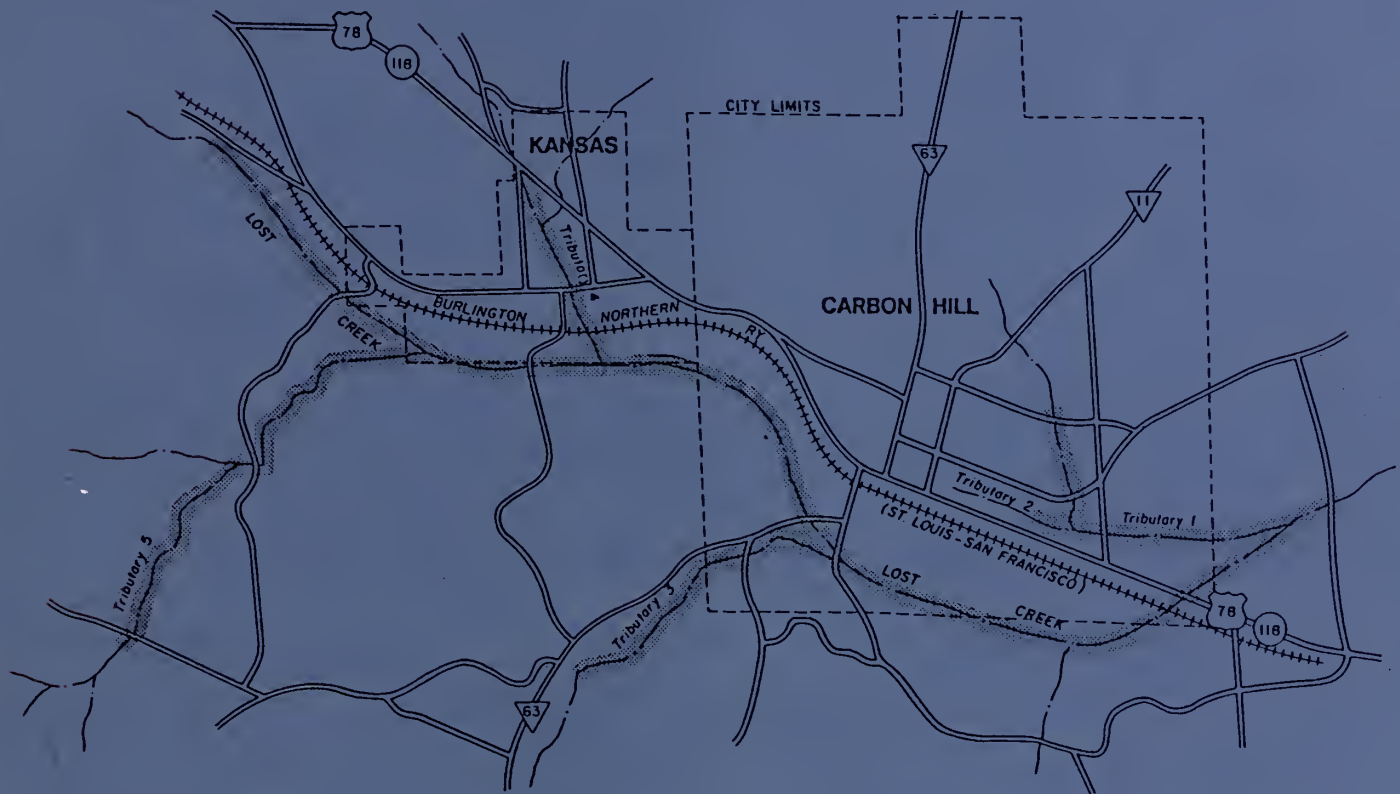


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# FLOOD PLAIN MANAGEMENT STUDY LOST CREEK AND TRIBUTARIES IN VICINITY OF CARBON HILL AND KANSAS, ALABAMA



prepared by

**U. S. Department of Agriculture  
Soil Conservation Service**

in cooperation with

**City of Carbon Hill**

**Town of Kansas**

**Walker County Soil and Water Conservation District**

**Birmingham Regional Planning Commission**

**Alabama Department of Economic and Community Affairs**

**May, 1985**

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Acknowledgements:

The cooperation and assistance given by the agencies, organizations, and municipalities during these flood hazard analyses are greatly appreciated.

These include:

Walker County Soil and Water Conservation District

City of Carbon Hill

Town of Kansas

Birmingham Regional Planning Commission (BRPC)

U.S. Geological Survey, Department of Interior (USGS)

Alabama Department of Economic and Community Affairs (ADECA)

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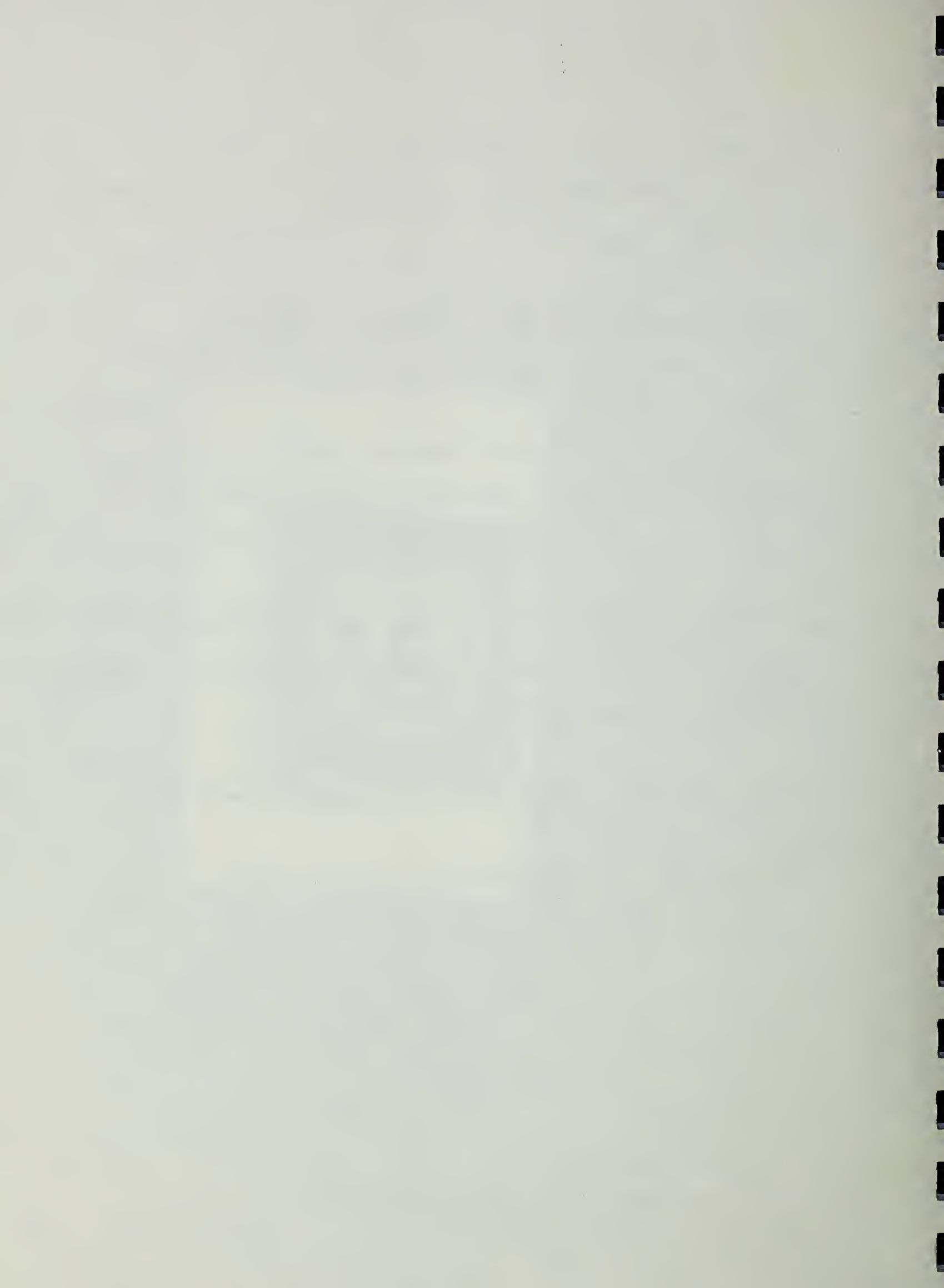
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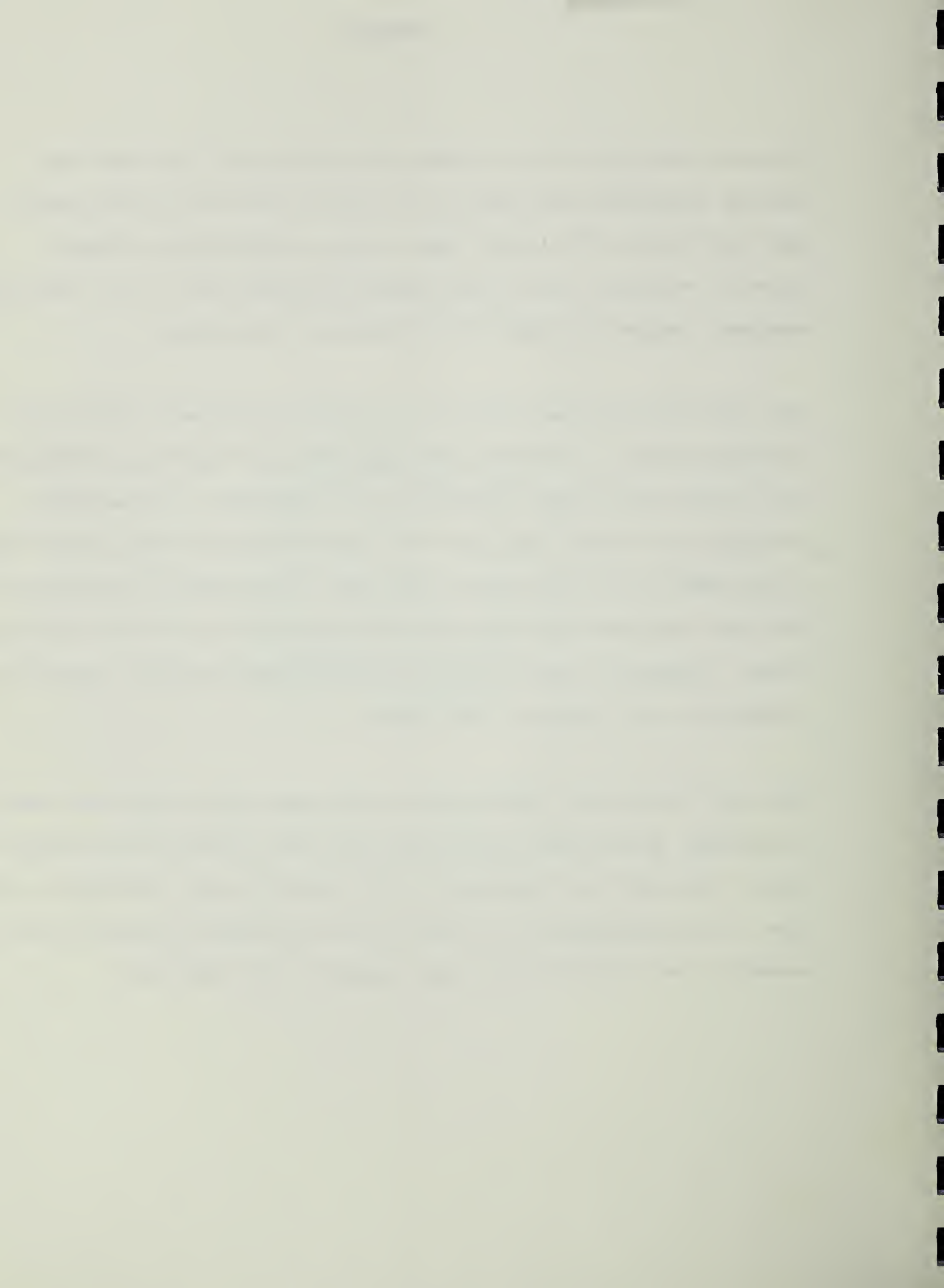


## FOREWORD

Pressures created by lack of suitable sites outside the flood plain have resulted in increased development of the flood plain areas in and adjacent to the City of Carbon Hill and the Town of Kansas, Walker County, Alabama. Technical information about flood hazards is essential for a local flood plain management program to be effectively planned and implemented.

This report provides the results of an analysis of structural solutions to the flooding problems in a portion of the study area and flood hazard information for 10 stream miles along Lost Creek and its tributaries. The watershed drainage areas involved range from 30.6 square miles at the lower study limit on Lost Creek to 0.3 square miles at the upper study limit of one tributary. The report includes Flood Hazard Area Photomaps and Flood Profiles for these streams. Regulatory and corrective measures that would minimize the risk of flooding are also discussed in the report.

The report includes the identification of the major flood-prone areas, history of flooding, and pertinent existing state and local flood-prone area regulations. State and local governmental units should find this information valuable in assessing potential solutions to flood problems and determining actions needed for the judicious use of lands adjacent to the flood plain.





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## INTRODUCTION

A flood insurance study was completed for the City of Carbon Hill in September, 1980 through the National Flood Insurance Program. The study did not provide flood prone area delineations for several areas subsequently flooded in Carbon Hill. The Town of Kansas was not included in the 1980 study. The City of Carbon Hill and Town of Kansas requested a flood plain management study to identify flood prone areas not included in the insurance study, to determine structural measures which may be utilized to reduce flood damages to existing properties, and to provide information needed to encourage wise use of the flood-prone area. This study was conducted in accordance with a plan of study developed in April 1983 by the study participants. USDA flood plain management studies in Alabama are carried out through a Joint Coordination Agreement (revised April 1983) between the USDA-Soil Conservation Service (SCS) and the Alabama Department of Economic and Community Affairs (ADECA). Data in this report are based on investigations and analyses performed by the SCS in cooperation with ADECA, the City of Carbon Hill, Town of Kansas, the Walker County Soil and Water Conservation District, and the Birmingham Regional Planning Commission.

The SCS conducts flood plain management studies under the authority of Section 6 of Public Law 83-566, in response to Federal Level Recommendation No. 3 of Water Resources Council revised Unified National Program for Flood Plain Management, September 1979; and in compliance with Executive Order 11988, dated May 24, 1977. Section 11-52-1 through 11-52-84, the Code of Alabama 1975, as amended, provides the zoning authority for municipalities to develop land use controls. Sections 11-19-1 through 11-19-24 of the Code of Alabama 1975, as

amended, provides authority for development of a comprehensive land management and use program in flood prone areas in the unincorporated portions of counties in the State. It allows counties through the county governing body (county commissions in Alabama) to meet the requirements of the National Flood Insurance Act of 1968 (as amended), and authorizes the county governing bodies to prescribe criteria for land management and use in flood-prone areas.

The objective of this flood plain management study is to furnish technical data to local governments so they can correct existing flood problems, where circumstances permit, utilizing structural measures and also develop procedures to prevent potential flood losses that might be caused by unwise development in flood-prone areas.

The report includes alternatives for reducing flood damages. These alternatives are based on an analysis of both structural and nonstructural measures including floodwater retarding structures, channel improvement, flood proofing, and flood warning devices.

Information on the possibility of future floods of various magnitudes and the extent of flooding which might occur is included for Lost Creek and tributaries within and adjacent to the City of Carbon Hill and Town of Kansas, Alabama. The extent of potential flooding from the 100-year and 500-year floods are shown on aerial photomaps. Elevations of expected flooding for selected recurrence intervals (10-, 50-, 100-, and 500-year events) are provided on flood profiles for the streams studied. (See "Glossary of Terms" in appendix B for detailed definitions of terms used in the report.)

By using the maps, tables, and profiles presented in this report, the flood elevations at selected locations along the Lost Creek Watershed streams may be determined. This information will permit local units of government to implement flood plain management regulations which recognize potential flood hazards.

The maps and profiles are based on conditions that existed at the time field surveys were made in 1983. Such factors as increased urbanization, encroachment of flood-prone areas, relocation or modification of bridges and other stream crossings, floodwater retarding structures, and stream channel improvement can have a significant effect on flood stages and areas inundated. Therefore, the results of any flood hazard analysis should be reviewed periodically by appropriate State and local officials and planners to determine if changes in watershed conditions would significantly affect future flood elevations.

The ADECA and BRPC can provide technical assistance in the use of the information contained in this report, the National Flood Insurance Program, and flood plain management in general. Also, the SCS can provide technical assistance through the Walker County Soil and Water Conservation District in the interpretation and use of the information contained in this report.



## DESCRIPTION OF STUDY AREA

### General

The City of Carbon Hill and Town of Kansas are located in Walker County, Alabama, within the Black Warrior River Basin (USGS Hydrologic Unit Code Mulberry Fork - 03160109-SCS-170). The study area includes flood-prone areas of Lost Creek Watershed (Lost Creek and tributaries) within and adjacent to the City of Carbon Hill and Town of Kansas (see location map, Appendix A, Sheet 1 of 1). Lost Creek is a perennial stream while its tributaries are intermittent. The watershed drainage area of Lost Creek is 30.6 square miles (0.9 miles downstream of U.S. Highway 78 crossing) and the tributary drainage areas range from 0.3 to 6.7 square miles. A total of 10 stream miles were studied.

Walker County, located about 20 miles northwest of Birmingham, had a population of 68,660 in 1980. The City of Carbon Hill, with a 1980 population of 2,452 experienced a 27 percent growth in the 1970-80 decade, while the Town of Kansas had a 1980 population of 267, an 18 percent growth from 1970 to 1980. The ADECA has projected the communities populations to increase to 3370 and 360 respectively by the year 2000. The areas of incorporation, at present, are Carbon Hill, approximately 5.5 square miles and Kansas, approximately 0.4 square miles. The incorporated areas subject to flooding by the 100-year frequency storm are Carbon Hill, 1.1 square miles, and Kansas, 0.1 square miles. Major transportation routes in the study area are U.S. Highway 78, County Roads 11 and 63, and the St. Louis - San Francisco Railroad (Burlington Northern Railroad).

## Climate

In general, rainfall is moderate to heavy throughout the year and temperatures are mild to warm with few extended periods of subfreezing weather. Subfreezing temperatures, while not uncommon, are usually of short duration. The average annual temperature for the area is about 62°F, the hottest month is July and the coolest is January. The normal frost-free period is from approximately April 5 to October 25, about 200 days. Rainfall amounts and runoff characteristics vary on a seasonal basis, with normal rainfall for winter and spring being greater than summer and autumn. The average annual precipitation for the area is 56 inches. October is the driest month with an average monthly rainfall of 2.9 inches. March is the wettest month with an average of about 6.8 inches. Because of this seasonal distribution of rainfall, most major floods occur in late winter or in early spring.

## Topography and Geology

The City of Carbon Hill and Town of Kansas are located in the northwest corner of Walker County on Lost Creek, about 25 miles upstream of its confluence with the Mulberry Fork of the Black Warrior River. Both communities are located on the flood plain and adjacent sloping land which joins the flood plain with the steep mountains which make up the majority of the watershed drainage area. Elevations in the flood plain range from 390 to 470 feet above mean sea level (msl) and in the main portion of the communities from 390 to 520 feet msl. Elevations of over 800 feet msl are found within the watershed resulting in over 400 feet of elevation change to the lower study area limit.



The area is underlain by the Pottsville Formation which is a thick sequence of sandstones and shales with coal beds interspersed. As in most of the Warrior Coal Field, several coal beds are present beneath a large part of the area. Locally, mining has been important for a long time. In earlier years, most mining was by tunneling, but in recent years by surface stripping.

### Soils

Soils within the 100-year flood hazard area of the watershed formed in loamy alluvium on flood plains and on stream terraces. Major terrace soils are Whitwell, Mooreville, Haggerty and Spadra. The soils on adjacent uplands formed in loamy marine sediments and loamy and clayey residuum. Major upland soils are Smithdale, Sunlight and Townley.

Whitwell, Haggerty and Moreville soils make up about 70 percent of the flood hazard area and are on the lower elevations within the area. These deep, moderately well drained to somewhat poorly drained soils are frequently flooded. These soils are poorly suited to cultivated crops and fairly well suited to pasture, hay, and woodland. Building site development and the construction of sanitary facilities are limited by wetness and flooding.

Spadra soils make up about 30 percent of the flood hazard area and are on the higher elevations within the area. These deep, well drained soils are rarely flooded and are considered prime farmland soils. They are well suited to cultivated crops, pasture, hay, and woodland. The hazard of rare flooding is the main limitation to industrial or residential development and to the construction of sanitary facilities.

If detailed soils information is desired for a specific location, the Walker County Soil and Water Conservation District or personnel in the Soil Conservation Service Field Office in Jasper should be consulted.

Land Use

Land use in the watershed is predominantly forest land with limited cropland and pastureland. Table 1 shows present land use for the watershed and the flood plain flooded by the 100-year flood:

TABLE 1  
PRESENT LAND USE

Land Use	Watershed		Flood Plain	
	Acres	Percent	Acres	Percent
Cropland	100	1	75	4
Pasture and Hayland	1,700	9	600	30
Forest Land	15,200	77	1,260	63
Urban and Miscellaneous	2,500	13	65	3
<b>TOTAL</b>	<b>19,500</b>	<b>100</b>	<b>2,000</b>	<b>100</b>

Wetlands

The area included in this flood plain management study is affected by Lost Creek and its tributaries. Portions of the flood plain are a part of the oak-hickory forest complex which is found in the higher and drier sections of the northern and central parts of the state.

Trees associated with this forest complex include several species of oak, hickory, and pine. Sweetgum, blackgum, ash, and sourwood are also found in this complex. There are numerous shrubs, vines, and herbaceous plants which make up the understory and ground cover in the forested portions. The cleared areas are cropland, grassland, idle, or urban and built-up land.

Wetlands occurring in the study area as classified by Wetlands of the United States (1971) are approximately 332 acres of Type 1 wetland and approximately 73 acres of Type 5 wetland.

### Fish and Wildlife

The major species of game fish in the study area include largemouth bass, bluegill, longear sunfish, and rock bass. There are also suckers, catfish, and numerous shiners and darters.

Wildlife diversity in the study area is fair. There are numerous small mammals, reptiles, and birds. Game animals include gray squirrels, cottontail rabbits, bobwhite quail, and the mourning dove.

None of the plants or animals listed as Endangered or Threatened by the U.S. Fish and Wildlife Service are known to occur in the study area.

### Archeological and Historical Sites

There are no registered historic places in the study area. There are 19 sites of archeological significance in Walker County as shown in the Environmental Data Inventory - State of Alabama, January 1, 1981, U.S. Army Corps of

Engineers and the State of Alabama, Office of State Planning and Federal Programs, State Planning Division (now ADECA). None are known to occur in the study area.

## FLOOD PROBLEMS

### Historical Floods

Problems identified as occurring in the watershed study area during the public participation process include flood damages to public and private property, flood plain erosion and sedimentation. The only problems considered to be significant to address were those associated with flooding.

The City of Carbon Hill and Town of Kansas have suffered costly damages annually from the floodwaters of Lost Creek and its tributaries. Flooding occurs an average of 4 to 5 times yearly, usually in late winter and early spring. Direct damages occur to roads and streets, bridges, other public facilities, businesses, and homes. Damages also occur on approximately 600 acres of pasture and 75 acres of cropland. Average annual damage resulting from both urban and agricultural flooding is \$97,300.

On March 5, 1983, about 7.5 inches of rain fell in 24 hours in the area resulting in a 100-year or greater frequency flood. There were 10 houses, 6 businesses, 6 publicly-owned properties, a recreational facility flooded; and 40 acres of truck crops damaged. There were other businesses and residences that received nuisance (inconvenience and lost opportunities) damage as a result of the storm. The greatest value of losses was to businesses in Carbon Hill. Estimates of damages from the March 5, 1983 storm exceeded \$250,000. The City of Carbon Hill swimming pool and other public facilities are inundated in every significant size storm (25-year frequency or greater).

## Potential Flood Problems

Approximately 2,000 acres in the study area are inundated by the 100-year flood. Future development within the flood plain should be regulated to minimize flood problems. A knowledge of the flood potential and hazard is important in land use planning and for management decisions concerning flood plain utilization. This report identifies those areas that are subject to flooding. Special emphasis is given to these flood hazard areas through maps, photographs, and profiles. This report also identifies potential structural measure solutions to reduce potential flood losses to existing developments within the flood plain. Information within the report can be utilized to provide a suitable basis for the adoption of land use controls to guide flood plain development and thereby prevent intensification of the loss problems.

The areas along Lost Creek and its tributaries which would be flooded by the 100-year and 500-year floods are shown on the Flood Hazard Area Photomap portion of the flood hazard area/flood profile sheets (appendix A, sheets 1 through 8). Flood profiles are shown for the 10,50, 100 and 500-year floods. The Photomap/Flood Profile Index in Appendix A shows the location and area covered by individual sheets. Flood elevations for several locations are shown in Table 2.

TABLE 2  
FLOOD ELEVATIONS  
FEET (MSL)

Location*	Flood Frequency			
	10-Year	50-Year	100-Year	500-Year
	Lost Creek			
U. S. Highway 78	402.8	404.2	404.8	405.8
South Pine Street	413.4	415.1	416.0	417.9
	Tributary 1			
Widows Road	406.2	407.1	407.5	408.4
	Tributary 2			
Poplar Street	409.6	409.7	410.2	411.6
	Tributary 4 (Trinity Creek)			
St. Louis - San Francisco Railroad (Burlington Northern)	430.3	431.8	432.6	433.7

\*Upstream side of road/railroad crossing over creek.





## USE OF FLOOD HAZARD AREA/FLOOD PROFILE DATA

The areas flooded by the 100-year and 500-year floods may vary somewhat from those shown on the Flood Hazard Area Photomap portion of the flood hazard area/flood profile sheets in appendix A because the contour interval and scale of the base maps do not permit precise plotting of the flood area boundaries. A more exact determination of the depth of flooding by the 100-year and 500-year floods at any particular point along the streams can be determined from the water surface profiles and the ground elevation at the point in question. To determine the depth of flooding or the height of a point above the flood, the following steps should be followed:

1. Locate the point in question on the Location Map and Photomap Index in Appendix A and refer to the appropriate flood hazard area/flood profile sheet.
2. Determine the stream station at the point in question (shown in feet on the flood hazard area/flood profile sheets).
3. Read the flood elevation for this stream station from the water surface profiles.
4. Determine the ground elevation at the point in question (NOTE: If elevation of point in question is unknown, the Elevation Reference Mark data in appendix B can be utilized with a surveying instrument to determine the elevation).
5. Compare the flood height with the ground elevation to compute the depth of the flooding or the height of land above the flood.

# THE HISTORY OF THE UNITED STATES

The history of the United States is a complex and multifaceted one, spanning centuries and encompassing a wide range of events, people, and ideas. From the early days of European exploration and settlement to the present day, the United States has undergone significant changes and challenges. This history is a testament to the resilience and ingenuity of the American people, who have built a nation that has shaped the world.

The early years of the United States were marked by the struggle for independence from British rule. The American Revolution was a pivotal moment in the nation's history, leading to the birth of a new country. The Constitution was drafted and signed, establishing the framework for the government. The years following the Revolution were a time of growth and expansion, as the United States spread across the continent.

## EXISTING PROGRAMS AVAILABLE TO REDUCE FLOOD PROBLEMS

The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 encourage wise management of flood-prone areas through local regulation. The State of Alabama, responding to the National Flood Insurance Program, authorized and granted powers, by Sections 11-19-1 to 11-19-24 of the Code of Alabama 1975, as amended, to each county government in Alabama to prescribe criteria for land management, including control measures in flood-prone areas. The Alabama Department of Economic and Community Affairs and the Birmingham Regional Planning Commission can assist the communities in carrying out this authority by developing comprehensive land management programs in flood-prone areas. The City of Carbon Hill has participated in the National Flood Insurance Program (NFIP) since May 18, 1977, and in the "Regular Phase" since March 16, 1981. The Town of Kansas is not currently participating in the National Flood Insurance Program, however, the Town can make application for eligibility. Entrance into this program would authorize the sale of flood insurance at subsidized rates for both residential and non-residential structures and mobile homes and their contents throughout the Town. The unincorporated portion of Walker County has participated in the NFIP through Walker County since July 2, 1979. The National Flood Insurance Act of 1968 requires local units of government to develop land use control measures for flood-prone areas based on competent evaluation of flood hazards and applicable state standards. The participating communities have agreed to adopt the codes and ordinances necessary to protect future development in the community from flood hazards.

In conformance with the requirements of the NFIP, Carbon Hill is already enforcing certain regulations in identified flood-prone areas. These include the basic subdivision and zoning ordinances and construction codes. Local regulatory programs for both communities should be implemented through the use of codes and ordinances and proper administrative procedures. Revision of existing codes and adoption of effective policies and procedures can result not only in protection of existing structures but also in the wise management of flood-prone areas in future years. The land use control measures in flood-prone areas are an important aspect of a flood plain management program. These controls include zoning, subdivision regulation, and construction standards. Additional regulations developed for the flood-prone areas should be integrated with the communities existing land use control policies. The ordinances that are amended and the additional controls that are adopted should be mutually supporting and should be compatible with the Cities overall development policies.

The Flood Hazard Area Photomaps/Flood Profiles prepared for this study could be adopted as part of the communities flood plain management program. A flood insurance study for Carbon Hill was completed in September 1980. However, this study did not include several areas receiving flood damages in Carbon Hill. Kansas was not included in the study. The flood zones shown in the September 1980 report were also included in this report with some changes in flood depths, based on a more detailed investigation, and additional flood data from actual storms occurring since 1980. It is recommended that the communities develop a program to publicize the availability of flood insurance and encourage community residents to participate in the program, especially those located in or near flood-prone areas. Flood insurance in eligible communities can be purchased from any State licensed insurance agent. Residents in

flood-prone areas should be made aware of the impacts of not obtaining the flood insurance coverage.



## OPPORTUNITIES FOR REDUCING FLOOD DAMAGES

The current level of flood damages indicate a need for development of structural measures to reduce these flood damages. A sound flood plain management program is needed to guide development and land use in the flood plain and to guide upland land use changes to avoid increasing runoff rates. Technical flood hazard information is a valuable tool which the communities can use to guide development and use of the flood-prone area, thereby minimizing future losses from flooding.

Several alternatives have been studied during development of this report to identify potential methods the communities can utilize to minimize future flood damages. These alternatives included the following measures: floodwater retarding structures, channel work, flood proofing, and flood warning. All alternatives include non-structural measures of appropriate land use control for the flood plain and the encouragement for existing structures to obtain flood insurance. A detailed discussion of the alternatives evaluated and a table comparing benefits and costs are contained in the Investigation and Analysis Section of this report. Summarization of these alternatives and recommendations to reduce flooding problems are as follows:

Alternative 1 -- 5.4 miles of channel enlargement on Lost Creek to convey the average annual flood.

These measures are estimated to reduce average annual flood damages on Lost Creek by 80 percent. (NOTE: Location of all measures discussed are shown on the photomap index and location map in appendix A.) Flood depths would be decreased which would reduce direct flood damages to homes, recreational facilities, fish hatchery, catfish ponds, 75 acres of cropland and indirect

damages associated with moving furniture, equipment, and either rerouting or closing roads. The nuisance of frequent flooding and the vector problems associated with low stream flow has adversely impacted the quality of life in the affected parts of the communities of Carbon Hill and Kansas. This alternative would noticeably improve these problems. The average annual benefits derived from this alternative are \$21,000 and the estimated average annual cost for this alternative is \$105,000 which results in a benefit - cost ratio of 0.2:1.0.

Alternative 2 -- Construction of a floodwater retarding structure (FRS #3) and 6,700 feet of outlet channel on Tributary 1, to convey the average annual flood.

These measures would reduce flood damages in the business district of Carbon Hill (north of Highway 78) by 75 percent. The reduced flood depths and frequency of flooding would prevent the loss of business, damages to buildings and contents, and improve the economic future of family owned businesses and the community. The reduction in flooding would also reduce vector problems and improve the quality of life. The average annual benefits derived from this alternative are \$53,000 and the average annual cost of this alternative is \$42,000. This alternative has a benefit - cost ratio of 1.3:1.0.

Alternative 3 -- Construction of two floodwater retarding structures (FRS #1 and FRS #2) on Tributary 5.

These measures would reduce flood damages on the flood plain of Lost Creek by 37 percent. The distance of the sites from the damaged areas reduces the effectiveness of these structures. The average annual damage reduction benefits of this alternative is \$10,000 compared to an annual cost of \$57,600 or a benefit - cost ratio of 0.2:1.0.



Alternative 4 -- Flood proofing to minimize flood damages on Lost Creek and construction of FRS #3 and 6,700 feet of channel on Tributary 1.

Flood proofing can provide some protection against flooding inside houses and public buildings. However, external and nuisance damages would not be reduced. Since most of the properties on Lost Creek are damaged by the less frequently occurring storms, 5-year frequency or greater, this treatment should be feasible. Flood proofing in the Carbon Hill business district, north of Highway 78 is not feasible, because the damage occurs on an average of once every year and the effects on business and nuisance to patrons will hinder the stability and economic future of this section of town. As a result, the measures in Alternative 2 were combined with flood proofing on Lost Creek as a feasible alternative. This alternative would provide similar benefits described in Alternative 2 and would provide an economically feasible treatment of the urban area flood damages on Lost Creek. Average annual benefits of this alternative are \$55,000 and average annual costs are \$43,800 resulting in a benefit - cost ratio of 1.3:1.0.

The recommended solution (Alternative 4) includes the following components:

1. Use flood plain information to prevent future flood damages through flood plain management.
2. Construct a floodwater retarding structure and outlet channel in the eastern portion of Carbon Hill (Tributary 1).
3. Flood proof selected structures along Lost Creek.
4. Inform local residents of assistance available through the Flood Insurance Program.
5. Coordinate channel design and spoil placement with coal company officials in conjunction with scheduled mining operations in the flood plain.

The total cost of the recommended plan should be about \$496,000 with annual benefits of \$55,000.

Based on information collected to date, flood damages in Carbon Hill and surrounding areas of Lost Creek Watershed can be addressed under the Small Watershed Program (PL 83-566). However, due to the relatively small size of the project, it is recommended that financial assistance be sought through other sources. If construction funds are obtained, SCS can provide technical assistance with design and installation pending availability of personnel.

APPENDIX A  
INVESTIGATION AND ANALYSIS  
LOCATION MAP AND FLOOD HAZARD AREA MAP INDEX  
FLOOD HAZARD AREA (PHOTOMAP/FLOOD PROFILE SHEETS)-SHEETS 1 THROUGH 8



## INVESTIGATION AND ANALYSIS

### Flood Hazard Area Evaluation

Delineation of the flood hazard area and evaluation of damages within the area required thorough investigations of the study area. This included field surveys and computer evaluations. Field surveys included valley/channel cross-sections, bridge and culvert sections, appraised value of improvements and elevations of high water marks. This data was used to prepare a computerized model of the flood plain. This model generated flood depth and damage information for eight floods of 24-hour duration ranging in size from a storm expected to occur four times each year to a storm expected to occur once every 500 years. Initially, the model was run to approximate present or existing conditions within the study area. This model run is termed "without project." The without project run was adjusted to approximate flood depths obtained from United States Geological Survey (USGS) gauge data and the surveyed flood marks.

### Preparation of Maps and Profiles

Flood Hazard Area Photomaps were prepared by drawing the limits of the 100-year and 500-year floods on aerial photos to indicate the extent of the area subject to inundation. The photomaps are reproductions of ASCS photomaps taken in November 1979. Flood profile stationing is in terms of feet and is measured from the aerial photographs. Flood profiles are shown for the 10-, 50-, 100-, and 500-year floods.

The flood hazard area photomaps and flood profiles are shown in Sheets 1 through 8 of this appendix. Flood hazard areas delineated on the photomap/flood profile sheets represent present watershed conditions. Changes within the watershed such as new roads, flood retarding structures, channel improvement, etc., will change the flood profile elevations. Users of the flood hazard maps should recognize structural changes in the flood plain and realize that the maps may not be accurate where the structural measures added affect flood flows.

### Formulation of Alternatives

In addition to the without project computer run, alternative runs were made to analyze potential methods which can be utilized to minimize flood damages in the study area. Several of the alternative runs involved structural measures such as floodwater retarding dams and channel enlargement, to control out-of-bank flooding. Data input for the computer model required preliminary designs to provide size, discharges and cost estimates of the structures.

Seven potential sites for Floodwater Retarding Structures (FRS) were identified using USGS topographical maps of the study area. Four of the sites were eliminated because of fixed improvements such as roads and houses in the flood plain. Two sites studied (FRS #1 and FRS #2) are located on the upper reaches of Tributary 5 which joins Lost Creek about 1 mile southwest of Kansas. The third site (FRS #3) identified for the study is in the northeast portion of Carbon Hill on Tributary 1. The three FRS studied are shown on the Location Map for the Photomap/Flood Profile Sheets in Appendix A. The embankment of FRS #1 would be about 32 feet high, 1,100 feet long, and contain

98,000 cubic yards of compacted earthfill. FRS #2 would also be about 32 feet high, 700 feet long, and contain 52,000 cubic yards of earthfill. FRS #3 as planned would be about 20 feet high, 300 feet long and contain 10,000 cubic yards of earthfill. Because of the location of FRS #3, it was proportioned and/or sized to meet the criteria for a high hazard dam.

The channel on Lost Creek was designed to convey the average annual storm (2.33-year frequency) within the channel banks. The channel on the downstream cross-sections ranged from 70 feet wide, 6.8 feet deep; to 30 feet wide and 5.8 feet deep on the upstream segments. This design will require the modification of two bridges and the deepening and shaping under one existing bridge. The approximate location and alignment of channel excavation on Lost Creek is shown on the Location Map in appendix A.

About 85 road, bridge, and valley cross-sections were surveyed along Lost Creek and its tributaries. The depth of flooding was determined for 8 storms of 24-hour duration, ranging from the 0.25-year to 500-year event. If floodwater retarding structures were installed at these sites about 3200 acres of the Lost Creek Watershed would be controlled. Maximum low-stage release from these three FRS's would be 15 to 18 cubic feet per second per square mile of drainage area. The FRS's were sized by floodrouting from topographical sheet data (20' contour interval) and were designed to detain peak rates of runoff from the 50-year and/or 100-year storms. These structures are designed to release the stored rainfall gradually over a period not to exceed 10 days.

Each of the structures and the channel were evaluated separately and in different combinations to determine their beneficial effect and to find the combination of the structural measures that were economically feasible.

## Alternatives

In all alternatives proper use of the flood plain through appropriate flood plain management (land use controls) and the use of flood insurance is recommended.

Alternative 1 - Considered channel enlargement on Lost Creek main channel. Enlargement began on the downstream end near the junction of Mill Creek and Lost Creek. Enlargement of the channel continued upstream about 5.4 miles.

Alternative 2 - This alternative considered installing FRS #3 with an outlet channel (on Tributary 1) to carry the flow into Lost Creek. The outlet channel would involve about 6700 feet with 1000 feet of the upstream portion of the outlet channel covered. The entrance to the covered section would require the use of four or five drop inlets. The remaining 5700 feet of outlet channel could be enlarged by earthen excavation. The installation of the channel would require the alteration and/or modification of four streets and two parking lots. Some utilities would require modification or relocation. Additional surveys would be needed to finalize the channel design. The proposed channel would convey release from FRS #3 and the average annual (2.33-year frequency) flow from the uncontrolled drainage area into Lost Creek.

Alternative 3 - Consisted of installing FRS #1 and FRS #2 on tributaries of Lost Creek. Site 1 would probably require the raising and repaving of a county road and FRS #2 would necessitate the rerouting of an existing power line. Both of these sites are approximately 3 miles upstream from the area receiving the greatest flood damages.



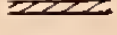






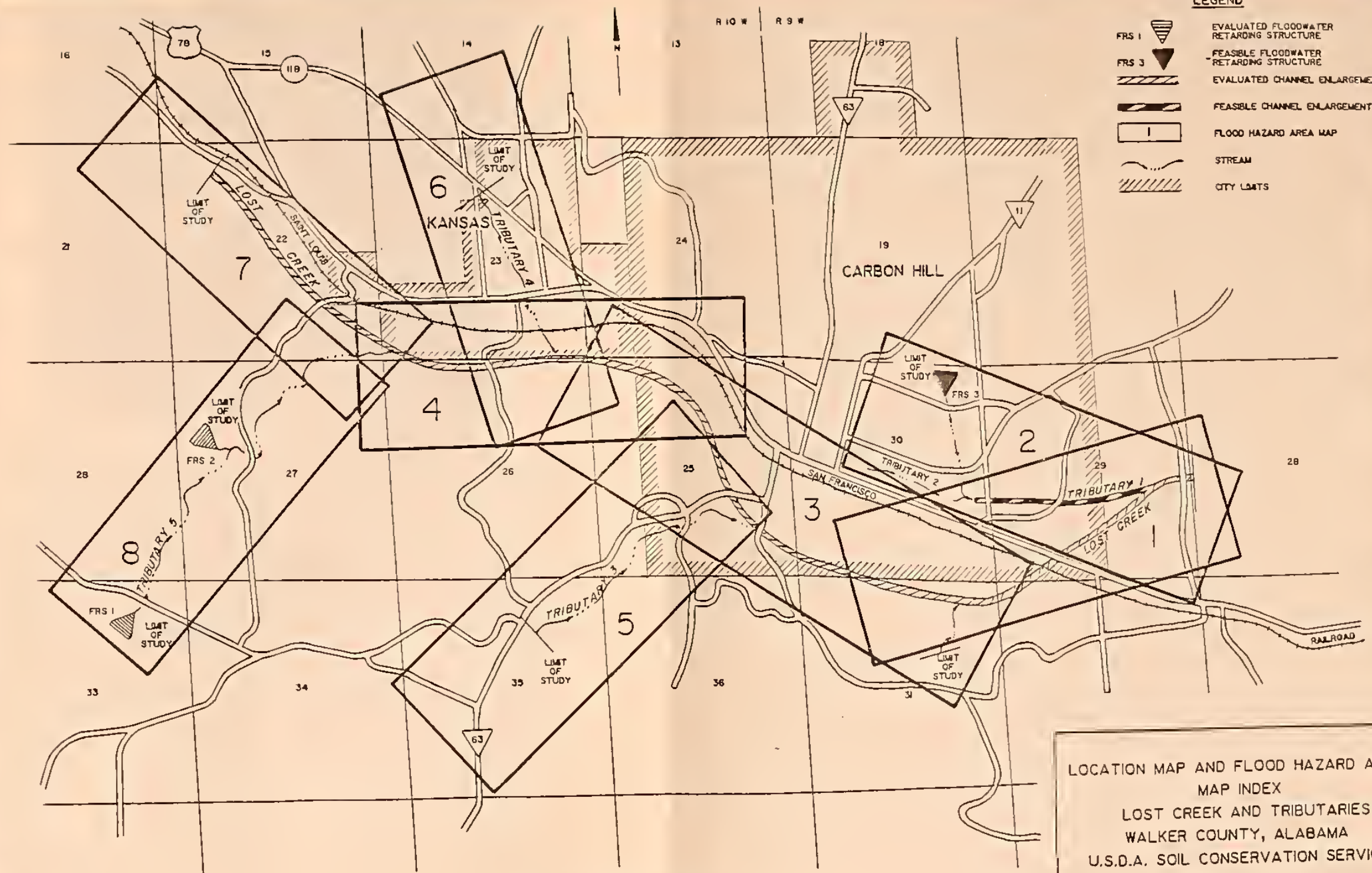
Alternative 4 - Considered Flood proofing of properties to reduce flood damages on Lost Creek in the urban area of Carbon Hill, and construction of FRS #3 and 6700 feet of channel on Tributary 1. There are 10 houses, 6 businesses, and 6 other structures that are currently receiving flood damages. Floodproofing would reduce damages to some of these structures. For example, the National Guard Armory floods about 0.3 feet above floor elevation with a storm frequency that exceeds the 100-year rainfall. The concrete block and brick structures could be floodproofed by installing baffle board barriers at door openings, around low windows, and other openings into the building. Flood warning devices were not considered viable because; (1) most damages are occurring to non-movable structures; and (2) there is little threat to loss of life based on depth of water and velocity of flow in houses. Thus, floodproofing of the residential property and National Fish Hatchery on Lost Creek is the only viable alternative other than flood insurance. Floodproofing would provide limited protection of structures and significant protection of the contents. Floodproofing of the business property on Tributary 1 would reduce some of the damage to the merchandise. However, loss of business, external damages and nuisance to clientele would significantly hinder the stability and economic future of this section of town. Therefore, flood proofing business property on Tributary 1 was not considered to be an acceptable part of the alternative. For this reason, Alternative 4 consists of the installation of FRS #3 and outlet channel on Tributary 1 and flood proofing of properties on Lost Creek.

The design and cost estimates for the floodwater retarding structures are based on USGS topographic maps (20 feet contour intervals) and therefore, are subject to change following more detailed surveys. The FRS and channel proposals in



**LEGEND**

- FRS 1  EVALUATED FLOODWATER RETARDING STRUCTURE
- FRS 3  FEASIBLE FLOODWATER RETARDING STRUCTURE
-  EVALUATED CHANNEL ENLARGEMENT
-  FEASIBLE CHANNEL ENLARGEMENT
-  FLOOD HAZARD AREA MAP
-  STREAM
-  CITY LIMITS



LOCATION MAP AND FLOOD HAZARD AREA  
 MAP INDEX  
 LOST CREEK AND TRIBUTARIES  
 WALKER COUNTY, ALABAMA  
 U.S.D.A. SOIL CONSERVATION SERVICE  
 Sheet 1 of 1

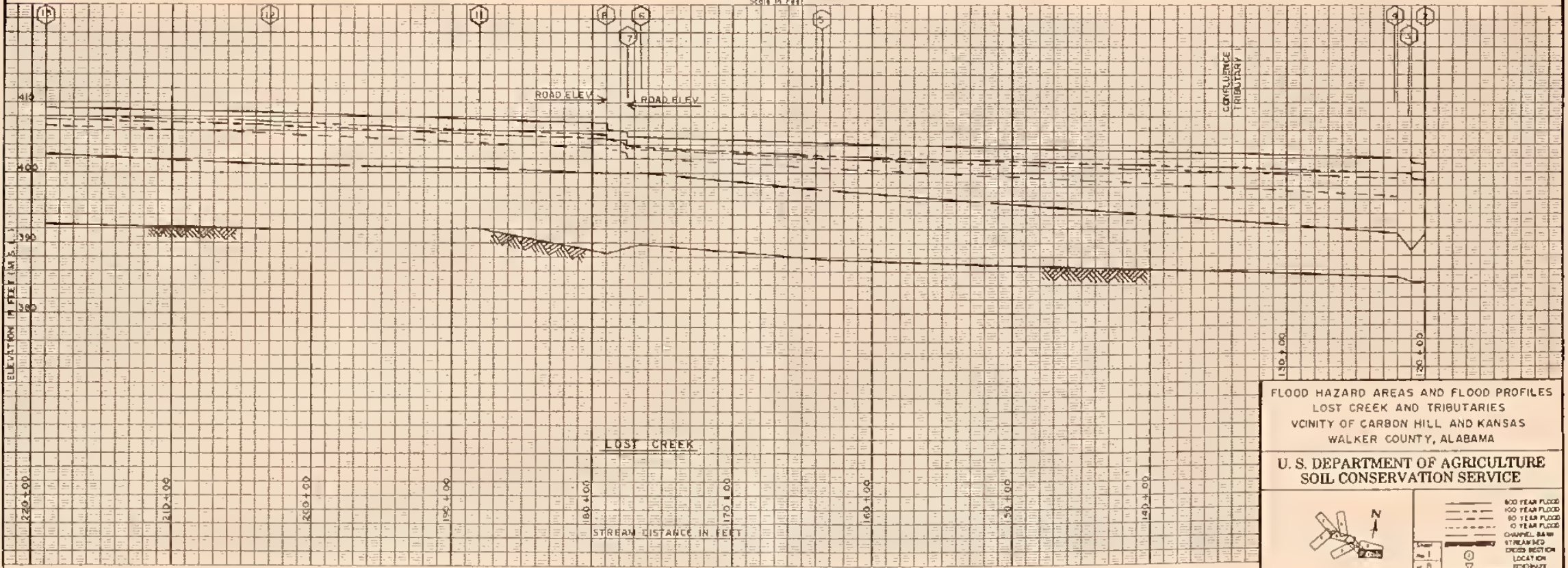


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FLOOD HAZARD AREAS AND FLOOD PROFILES  
 LOST CREEK AND TRIBUTARIES  
 VICINITY OF CARBON HILL AND KANSAS  
 WALKER COUNTY, ALABAMA

U. S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE



- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 10 YEAR FLOOD
- CHANNEL BANK
- STREAM BED
- CROSS SECTION
- LOCATION
- STAKE



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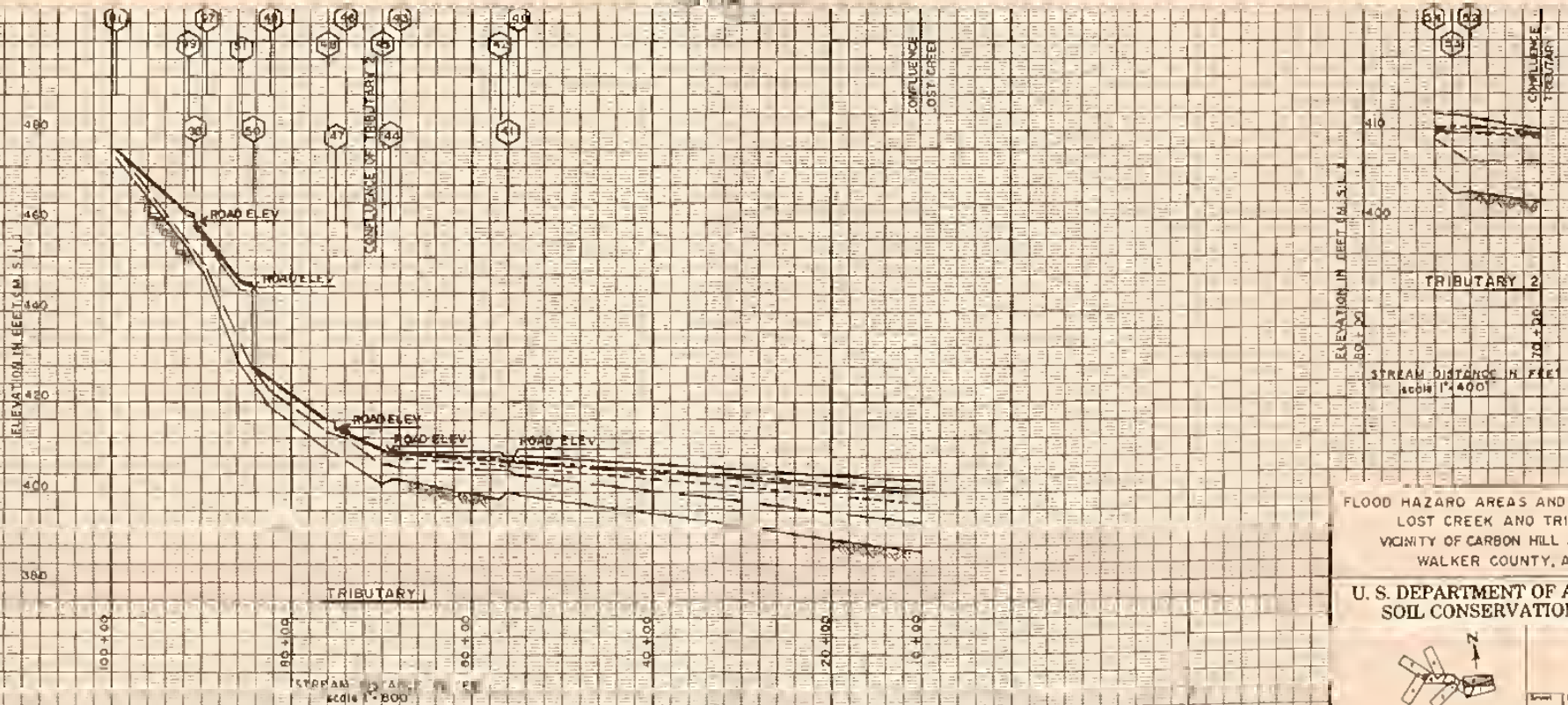


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ASCS PHOTOGRAPHY 1979



FLOOD HAZARD AREAS AND FLOOD PROFILES  
 LOST CREEK AND TRIBUTARIES  
 VICINITY OF CARBON HILL AND KANSAS  
 WALKER COUNTY, ALABAMA

U. S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE



- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- CHANNEL BANK
- STREAMBED CROSS SECTION
- LOCATION

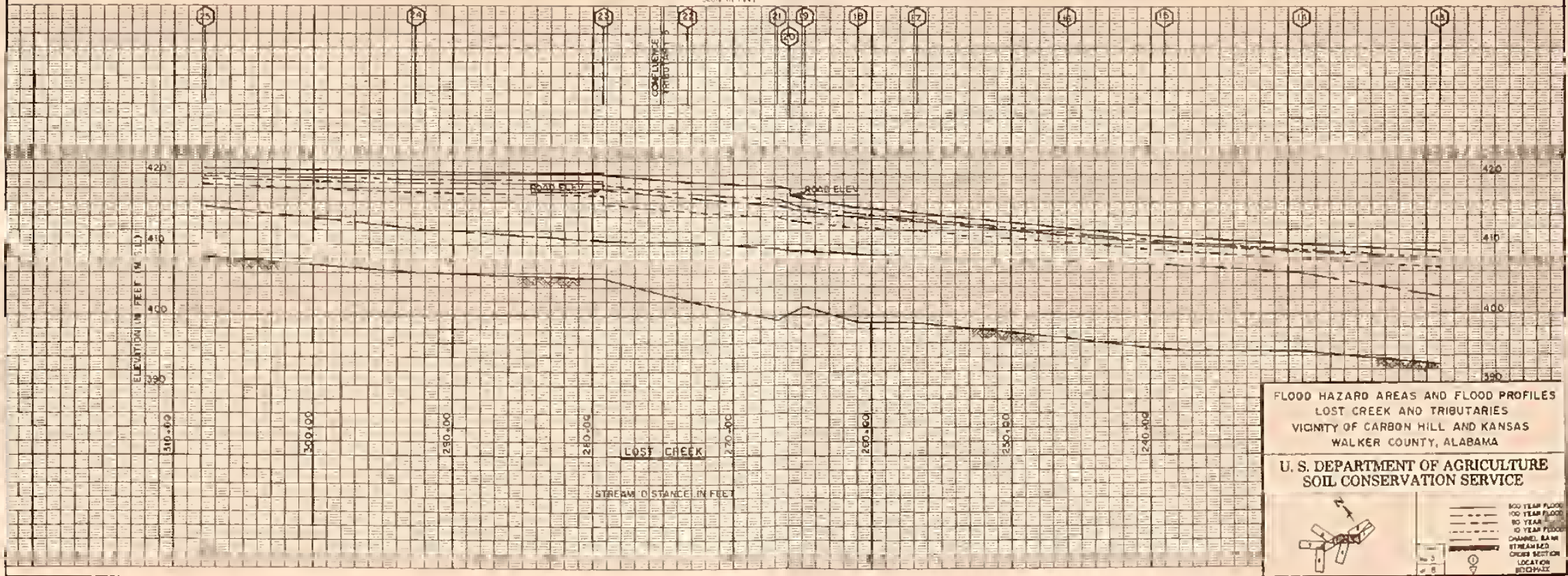






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FLOOD HAZARD AREAS AND FLOOD PROFILES  
 LOST CREEK AND TRIBUTARIES  
 VICINITY OF CARBON HILL AND KANSAS  
 WALKER COUNTY, ALABAMA

U. S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE





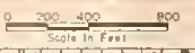
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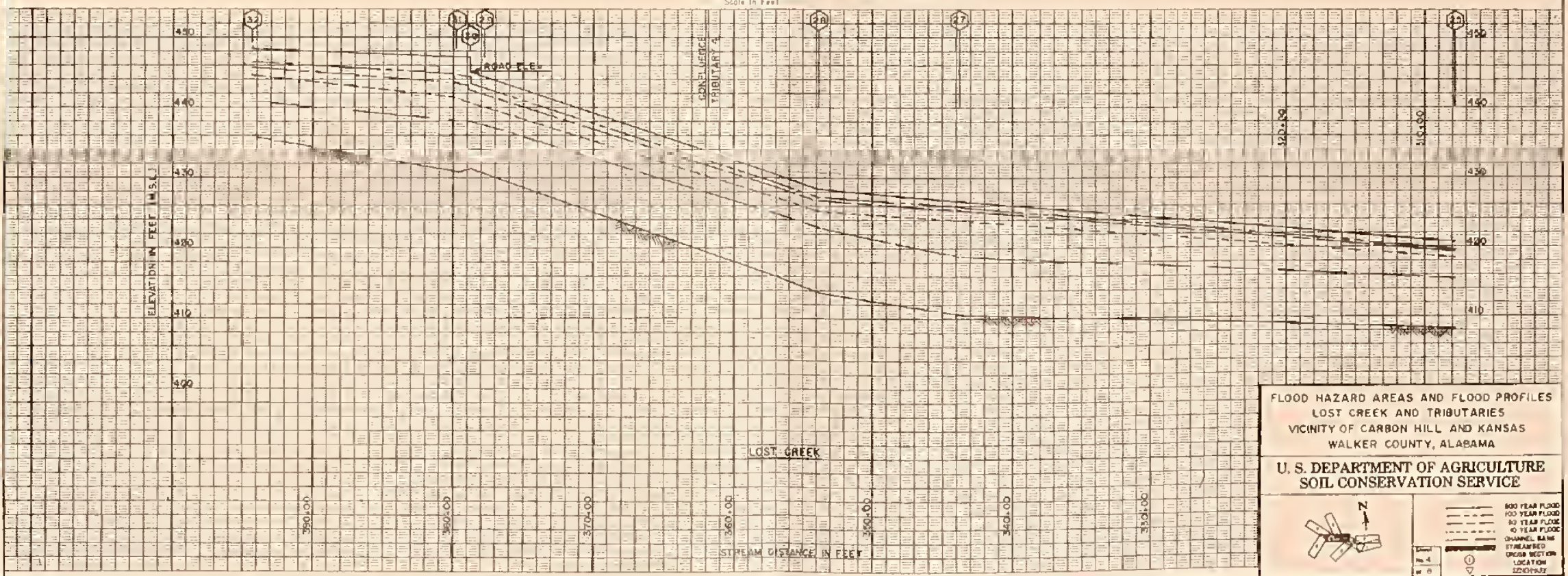
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ASCS PHOTOGRAPHY 1979

Match to Sheet 5



FLOOD HAZARD AREAS AND FLOOD PROFILES  
 LOST CREEK AND TRIBUTARIES  
 VICINITY OF CARBON HILL AND KANSAS  
 WALKER COUNTY, ALABAMA

U. S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE

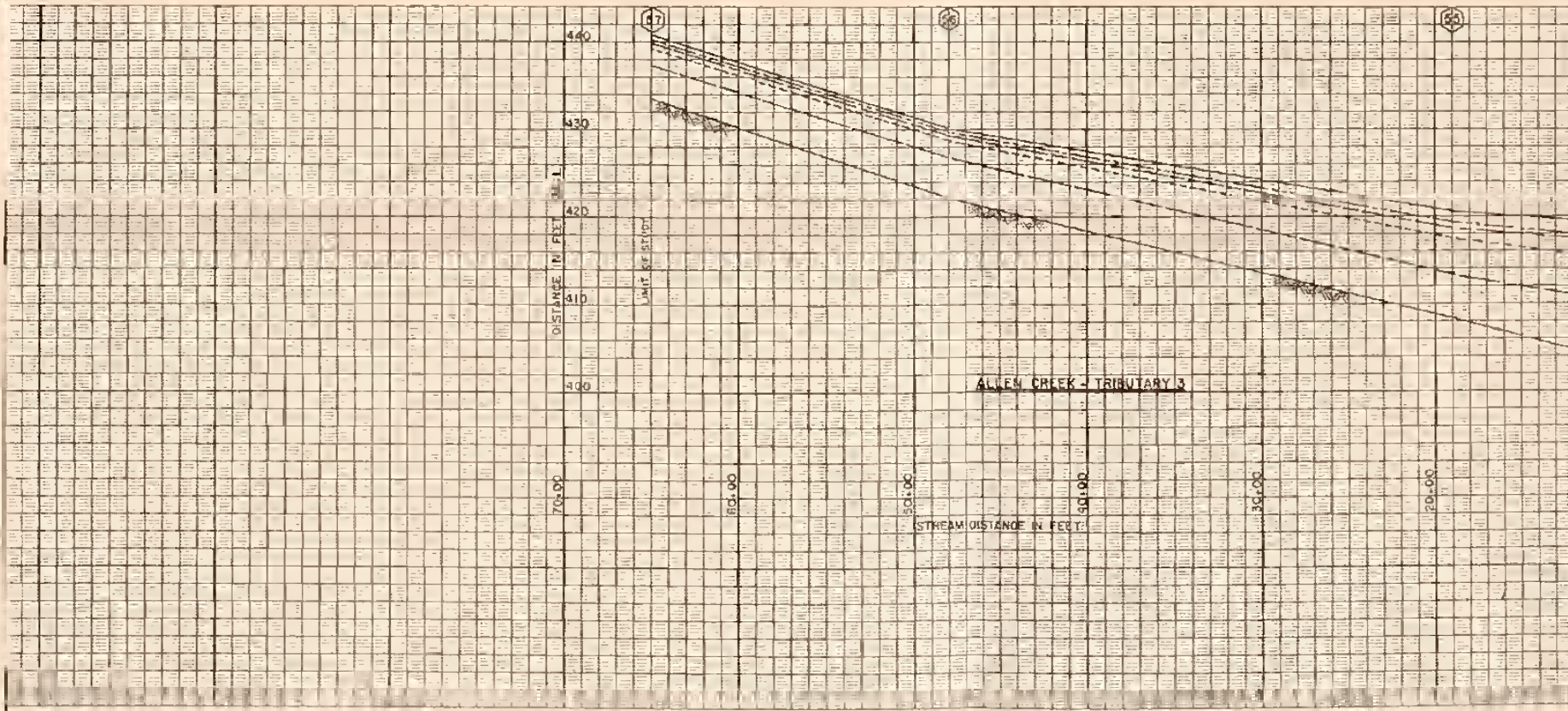


- 100 YEAR FLOOD
- - - 50 YEAR FLOOD
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- CHANNEL BANK
- - - STREAMBED
- CROSS SECTION
- LOCATION
- ▽ ELEVATION





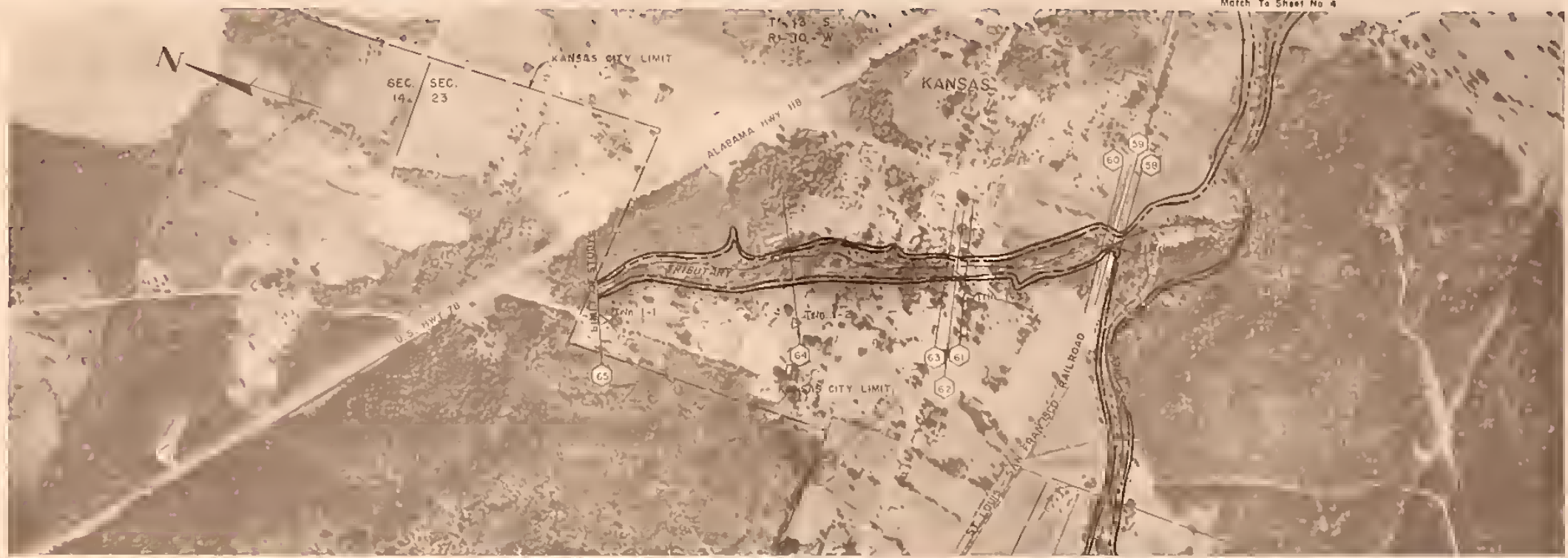
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LOST CREEK AND TRIBUTARIES  
VICINITY OF CARBON HILL AND KANSAS  
WALKER COUNTY, ALABAMA

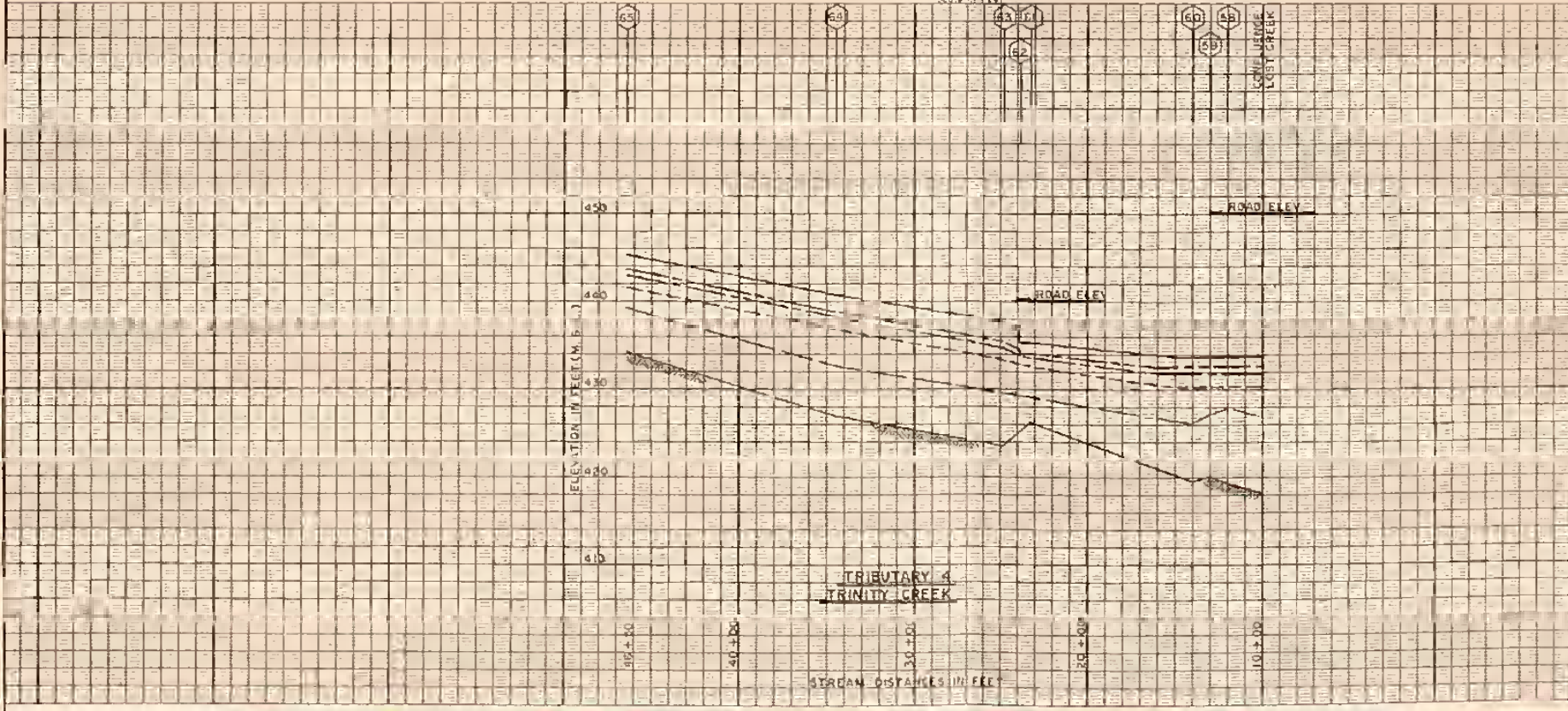
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SOIL CONSERVATION SERVICE





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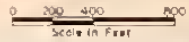
FLOOD HAZARD AREAS AND FLOOD PROFILES  
 LOST CREEK AND TRIBUTARIES  
 VICINITY OF CARBON HILL AND KANSAS  
 WALKER COUNTY, ALABAMA

U. S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE

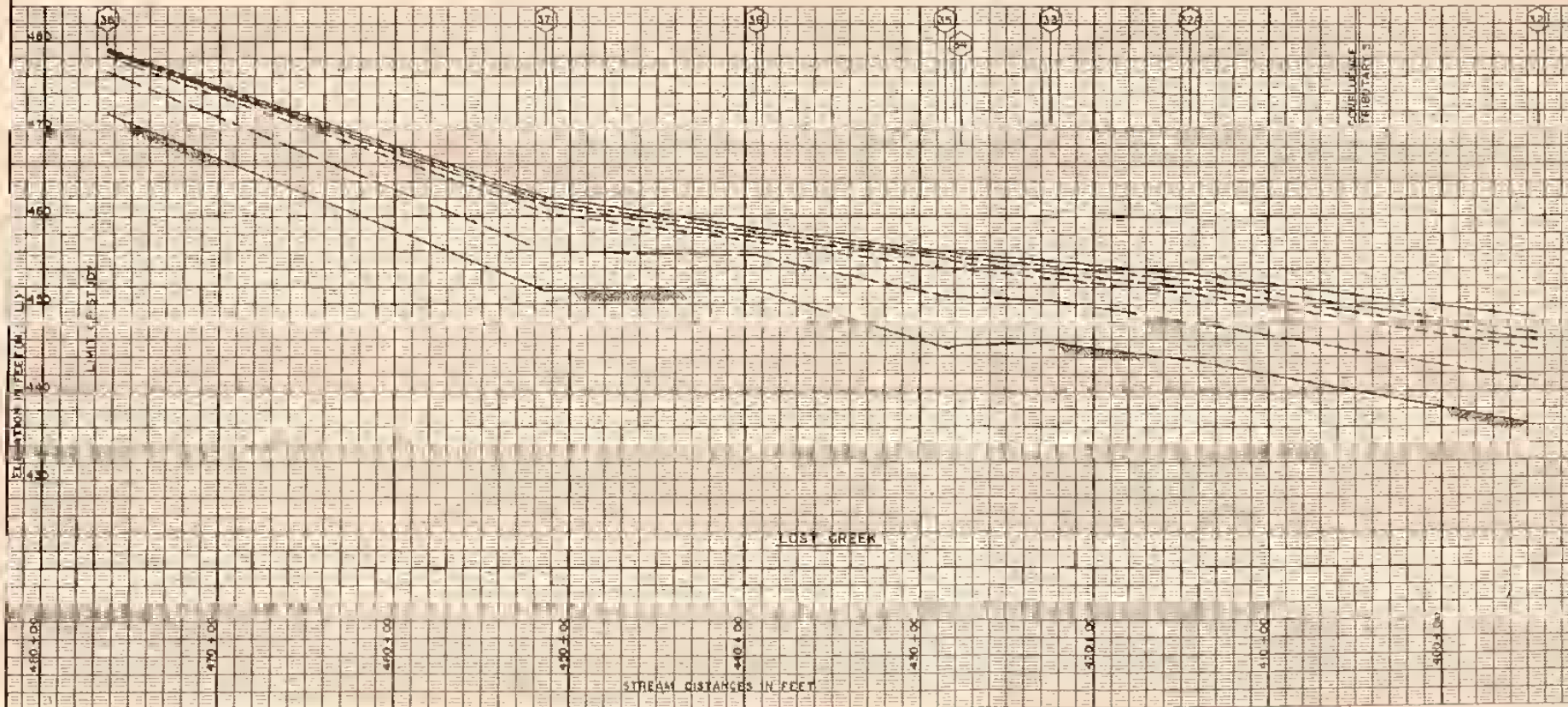
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 CHANNEL BANK  
 STREAM BED  
 CROSS SECTION LOCATION







ASCS PHOTOGRAPHY 1979

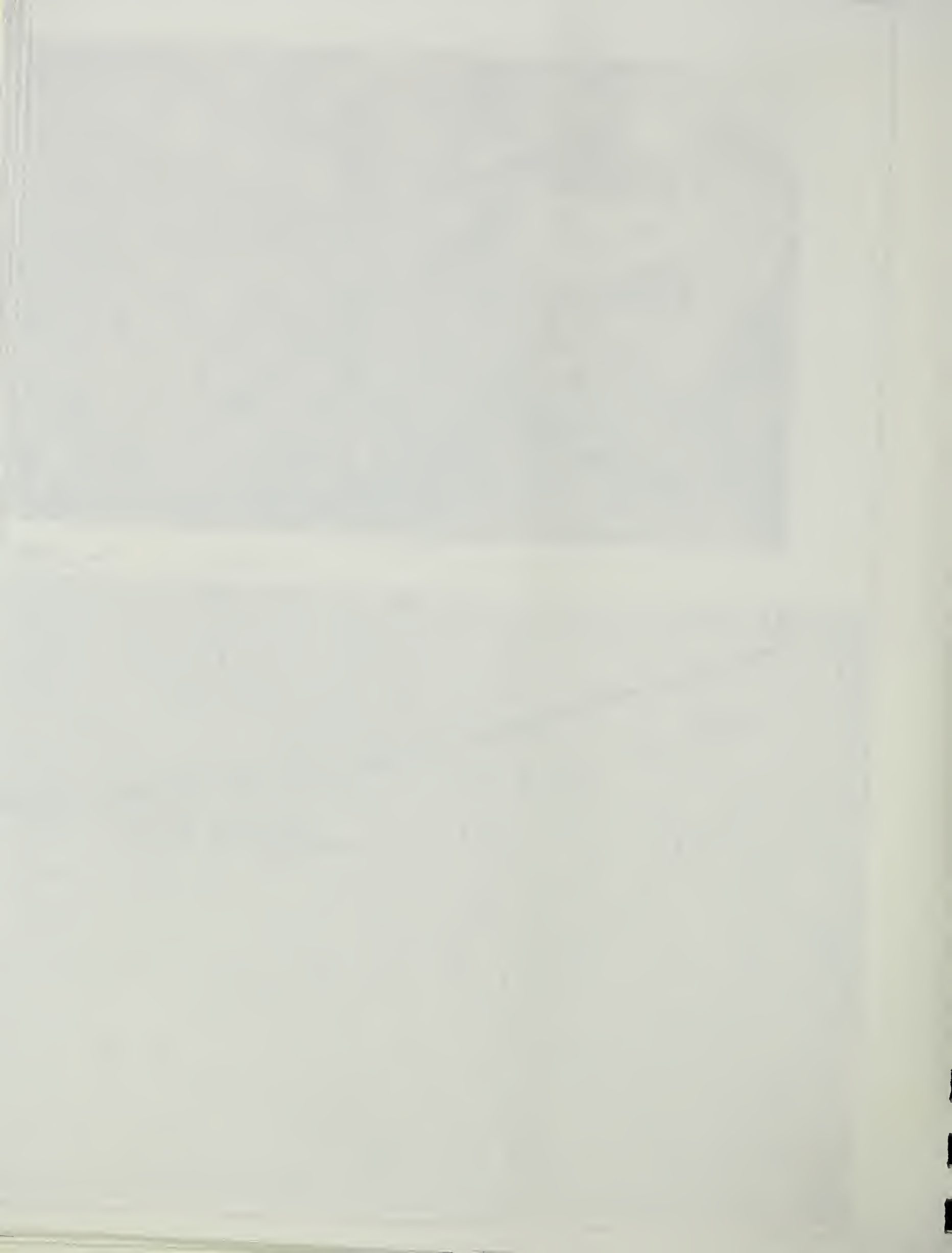


FLOOD HAZARD AREAS AND FLOOD PROFILES  
 LOST CREEK AND TRIBUTARIES  
 VICINITY OF CARBON HILL AND KANSAS  
 WALKER COUNTY, ALABAMA

U. S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE



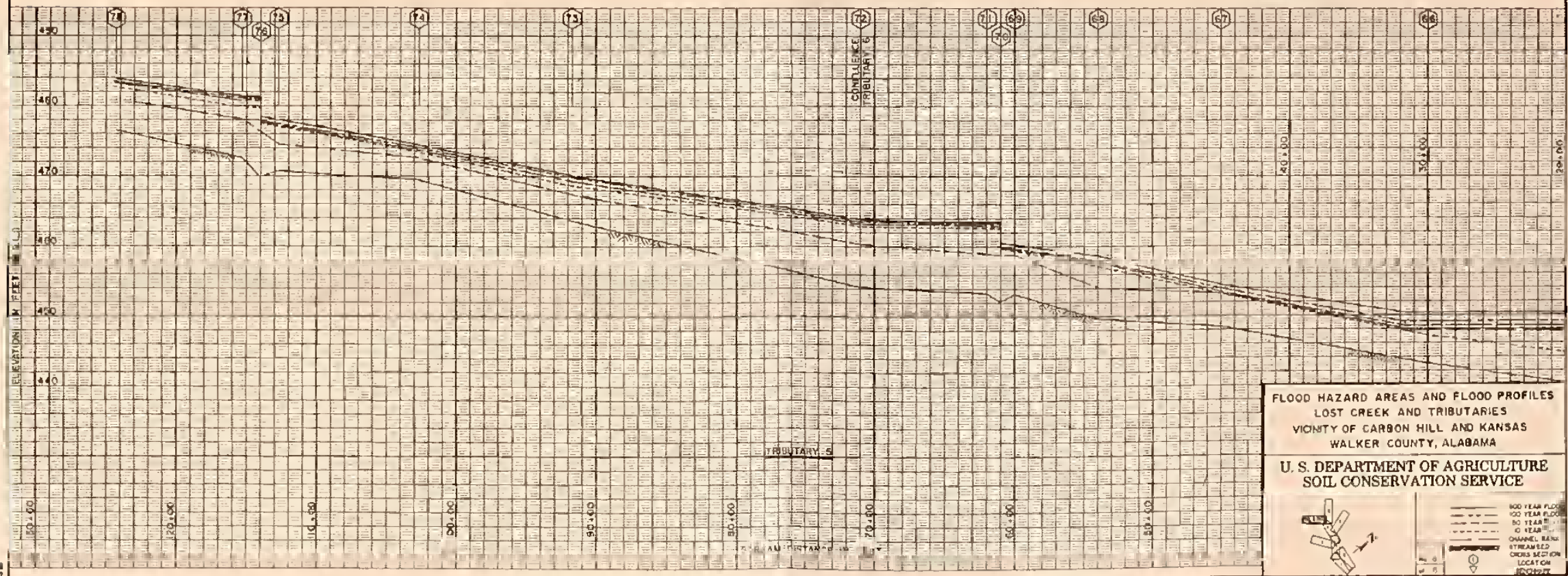
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---	100 YEAR FLOOD
---	50 YEAR FLOOD
---	10 YEAR FLOOD
---	CHANNEL BANK
---	STREAMBED
---	CROSS SECTION
---	LOCATION
---	PROPERTY





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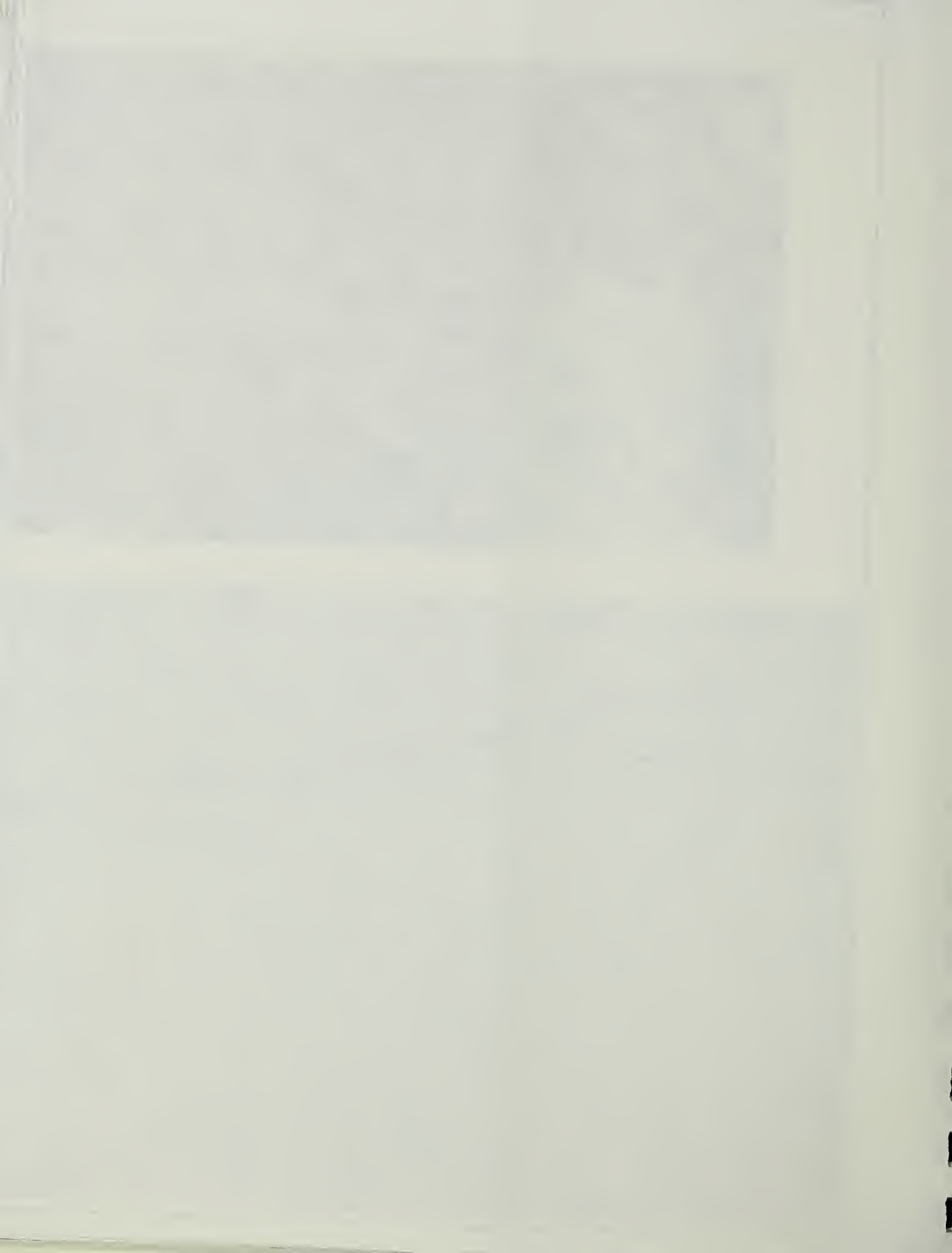


FLOOD HAZARD AREAS AND FLOOD PROFILES  
LOST CREEK AND TRIBUTARIES  
VICINITY OF CARBON HILL AND KANSAS  
WALKER COUNTY, ALABAMA

U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE



100 YEAR FLOOD  
50 YEAR FLOOD  
10 YEAR FLOOD  
CHANNEL BANK  
STREAMBED  
CROSS SECTION  
LOCATION  
PINPOINT



APPENDIX B  
ELEVATION REFERENCE MARKS  
GLOSSARY OF TERMS  
REFERENCES CITED



ELEVATION REFERENCE MARKS

(See Flood Hazard Areas)





TABLE 4  
REFERENCE MARKS  $\frac{1}{-}$

REFERENCE MARK	ELEVATION IN FEET (MSL)*	DESCRIPTION OF LOCATION
USGS B-95	429.599	-- At Carbon Hill, Walker County, on the St. Louis - San Francisco Railway (Burlington Northern), 75-feet south of the station ticket-office, at pole 674/31, and 60-feet south of the centerline of the main track. A standard disk, stamped "B 95 1935" and set in the top of a concrete post.
USGS U-171	422.565	0.5 mile southwest along the Berry road from the St. Louis - San Francisco Railway (Burlington Northern) station at Harbon Hill, Walker County, 12.4-feet northwest of the centerline of the road, at a concrete bridge, in the top of the southwest end of the northwest curb, and about 1-1 $\frac{1}{2}$ feet higher than the road. A standard disk, stamped "U 171 1944."
USGS V-171	447.778	1.6 miles southwest along the Perry road from the St. Louis - San Francisco Railway (Burlington Northern) station at Carbon Hill, Walker County, 15-feet southeast of the centerline of the road, at a large concrete culvert, in the top of the northeast end of the southeast head wall, and about 1/2-foot higher than the road. A standard disk, stamped "V 171 1944."
C-95 (Replaced)	427.87	The point being located on top of the southeast bolt of a railroad light which is located west of the old coal chute. Chute is non-existing. Railroad light is located approximately 100-feet west of a field road crossing. The bench mark replaces C-95 of the Coast and Geodetic Survey.
ALN 1-1	454.46	The point being a nail in the west side of a guy wire to power pole located 25-feet north of centerline of paved road being the Dobbins, Carbon Hill Road. The intersection of Highway 62 and said road is 174-feet southeast.
ALN 1-2	434.73	The point being a nail in the east side of a 20-inch pine tree. The tree is one of three pines growing together. Said tree is the

TABLE 4 (Continued)

REFERENCE MARK	ELEVATION IN FEET (MSL)*	DESCRIPTION OF LOCATION
		southeast tree. Clump of trees are located 33-feet north of the edge of paving of Highway 62, and 300-feet east of a drive to a (gray) brick house. The tree is located on Valley Section #56.
ALN 1-3	415.57	The point being located is on top of the northeast corner of a drop inlet grate. Grate is 1' X 1' in dimension. Grate located 63-feet north of the northeast corner of a garage to the Carbon Hill National Fish Hatchery. Grate is also located 9-feet south of a 36" willow oak tree.
CLMN 1-1	451.79	The point being two horizontal nails in the southwest side of an 8" water oak. Nails approximately 1-foot above ground. Tree located 25-feet west of centerline of paved road and approximately 50-feet south of the east end of Valley Section #51. Tree also located 400 feet south of the intersection of North Poplar Street and 8th Avenue East.
CLMN 1-2	494.91	The point being two horizontal nails in the southwest side of power pole and light pole. Nails approximately 1-foot above ground. Power pole is located approximately 500-feet north of road culvert. Power pole also located 30-feet east of the east edge of pavement, also 30-feet east of Road Section #80.
CLMN 1-3	407.86	The point being a chiseled "X" in the top of a 0.6-foot concrete curb. "X" located 9.4 feet west of the east end of curb. The curb is the north curb for the drive-thru window of Bank of Carbon Hill.
CLMN 1-4	415.09	The point being two horizontal nails in the east side of a power pole. The nails are located 1-foot above ground. The power pole is located on the south side of a paved road, 15-feet off the edge of pavement. Power pole is also located approximately 20-feet west of the west bank of Rocky Branch, also on Valley #48.

TABLE 4 (Continued)

REFERENCE MARK	ELEVATION IN FEET (MSL)*	DESCRIPTION OF LOCATION
CLMN 1-5	414.92	The point being two horizontal nails in the east side of power pole and light pole. The nails are approximately 1-foot above ground. Pole located approximately 14-feet west of edge of paved road and also being located east of a picnic, playground area, also approximately 30-feet east of Valley Section #45.
CLMN 1-6	406.09	The point being two horizontal nails in the southeast side of a power pole. The power pole is located 25-feet east of edge of pavement. Power pole also located approximately 100-feet north of the north end of a steel bridge, also on Valley #40.
LTCR 1-1	482.76	The point being a chiseled "X" on top of the northeast corner of the south of a concrete bridge. The curb extends approximately 1" higher than the road-bridge elevation. Bridge is over Lost Creek on tributary coming out of the south.
LTCR 1-2	462.46	The point being a chiseled "X" on top of the southwest corner of the north abutment to a steel bridge. The abutment is made of concrete and extends out past the width of the bridge. The bridge is located over Lost Creek on Halley's Bottom Road.
LTCR 1-3	479.64	The point being a nail in the east side of a 10" popular tree. The nail is approximately 1" above the ground. The tree is located at the south end of the west edge of a pasture and approximately 35-feet north of the north creek bank. The tree is also located 15-feet west of Valley Section #38, also located 900-feet south of paved road.
LTCR 1-4	468.31	The point being a nail in the east side of an 8-inch pine tree. The nail is approximately 1" above the ground. The tree is also flagged and blazed. The tree is located approximately 150-feet south of the railroad crossing of a paved road. The tree is also located on Valley Section #37.

TABLE 4 (Continued)

REFERENCE MARK	ELEVATION IN FEET (MSL)*	DESCRIPTION OF LOCATION
LTCR 1-5	463.34	The point being a nail in the west side of a 5" pine. The nail is approximately 0.3-foot above the ground. The tree is located on Valley Section #36, 200-feet south of railroad track and approximately 500-feet north of the creek. The pine is blazed and flagged.
LTCR 1-6	471.12	The point being a nail in the top of a pine stump located west of the paved road on Valley Section #66. The stump is located 3-feet high on top of bank above road.
LTCR 1-7	445.36	The point being a nail in the west side of a 30" double-trunk oak, approximately 0.8-foot above the ground. The tree is blazed above the nail. The tree is located on the south bank of Lost Creek and 5-feet north of an old barbed-wire fence. The tree is also located 135-feet west of hedgerow and is located 20-feet left of Valley Section #32.
LTCR 1-8	444.59	The point being a chiseled "X" in the top of the southwest corner of the northwest wingwall of a bridge. The bridge is located over Lost Creek and is approximately 1 mile south from the old U.S. Highway 78 on the Iron Mountain Road.
LTCR 1-9	420.61	The point being 2-horizontal nails in the south side of a 20" walnut tree. The nails are approximately 1-foot above the ground. The tree is located at the end of a dead end street, and 75-feet east of Station 10 + 50 on Valley Section #17.
LTCR 1-11	417.77	The point being on top of ground rod to a power pole. Rod is extended 1.3-feet above ground and runs up the side of the power pole. The rod is located on the east side of the power pole. Power pole located 50-feet south of the centerline of a paved road. Road being parallel and south of railroad track. Road being Frisco Street. Power pole also 210-feet west of the west property line of Drummond Central Warehouse.

TABLE 4 (Continued)

REFERENCE MARK	ELEVATION IN FEET (MSL)*	DESCRIPTION OF LOCATION
LTCR 1-17	409.43	The point being a chiseled "X" on top of the southeast corner of the west concrete abutment to a railroad trestle which is located over Lost Creek. The trestle is located east of town of Carbon Hill.
LTCR 1-18	410.68	The point being a chiseled "X" in the top of the north curb at the southeast corner of U.S. Highway 78 bridge crossing Lost Creek. The bridge is located approximately 1 mile east of the City of Carbon Hill, Alabama in the west bound lane.
LTCR 1-19	403.55	The point being two horizontal nails in the northeast side of a power pole. The pole is located approximately 150-feet south of the new shop building for the Walker County, District 2, Maintenance Facility.
LTCR 1-20	390.63	The point being two horizontal nails in the northwest side of an 8" oak. The tree is located on the north bank of Lost Creek, approximately 100-feet upstream from Road Bridge, and approximately 15-feet east of Valley Section #4.
LTCR 1-21	399.08	The point being a chiseled "X" in the top of the "S" corner of the west bent support. The concrete bent support is located 25-feet east of the west end of the bridge. The bridge is made of steel and is located over Lost Creek, approximately 1 mile northeast of the community of Pocahontas in Walker County.
TRIN 1-1	482.53	The point being a nail in the northeast side of an 18-inch Shogbark Hickory tree, approximately 1-foot above the ground. The tree is located at the inside fork of two paved roads running north from the old U. S. Highway 78 at Kansas, AL, and approximately 700-feet south of the new U.S. Highway 78.
TRIN 1-2	472.24	The point being a nail in the west side of a power pole, approximately 0.3-foot above ground. The power pole is located 30-feet east of the centerline of paved road and approximately 75-feet south of a white with

TABLE 4 (Continued)

REFERENCE MARK	ELEVATION IN FEET (MSL)*	DESCRIPTION OF LOCATION
		half red brick house. The power pole is also located approximately 20-feet north of the west end of Valley Section #64.
TRIN 1-3	439.44	The point being chiseled "X" on top of the north corner of the west abutment of a bridge. The abutment is concrete and is approximately 1-foot lower than the top of the road. The bridge is located on the Old U.S. Highway 78 in Kansas, AL, approximately 0.7 mile west of the new U.S. Highway 78 intersection. The bridge crosses Trinity Creek.
TRIN 1-4	452.27	The point being a chiseled "X" in the top of the west concrete abutment to a railroad trestle. The "X" is at the northwest corner of the abutment. The trestle is located over Trinity Creek in the Town of Kansas, AL. The trestle is also located approximately $\frac{1}{4}$ mile east of the intersection of Iron Mountain Road.

\* Mean Sea Level (MSL)

1/ Locations designated on Flood Hazard Area Photomaps/Flood Profiles (Appendix A, Sheets 1 through 8).

## GLOSSARY OF TERMS

Bridge Area -- The effective hydraulic flow area of a bridge opening accounting for the presence of piers, attached conduits, and skew (alignment), if applicable.

Channel -- A natural or artificial water course of perceptible extent with definite bed and banks to confine and conduct continuously or periodically flowing water.

Flood -- "Flood" or "flooding" means a general and temporary condition of partial or complete inundation of normally dry land areas from:

- (1) The overflow of inland or tidal waters and/or
- (2) The unusual and rapid accumulation of runoff of surface water from any source.

Flood Frequency -- A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative streamflow or rainfall and runoff records. It is customary to estimate the frequency with which specific flood stages or discharges may be equalled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequency," but in practice the term "frequency" is used. The frequency of a particular stage of discharge is usually expressed as occurring once in a specified number of years. Also see definition of "recurrence interval." For example - A 100-year flood is one having an average frequency of occurrence in the order of once in 100 years. It has a 1 percent chance of

being equalled or exceeded in any given year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the general region of the watershed.

Flood Hazard Area -- Synonymous with Flood Plain (general). Used in FEMA National Flood Insurance Program. Commonly used in reference to flood map.

Flood Peak -- The highest stage or discharge attained during a flood event; also referred to as peak stage or peak discharge.

Flood Plain (general) -- The relatively flat area or low lands adjoining the channel of a river, stream, or watercourse; ocean, lake, or other body of standing water which has been or may be covered by floodwater.

Floodway Fringe -- The portion of the flood plain beyond the limits of the floodway. Flood waters in this area are usually shallow and slow moving.

Flood Plain (specific) -- A definitive area within a flood plain (general) or flood-prone area known to have been inundated by a historical flood, or determined to be inundated by floodwater from a potential flood of a specified frequency.

Flood-Prone Area -- Synonymous with Flood Plain (general). Used in Alabama land management and use law.



Flood Profile -- A graph showing the relationship of water surface elevation to stream channel location. It is generally drawn to show the water surface to elevation for the peak of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage -- The elevation of the overflow above the natural banks of a stream or body of water. Sometimes referred to as the elevation and the flood peak elevation measures for a specific storage area.

Floodway -- The channel of the stream and adjacent portions of the flood plain designated to carry the flow of the design flood. In Alabama this is the 100-year frequency flood.

High Water Mark (HWM) -- The maximum observed and recorded height or elevation that floodwater reached during a storm, usually associated with the flood peak. The high water mark may be referenced to a particular building, bridge, or other landmark, or based on debris deposits on bridges, fences, or other evidence of the flood.

Low Bank -- The highest elevation at a specific stream channel cross section at which the flow in the stream can be contained in the channel without overflowing into adjacent overbank areas.

Low Point on Roadway -- The lowest elevation on a road profile usually in the vicinity of where the road crosses the stream. It is the first point on the roadway to be flooded.

Potential Flood -- A spontaneous event (natural phenomenon) capable of occurring from a combination of meteorological, hydrological, and physical conditions; the magnitude of which is dependent upon specific combinations. See Flood and Flood Frequency.

Prime Farmlands -- Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. Land that may qualify as prime farmland could be cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water. It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air.

Recurrence Interval -- The average interval of time expected to elapse between floods of a particular severity based on stage or discharge. Recurrence interval is generally expressed in years and is determined statistically from actual or representative streamflows. Also see definition of Flood Frequency.

Roadway at Crossing (Top) -- The elevation of the roadway immediately above the stream channel. It may be higher than the low point of the roadway.

Runoff -- That part of precipitation which flows across the land and enters a perennial or intermittent stream.

Stream Channel -- A natural or artificial watercourse of perceptible extent, with definite bed and banks to confine and conduct continuously or periodically flowing water.

Stream Channel Bottom -- The lowest part of the stream channel (either in a constructed cross section or a natural channel). Bottom may be plotted and connected to provide a stream bottom profile.

Stream Channel Flow -- That water which is flowing within the limits of a defined watercourse.

Stream Terrace -- A flat or undulating plain bordering a flood plain. Terraces normally occur at higher elevations than flood plains and usually are either free from flooding or flooded less often than once every two years.

Structural Bottom of Opening -- The lowest point of a culvert or bridge opening with a constructed bottom through which a stream flows that could tend to limit the stream channel bottom to that specific elevation. This structural bottom may be covered with sediment or debris which further restricts the size of the opening.

Top of Opening -- The lowest point of a bridge, culvert or other structure over a river, stream or watercourse that limits the height of the opening through which water flows. This is referred to as "low steel" or "low chord" in some regions.

Watershed -- A drainage basin or area which collects and transmits runoff usually by means of streams and tributaries to the outlet of the basin.

Watershed Boundary -- The divide separating one drainage basin from another.

## REFERENCES CITED

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