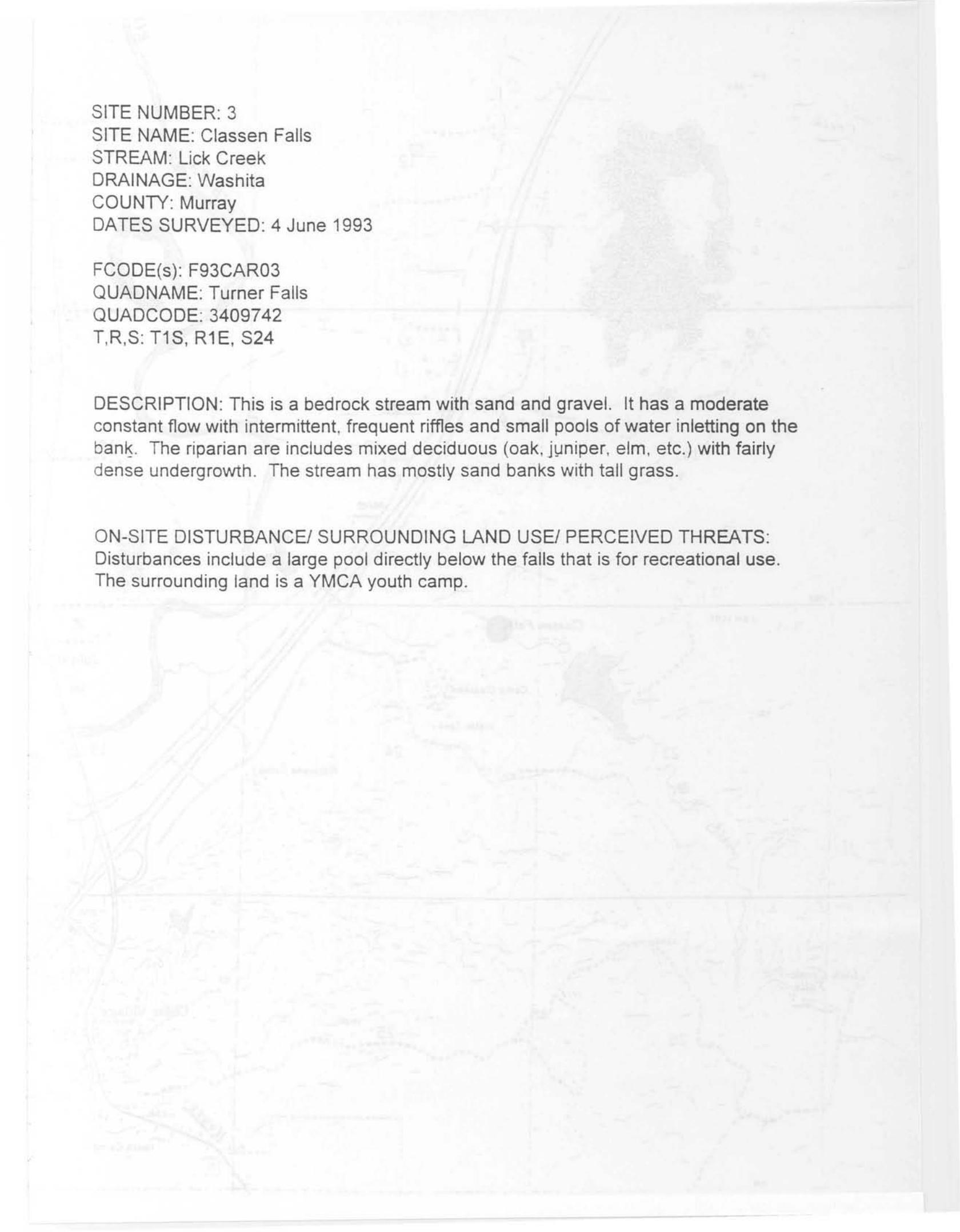
BM 1249

1065

14

15

10

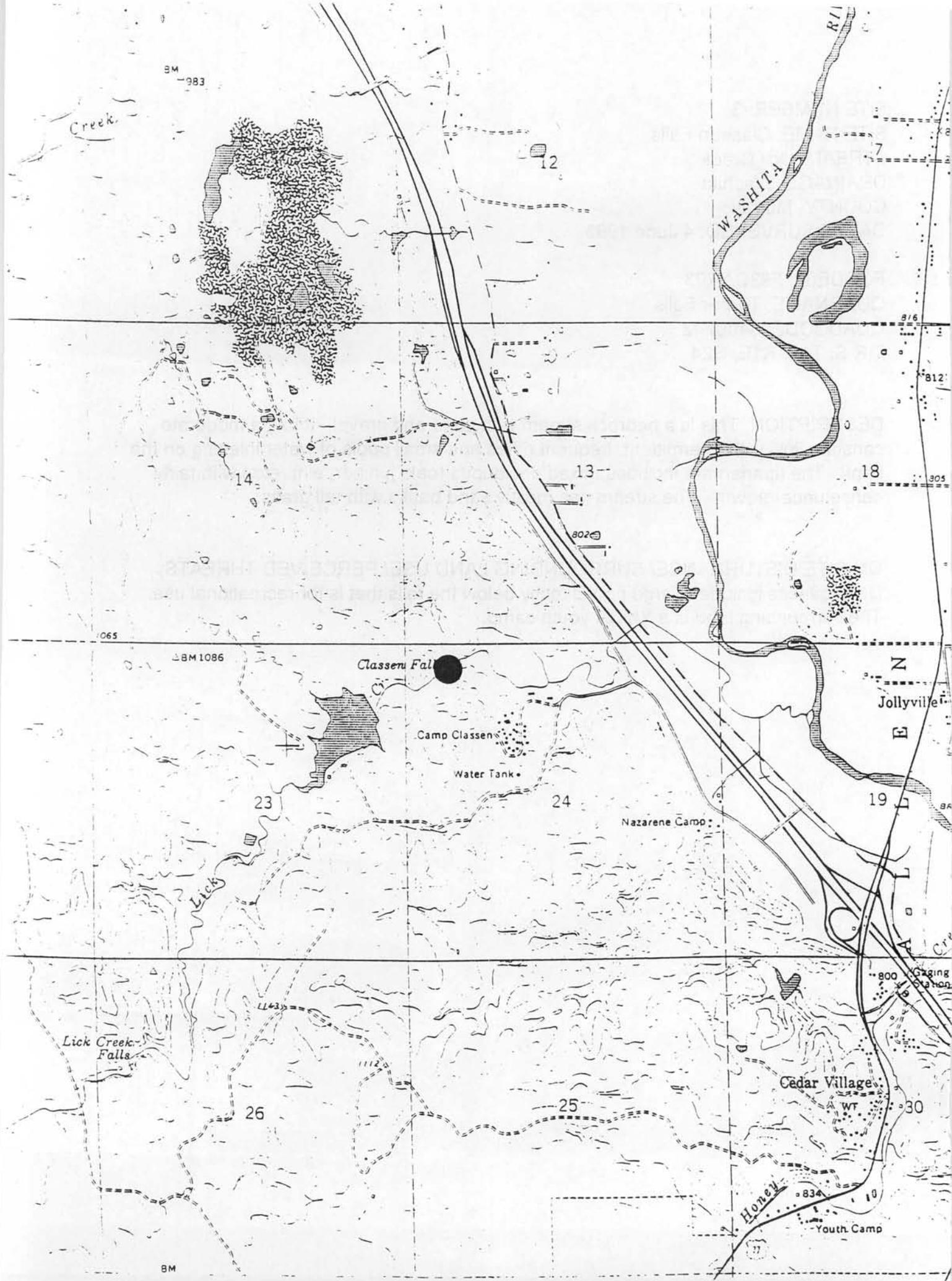


SITE NUMBER: 3
SITE NAME: Classen Falls
STREAM: Lick Creek
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 4 June 1993

FCODE(s): F93CAR03
QUADNAME: Turner Falls
QUADCODE: 3409742
T,R,S: T1S, R1E, S24

DESCRIPTION: This is a bedrock stream with sand and gravel. It has a moderate constant flow with intermittent, frequent riffles and small pools of water inletting on the bank. The riparian are includes mixed deciduous (oak, juniper, elm, etc.) with fairly dense undergrowth. The stream has mostly sand banks with tall grass.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances include a large pool directly below the falls that is for recreational use. The surrounding land is a YMCA youth camp.

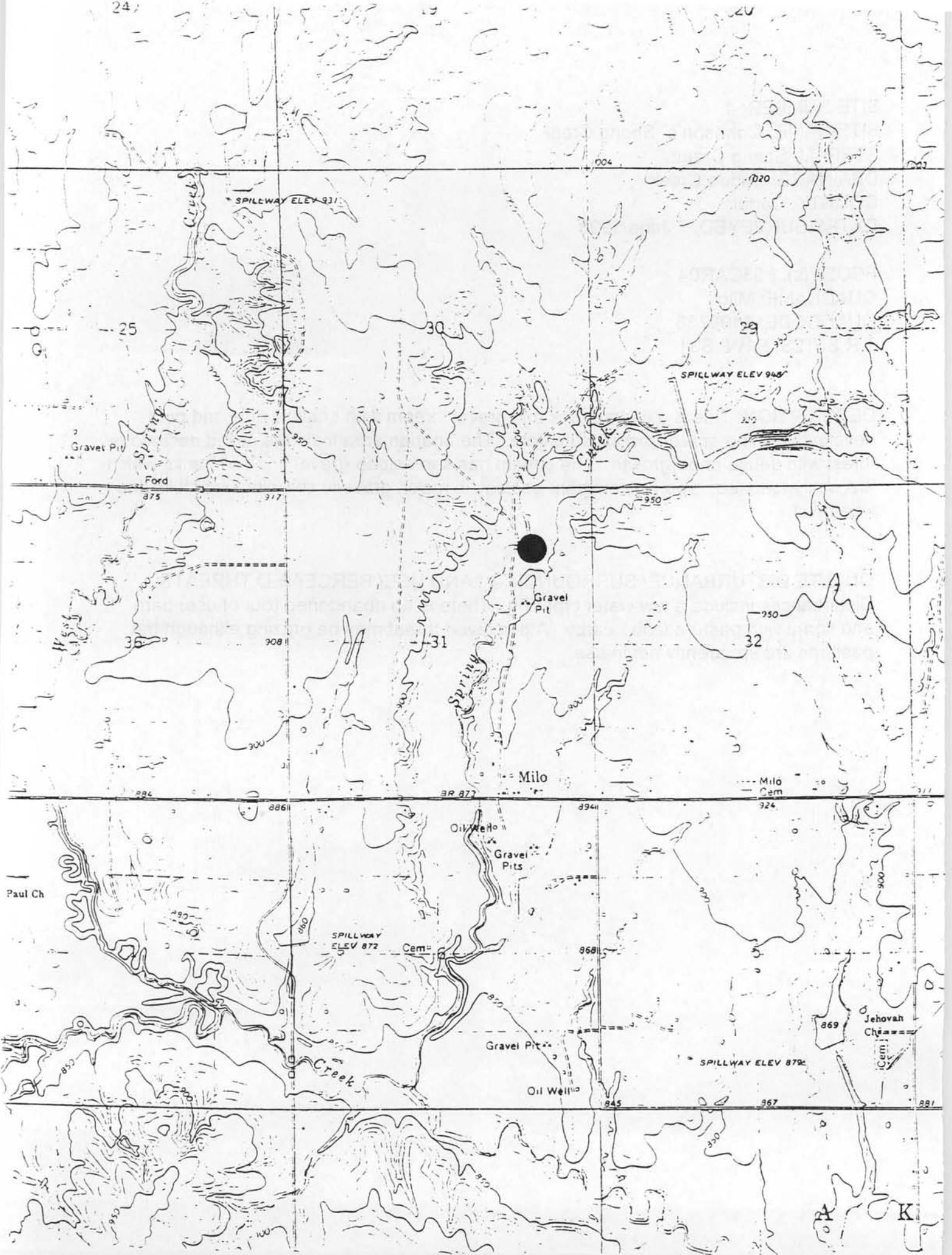


SITE NUMBER: 4
SITE NAME: "Johnson's" Spring Creek
STREAM: Spring Creek
DRAINAGE: Caddo Creek
COUNTY: Carter
DATES SURVEYED: 7 June 1993

FCODE(s): F93CAR04
QUADNAME: Milo
QUADCODE: 3409733
T,R,S: T2S, R1W, S31

DESCRIPTION: This is a coarse rock and gravel stream with shallow riffle and pool development and gravel and silt substrate. The riparian area includes mixed deciduous forest with dense undergrowth. The stream has semi-steep gravel and soil banks which are well vegetated. The predominant geology is rocky, gravelly soil with slight hills and little relief.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances include a low water crossing. There is an abandoned (out of use) barn and corral with pasture land nearby. A perceived threat may be grazing although the pastures are apparently not in use.



A K

SITE NUMBER: 5
SITE NAME: Mountain Lake Spillway
STREAM: Hickory Creek
DRAINAGE: Caddo Creek
COUNTY: Carter
DATES SURVEYED: 7 June 1993, 13 June 1995

FCODE(s): F93CAR05, F95HIL08
QUADNAME: Milo
QUADCODE: 3409733
T,R,S: T2S, R1W, S34

DESCRIPTION: This is a travertine bedrock and gravel stream with a lot of exposed bedrock. It has well developed riffles and pools. The riparian area includes willows and mimosa with other deciduous (oak, elm, sycamore). There are open lawns below a dam and denser growth farther down. The stream has low gravel or eroded banks. The predominant geology is low hills with rock outcroppings.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances include a low water crossing, fishing, wading, etc. The surrounding land is used for recreation (Mountain Lake) and ranching (Arbuckle Ranch). Grazing and recreation are a perceived threat to the stream.
Note: We were unable to light trap at this sight. We were denied access.

UCKLE Lake
Picnic Area

789

087

Hickory Falls

MOUNTAIN

938

27

63

Spring

Woodford

34

Cem

35

897

718

723

904

8761

902

894

902

904

894

905

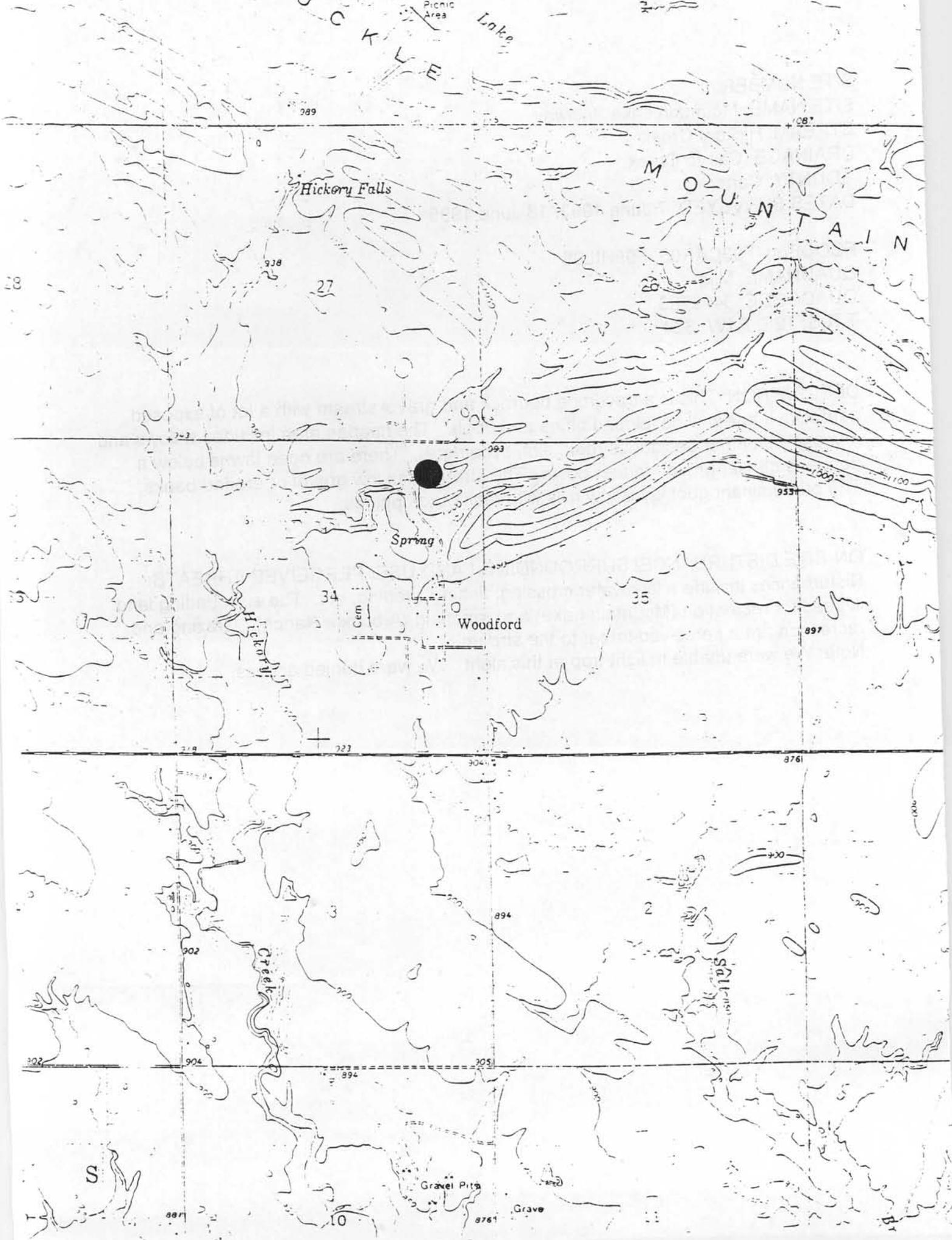
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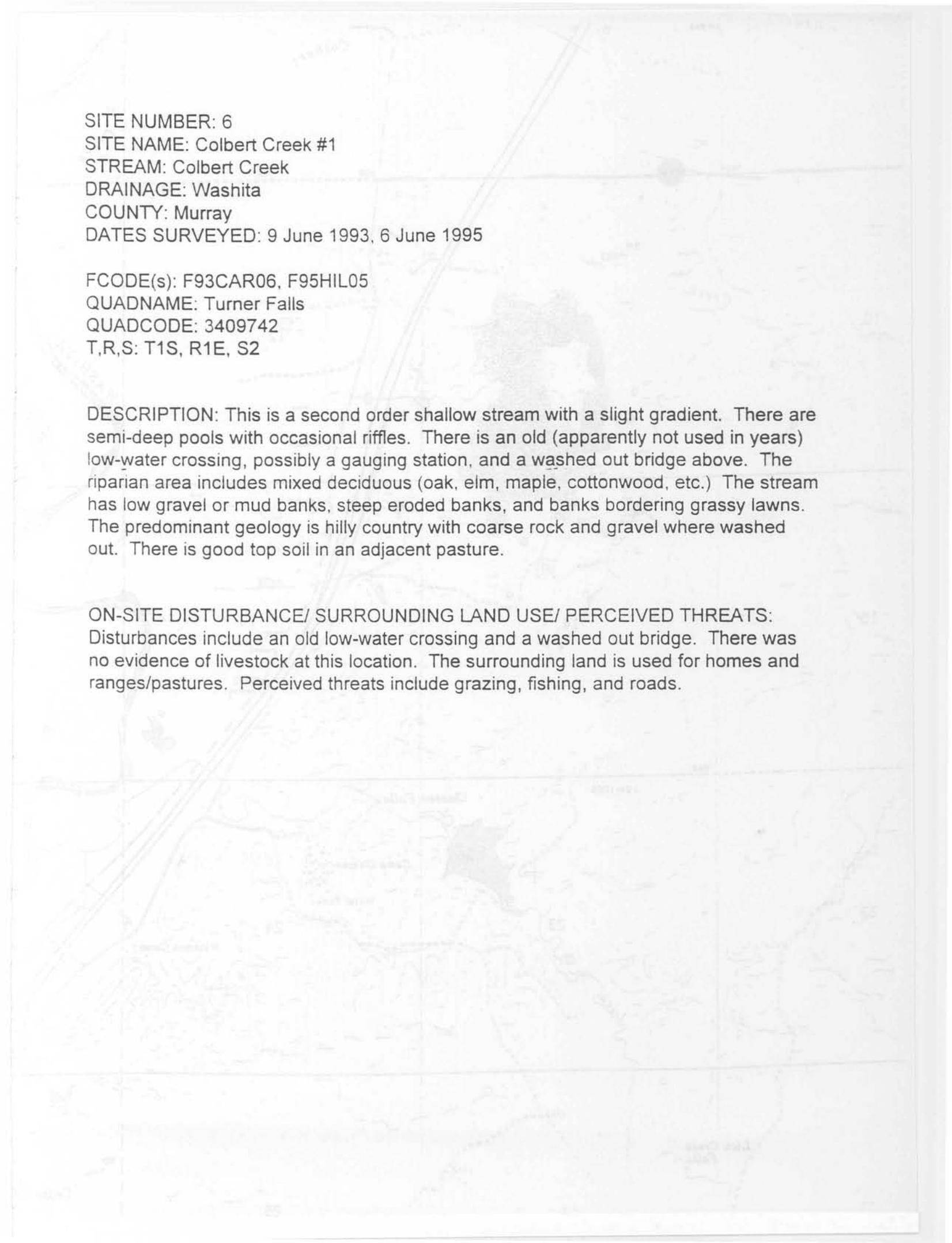
Gravel Pit

Grave

10

8761





SITE NUMBER: 6
SITE NAME: Colbert Creek #1
STREAM: Colbert Creek
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 9 June 1993, 6 June 1995

FCODE(s): F93CAR06, F95HIL05
QUADNAME: Turner Falls
QUADCODE: 3409742
T,R,S: T1S, R1E, S2

DESCRIPTION: This is a second order shallow stream with a slight gradient. There are semi-deep pools with occasional riffles. There is an old (apparently not used in years) low-water crossing, possibly a gauging station, and a washed out bridge above. The riparian area includes mixed deciduous (oak, elm, maple, cottonwood, etc.) The stream has low gravel or mud banks, steep eroded banks, and banks bordering grassy lawns. The predominant geology is hilly country with coarse rock and gravel where washed out. There is good top soil in an adjacent pasture.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances include an old low-water crossing and a washed out bridge. There was no evidence of livestock at this location. The surrounding land is used for homes and ranges/pastures. Perceived threats include grazing, fishing, and roads.

Colbert

795
Creek

3821

809

796

795

BM 983

Creek

10

12

WASHITA

15

14

13

1065

BM 1086

Classen Falls

Camp Classen

Water Tank

Nazarene Camp

22

23

24

Lick

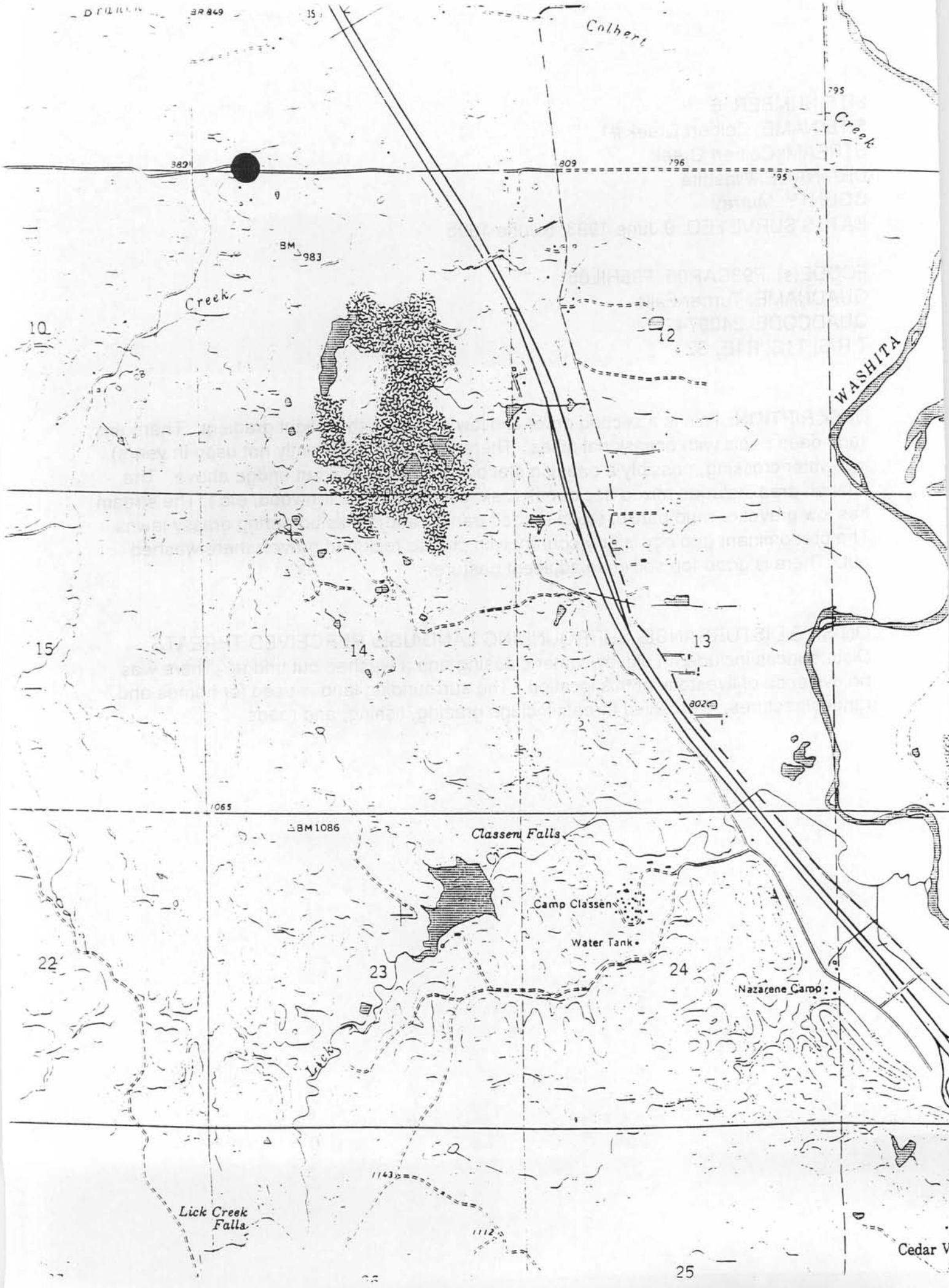
Lick Creek Falls

1143

1112

Cedar Vil

25



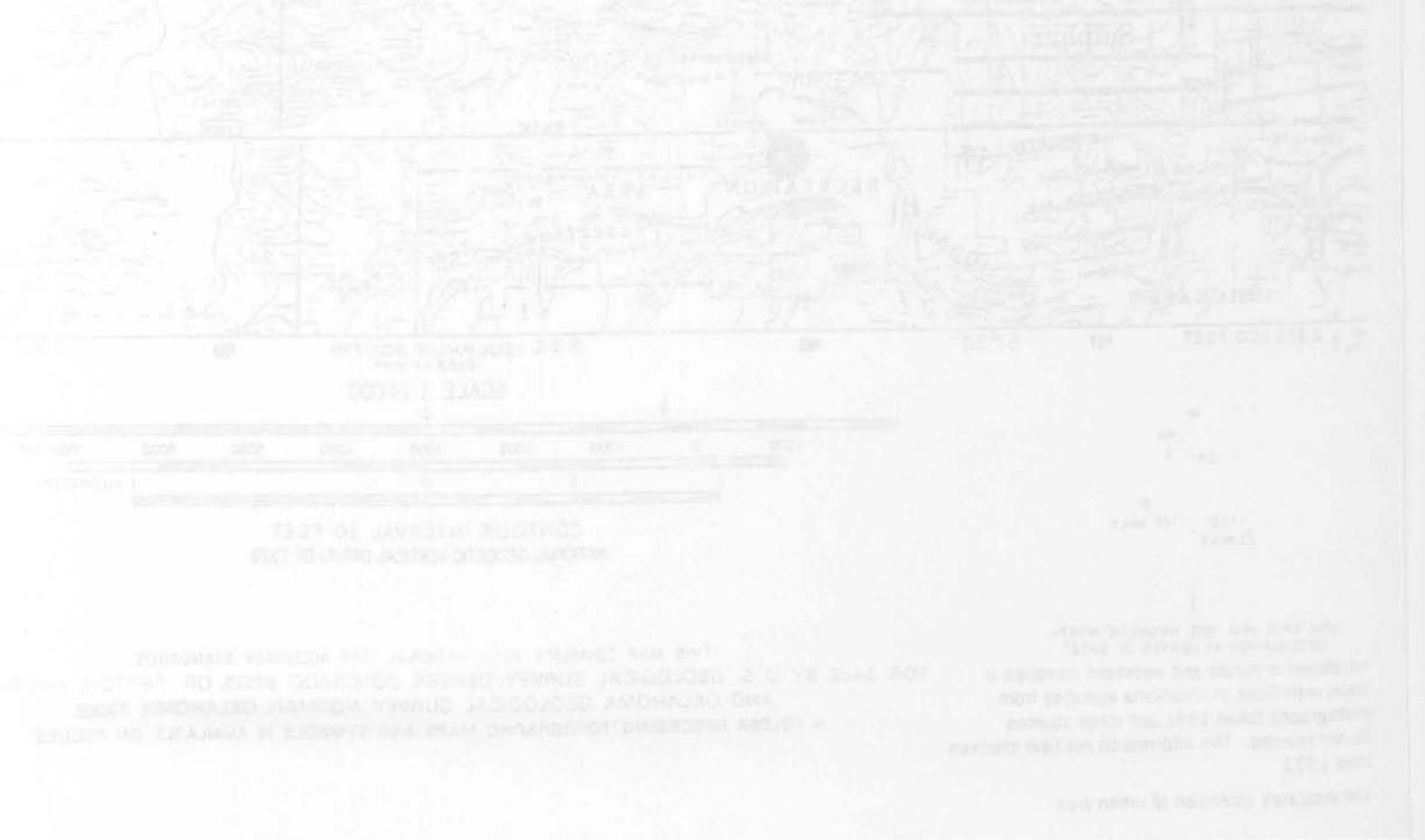
SITE NUMBER: 7
SITE NAME: Tavertine
STREAM: Tavertine Creek
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 9 June 1993, 2 June 1995

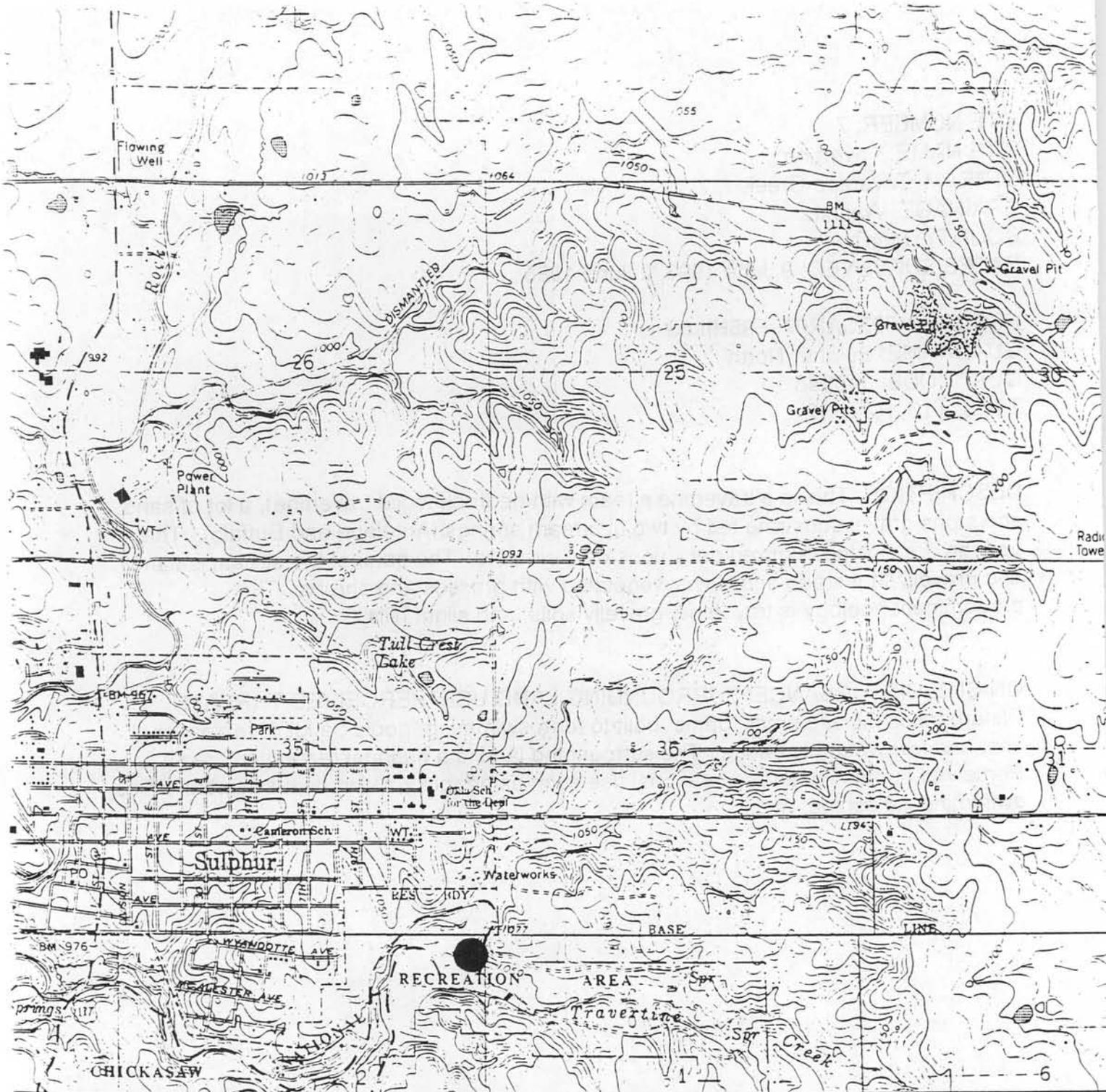
FCODE(s): F93CAR07, F95HIL03
QUADNAME: Sulphur North
QUADCODE: 349658
T,R,S: T1S, R3E, S2

DESCRIPTION: This is a travertine stream with bedrock (solid travertine), a lot of sand, and stone gravel substrate fed by two upstream springs (Antelope and Buffalo). The riparian area includes mixed deciduous oak, elm, etc. The bank of the stream is sandy and gravelly, not steep and is well vegetated with grasses and shrubs. The predominant geology is travertine, gravelly soils, and slight hills.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:

Disturbances include small "dams" built to form swimming "pools", a lot of recreational use, and low-water crossings. The surrounding land is a national recreation area. Perceived threats include recreational use such as people walking over travertine riffles, swimming, splashing, etc...





231000 FEET 687 57'30" 688 R 3 E (SULPHUR SOUTH) 6652 IV NW 690 R 4 E
 SCALE 1:24000
 1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
 1 KILOMETER
 CONTOUR INTERVAL 10 FEET
 NATIONAL GEODETIC VERTICAL DATUM OF 1929

UTM GRID AND 1993 MAGNETIC NORTH
 DECLINATION AT CENTER OF SHEET
 Areas shown in purple and woodland compiled in
 cooperation with State of Oklahoma agencies from
 photographs taken 1991 and other sources
 were not revised. This information not field checked
 dated 1993
 Pink tint indicates extension of urban area

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
 FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA
 AND OKLAHOMA GEOLOGICAL SURVEY, NORMAN, OKLAHOMA 73069
 A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

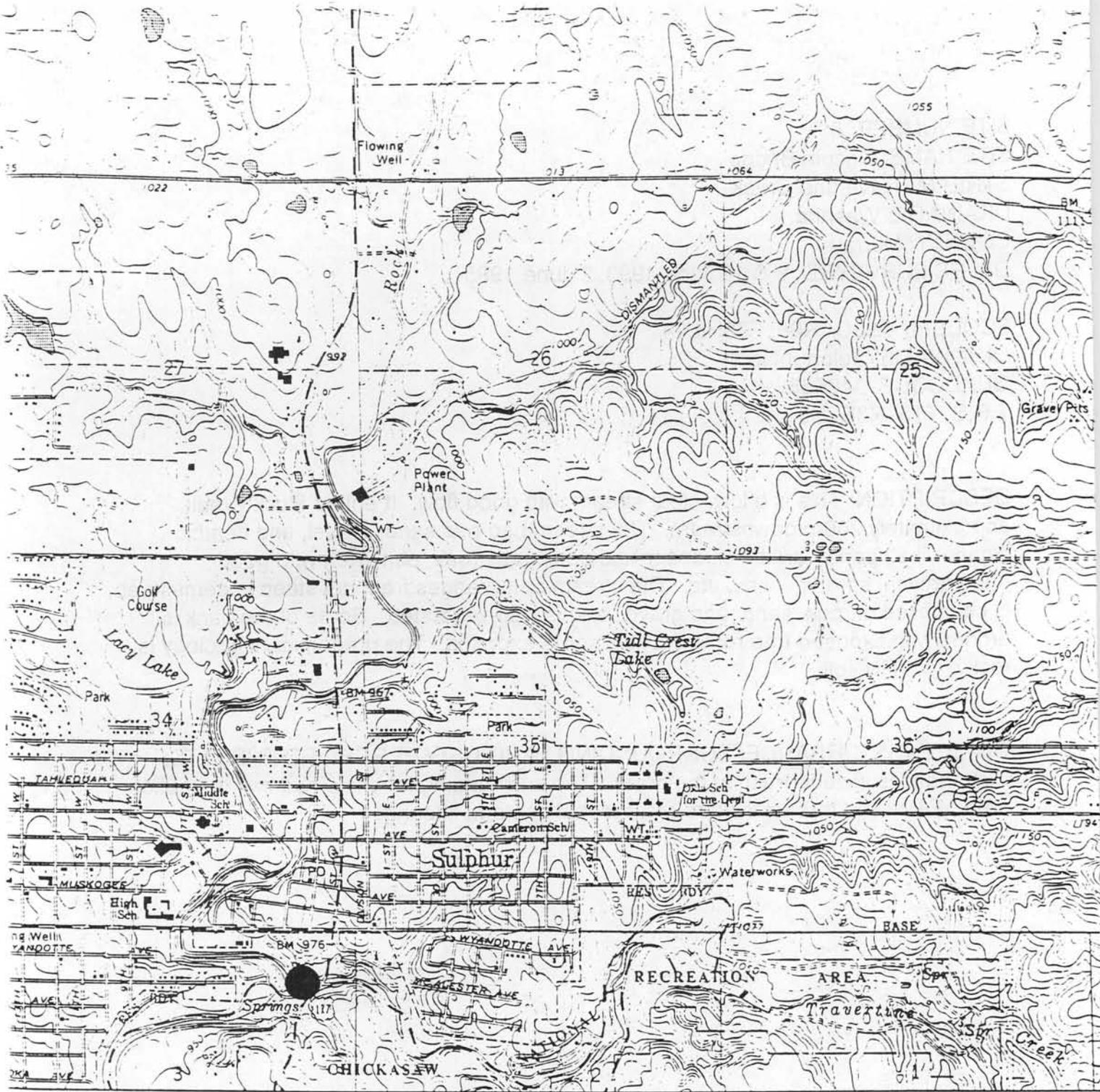
SITE NUMBER: 8
SITE NAME: Lincoln Bridge
STREAM: Travertine Creek
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 9 & 10 June 1993, 2 June 1995

FCODE(s): F93CAR08, F95HIL04
QUADNAME: Sulphur North
QUADCODE: 349658
T,R,S: T1S, R3E, S3

DESCRIPTION: This is a low, clear stream with good flow. It enters Rock Creek approximately 200m downstream. The stream bed has sand, gravel, and benthic algae. The riparian area includes mixed deciduous (oak, elm, etc.) with good undergrowth, shrubs, vines, etc. The stream bank ranges from not steep to semi-steep, is composed of rock, sand, and gravel, and is well-vegetated. Some of the bank is eroded with exposed tree roots but little soil is exposed. The predominant geology is rocky, gravelly soil.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances include trash in the creek. The surrounding land is a national recreation area. Perceived threats include recreational use and littering.



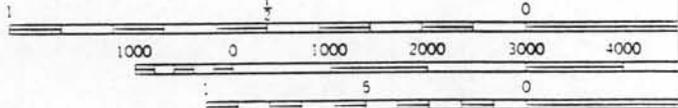


DRAKE 7 MI. 2 310 000 FEET 687 57'30" 688 R 3 E. (SULPHUR SOUTH) 6652 IV NW

al Survey

SCALE 1:24 000

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coordinate

GN MN
1" = 10' 21 MILS
1" = 6' 107 MILS

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1983

icks, zone 14, shown in blue

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83 for 7.5-minute

UTM GRID AND 1993 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Revisions shown in purple and woodland compiled in cooperation with State of Oklahoma agencies from aerial photographs taken 1991 and other sources. Contours not revised. This information not field checked. Map edited 1993.

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO, AND OKLAHOMA GEOLOGICAL SURVEY, NORMAN, OKLAHOMA. A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE FROM THE U. S. GEOLOGICAL SURVEY, DENVER, COLORADO.

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Purple tint indicates extension of urban area

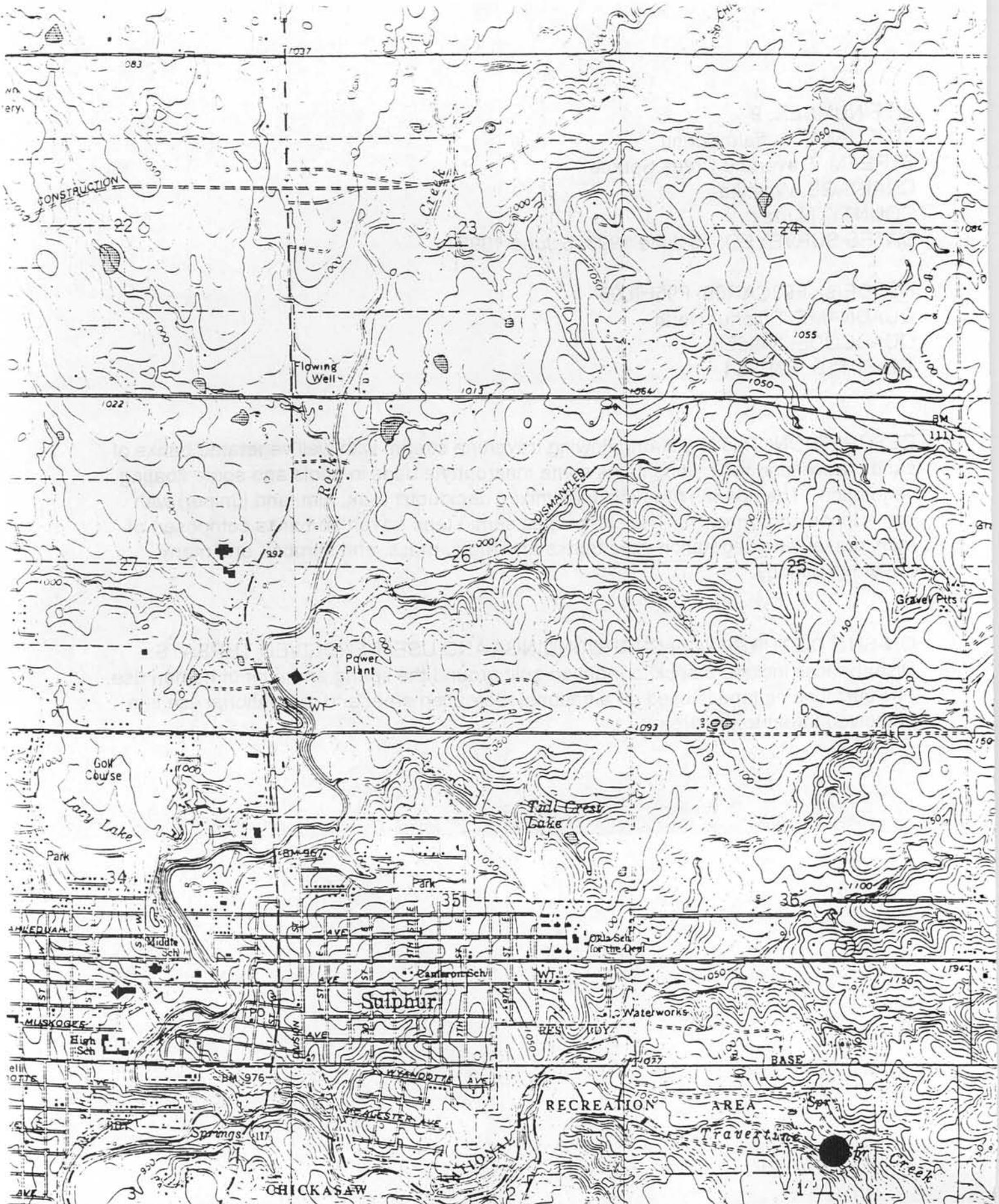
SITE NUMBER: 9
SITE NAME: Buffalo Spring
STREAM: Travertine Creek Source
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 10 June 1993, 6 June 1995

FCODE(s): F93CAR09, F95HIL06
QUADNAME: Sulphur North
QUADCODE: 349658
T,R,S: T1S, R3E, S1

DESCRIPTION: This is a strong flowing travertine stream with well vegetated banks of sandy gravel and rock. It contains some macrophyte beds in pools and some floating vegetation. The riparian area includes mixed deciduous (oak, elm, and juniper) with semi-dense undergrowth. The stream has semi-steep travertine banks composed of rock, gravel, and vegetation (tree trunks and roots, grass, and shrubs), and many travertine springs.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:

Disturbances include a brick foundation built around the spring and a lot of human use. The surrounding land is used as a national recreation area, and recreational use is a perceived threat to the area.



DRAKE 7 MI 2 310 000 FEET
22 MI TO U.S. 701

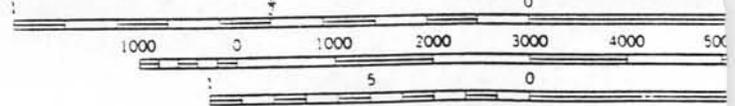
687 57'30" 688

R 3 E (SULPHUR SOUTH)
6652 IV NW

SCALE 1:24,000

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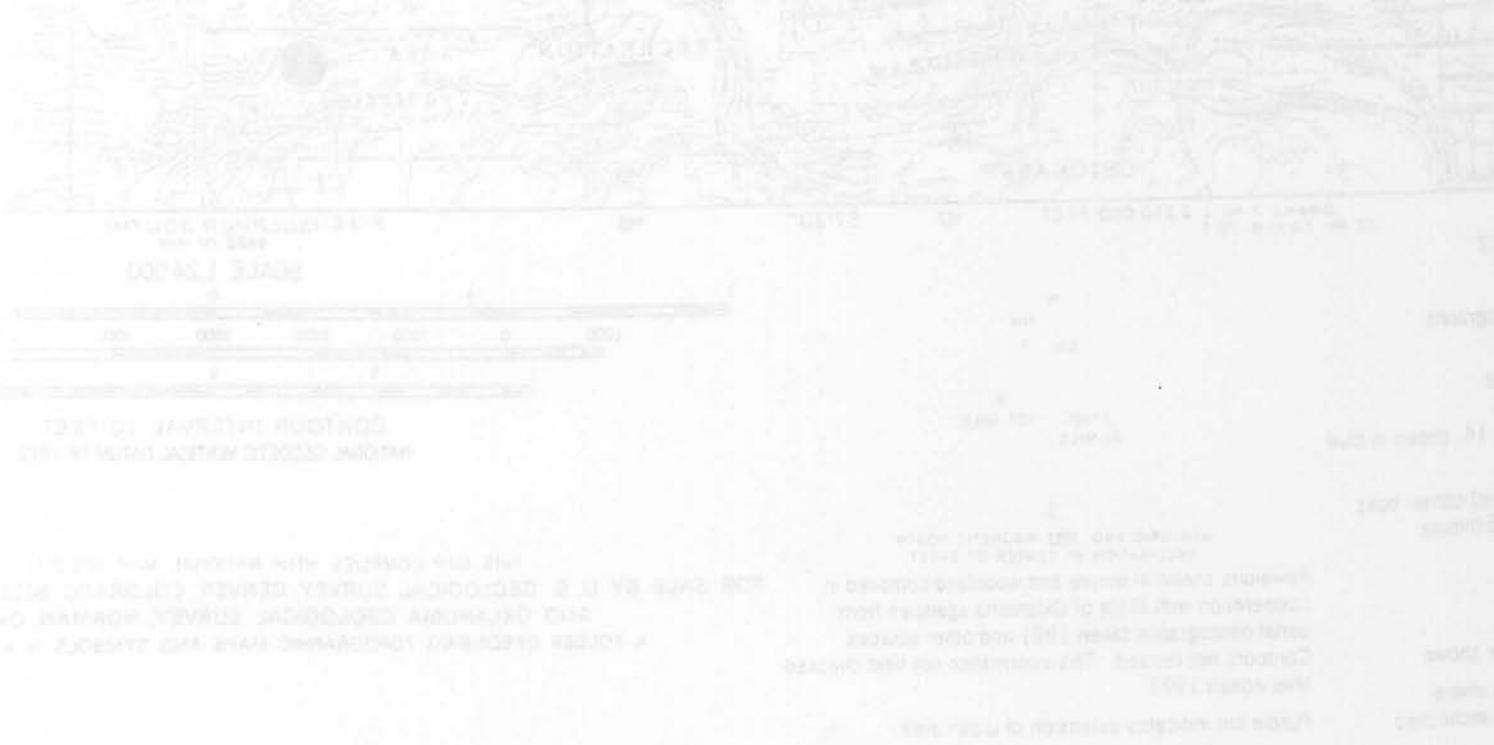
CONTOUR INTERVAL 10 FEET

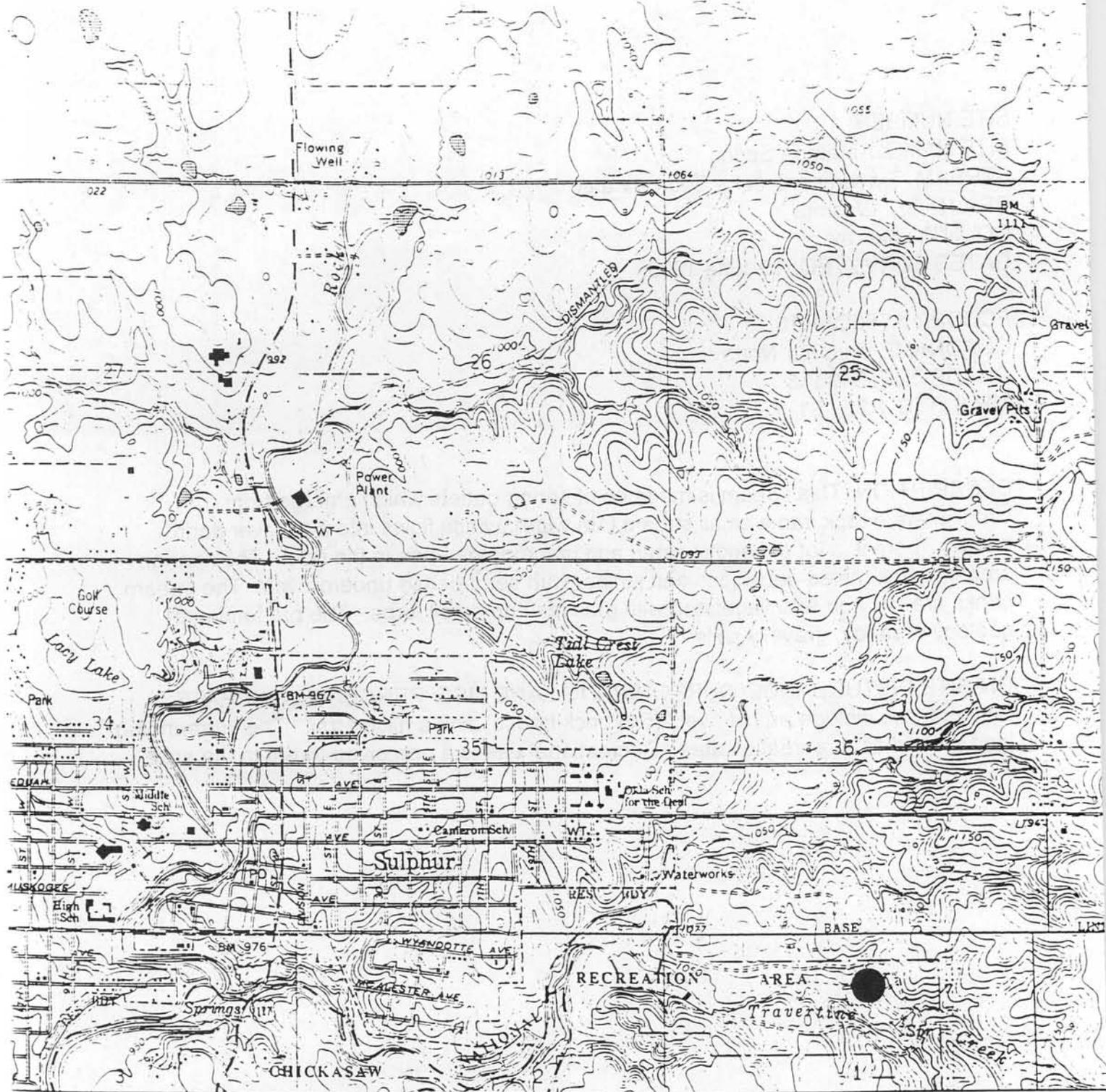
SITE NUMBER: 10
SITE NAME: Antelope Spring
STREAM: Travertine Creek - Source water
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 10 June 1993

FCODE(s): F93CAR10
QUADNAME: Sulphur North
QUADCODE: 349658
T,R,S: T1S, R3E, S1

DESCRIPTION: This stream is made up of spring outlets which emerge from conglomerate rock into a small stream (1m wide), which flows into a "beaver pond" below. There is a lot of benthic algae and macrophyte beds in the pool. The riparian area includes mixed deciduous and juniper with semi-dense undergrowth. The stream banks are low and well vegetated with grasses and small forbs. The predominate geology is sandy, gravelly soils.

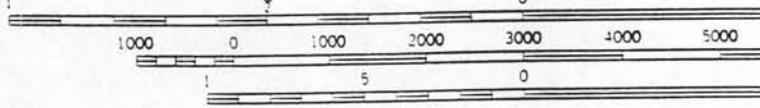
ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances include an old "well" (5x5 brick house) and a hiking trail. The surrounding land is used as a recreation area. Recreational use is a perceived threat to the area.





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SCALE 1:24 000



CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

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UTM GRID AND 1993 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Revisions shown in purple and woodland compiled in cooperation with State of Oklahoma agencies from aerial photographs taken 1991 and other sources
Contours not revised. This information not field checked
Map edited 1993
Purple tint indicates extension of urban area

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, AND OKLAHOMA GEOLOGICAL SURVEY, NORMAN, OKLA. A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SITE NUMBER: 11
SITE NAME: Bromine Pavillion
STREAM: Rock Creek
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 10 June 1993, 13 June 1995

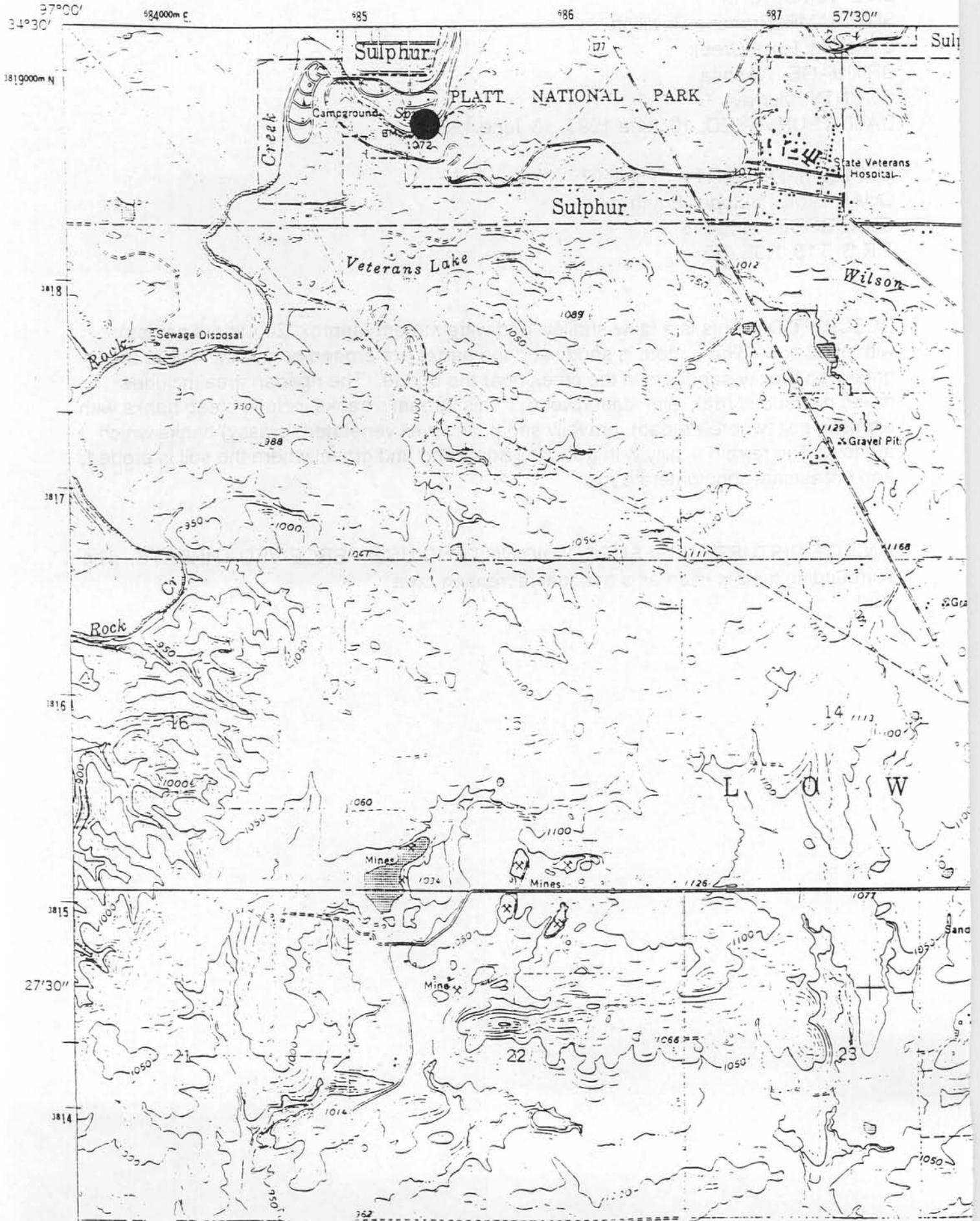
FCODE(s): F93CAR11, F95HIL07
QUADNAME: Sulphur South
QUADCODE: 3409648
T,R,S: T1S, R3E, S3

DESCRIPTION: This is a fairly shallow and wide stream (approx. 20 meters across) with good flow. The bottom is sandy and the banks are eroded or grassy. There are grassy and rocky sandbars in the creek near the bridge. The riparian area includes mixed deciduous (oak, elm, cottonwood). This stream's banks include steep banks with exposed soil (where eroded), gravelly shoal, and well vegetated (grassy) banks which are low. The terrain is hilly with good top soil, sand and gravel where the soil is eroded, and occasional conglomerate rock.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: The surrounding land is used as a national recreation area.

55311 SE
102415

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



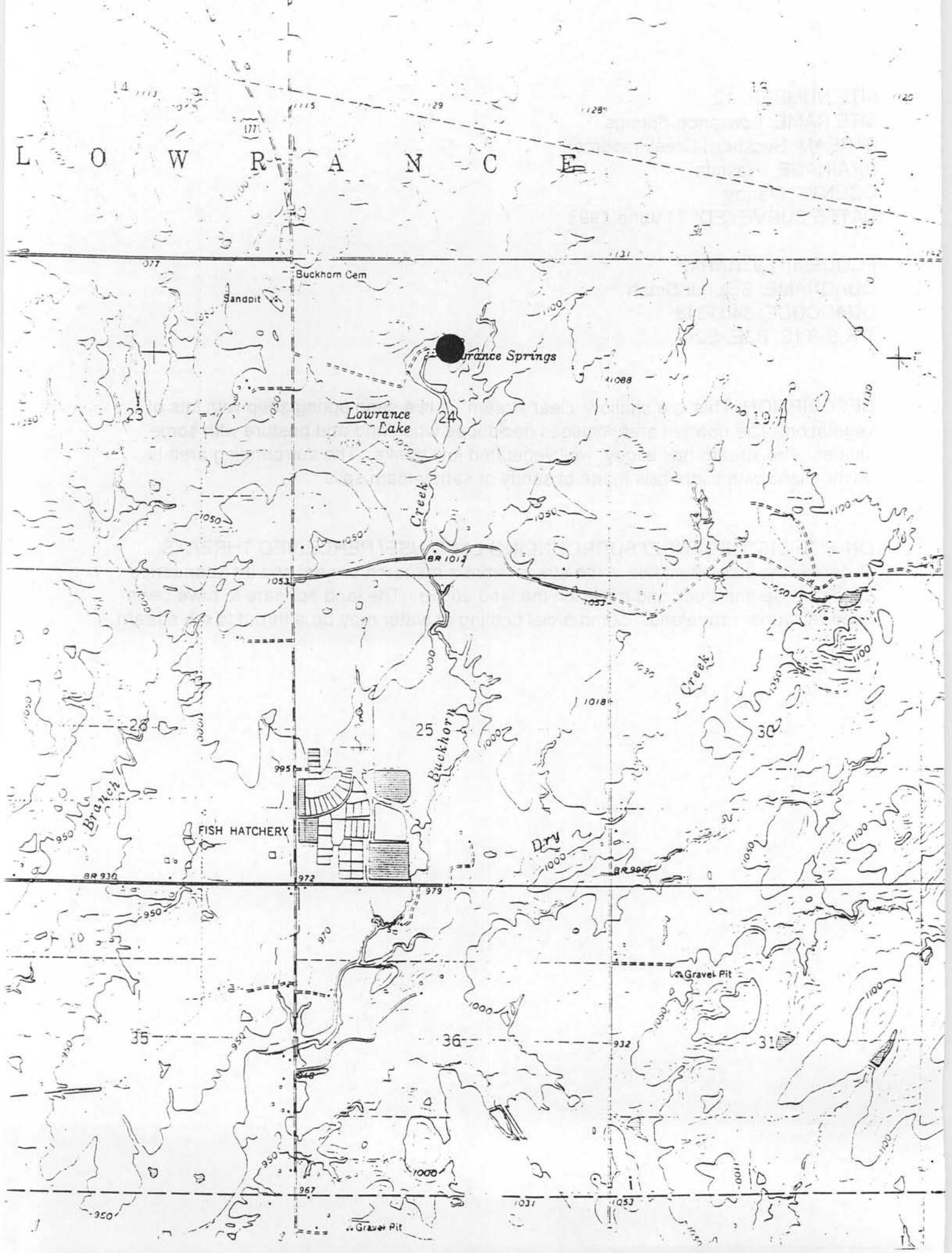
SITE NUMBER: 12
SITE NAME: Lowrance Springs
STREAM: Buckhorn Creek (source)
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 11 June 1993

FCODE(s): F93CAR12
QUADNAME: Sulphur South
QUADCODE: 3409648
T,R,S: T1S, R3E, S24

DESCRIPTION: This is a shallow, clear stream. It is a sand spring seep with lots of vegetation. The riparian area includes deciduous woodland and pasture with some juniper. The stream has soggy, well vegetated low banks. The surrounding area is pasture land with slight hills made of sandy or sandy-loam soils.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances include stakes in the stream from a research project and an abandoned spring house and truck and trailer on the land above. The land appears to have been used as former rangeland. Commercial bottling of water may be a threat to the stream.

L O W R A N C E

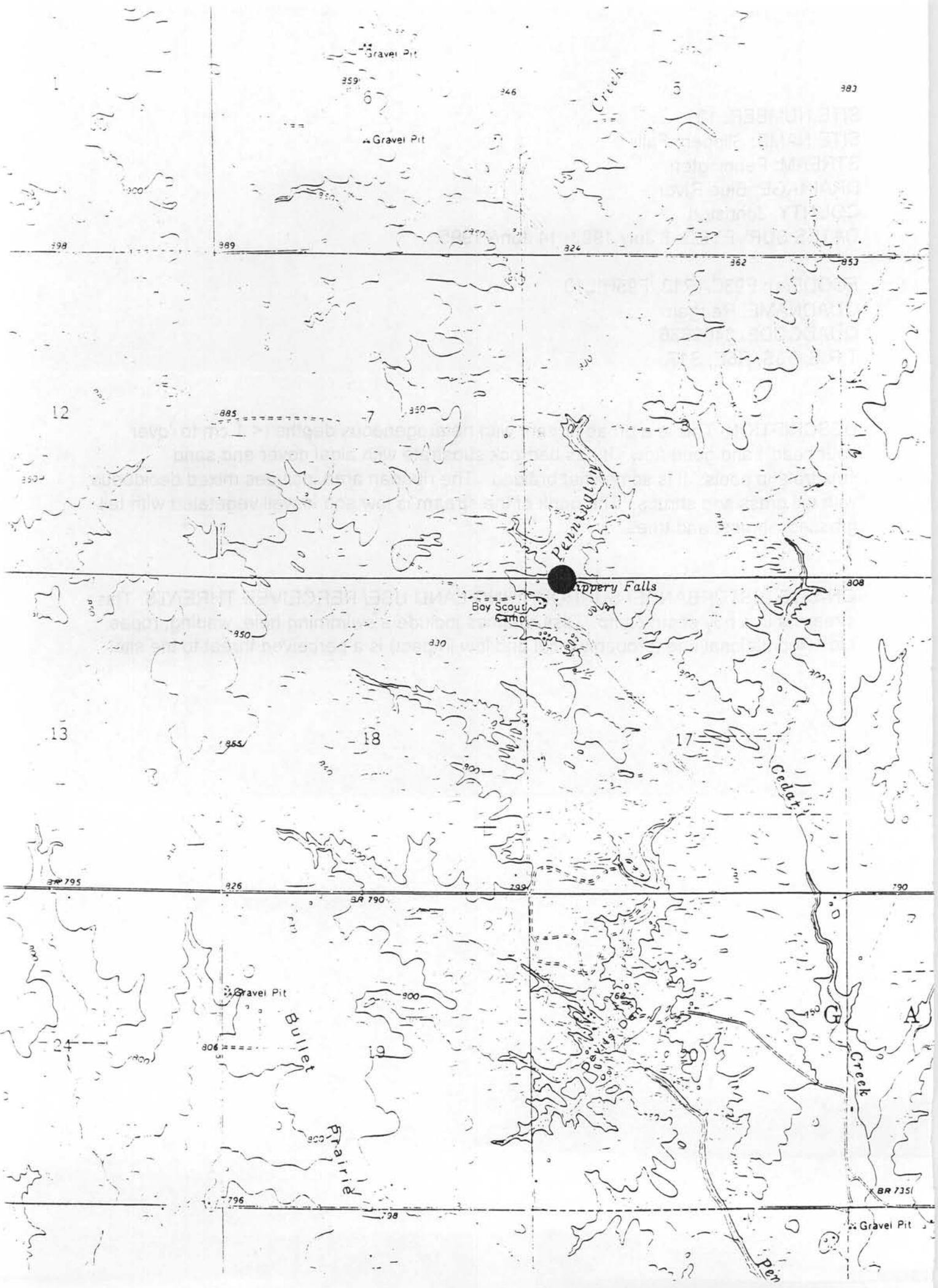


SITE NUMBER: 13
SITE NAME: Slippery Falls
STREAM: Pennington
DRAINAGE: Blue River
COUNTY: Johnston
DATES SURVEYED: 8 July 1993, 14 June 1995

FCODE(s): F93CAR13, F95HIL10
QUADNAME: Reagan
QUADCODE: 3409636
T,R,S: T3S, R6E, S17

DESCRIPTION: This is a broad stream with heterogeneous depths (< 1 cm to "over your head") and good flow. It has bedrock substrate with algal cover and sand substrate in pools. It is somewhat braided. The riparian area includes mixed deciduous with tall grass and shrubs. The bank of the stream is low and is well vegetated with tall grasses, shrubs, and trees.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: This stream is in a boy scout camp. Disturbances include a swimming hole, wading, ropes, etc. Recreational use (probably local and low impact) is a perceived threat to the site.



Gravel Pit

359

346

383

Gravel Pit

398

389

324

362

853

12

885

7

350

350

Pennington

Tippery Falls

Boy Scout Camp

808

13

355

18

17

Cedar Creek

795

326

BR 790

790

790

Gravel Pit

Bullet Prairie

24

306

19

900

G

A

Creek

796

798

BR 735

Gravel Pit

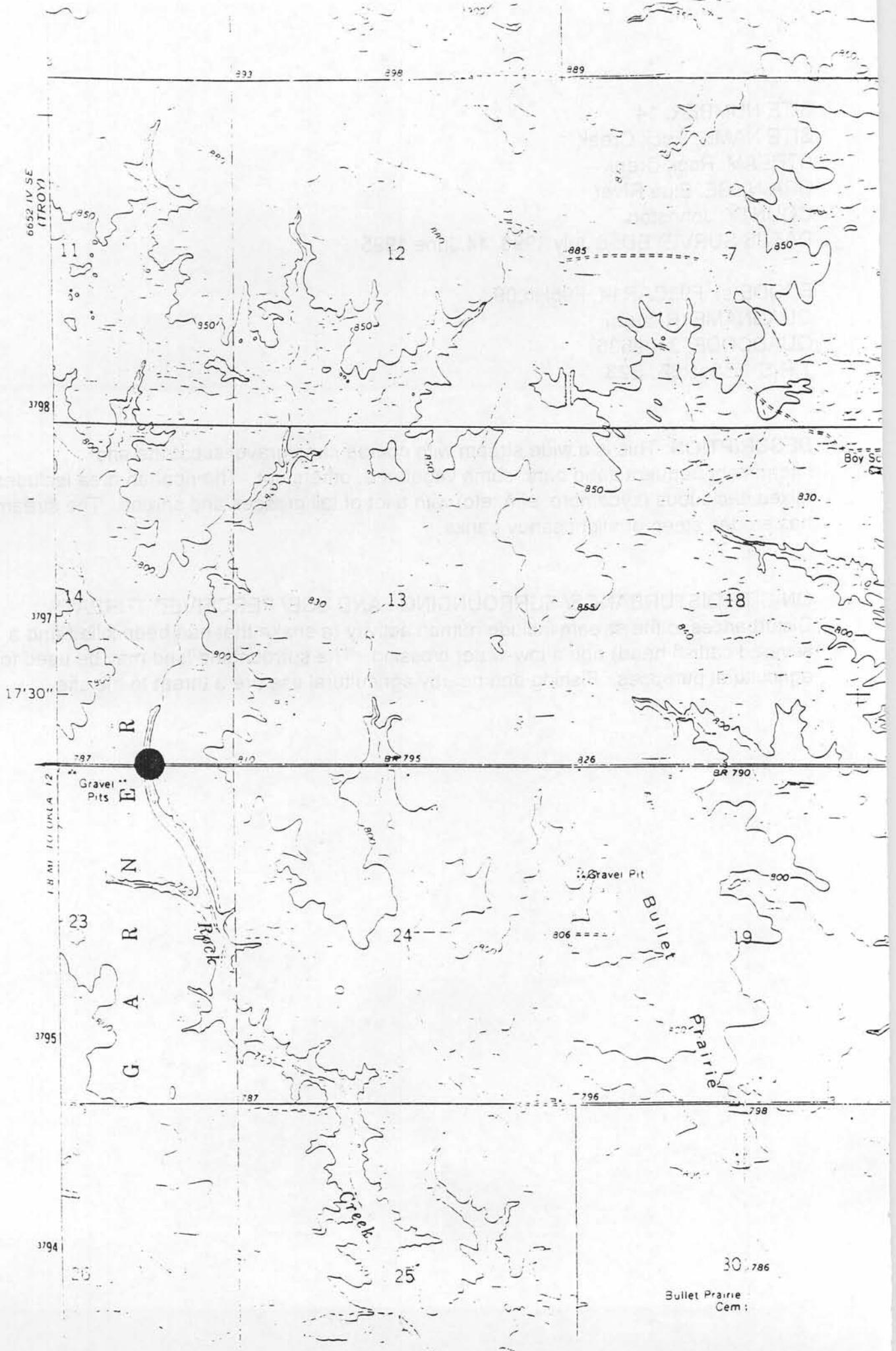
Pen

SITE NUMBER: 14
SITE NAME: Rock Creek
STREAM: Rock Creek
DRAINAGE: Blue River
COUNTY: Johnston
DATES SURVEYED: 8 July 1993, 14 June 1995

FCODE(s): F93CAR14, F95HIL09
QUADNAME: Reagan
QUADCODE: 3409636
T,R,S: T3S, R5E, S23

DESCRIPTION: This is a wide stream with coarse sand/gravel substrate and intermittent frequent sand bars, some vegetated, others not. The riparian area includes mixed deciduous (sycamore, elm, etc) with a lot of tall grasses and shrubs. The stream has eroded steep or slight sandy banks.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances to the stream include human activity (a snake that had been killed and a severed catfish head) and a low-water crossing. The surrounding land may be used for agricultural purposes. Fishing and nearby agricultural use are a threat to the site.



6652 IV SE
(TROY)

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Rock
Creek

Bullet
Prairie

Bullet Prairie
Cem:

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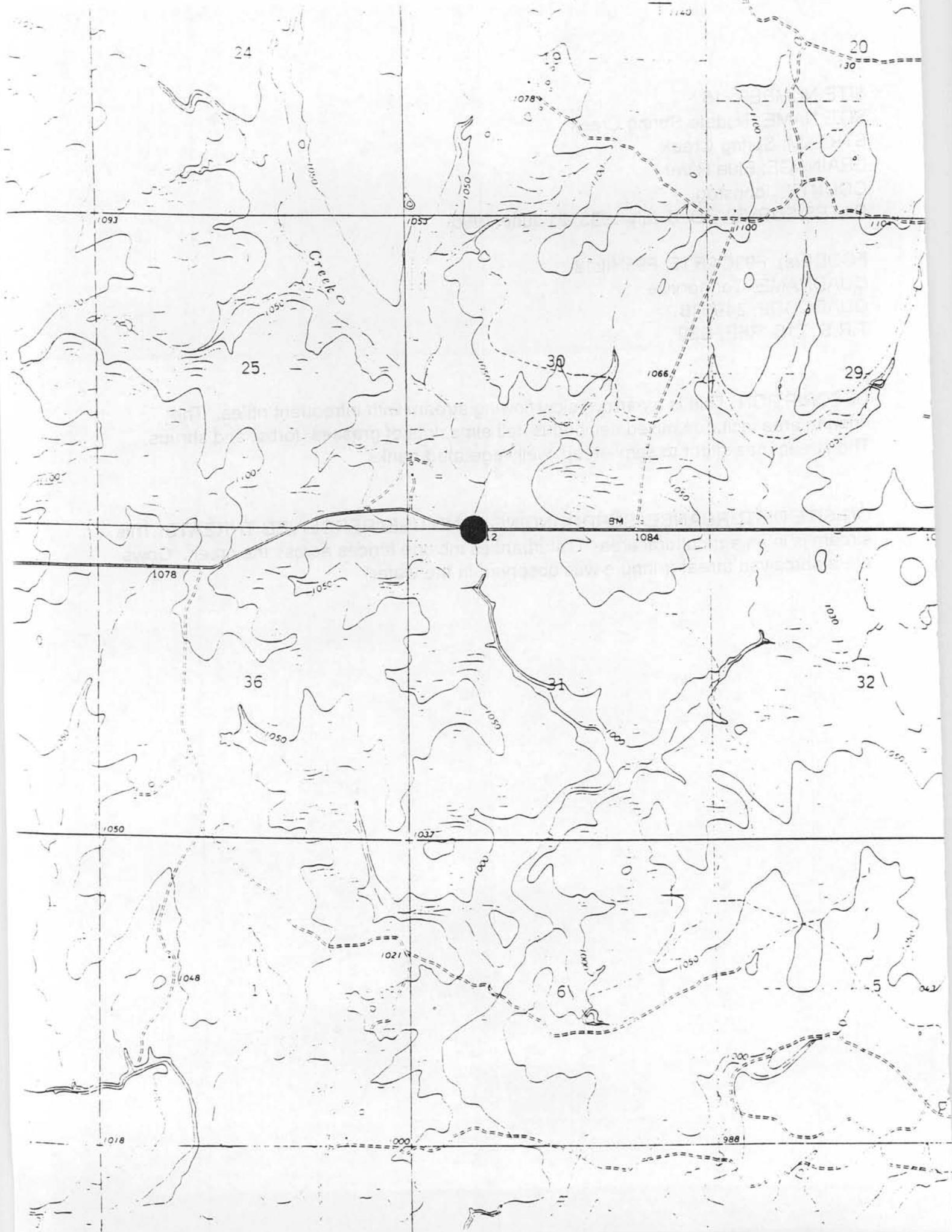
786

SITE NUMBER: 15
SITE NAME: Tisdale Spring Creek
STREAM: Spring Creek
DRAINAGE: Blue River
COUNTY: Johnston
DATES SURVEYED: 8 July 1993, 21 June 1995

FCODE(s): F93CAR15, F95HIL12
QUADNAME: Connorville
QUADCODE: 349646
T,R,S: T1S, R6E, S30

DESCRIPTION: This is a narrow, slow flowing stream with infrequent riffles. The riparian area includes mixed deciduous, tall elms, lots of grasses, forbs, and shrubs. The stream has slight to semi-steep, well vegetated banks.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: This stream is in an agricultural area. Disturbances include fences across the creek. Cows are a perceived threat (manure was observed in the water).

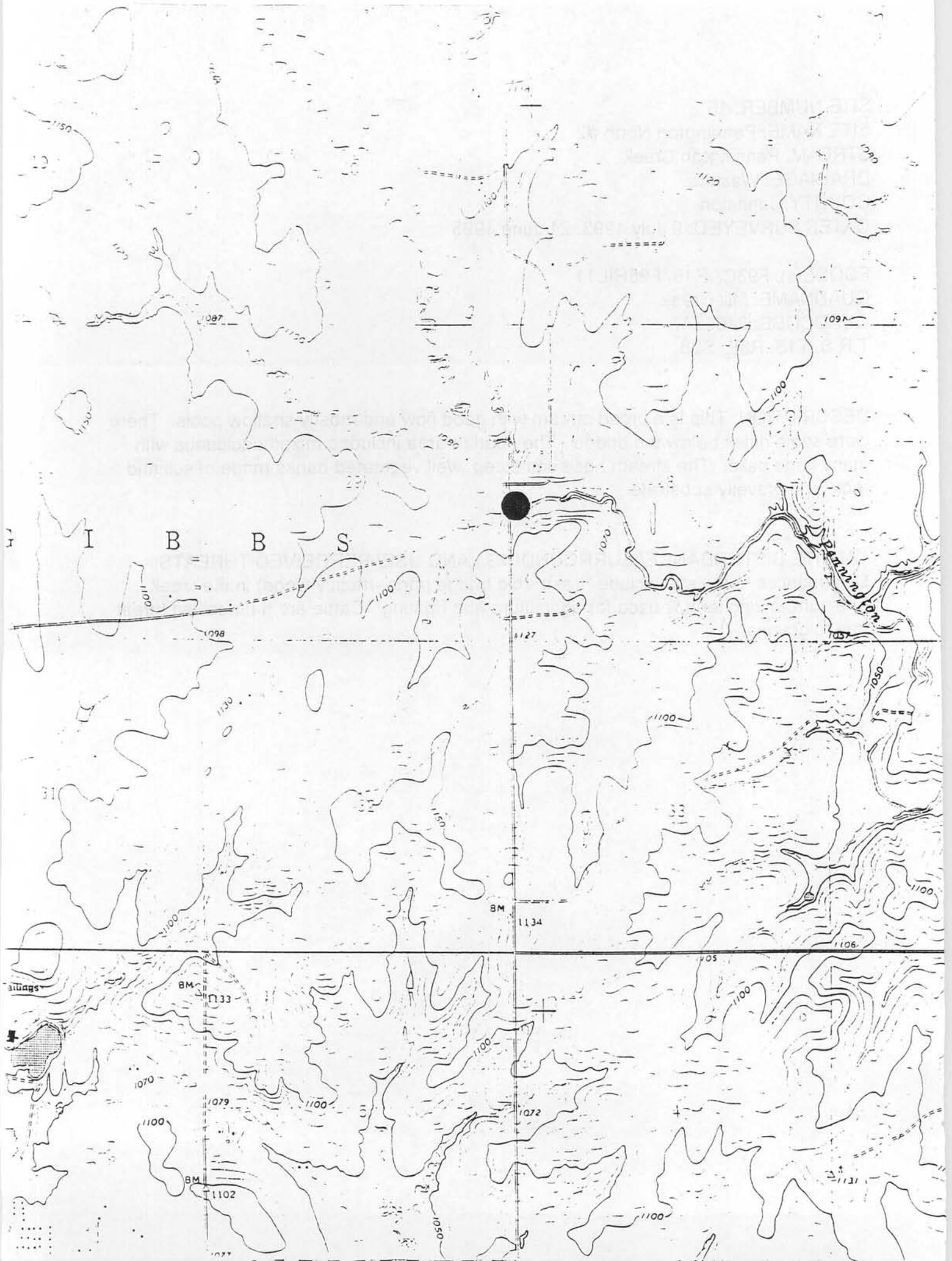


SITE NUMBER: 16
SITE NAME: Pennington North #2
STREAM: Pennington Creek
DRAINAGE: Washita
COUNTY: Johnston
DATES SURVEYED: 9 July 1993, 21 June 1995

FCODE(s): F93CAR16, F95HIL11
QUADNAME: Mill Creek
QUADCODE: 3409647
T,R,S: T1S, R5E, S28

DESCRIPTION: This is a broad stream with good flow and mostly shallow pools.. There were some riffles below the bridge. The riparian area includes mixed deciduous with many large oaks. The stream has semi-steep, well vegetated banks made of soil and rock, and gravelly substrate.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances to the site include "trash" (old bridge parts--mostly wood) in the creek. The surrounding land is used for agriculture and hunting. Cattle are a perceived threat due to grazing.



SITE NUMBER: 17
SITE NAME: Lowrance Creek
STREAM: Lowrance Creek
DRAINAGE: Washita
COUNTY: Murray
DATES SURVEYED: 9 July 1993, 5 July 1995

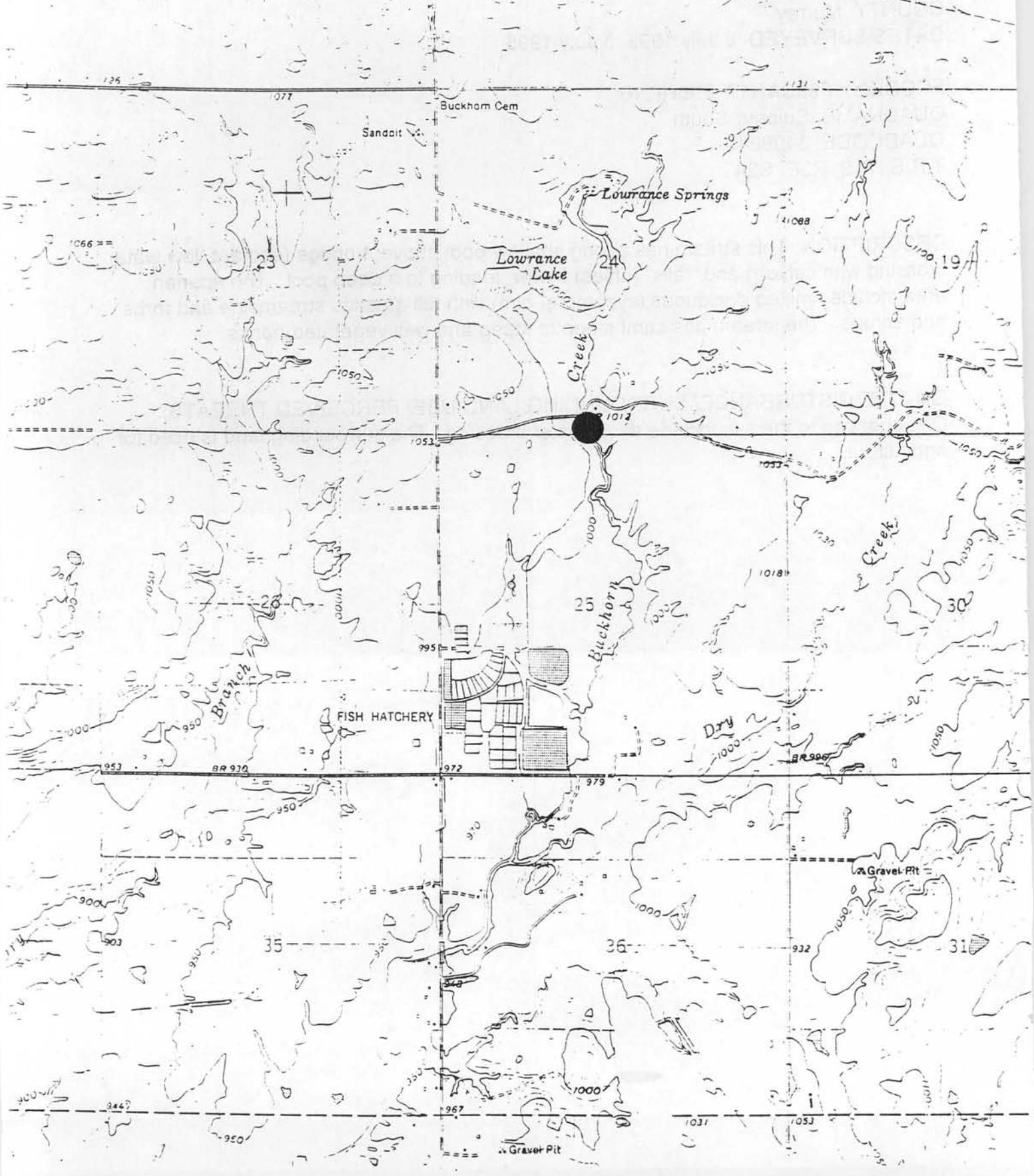
FCODE(s): F93CAR17, F95HIL16
QUADNAME: Sulphur South
QUADCODE: 3409648
T,R,S: T1S, R3E, S24

DESCRIPTION: This stream has a long shallow pool above a bridge (cement, low water crossing with culvert) and "falls" (riffles) below, leading to a deep pool. The riparian area includes mixed deciduous (sycamore/ elm) with tall grasses streamside and forbs and shrubs. The stream has semi-steep to steep and well vegetated banks.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:

Disturbances to the site include a low-water crossing. The surrounding land is used for agriculture.

L O W R A N C E

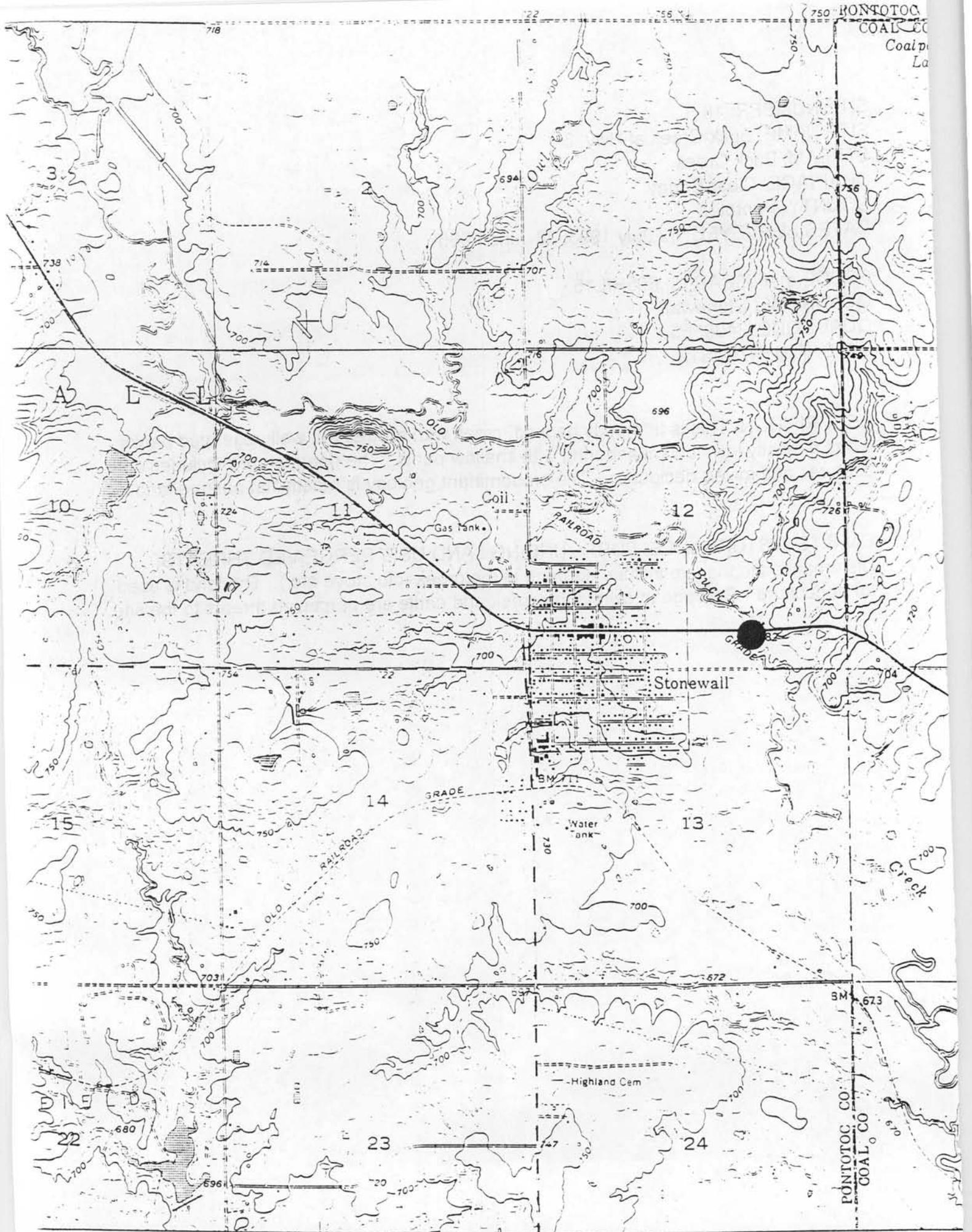


SITE NUMBER: 18
SITE NAME: Buck Creek at Hwy. 3
STREAM: Buck Creek
DRAINAGE: Clear Boggy
COUNTY: Pontotoc
DATES SURVEYED: 12 July 1993, 28 June 1995

FCODE(s): F93CAR18, F95HIL15
QUADNAME: Stonewall
QUADCODE: 3409665
T,R,S: T2N, R7E, S12

DESCRIPTION: This is a "muddy banked" creek with eroded but well vegetated banks. It has a mostly low flow meandering with shallow pools. The riparian area includes pastures and mixed deciduous. The predominant geology is mostly flat pasture land.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances to the site include garbage in the creek (old stove etc.). The land is used for agriculture. Garbage thrown in the creek and cattle are perceived threats to the site.



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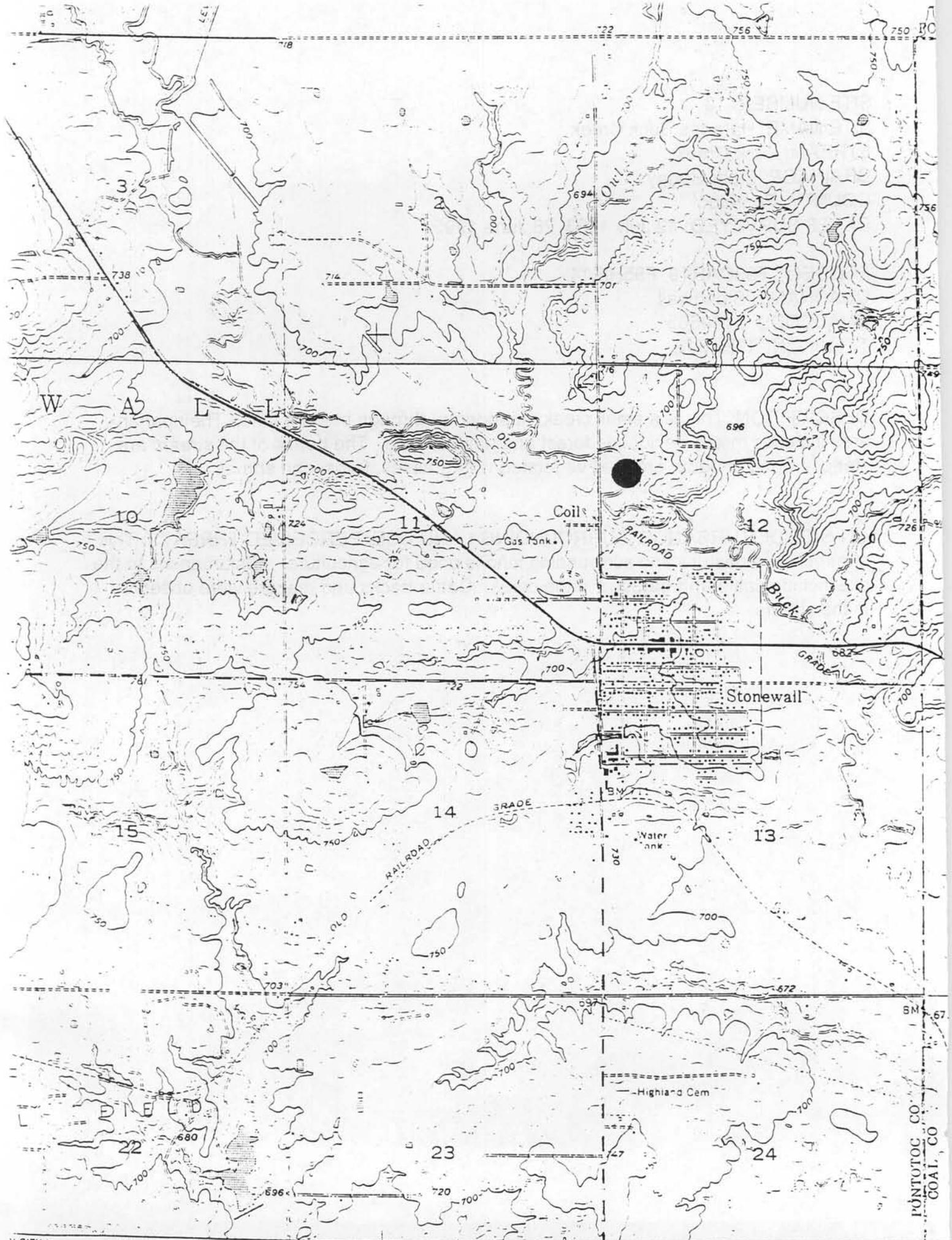
SITE NUMBER: 19
SITE NAME: Harper's Buck Creek
STREAM: Buck Creek
DRAINAGE: Clear Boggy
COUNTY: Pontotoc
DATES SURVEYED: 12 July 1993, 28 June 1995

FCODE(s): F93CAR19, F95HIL14
QUADNAME: Stonewall
QUADCODE: 3409665
T,R,S: T2N, R7E, S12

DESCRIPTION: This is a small creek meandering through pasture land. The riparian area includes mixed deciduous forest and pasture land. The banks of the stream are steep, eroded, muddy, and well vegetated with grasses, forbs, and shrubs.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: This stream is in a pasture and surrounding land is used for agriculture. Disturbances to the site include cattle and garbage in the creek. Cattle tracks and manure were observed in the stream.



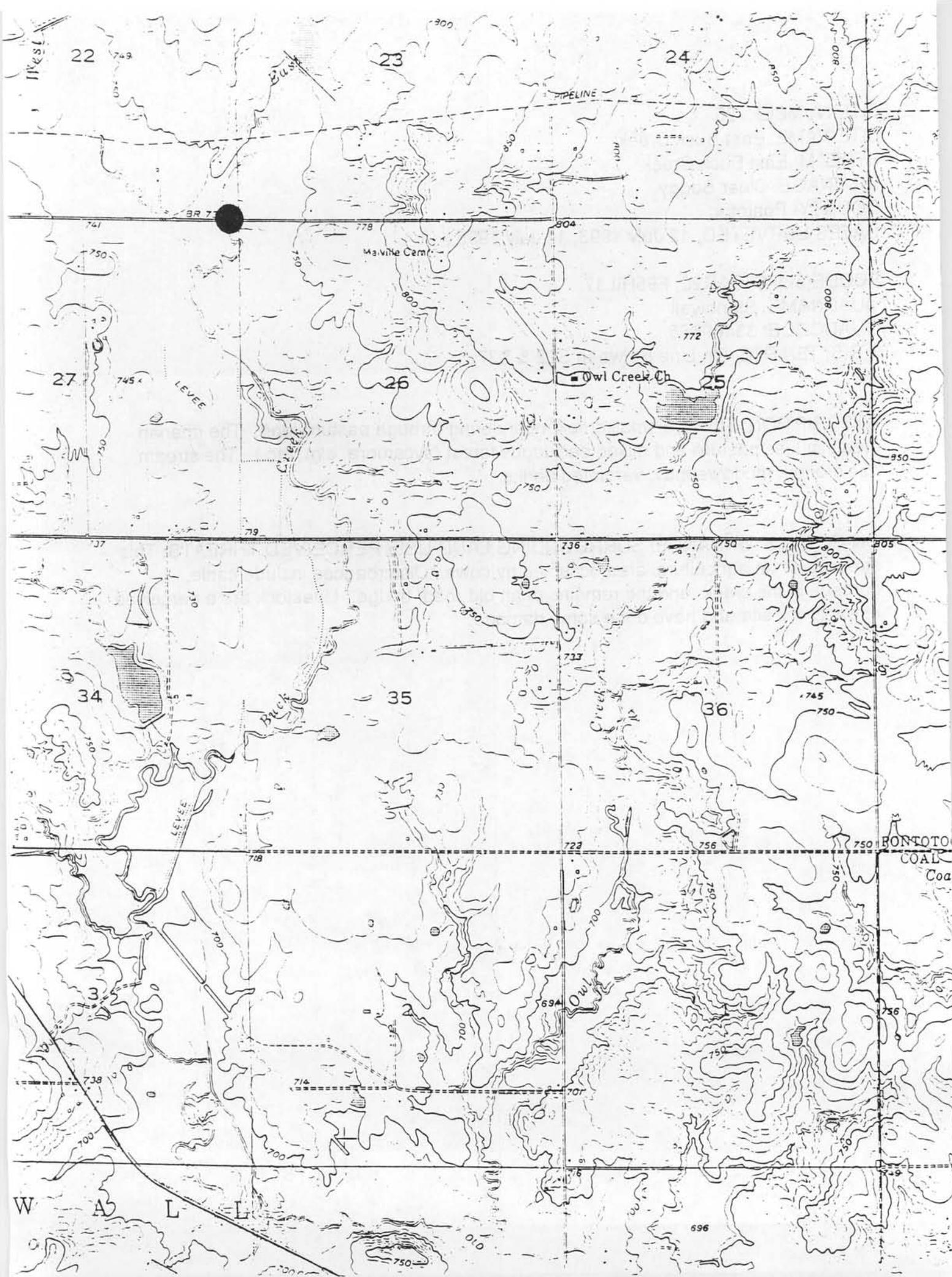


SITE NUMBER: 20
SITE NAME: East Buck Creek
STREAM: East Buck Creek
DRAINAGE: Clear Boggy
COUNTY: Pontotoc
DATES SURVEYED: 12 July 1993, 11 July 1995

FCODE(s): F93CAR20, F95HIL17
QUADNAME: Stonewall
QUADCODE: 33409665
T,R,S: T3N R7E, On Line Between S22 & S27

DESCRIPTION: This is a small creek meandering through pasture land. The riparian area includes pasture and mixed deciduous forest (sycamore, elm, etc.). The stream has eroded, muddy/sandy, vegetated banks.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: This stream is in an agricultural area occupied by cows. Disturbances include cattle, garbage in the creek, and the remains of an old road/ bridge. Livestock are a perceived threat to the site and have done some damage.



SITE NUMBER: 21
SITE NAME: West Buck Creek
STREAM: West Buck Creek
DRAINAGE: Clear Boggy
COUNTY: Pontotoc
DATES SURVEYED: 12 July 1993, 11 July 1995

FCODE(s): F93CAR21, F95HIL18
QUADNAME: Stonewall
QUADCODE: 3409665
T,R,S: T3N, R7E, On Line Between S22 & S27

DESCRIPTION: This is a small creek meandering through pasture land. The riparian area includes pasture land with occasional deciduous trees (sycamore, oak, elm, pecan). The stream has sand and mud banks which range from not steep to steep where severely eroded. There is a rocky portion on the west side near a road.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: This stream is on land used for agriculture. Disturbances and threats to the area include cattle in the creek.

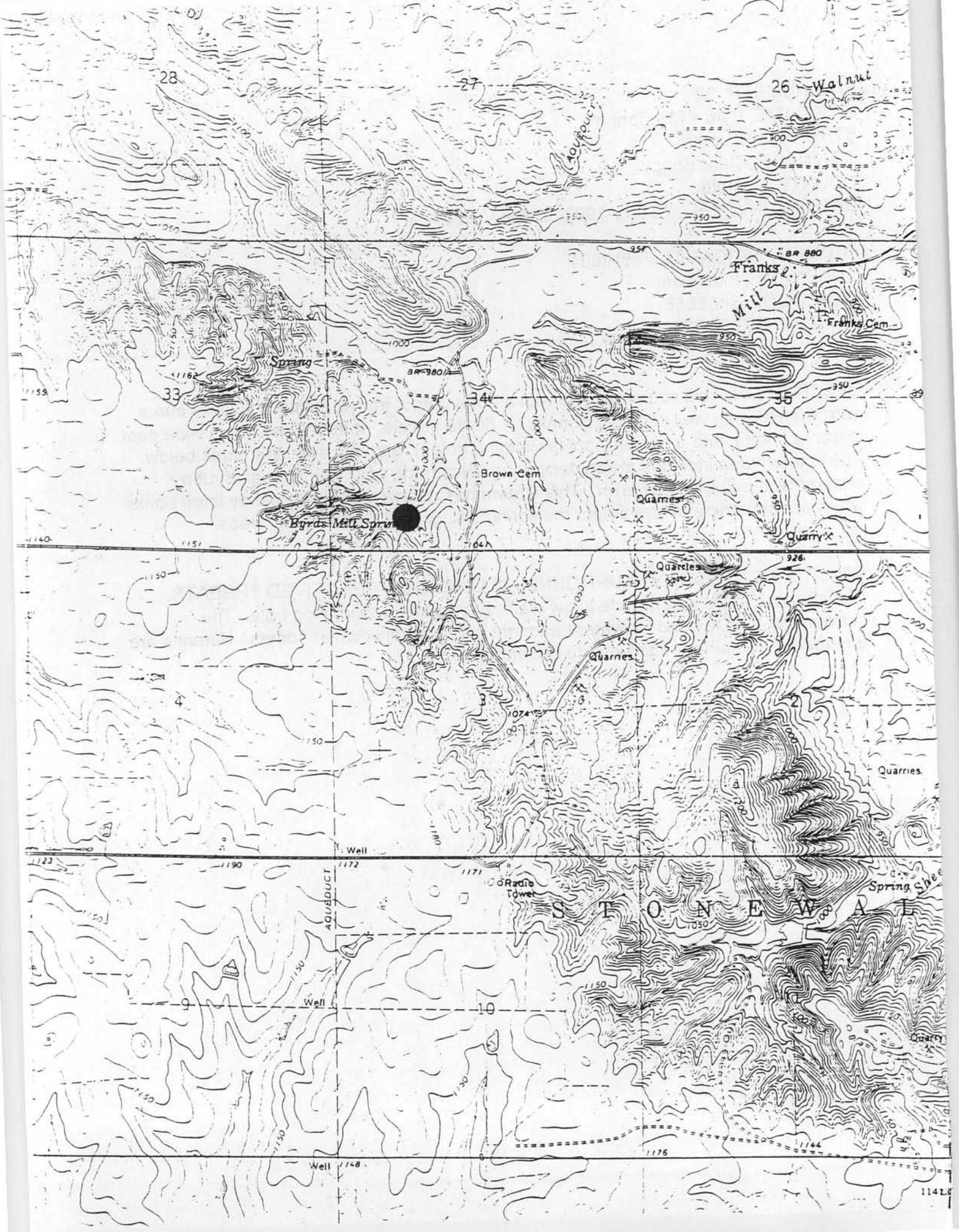
SITE NUMBER: 22
SITE NAME: Byrd's Mill Spring
STREAM: Mill Creek
DRAINAGE: Clear Boggy
COUNTY: Pontotoc
DATES SURVEYED: 13 July 1993, 22 May 1995

FCODE(s): F93CAR22, F95HIL01
QUADNAME: Fittstown
QUADCODE: 3409656
T,R,S: T2N, R6E, S34

DESCRIPTION: This stream begins with a good output from a spring and flows into a narrow creek with well vegetated banks for 50-60 meters. It then flows into a wide pool, under a bridge, into a deeper pool (swimming hole?), and into a narrow creek below. The riparian area includes mixed deciduous (sycamore, oak) with a lot of shrubby undergrowth and a grassy lawn. This stream has coarse gravel and sandy loam banks which are shrubby and steep near the spring and grassy in less steep areas.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:

Disturbances to the site include a low-water bridge and a swimming hole. The surrounding land is used for water treatment and privately owned homes. Humans are a perceived threat to the site due to recreational use.



SITE NUMBER: 23
SITE NAME: Mill Creek
STREAM: Mill Creek
DRAINAGE: Clear Boggy
COUNTY: Pontotoc
DATES SURVEYED: 13 July 1993

FCODE(s): F93CAR23
QUADNAME: Fittstown
QUADCODE: 3409656
T,R,S: T2N, R6E, S35

DESCRIPTION: This is a broad creek with pools and occasional riffles. The riparian area is dense and includes mixed deciduous forest with dense undergrowth adjacent to the stream. The stream has semi-steep rocky/ gravelly banks which are well vegetated with a lot of roots.

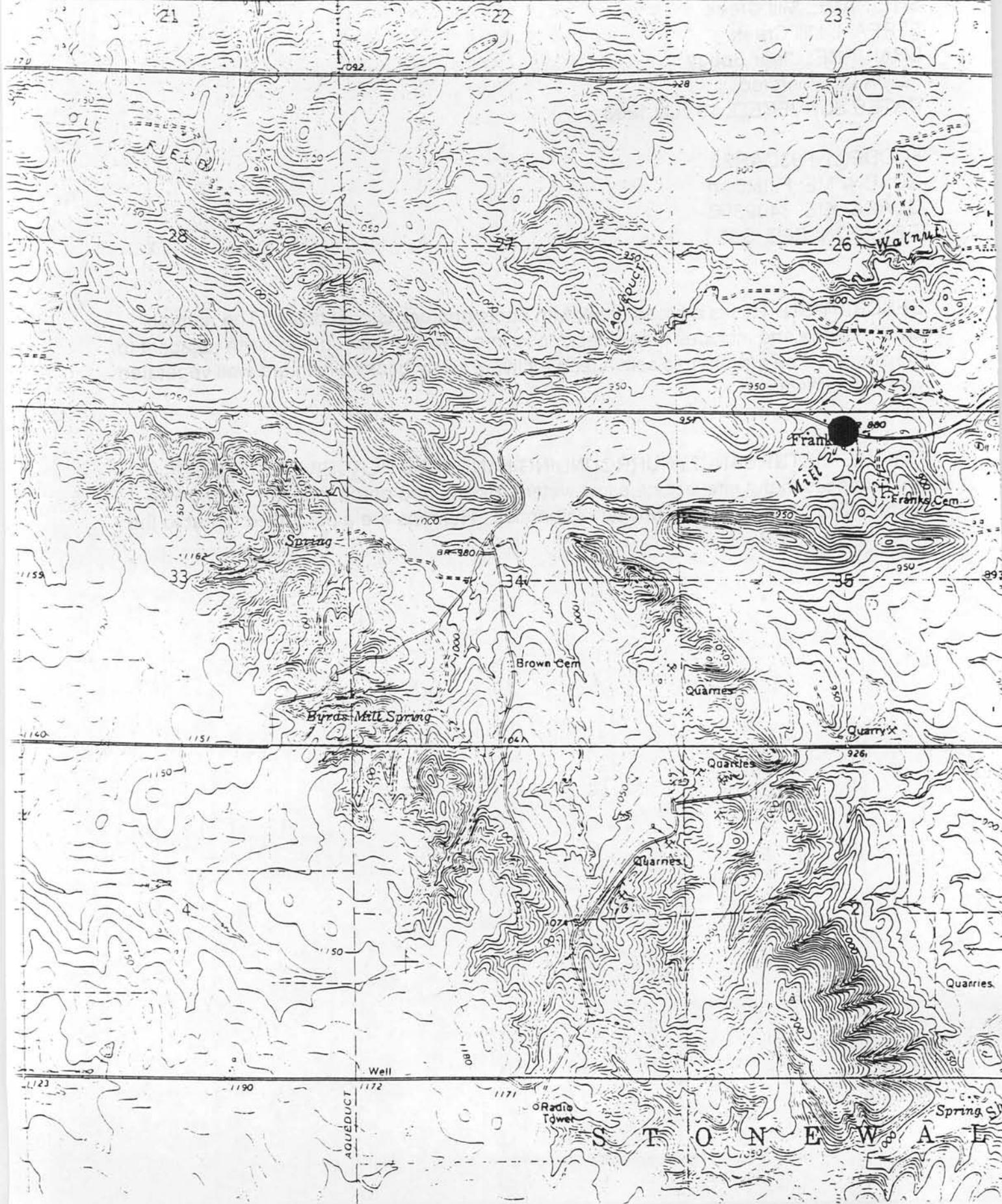
ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances to the site include a low-water crossing and garbage in the creek. The surrounding land is used for private residences. Humans are a perceived threat to the site.

FITTSTOWN

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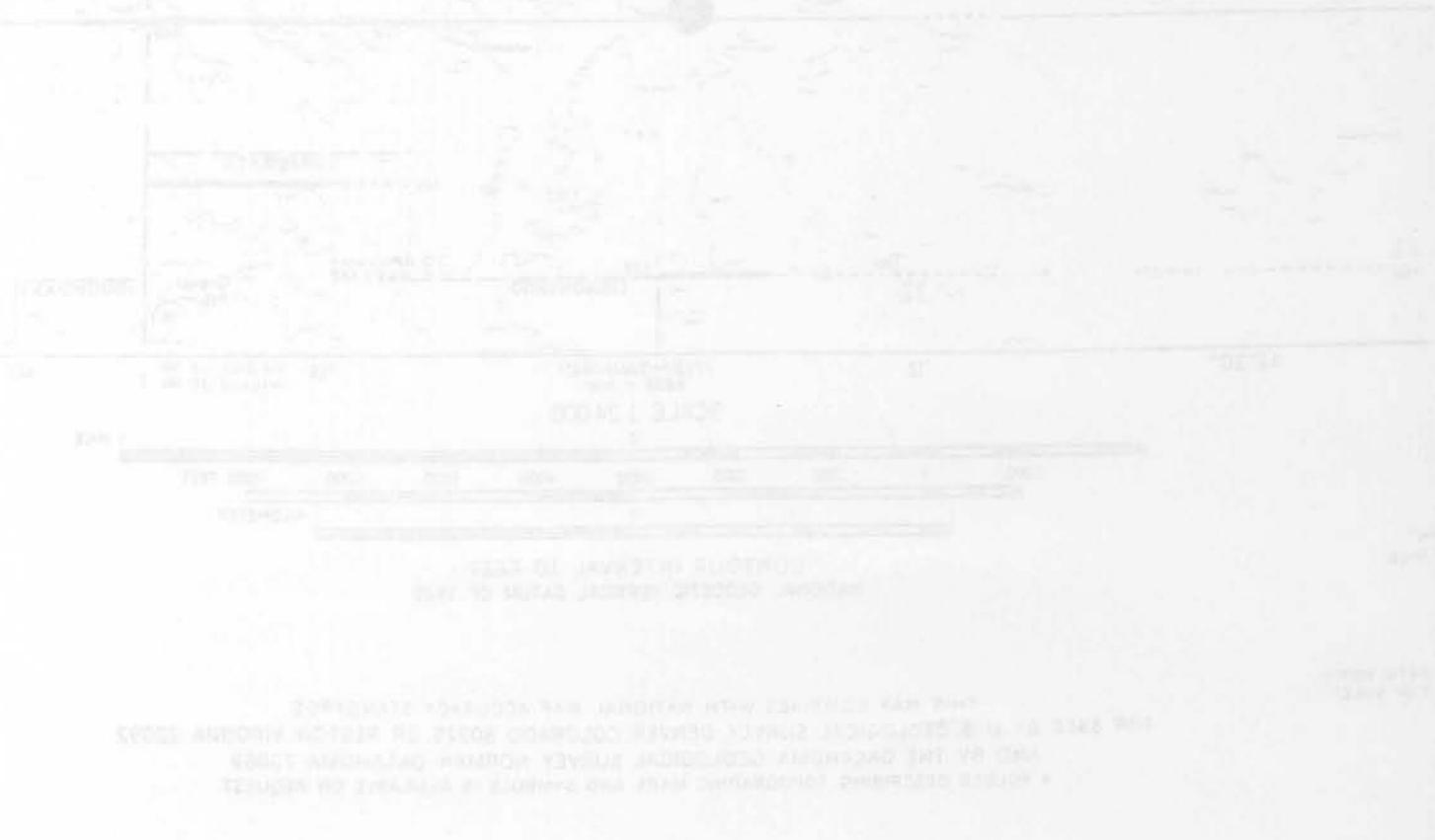


SITE NUMBER: 24
SITE NAME: Tishomingo Golf Course
STREAM: Pennington Creek
DRAINAGE: Washita
COUNTY: Johnston
DATES SURVEYED: 14 July 1993, 22 June 1995

FCODE(s): F93CAR24, F95HIL13
QUADNAME: Reagan
QUADCODE: 3409636
T,R,S: T3S, R5E, S29

DESCRIPTION: This is a broad rocky stream with occasional riffles and long shallow pools. There is a large flat granite outcropping in the creek. The riparian area includes mixed deciduous and tall grasses. The stream has sandy and rocky banks with some erosion. The banks range from steep at rocky outcroppings to gradual where there is sand and vegetation. The predominant geology is granite outcroppings and deep sand/soil.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: The stream runs through a golf course.

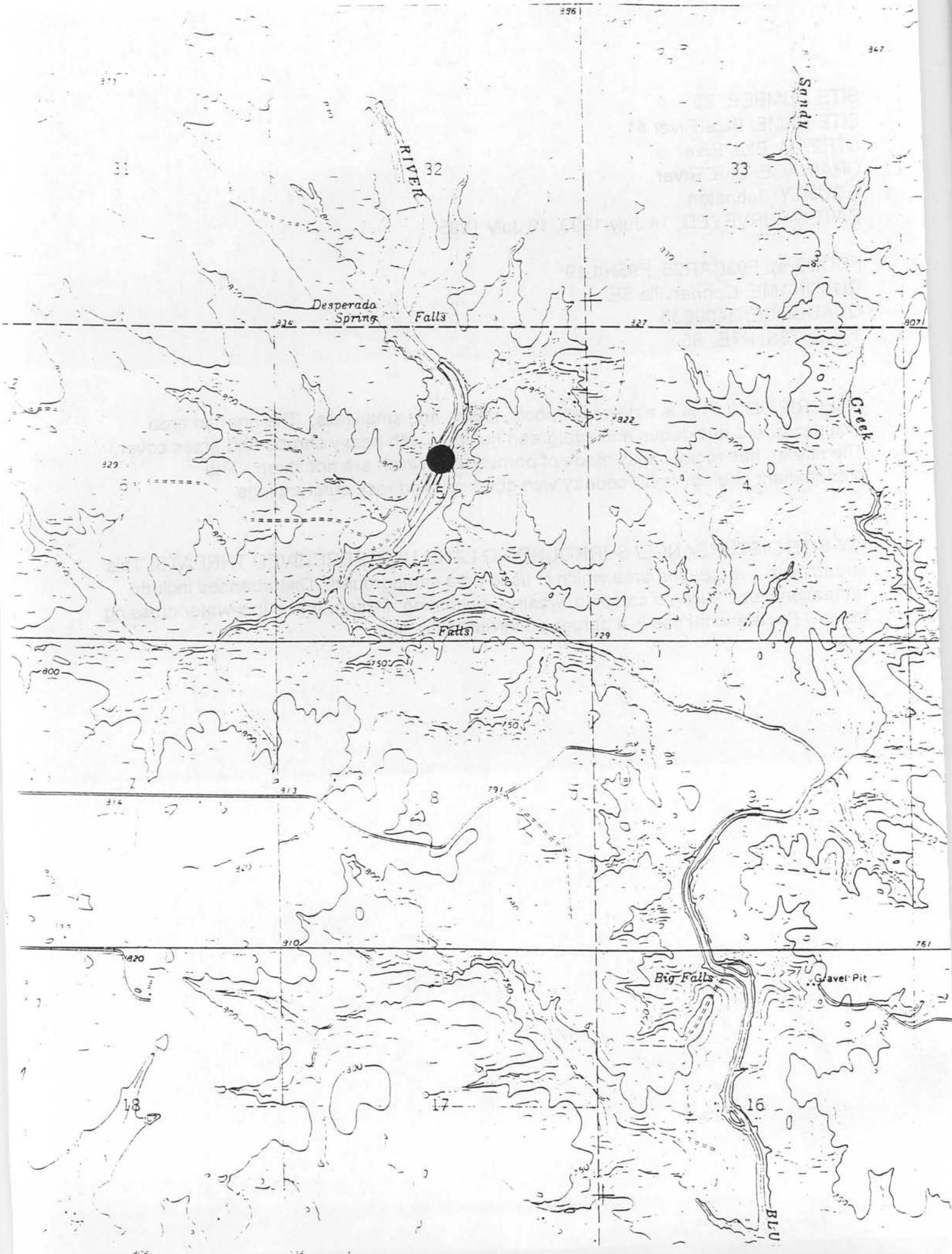


SITE NUMBER: 25
SITE NAME: Blue River #1
STREAM: Blue River
DRAINAGE: Blue River
COUNTY: Johnston
DATES SURVEYED: 14 July 1993, 18 July 1995

FCODE(s): F93CAR25, F95HIL19
QUADNAME: Connerville SE
QUADCODE: 3409635
T,R,S: T3S, R7E, S5

DESCRIPTION: This is a river with pools, riffles, and small falls. The riparian area includes mixed deciduous and evergreen (juniper) with heavy shrubs and grass cover. The stream has rocky banks made of porous rock which are not steep. The predominant geology is hill country with good soil and rock outcroppings.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: This stream is in a recreation area which is used as a campground. Disturbances include recreational use such as camping, wading, swimming, fishing, and a low-water crossing below. Recreational use is a perceived threat to the site.



SITE NUMBER: 26
SITE NAME: Pecan Creek
STREAM: Pecan Creek
DRAINAGE: Blue River
COUNTY: Johnston
DATES SURVEYED: 15 July 1993, 26 July 1995

FCODE(s): F93CAR26, F95HIL20
QUADNAME: Connerville SE
QUADCODE: 3409635
T,R,S: T2S, R6E, S25

DESCRIPTION: This is a small creek with large boulders meandering through woodland. The riparian area is fairly open, adjacent to a bridge crossing, and includes mixed deciduous (oak, elm, hardwood, sycamore) with dense grasses and shrubs. The stream has well vegetated rocky or sandy banks. The predominant geology is sandy soil with granite boulder outcrops.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:

Disturbances to the site include a bridge, an old low-water crossing, and garbage in the creek. The surrounding land is used for agriculture. Garbage and hunting (shotgun shells found) are a perceived threat to the area.

Falls

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U.S. GEOLOGICAL SURVEY

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Bridge BM 869

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HARRIS

Falls

Falls

Wagon
Creek

Creek

BLUE

Gravel Pits

3804

3803

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T 25

T 35

3801

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31

32

Desperado
Springs

Falls

BR 818

329

822

Falls

729

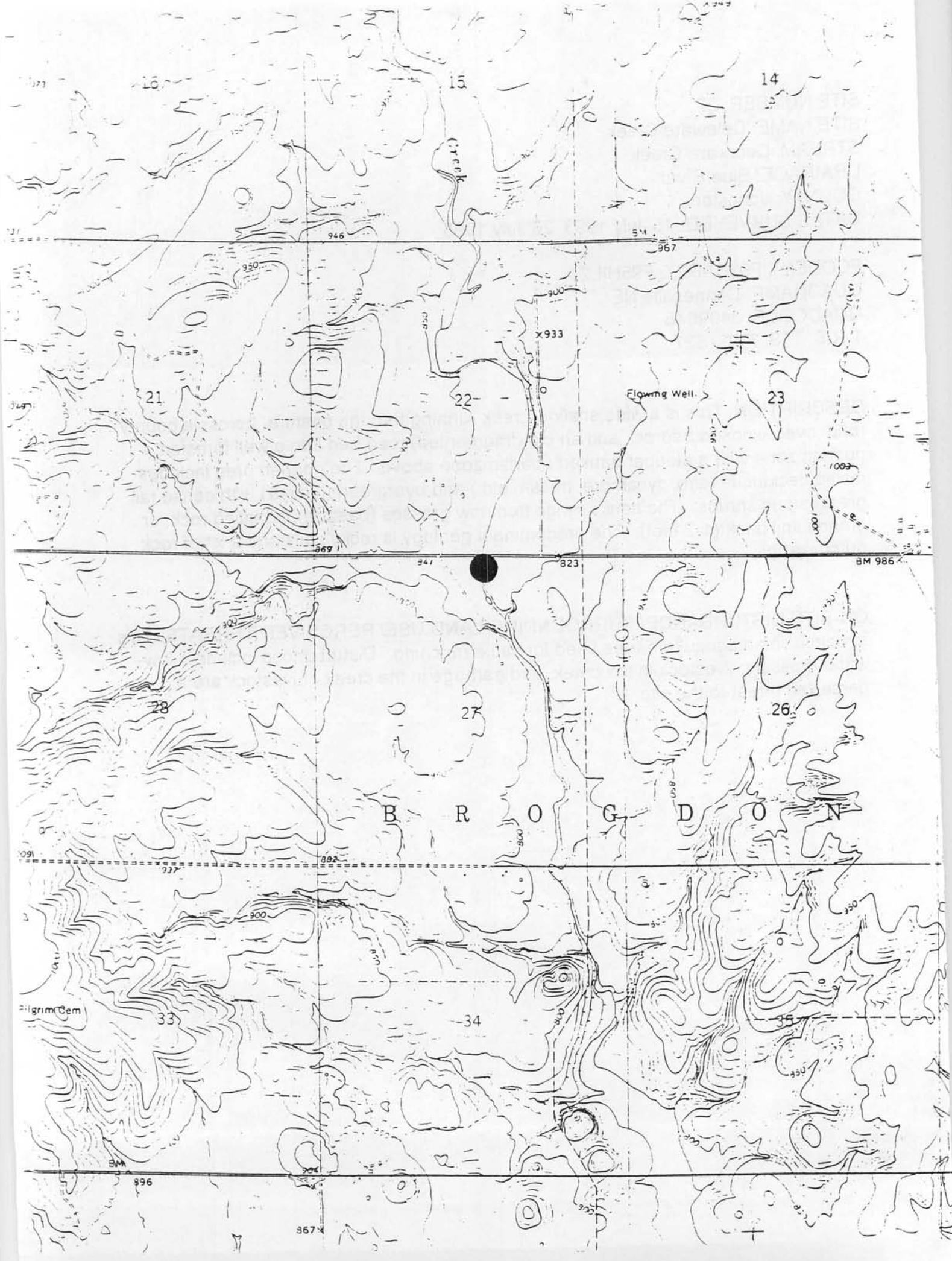
815

SITE NUMBER: 27
SITE NAME: Delaware Creek
STREAM: Delaware Creek
DRAINAGE: Blue River
COUNTY: Johnston
DATES SURVEYED: 15 July 1993, 26 July 1995

FCODE(s): F93CAR27, F95HIL21
QUADNAME: Connerville NE
QUADCODE: 3409645
T,R,S: T1S, R7E, S27

DESCRIPTION: This is a wide shallow creek running through pasture, across a county road, over exposed bedrock and an old (fragmented) road bed into a well forested riparian zone with a steeper banked riparian zone above. The riparian area includes mixed deciduous (elm, sycamore, pecan, etc.) and evergreen (juniper) with dense tall grasses and shrubs. The banks range from low grasses (pasture), stratified rock, or eroded soil bank (1-2 feet). The predominant geology is rocky soils and a lot of rock outcroppings.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS: This stream is in an agriculture area used for cattle ranching. Disturbances include a low-water crossing, livestock in the creek, and garbage in the creek. Livestock are a perceived threat to the site.



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Flowing Well

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SITE NUMBER: 28
SITE NAME: Cummin's Spring
STREAM: Cummin's Spring
DRAINAGE: Blue River
COUNTY: Johnston
DATES SURVEYED: 15 July 1993

FCODE(s): F93CAR28
QUADNAME: Connerville
QUADCODE: 349646
T,R,S: T1S, R6E, S24

DESCRIPTION: This is a fresh spring bubbling (via cement pool) into a narrow stream, then feeding into the Blue River. The spring head is well vegetated. The riparian area includes mixed deciduous (oak and elm). This stream has improved (rock and concrete) then eroded banks and sandy substrate soil.

ON-SITE DISTURBANCE/ SURROUNDING LAND USE/ PERCEIVED THREATS:
Disturbances to the site include a cabin, spring "pool", old pool, stairways, etc. The surrounding land is used for recreation with agriculture nearby. There are few perceived threats with the present owner.

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