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March 1993

US Army Corps of Engineers
Waterways Experiment Station

Demonstration Erosion Control Project Monitoring Program

Fiscal Year 1992 Report

Volume I: Main Text

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Prepared for U.S. Army Engineer District, Vicksburg

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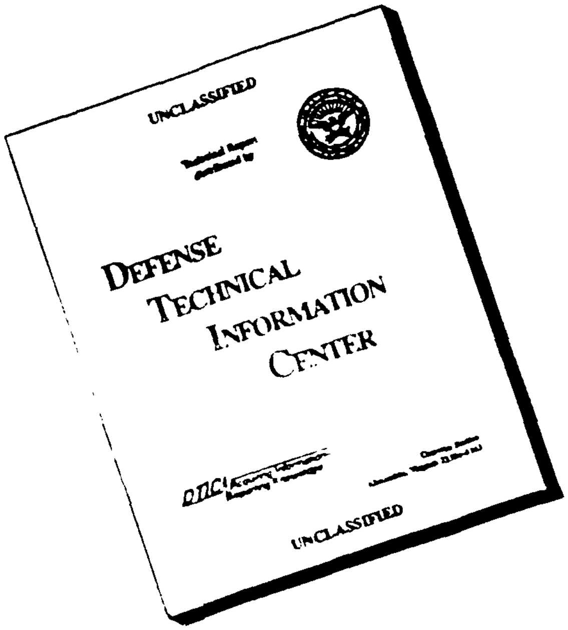

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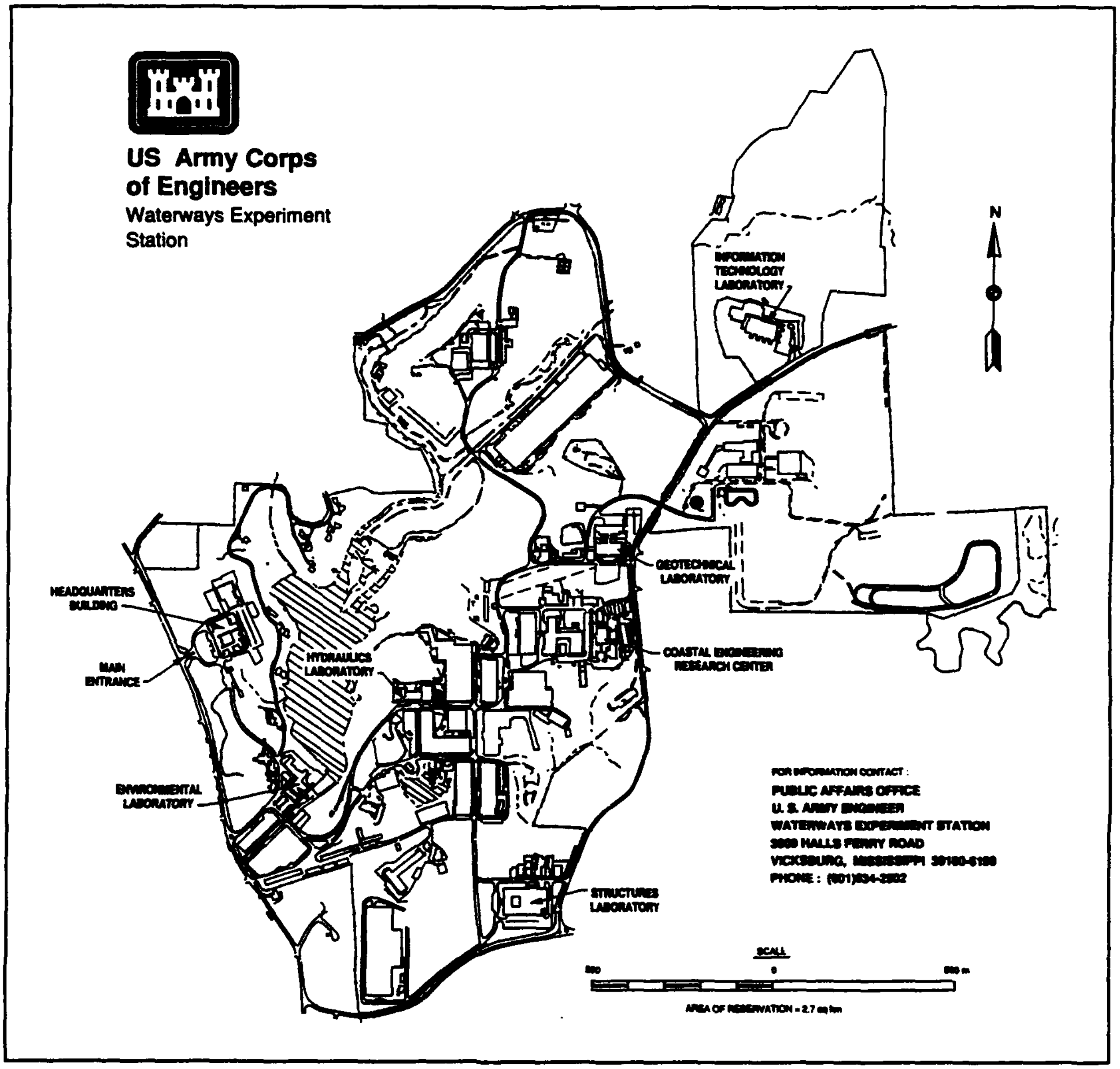

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Contents

Preface

This report discusses work performed by the Hydraulics Laboratory (HL) of the U.S. Army Engineer Waterways Experiment Station (WES) requested and sponsored by the U.S. Army Engineer District (USAED), Vicksburg.

The report was prepared by personnel of the Waterways Division (WD) and Hydraulic Structures Division (HSD), HL, and by the Civil Engineering Department of Colorado State University (CSU), Fort Collins, CO. Appendixes A, B, C, D, and F, prepared by HL personnel, are published as separate volumes. Appendix E, also a separate volume, was prepared by the Civil Engineering Department of CSU.

WES acknowledges with appreciation the assistance and direction of Messrs. Franklin E. Hudson, Life Cycle Program Manager (LCPM), USAED, Vicksburg; Phil G. Combs, Acting Chief, River Stabilization Branch, Engineering Division, USAED, Vicksburg; and Charles D. Little, Hydraulics Section, Hydraulics Branch, Engineering Division, USAED, Vicksburg.

The report was prepared under the direct supervision of Mr. Michael J. Trawle, Chief, Math Modeling Branch (MMB), WD, and under the general supervision of Messrs. Marden M. Boyd, Chief, WD; Glenn A. Pickering, Chief, HSD; R. A. Sager, Assistant Director, HL; and Frank A. Herrmann, Director, HL. This report was prepared by Messrs. Nolan K. Raphelt, Terry N. Waller, David D. Abraham, Billy E. Johnson, and William A. Thomas, Mmes. Sandra K. Martin and Lisa C. Hubbard, and Dr. Bobby J. Brown, HL: Drs. Chester C. Watson and Steven R. Abt, CSU; and Dr. Colin R. Thorne, University of Nottingham, Nottingham, England, under contract to CSU.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Leonard G. Hassell, EN.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
acres	4,046.873	square meters
degrees (angle)	0.01745329	radians
cubic feet	0.02831685	cubic meters
feet	0.3048	meters
inches	25.4	millimeters
miles (U.S. statute)	1.609347	kilometers
pounds (mass)	0.4535924	kilograms
pounds (mass) per cubic foot	16.01846	kilograms per cubic meter
square miles	2.589998	square kilometers

Summary

The authorized plan for the Demonstration Erosion Control (DEC) Project in the Yazoo Basin, Mississippi, provides for the development of a system for control of sediment, erosion, and flooding in the foothills area of the basin. The area's 15 watersheds are Abiaca Creek, Batupan Bogue, Black Creek, Burney Branch, Cane-Mussacuna Creek, Coldwater River, Hickahala-Senatobia Creek, Hotophia Creek, Hurricane-Wolf Creek, Long Creek, Otoucalofa Creek, Pelucia Creek, Sherman Creek, Toby Tubby Creek, and Town Creek (Charleston).

Public Law 98-8, the Emergency Jobs Appropriation Act of 1982, provided for the initial authorization of the DEC Project as a cooperative effort through the U.S. Department of Agriculture (USDA) Soil Conservation Service. Public Law 98-50, the Energy and Water Development Appropriation Act for Fiscal Year (FY) 1984, further directed joint effort by the U.S. Army Corps of Engineers and Soil Conservation Service for the foothills area of the Yazoo Basin. Public Law 99-662, the Water Resources Development Act of 1986, specified that the DEC Project was authorized by Public Law 98-8, and further directed that the DEC Project was exempt from the cost-sharing requirements of Public Law 99-662.

To assist in the evaluation of the performance of erosion control features installed as part of the DEC Project, the Hydraulics Laboratory (HL) of the U.S. Army Engineer Waterways Experiment Station (WES) initiated a comprehensive monitoring program in July 1991. The WES portion of the DEC monitoring program is designed as a multiyear program planned through FY 1997. The components of the monitoring program, including the design and implementation of an engineering database, development of evaluation procedures and design tools, and all field data collected through June 1992 are presented in detail in this report.

The field data collected through June 1992 for hydraulic structures monitoring included stage measurements at 29 continuous recording gauges and 33 crest gates, located in 9 DEC watersheds (Black River, Abiaca Creek, Coldwater River, Hickahala-Senatobia, Burney Branch, Hotophia Creek, Otoucalofa Creek, Batupan Bogue, and Long Creek). Also, detailed channel geometry data were collected at 20 sites in 9 DEC watersheds (Black Creek, Abiaca Creek, Coldwater River, Hickahala-Senatobia, Burney Branch, Hotophia Creek,

Otoucalofa Creek, Batupan Bogue, and Long Creek), representing the initial survey in a series of semiannual surveys designed to evaluate long-term channel response to changes in hydrologic and hydraulic regime.

The engineering database/Geographic Information System (GIS) being used in the DEC monitoring program to manage the large amount of data being assembled is based on Intergraph hardware and software. As of June 1992, the database includes the locations of all existing Corps low-drop and high-drop structures, bank stabilization works, levees, floodwater-retarding structures, and riser pipe structures in all 15 DEC watersheds. The database contains digital elevation models (DEM) for all 15 DEC watersheds. The database also includes aerial photos (registered to state plane coordinates) for one watershed (Coldwater River) and Spot-view satellite photography for four other watersheds (Black, Hickahala-Senatobia, Cane-Mussacuna, and Hurricane-Wolf). Land use data on 1-acre grids are in the database for five watersheds (Coldwater, Hickahala-Senatobia, Long, Cane-Mussacuna, and Hurricane-Wolf). The database contains all major tributaries and highways for all 15 watersheds. Soil grid data for one watershed (Coldwater River) are in the database.

Detailed geomorphic studies were conducted on three watersheds using survey data from 1985 and 1991. The surveys consisted of channel profiles and cross sections made at half-mile intervals. The surveys were used to assess channel changes from 1985 to 1991. Channel profiles were compared to determine zones of aggradation or degradation. Channel cross sections were compared to determine width and depth changes. Finally, the channel geometries were applied to the HEC-2 computer model to evaluate changes in hydraulic parameters resulting from the channel changes between 1985 and 1991. In addition, a broad-based geomorphic assessment was conducted using aerial reconnaissance videos on all 15 watersheds.

An Intergraph-based procedure (design tool) that takes advantage of the engineering database/GIS was developed to support the U.S. Army Engineer District, Vicksburg, hydraulic design of riser pipes. The procedure automates a number of the steps previously done manually, resulting in significant reduction in the time required to conduct the hydraulic design for riser pipes. As of June 1992, the procedure was available for application in the Coldwater River basin.

A design procedure for stabilizing incised channels (design tool), based on the computer program "Hydraulic Design for Channels," SAM, was developed and tested on a DEC watershed (Long Creek). The test application consisted of evaluating the effectiveness of low-drop structures in stabilizing the stream channel against further degradation. The proposed procedure has merit in assisting the engineer in designing structural solutions that have the potential for long-term beneficial impact in reducing channel degradation and streambank erosion.

To initiate the evaluation of the hydraulic performance of selected structures, two high-drop structures (on Hotophia Creek and Burney Branch watersheds) and four low-drop structures (one on Long Creek and three on Batupan Bogue watersheds) were instrumented to collect stage data just upstream and downstream of the structure. Once sufficient data are collected, factors to be evaluated include discharge coefficients, energy dissipation, flow distribution, and effect of submergence on performance.

The potential for bendway weirs as streambank protection in DEC watersheds was tested using a physical model. The bendway weir concept was previously developed on a WES movable-bed model study of reaches on the Mississippi River. Since in those previous studies the weirs redistributed the movement of water and sediment through bendways, the idea that bendway weirs may prove beneficial in bank protection by reducing outside-bend velocities was logical. Even though the model study was limited in scope, testing only a few options, enough was learned to design a reasonable application for a field demonstration of the bendway weir concept.

Another model study was initiated to investigate the feasibility of a sheet-pile grade control structure with a 10-ft drop. Current design criteria for a sheet-pile grade control structure limit the drop height to 6 ft. The purpose of this study is to modify and/or develop guidance regarding both the hydraulic design and the stable riprap design to accommodate a 10-ft drop structure.

The results and conclusions of each part of the monitoring program for FY 92 are described in this report.

1 Introduction

Background

The Demonstration Erosion Control (DEC) Project provides for the development of a system for control of sediment, erosion, and flooding in the foothills area of the Yazoo Basin, Mississippi (Figure 1). Structural features used in developing rehabilitation plans for the DEC watersheds include high-drop grade control structures similar to the Soil Conservation Service (SCS) Type C structure; low-drop grade control structures similar to the Agricultural Research Service (ARS) low-drop structure; pipe drop structures; bank stabilization, which includes riprap, longitudinal and transverse dikes, and riprap bank protection; and a combination of retention and detention reservoirs. In addition, other features such as levees, pumping plants, land treatments, and developing technologies may also be utilized.

Evaluation of the performance of these erosion control features can contribute to the improvement and development of design guidance. Most of the previous Yazoo Basin evaluation has been limited to single-visit data collection, with no comprehensive monitoring of the structure or the effect of the structure on channel stability. The portion of the DEC Monitoring Program being conducted by the Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station (WES), is a multiyear program initiated in late Fiscal Year (FY) 1991 and planned through FY 97. To fully document the impacts of the DEC project will require more than 6 years. A monitoring plan for the DEC project after FY 97 will be provided at the appropriate time.

Objective

The purpose of monitoring is to evaluate and document watershed response to the implemented DEC Project. Documentation of watershed response to DEC Project features will allow the participating agencies a unique opportunity to determine the effectiveness of existing design guidance for erosion and flood control in small watersheds.

The objective of this report is to document the WES monitoring activities during the period from March 1991 through May 1992.

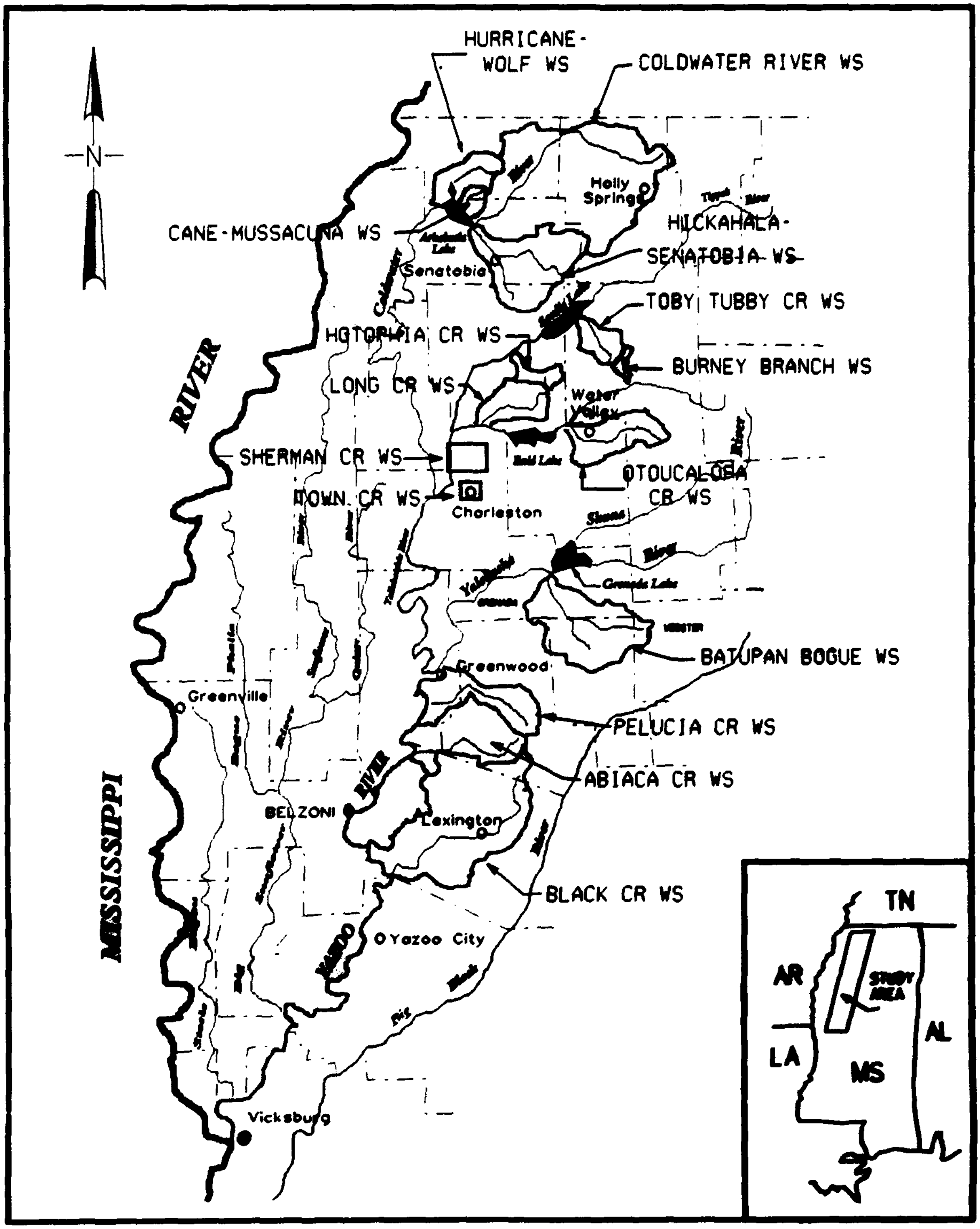


Figure 1. Vicinity map of DEC watersheds

Approach

To provide the information necessary for the effective evaluation of the DEC Project, the DEC Monitoring Program includes eleven technical areas that address the major physical processes of erosion, sedimentation, and flooding:

a. Stream gauging.

b. Data collection and data management.

c. Hydraulic performance of structures.

d. Channel response.

e. Hydrology.

f. Upland watersheds.

g. Reservoir sedimentation.

h. Environmental aspects.

i. Streambank stability.

j. Design tools.

k. Technology transfer.

The WES portion of the monitoring program has primary responsibility for all technical areas except stream gauging and environmental aspects. The primary responsibility for these technical areas rests with the U.S. Geological Survey (USGS) and ARS, respectively.

Technical Area Descriptions

The following is a general description of the work being performed by WES in the nine technical areas.

Data collection and data management

The purpose of the data collection and data management technical area is to assemble, to the extent possible, all data that have been accumulated to date in the DEC Project, and develop an engineering database that will be periodically updated as new monitoring data are collected and analyzed. The database resides on an Intergraph workstation, and access to the database is made user-friendly with Intergraph software. The database is available to all participants in the monitoring program to provide for analysis and evaluation of the various elements of the DEC Project. In addition to the extensive hydraulic and sedimentation data being collected in the monitoring program, the database contains survey data, aerial photography, conventional photography, USGS digital elevation grids, USGS quadrangle maps, watershed development master plans, project feature designs and specifications, trip reports and field observations, study reports by others, and all reports and professional papers published as a result of the monitoring program.

Hydraulic performance of structures

Six grade control structures were selected for detailed data collection to evaluate hydraulic performance. The structures were selected on the basis of special features, including high drop, low drop, significant upstream flow constriction, limited upstream flow constriction, free flow, and submerged flow. The structures were instrumented to collect data to evaluate discharge coefficients, energy dissipation, flow velocity distribution, and effects of submergence on performance. All riprap bank stabilization measures in each watershed will be visually monitored and problem areas identified. A minimum of three riprap bank stabilization installations including riprap blanket revetment, riprap toe protection, and riprap dikes were selected to evaluate toe and end section scour. Data are being collected during runoff events to measure magnitude and location of maximum scour and the corresponding hydraulic parameters. This technical area also includes the construction of a physical model of a low-drop structure. The model is being used to determine if cost reduction modifications can be made to the low-drop structure design that either maintain or enhance performance characteristics.

Channel response

The channel response monitoring is directed toward two major areas: channel sedimentation and channel-forming discharge. Monitoring for channel sedimentation includes an annual geomorphic update of selected watersheds. In addition to the geomorphic update, 20 sites where structures exist or are anticipated were selected for intensive monitoring over the life of the program. Channels upstream and downstream of the selected structures are being monitored for cross-section changes, thalweg changes, berm formation, bank failure, and vegetation development. Five additional sites where no structures are planned are also being monitored. These five sites serve as a control group and assist in the evaluation of channel response to structures. Photo documentation of structures and channels is being conducted and included in the database. A subset of these structures and channels is being instrumented for stage, discharge, suspended sediment concentration, and bed-load material measurements. The numerical sediment transport model HEC-6 and the new computer program SAM (Thomas et al., in preparation) are being used to predict the stability of channels monitored by this work effort. Also, the DEC watersheds are providing data that will be used to test design procedures and techniques for the channel-forming discharge concept. Successful development of such channel-forming discharge methodology could result in significant design cost savings for the DEC project.

Hydrology

Rainfall provides the energy to sustain erosional processes. The ability to measure rainfall and compute runoff accurately is crucial in the design of stable flood control channels. Accurate flow rates are needed to design functional project features properly and maintain stability in the channel system. HEC-1 hydrologic models of a selected number of watersheds are being developed. Hydrologic modeling and hydraulic structures monitoring are being coordinated so that hydrologic parameters used in HEC-1 can be determined at locations in the watersheds where USGS gauging stations do not exist.

Upland watersheds

ARS has been given the primary responsibility for this technical area. WES was not active in this area during FY 92. The two items related to the upland watersheds to be monitored by ARS are system sediment loading (sediment yield) and sediment production from gully formation. Stabilization measures being installed to reduce upland erosion will be monitored by ARS over the next 5 years to determine if a measurable change in the quantity of sediment being transported from watersheds occurs. Data already collected by USGS and ARS over the past 5 years will be analyzed and interpreted by ARS to serve as the base for future comparisons. Future plans include the numerical modeling of sediment runoff from watersheds by WES as part of the analysis and interpretation process. Also, sediment production from two or three active gullies will be analyzed by ARS by comparing surveys made prior to the design of drop pipes and the survey made just prior to construction of the drop pipes.

Reservoir sedimentation

The major sources of reservoir deposition are upland erosion, erosion of the channel banks, and erosion of the channel bed. The reduction of the inflowing sediment load is being addressed in the channel response, bank stability, and upland watershed technical areas. Starting in FY 94, WES will use the results of the analysis performed in these areas to determine the effects of the project on reservoir sedimentation.

Streambank stability

Streambank stability depends on hydraulic parameters related to flow conditions and the characteristics of the materials in the banks. All channels will be visually monitored on a periodic basis to determine reaches that are experiencing severe bank stability problems. In addition to the overall visual monitoring, five sites where aggradation is occurring and five sites where bank caving is occurring were selected for detailed monitoring. At the selected sites, surveys of closely spaced sections will be made semiannually to document changes. After sufficient data have been collected, numerical models such as the USGS BRI-STARS will be applied to determine if existing numerical techniques can be adapted to predict bank stability and/or bank failures accurately.

Design tools

The procedures and techniques used in the design of the different features of the DEC Project have the potential for national and international applications. Effective application of these design procedures and techniques may require development of computer-based packages and the validation of numerical models such as HEC-1, HEC-6, and SAM. In conjunction with ongoing research, WES is developing design tools specifically targeted for the planning and design of stable flood control projects.

Technology transfer

Technology transfer is an important part of the DEC Project and will be given high priority at WES during the life of the monitoring program. When appropriate, WES personnel will present results at national and international technical conferences and symposiums. When appropriate, WES personnel will host workshops and training classes for both Corps and non-Corps personnel. WES will annually report on the DEC monitoring program using several different formats. For FY 92, these include the following:

a. A video report on channel degradation processes.

b. An updated engineering database on the Intergraph system including aerial photos, surveys (channel and structural), results of numerical studies, etc.

c. A short executive summary report.

d. A detailed WES technical report on monitoring, data collection, data analysis, and project evaluation.

2 Engineering Database

Approach

The purpose of the engineering database/Geographic Information System (GIS) is to serve as a repository for all design, analysis, and monitoring data collected on the DEC Project. The engineering database/GIS concept was chosen for the DEC Project because it allows for the storage, retrieval, analysis, and graphical display of all data. When completed, it is anticipated that the database will contain design data for all project features such as low- and high-drop structures, bank stabilization structures, flood water retarding structures, channel improvements, levees, riser pipes, and box culverts. Every effort will be made to include data from all participating agencies in the DEC project.

The database will contain an index of all studies, analyses, and published reports for the DEC Project. Important or significant reports from the index list will be incorporated as documents into the database. The database will be tied to the GIS system for graphical display of the data. The Informix relational database will be used to store the data, which will allow analysis of project features when desired. In addition to the Informix relational database, the Hydrologic Engineering Center's (HEC's) data storage system, HECDSS, will be embedded in the engineering database/GIS. The HECDSS database will contain stage, discharge, and cross-section data and will serve as a base for running numerical models. It is anticipated that HEC-1, HEC-2, and, later in the project, three-dimensional hydraulic models will run from data stored in the database. The database will also contain soil type or soil group data, land use, and SCS curve numbers on a 1-acre[1] grid for all of the DEC watersheds. This will make the database a valuable source for hydrologic data. The 1:24,000 digital quadrangle maps, digital elevation models (DEM's), will be incorporated into the engineering database for all the DEC watersheds. Initially, streams and roads from the 1:100,000 USGS digital line graphs will be incorporated into the database. As the 1:24,000 Digital Line Graph (DLG) data become available, they will be added to the database. Satellite photography will be incorporated into the database and will be used as a visual

[1] A table of factors for converting non-SI units of measurement to SI units is found on page vii.

reference for all project features. In addition to the satellite photographs, photographs from the U.S. Army Engineer District, Vicksburg, will be incorporated into the database on an as-needed basis. These photographs will serve to give more detailed data than the satellite photographs.

Computer Hardware and Software

The engineering database/GIS is being developed on the Intergraph 6040 workstation. The engineering database/GIS uses a number of MGE products. MGE is the umbrella under which Intergraph's GIS and database management software run. Software used in the system includes the Microstation software package. Microstation capabilities include computer-aided drafting and design (CADD), editing and placement of project features, editing and drawing on project features, and design and development of new design files. Also under MGE are IRAS-32 for imaging processing, IVEC for vectorization of scanned data, and Grid Analysis. Grid Analysis is used to develop grids for soil type, land use, slope, and elevation. Imager is used for image processing. Imager is also used with Grid Analysis for the hydrologic studies. MGE Terrain Modeler and a number of MGE translator programs translate DLG and DEM data into the Intergraph format. It is anticipated two additional Intergraph pieces of software will become important in the database. The DBX software will be used for document storage and retrieval, and the Inroads program will be used to store terrain model data and survey data, develop HEC decks for two- and three-dimensional models, and monitor surveys and changes in cross sections and survey areas. The HEC database will be used for storage of stage discharge and cross-section data.

Status

As of 1 June 1992, the engineering database consisted of the locations and design parameters for all construction existing in FY 92 by the U.S. Army Corps of Engineers for riser pipe, low-drop, and high-drop structures; bank stabilization; and box-culvert grade control structures. Locations of proposed and constructed levees, floodwater retarding structures, and channel improvement and box control structures are also in the database. These structures are listed in Tables 1-9.[1] The database contains DEM's by quadrangle maps for the 15 DEC watersheds. Most of the area is covered by 1:24,000 DEM's. In a few locations, the 1:250,000 DEM data are used because the 1:24,000 DEM data do not exist at this time. Aerial photos taken by the Vicksburg District are registered to state plane coordinates and are in the database for the

[1] Copies of maps of these watersheds are available from the U.S. Army Engineer Waterways Experiment Station, ATTN: CEWES-HR-M, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199. The maps are also available in the DEC database, which is accessible by both WES and the Vicksburg District.

Coldwater River basin. Spot-View satellite photography is in the database for the Black, Hickahala-Senatobia, Cane-Mussacuna, and Hurricane-Wolf basins. Land use data are provided by the Vicksburg District for the Coldwater basin, and ARS land use data for Hickahala-Senatobia, Long, Hurricane-Wolf, and Cane-Mussacuna basins are incorporated into the database on a 1-acre grid. The database contains all major tributaries and highways for the 15 DEC watersheds. The 1:100,000 digital DLG files are the source of the stream and highway data. Soil grid data for the Coldwater watershed are in the database. Soil group data for the Black, Hickahala-Senatobia, Long, Hurricane-Wolf, and Cane-Mussacuna watersheds are presently being collected for inclusion into the database.

3 Channel Response, Semi-annual Survey of 20 Long-Term Sites

In December of 1991, field monitoring of 20 DEC stability sites was begun. The locations of the watersheds containing the 20 study sites are shown in Figure 2. This report gives a summary of the first 6 months of the monitoring effort.

Objectives

The objectives of the field monitoring program and related analyses are to continue to monitor, document, and interpret the response of DEC channels to changes in the hydrologic and hydraulic regime, to monitor structure conditions, and to analyze the changes in bank stability. The primary objective of the work is to assist in developing improved design guidance for the DEC Project. The database will include survey and other data for 20 sites. Several areas of interest are being addressed in the program:

a. Development of the basic understanding of the physical principles involved in assessing channel bank stability as the stream channel aggrades.

b. Defining the effective discharge and channel-forming or dominant discharge in channel stabilization.

c. Determining the effect of grade control on channel planform.

d. Determining the temporal and spacial effectiveness of grade control.

e. Determining the effect of channel rehabilitation on flood wave attenuation.

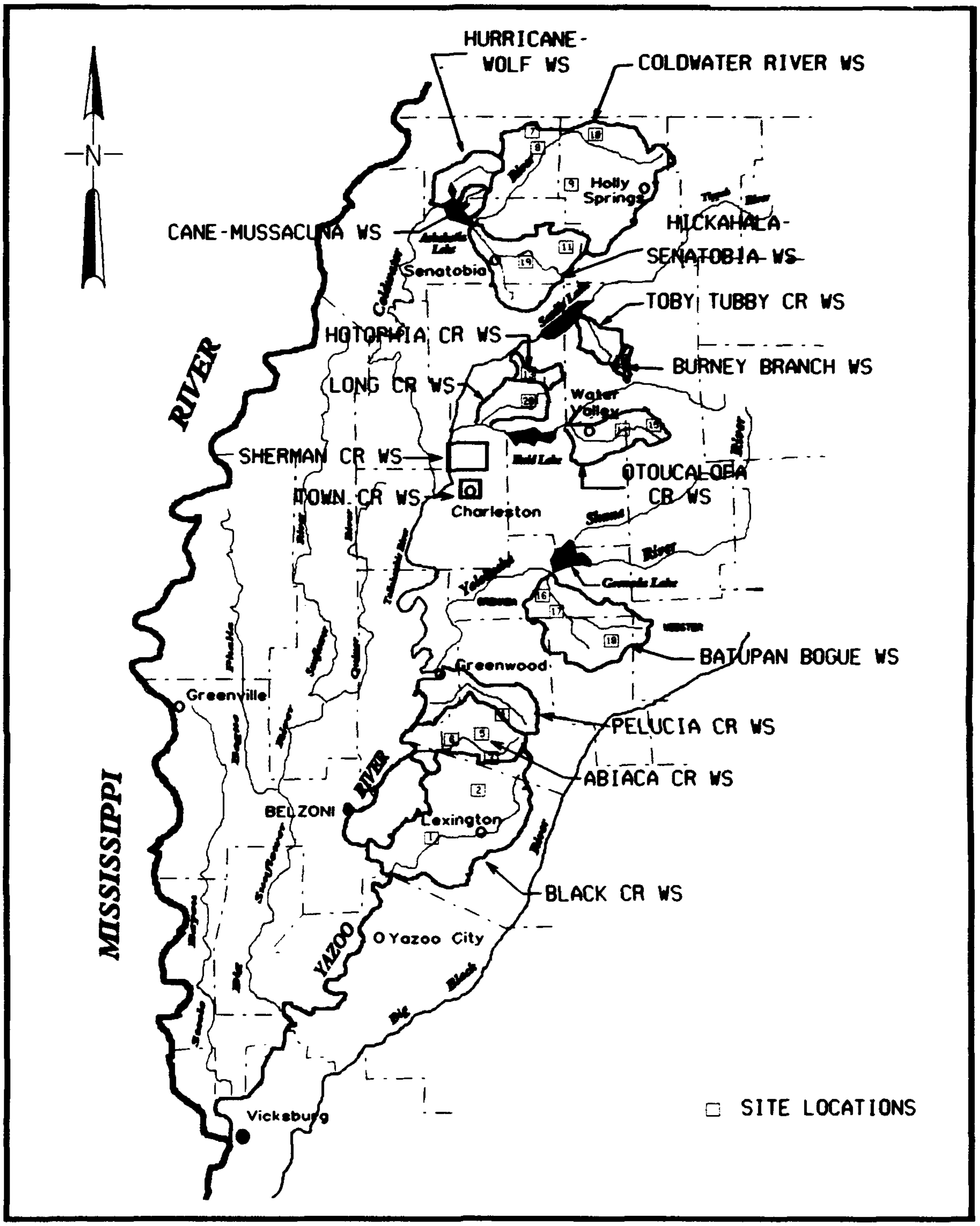


Figure 2. DEC study sites

The sites include drop structures, bank stabilization, reaches affected by reservoirs, channelization, sediment traps, and sites that vary in the degree of active erosion.

The development of berms is being monitored by sampling of the material, measurement of the size and shape, quantification of vegetation development, examination of cross-section soil development, and photographs. Vane shear strength is measured to determine characteristics for each stratigraphic unit and for berms. Soil and sediment samples are being collected for sieve analysis. Bank stability is being analyzed using the methods recommended by Thorne, Biedenharn, and Combs (1988). A sketch of types of bank failure encountered will be made, the site will be photographed, and the type of failure will be noted.

Data are being analyzed and tabulated for use by other investigators at WES. In addition, students working toward advanced engineering degrees at Colorado State University, Fort Collins, CO, will be funded under contract to do research on a topic related to DEC channel response.

Monitoring Sites

The selected sites include approximately 15 existing low-drop structures, 3 existing high-drop structures, 20 anticipated low-drop sites, 2 anticipated high-drop sites, chevron dikes, bank stabilization, and 6 control reaches in approximately 30 miles of study reach at 20 different locations. These sites have been selected to represent many of the different DEC watersheds, types of channel planform and sediment gradation, particular causes of instability, types of channel rehabilitation, and locations of special interest. Each site will be briefly discussed in the following sections.

Harland Creek

Site 1 is located on Harland Creek in the Black Creek watershed. The site is near Eulogy, MS, and can be found on the Lexington quadrangle map in T14N, R1E, Sections 22 and 27. Harland Creek is a mixed sand and gravel bed stream, exhibiting some of the original meandering tendency shown on the map (Figure 3). The study reach is approximately 4,000 ft in length, 2,000 ft upstream and downstream of the county road bridge. The stream is unstable, with bank erosion and significant channel widening. Several areas of massive bank failures were identified, and these failure sites, along with bed and bank erosion, provide a high sediment yield to the downstream.

The site was chosen because it has a mixed bed load, stabilization measures have not been constructed in the reach for the initial survey, and a major reservoir is planned immediately upstream of the site. Presently, there is no stream gauging in the reach; however, this site will be gauged in the future.

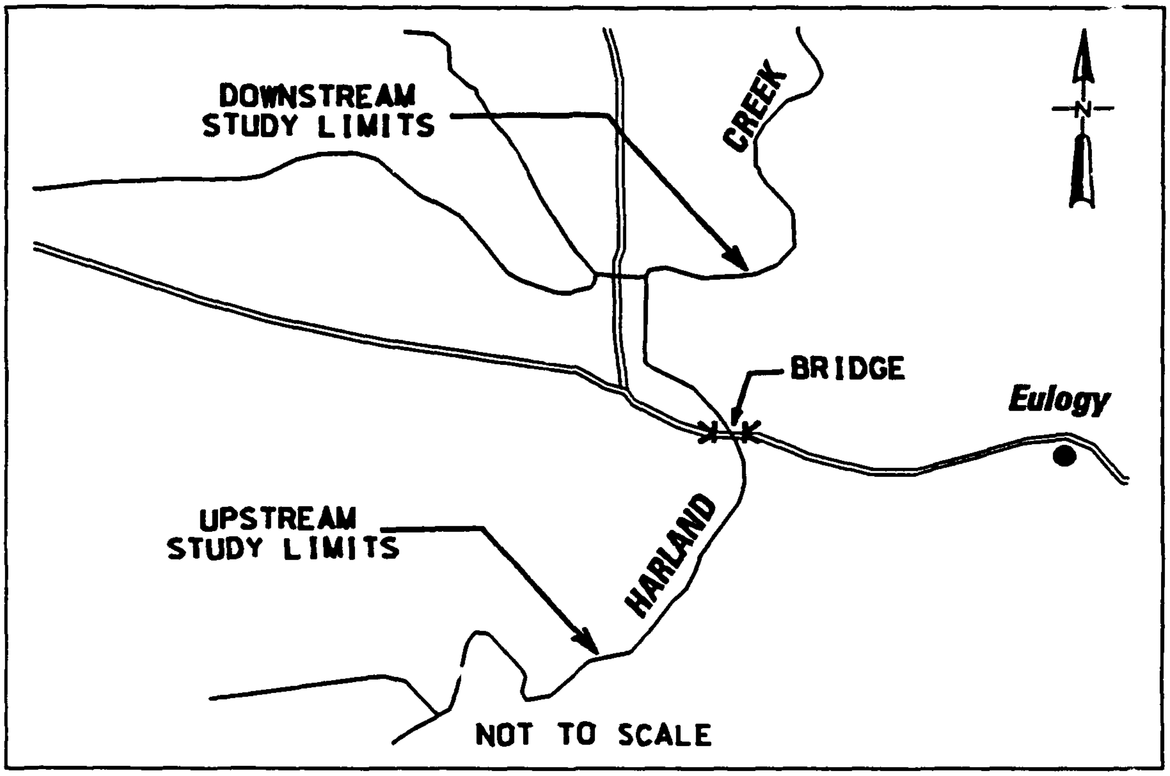


Figure 3. Harland Creek (Site 1)

The watershed area at the site is approximately 27 square miles. HEC-1 hydrology and HEC-2 hydraulics were developed by Northwest Hydraulic Consultants, Inc. (NWHC) (1988). Portions of the study reach were surveyed during 1991 for planning of construction of bank stabilization. The 1992 field data will allow a comparison of the existing conditions with the previous contractor analyses, and provide a baseline of detail field information for comparison after the planned reservoir is constructed.

Fannegusha Creek

Site 2 is located on Fannegusha Creek, also in the Black Creek watershed, and can be found on the Coila quadrangle map in T16N, R3E, Sections 1 and 2. As shown in Figure 4, the study reach is approximately 4,000 ft in length, 2,000 ft upstream and downstream of a county road bridge. Two low-drop structures are planned for the site, immediately downstream of the bridge and approximately 2,000 ft downstream of the bridge. The stream is presently unstable, and it has been reported that the county bridge has been closed since January 1992 due to channel widening. Initial observations indicate that the channel will continue to widen without stabilization measures due to a downstream oversteepened reach.

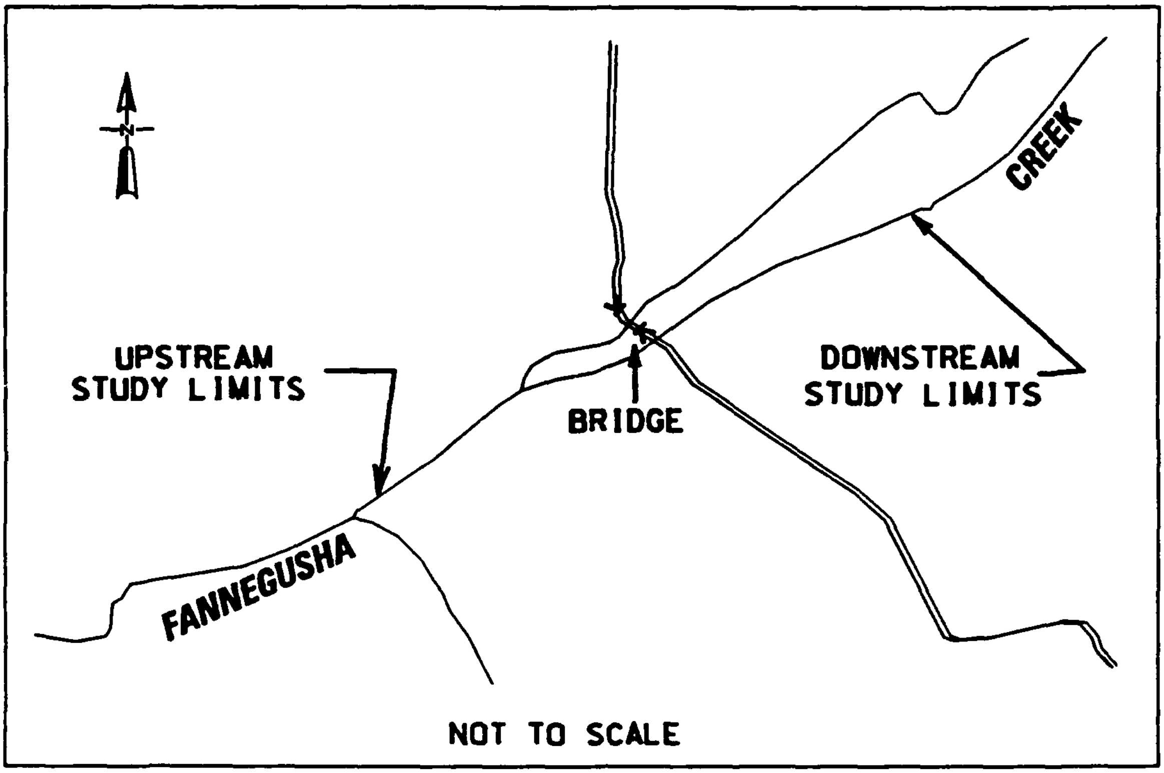


Figure 4. Fannegusha Creek (Site 2)

Watershed area at the site is approximately 18 square miles. HEC-1 hydrology and HEC-2 hydraulics were developed by NWHC (1988). This reach was chosen as representing a very unstable sand bed channel. The 1992 field data collection will begin to establish baseline data from which evaluation of the effects of the two proposed low-drop structures can be made.

Abiaca Creek

Four sites have been selected in the Abiaca Creek watershed, and these sites can be found on the Seven Pines quadrangle map. Water Engineering and Technology, Inc. (WET) (1989a), prepared HEC-1 hydrology and HEC-2 hydraulics based on surveys provided by the Vicksburg District. WES recently completed a HEC-6 analysis of Abiaca Creek (Freeman et al. 1992). The drainage area of the watershed is about 100 square miles, and SCS reservoirs control approximately 60 percent of the watershed. Coila Creek is the principal tributary to Abiaca Creek, and this watershed is approximately 76 percent controlled. Upstream of the Coila Creek confluence, Abiaca Creek is about 49 percent controlled. Along with the importance of this watershed supplying water to a downstream wildlife area, this watershed has been severely affected by sand and gravel mining.

Site 3, shown in Figure 5, is located in T17N, R3E, Section 20, at the

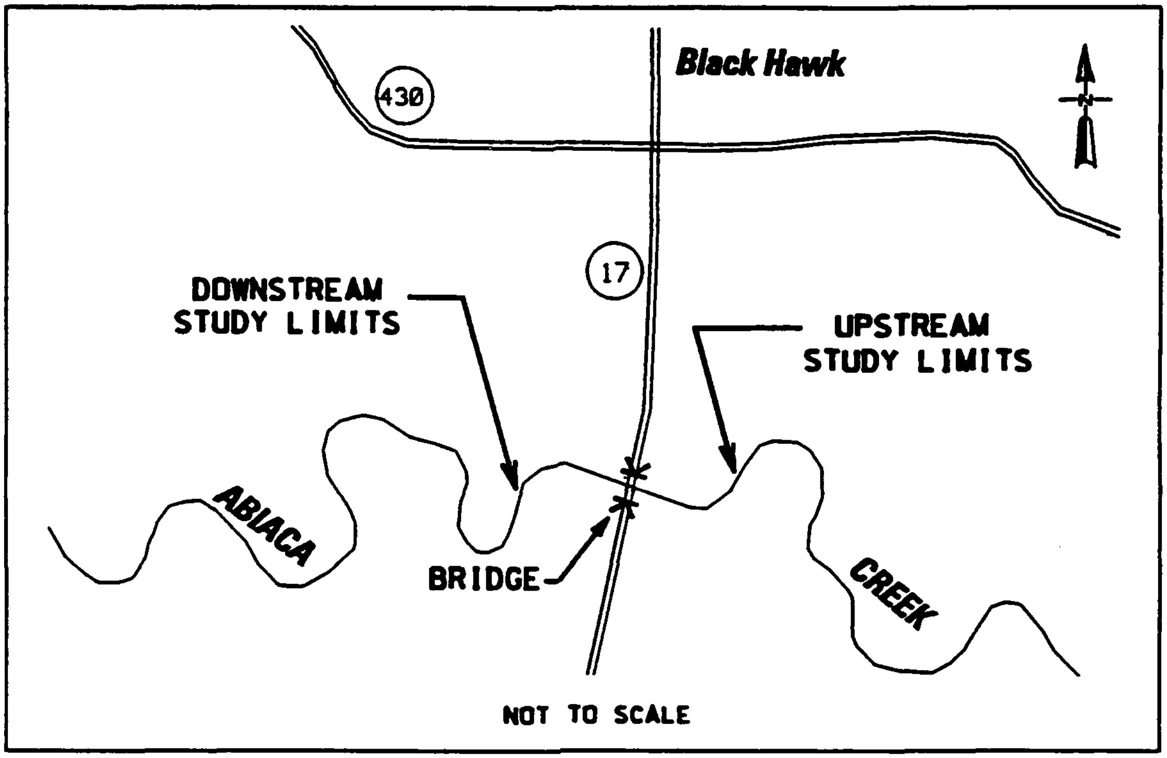


Figure 5. Abiaca Creek at Highway 17 (Site 3)

Highway 17 crossing of Abiaca Creek. The approximate watershed area at this site is 26.5 square miles. This site was selected because of the relative stability of the channel at this location, particularly in comparison to the downstream sites that have been severely impacted by gravel mining. The streambed at Site 3 is primarily a sand bed with minor amounts of gravel, and the banks are generally well-vegetated with mature vegetation down to the low-water surface; however, erosion of the outside bank of the bendway was noted.

Site 4 is on Abiaca Creek and extends approximately 4,000 ft upstream from the confluence with Coila Creek as shown in Figure 6. This site is located in T17N, R2E, Section 4, and has a watershed area of approximately 44 square miles. This site is also located approximately 1.8 miles downstream of a major sand and gravel processing operation that can be associated with increased supply of suspended and bed material load. Streambanks in this reach are relatively stable, and the bed gives the appearance of an aggraded reach.

Site 5 is located on Coila Creek, a tributary to Abiaca Creek. The site extends upstream approximately 4,000 ft from the confluence with Abiaca Creek as shown in Figure 7 in T17N, R2E, Section 4. The site has a watershed area of approximately 42 square miles, very similar to Site 4, which allows the comparison of two almost equal size drainage basins. A high

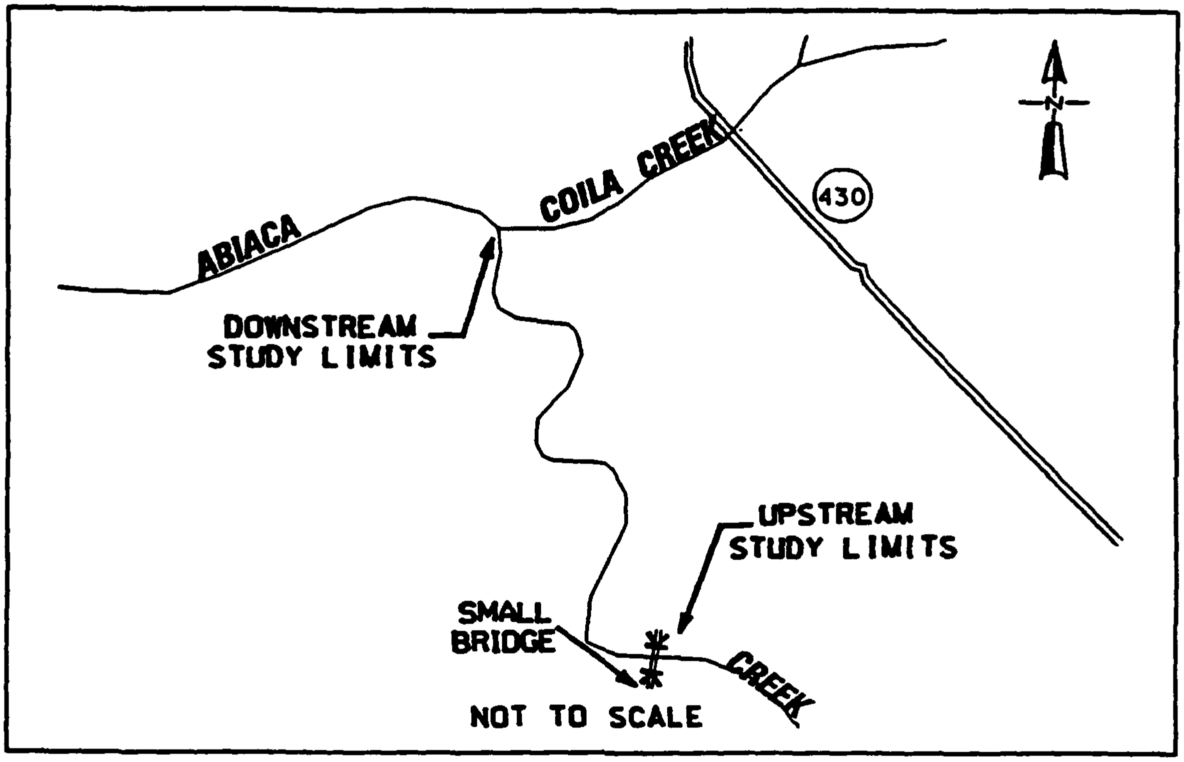


Figure 6. Abiaca Creek above Coila Creek confluence (Site 4)

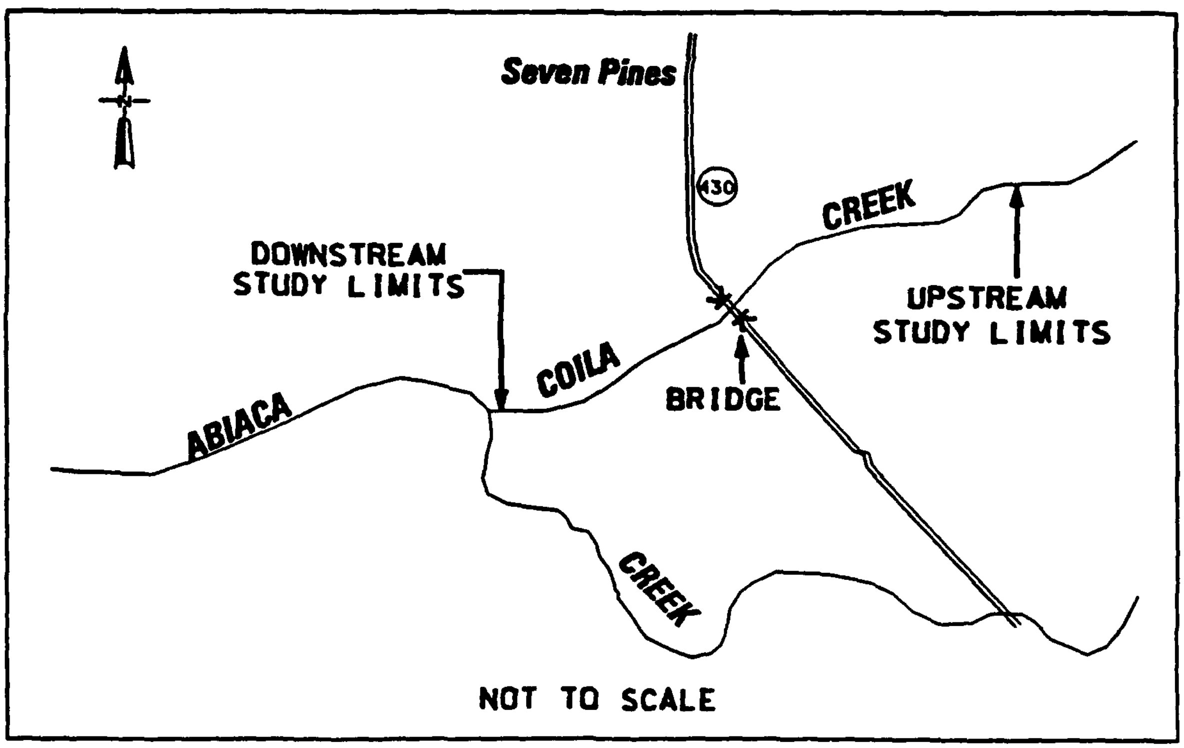


Figure 7. Coila Creek (Site 5)

proportion of the Coila Creek basin is controlled by SCS reservoirs, and the gravel mines on Coila Creek are not as active as the Abiaca Creek sites.

Site 6 is located on Abiaca Creek as the stream emerges from the hill line into the flatter Yazoo Delta in T17N, R1E, Sections 13 and 14, as shown in Figure 8. Drainage area at this location is approximately 99 square miles. This is the site of the Pine Bluff gauging station with records from 1963 to 1980. This station has recently been reactivated and includes a pumped sediment sampler. The study reach extends approximately 4,000 ft downstream of the Pine Bluff gauging station.

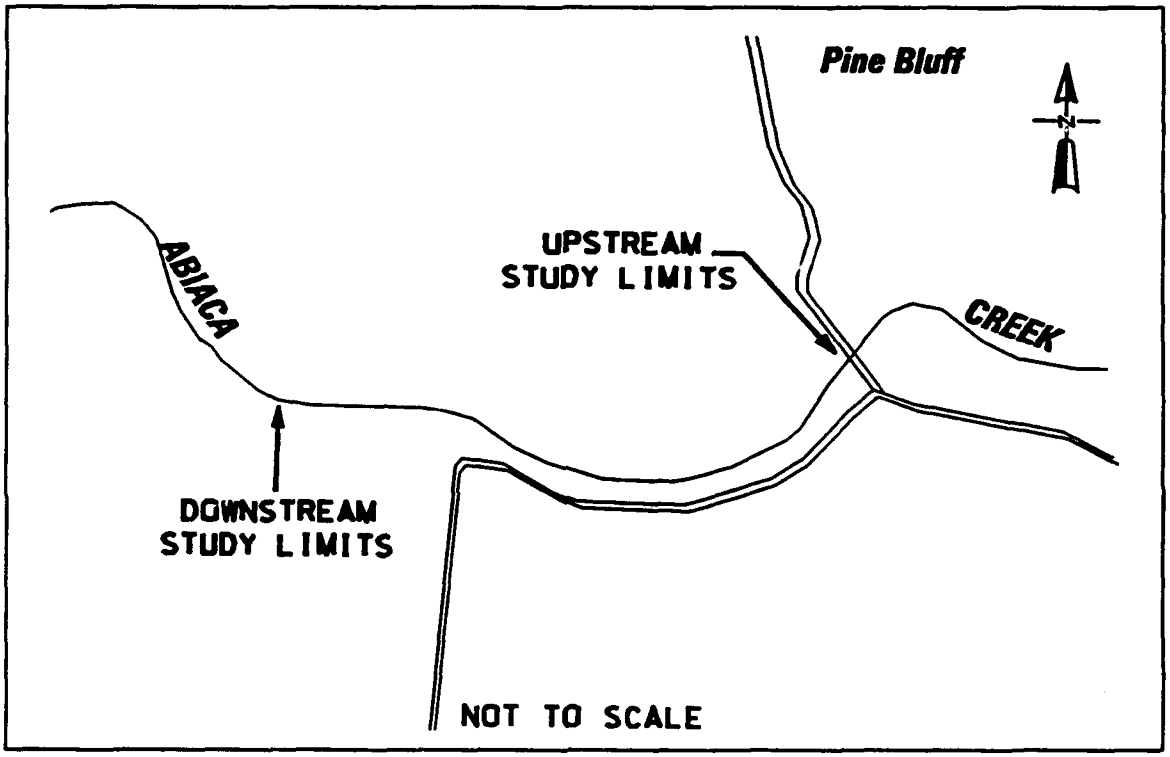


Figure 8. Abiaca Creek (Site 6)

Channelization of the lower basin during the early 1920's set in motion a complex cycle of channel incision, and continuing mining of the watershed complicates rehabilitation of the watershed. The Vicksburg District is presently designing sediment trapping immediately upstream of the wildlife area. The complexity and importance of the watershed emphasize the purpose of these four study sites. The Vicksburg District has suggested an additional study site at the downstream extent of the sediment trapping facility for future years.

Coldwater River Basin

The hydrology (HEC-1) of the Coldwater River basin was developed by Lenzotti and Fullerton Consulting Engineers, Inc. (1990). Surveys of the channels were completed in 1991 by the Vicksburg District, and HEC-2 hydraulics has subsequently been developed.

Site 7 is located on Nolehoe Creek in the Coldwater River basin near the community of Olive Branch, MS. The site is located on the Hernando quadrangle map, T1S, R7W, Section 35, and has a drainage area of approximately 3.7 square miles. The study reach is approximately 4,000 ft in length, extending downstream from a box culvert, as shown in Figure 9. The channel is extremely unstable and is deeply incised. Bed material load ranges from sand to in excess of 30 mm. Two low-drop structures are planned for the reach, and stream stage recording stations have been recently installed by WES.

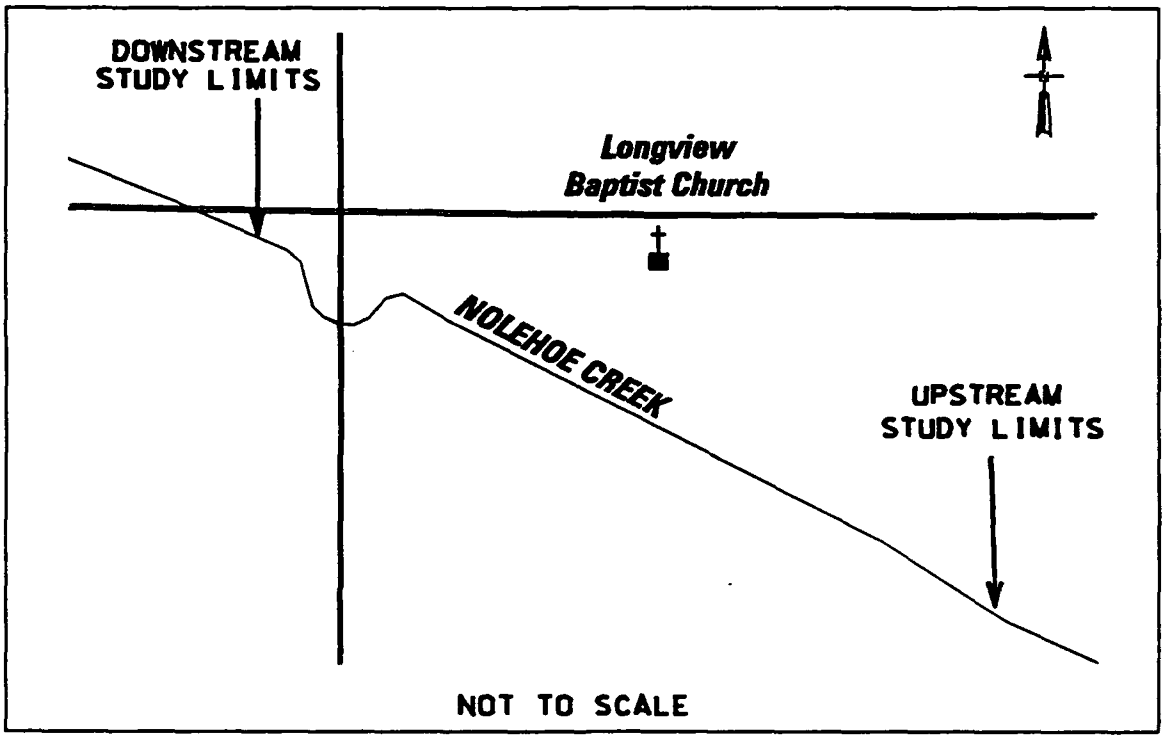


Figure 9. Nolehoe Creek (Site 7)

This site was selected for two reasons: the incising reach is controlled upstream and downstream by stable box culverts and the reach is representative of suburban development in the metropolitan Memphis area. An interview with a local landowner confirmed that a major cutoff of the channel had been made in the last 10 years. These conditions are typical of the result of ill-planned local development improvements, and the documentation of the resulting problems may be of value in assisting future local drainage planning.

Site 8 is on Lick Creek in the Coldwater River basin, approximately 2 miles south of Olive Branch, MS, at the site of an anticipated high-drop structure that is planned to protect the Highway 305 bridge. As shown in Figure 10, the study reach is approximately 4,000 ft in length, 2,000 ft upstream and downstream of the bridge, in T2S, R6W, Section 3. This site is also on the Hernando quadrangle map. Watershed area is approximately 8.5 square miles. Stream gauging is planned for the future at this site; however, no stream gauging is presently available.

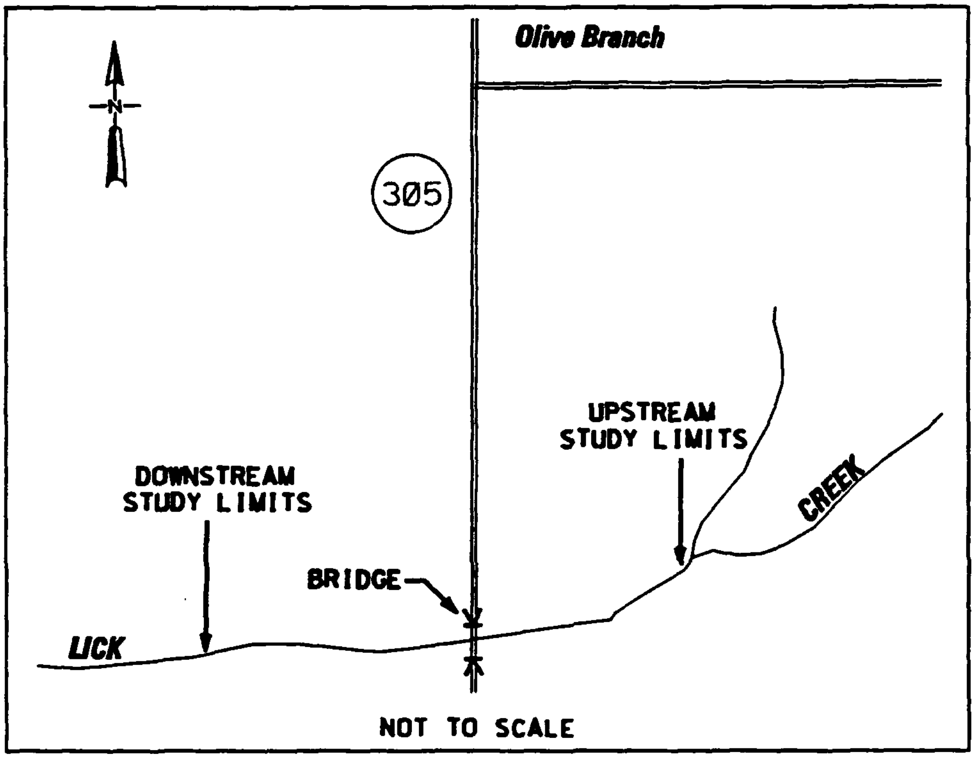


Figure 10. Lick Creek (Site 8)

This site was selected to monitor the effects of a planned high-drop structure. Lick Creek is actively degrading downstream of the bridge, and incision has begun upstream of the bridge.

Site 9 is located on Red Banks Creek in the Coldwater River basin. As shown in Figure 11, the study reach extends approximately 2.5 miles upstream from the bridge on the county road between the communities of Warsaw and Watson, MS. This site can be located on the Byhalia quadrangle map, T3S, R5W, Section 24, and R4W, Sections 19 and 20, and has a watershed area of approximately 28 square miles. The bed sediment load is sand, and the stream flows in a deeply incised and widened, straight channel resulting from earlier channelization.

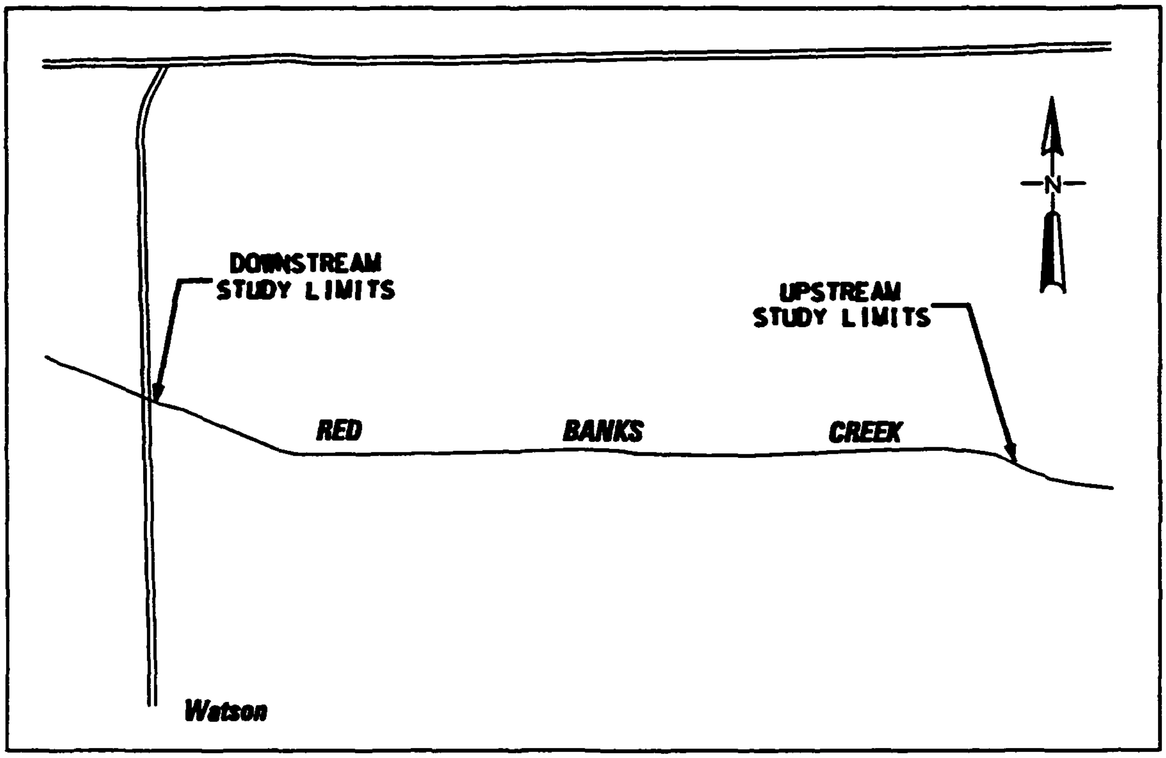


Figure 11. Red Banks Creek (Site 9)

Site 9 is unique in that it is the only DEC site using chevron dikes and longitudinal dikes for channel stabilization. Early indications based on the January 1992 field effort indicate that this combination is effective in storing sediment and causing channel aggradation; however, the chevron dikes appear to be in need of repair.

Site 10 is on Lee Creek in the Coldwater River basin, approximately 6 miles north of Victoria, MS. The site can be located on the Byhalia quadrangle map in T2S, R4W, Sections 9 and 10. As shown in Figure 12, the study reach extends approximately 2,000 ft upstream and downstream of the highway bridge. The channel is relatively stable and is transporting minor amounts of gravel in a sand bed. Upstream of the bridge, the channel exhibits some meandering and apparently has not been channelized in this reach. Downstream of the bridge, the channel is stable with mature, 14-in.-diameter trees near the low-water surface. The remnants of spoil piles indicate that the lower channel has been channelized. This reach provides an excellent opportunity to document a stable, channelized, sand bed stream.

Hickahala Creek

Hickahala Creek is a major tributary to the Coldwater River with a drainage area of approximately 230 square miles at the confluence with the Coldwater. Simons, Li and Associates (SLA) (1987) conducted field reconnaissance,

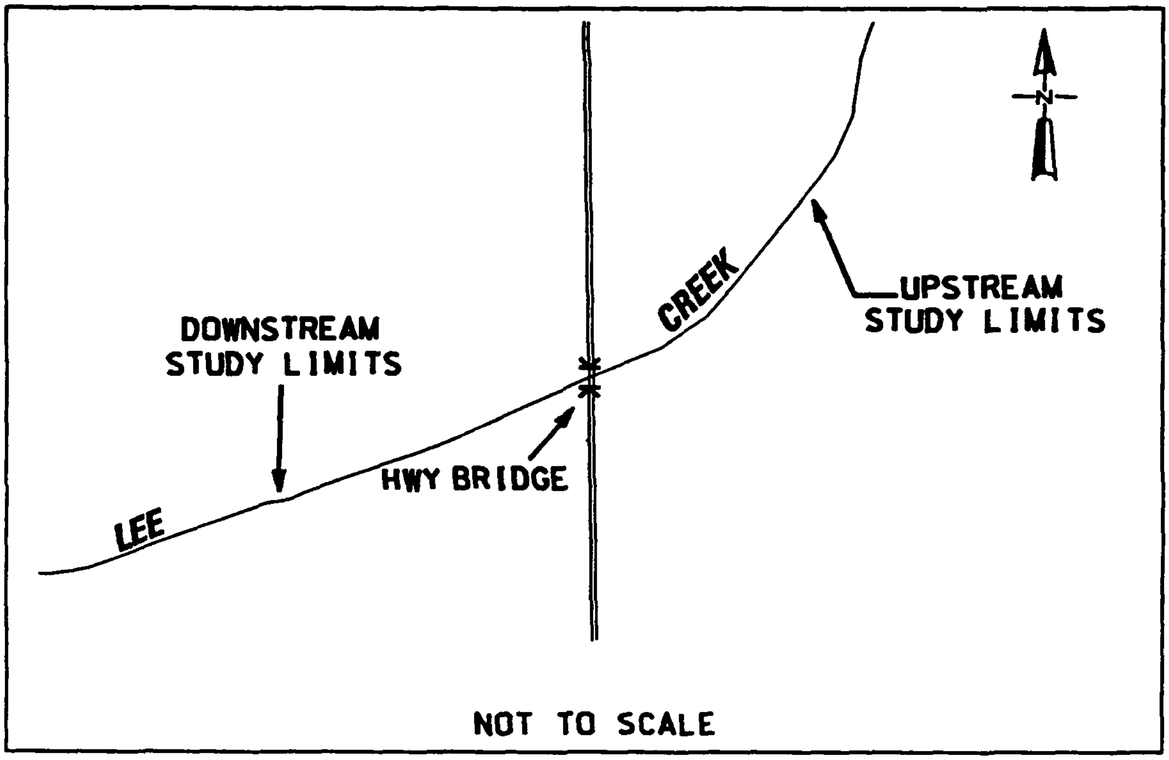


Figure 12. Lee Creek (Site 10)

developed HEC-1 hydrology and HEC-2 hydraulics, and conducted sediment transport analyses for the Vicksburg District in 1987. The hydraulic computations were prepared based on channel geometry from 1968 and 1985 surveys. Additional surveys have been made in selected areas to assess the effects of stabilization measures on James Wolf Creek, and construction-related surveys have been conducted on James Wolf and upper Hickahala Creeks. USGS stream gauge records are available near the mouth of the watershed.

Site 11 is located in the upper watershed of Hickahala Creek, with a watershed area of approximately 9 square miles. The site is located on the Tyro quadrangle map in T5S, R5W, Sections 2 and 3. As shown in Figure 13 the site begins at a county road bridge and extends downstream to the confluence with the South Fork, and continues downstream on Hickahala Creek for approximately 1.25 miles. The total study reach is approximately 2 miles in length and includes an existing and two proposed low-drop structures. The lower portion of the study reach is actively incising into a clay, cohesive bed. The upstream portion of the study reach is relatively stable with a sand bed. The reach was selected to monitor the response of the complex of structures.

Burney Branch

Site 12 is located on Burney Branch near Oxford, MS. The study reach begins at the Highway 7 crossing of Burney Branch and extends downstream

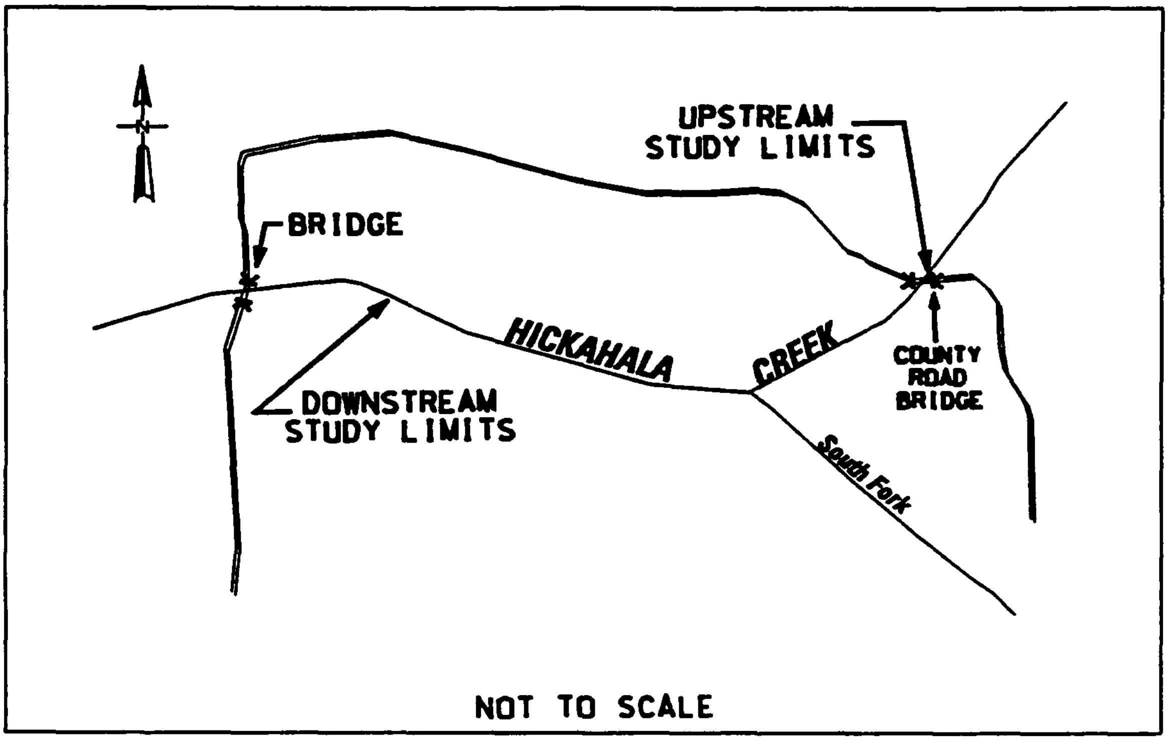


Figure 13. Hickahala Creek (Site 11)

for a distance of approximately 1 mile through a reach containing two SCS high-drop structures as shown in Figure 14. Drainage area of Burney Branch at this location is approximately 10 square miles. The site can be located on the Oxford quadrangle map, T9S, R3W, Sections 4 and 9.

The two high-drop structures have been very successful in rehabilitating this reach of Burney Branch. Both structures were constructed in 1982 by the SCS, and the effects of the structures on the channel were surveyed and analyzed in 1984 by Watson and Harvey (1988). These structures were designed to contain the 100-year discharge and include the provision for floodplain storage using valley dams in conjunction with each structure. The original design of the structures provided for a bed slope of 0.0008 between structures, based on Lane's (1955) tractive stress analysis. The 1984 surveyed bed slope was 0.0012, indicating that the upstream sediment yield was greater than planned. Since 1984, several major channel stabilization projects have been constructed upstream. The survey made in January 1992 will document the effects of changes since 1984 and will provide data with which to evaluate channel change as sediment supply is reduced. Channel stabilization under conditions of reducing sediment supply is a situation that will be faced as the success of the DEC programs is realized. Potentially, upstream stabilization can cause stability problems downstream.

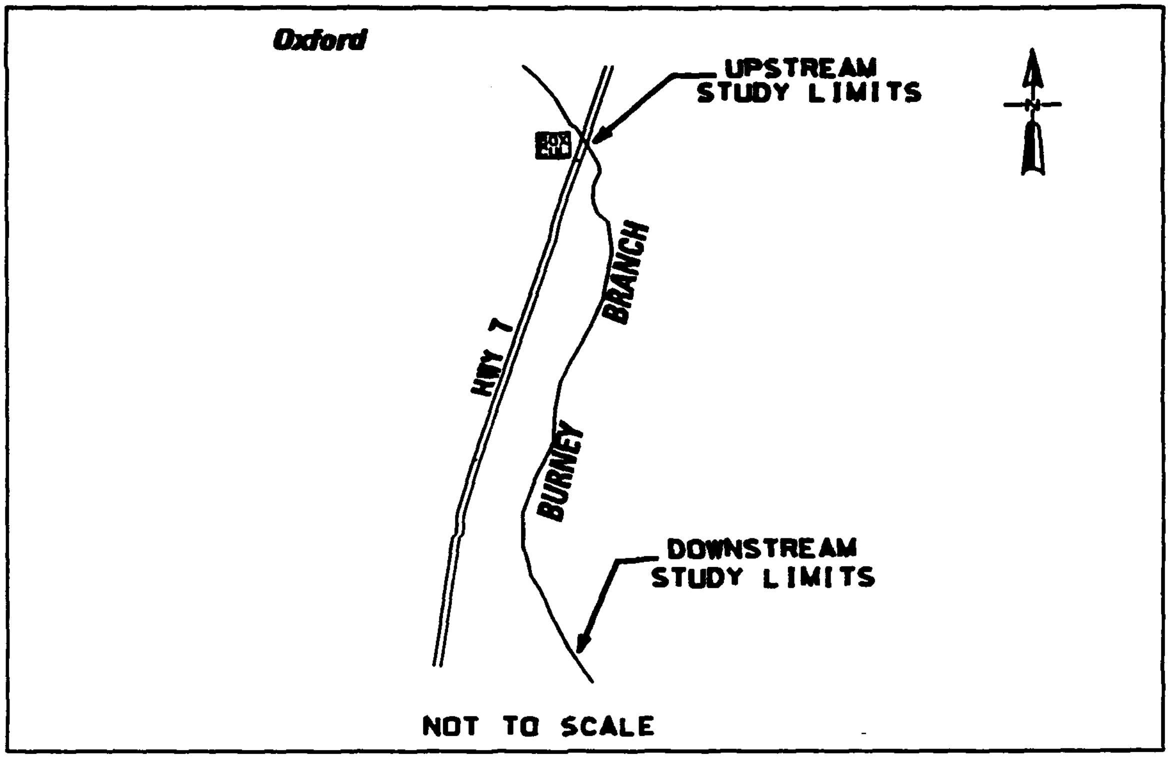


Figure 14. Burney Branch (Site 12)

Hotophia Creek

Site 13 is located on Hotophia Creek, west of Oxford, MS. As shown in Figure 15, the site encompasses approximately 2 miles of Hotophia and Marcum Creeks and is located on the Sardis quadrangle map T9S, R6W, Sections 1 and 2, and in T9S, R5W, Section 6. The watershed area at the site on Hotophia Creek is approximately 17 square miles. A USGS gauging station is located at the Highway 6 bridge crossing the creek. The study reach includes the confluences of Marcum Creek and Deer Creek with Hotophia Creek. A low- drop structure on Hotophia Creek is at the downstream extent, two low-drop structures are on Deer Creek, a high-drop structure is located on Hotophia Creek immediately downstream of the Marcum Creek confluence, and a low drop is located on Marcum Creek. The high drop on Hotophia Creek is the first high-drop structure constructed by the Corps in the DEC Program.

Hotophia Creek was channelized in 1961, and was surveyed by the Vicksburg District in 1985. WET (1987a) conducted field reconnaissance in 1986 and prepared HEC-1 hydrology and HEC-2 hydraulics. Surveys related to the construction have been made by the Vicksburg District, and the study reach was surveyed in January 1992. This site is important because of the complexity of the various constructed elements, and the need to document channel response to the high-drop grade control. In addition, data from Burney Branch and Hotophia Creek provide the opportunity for a comparison of data from adjacent watersheds.

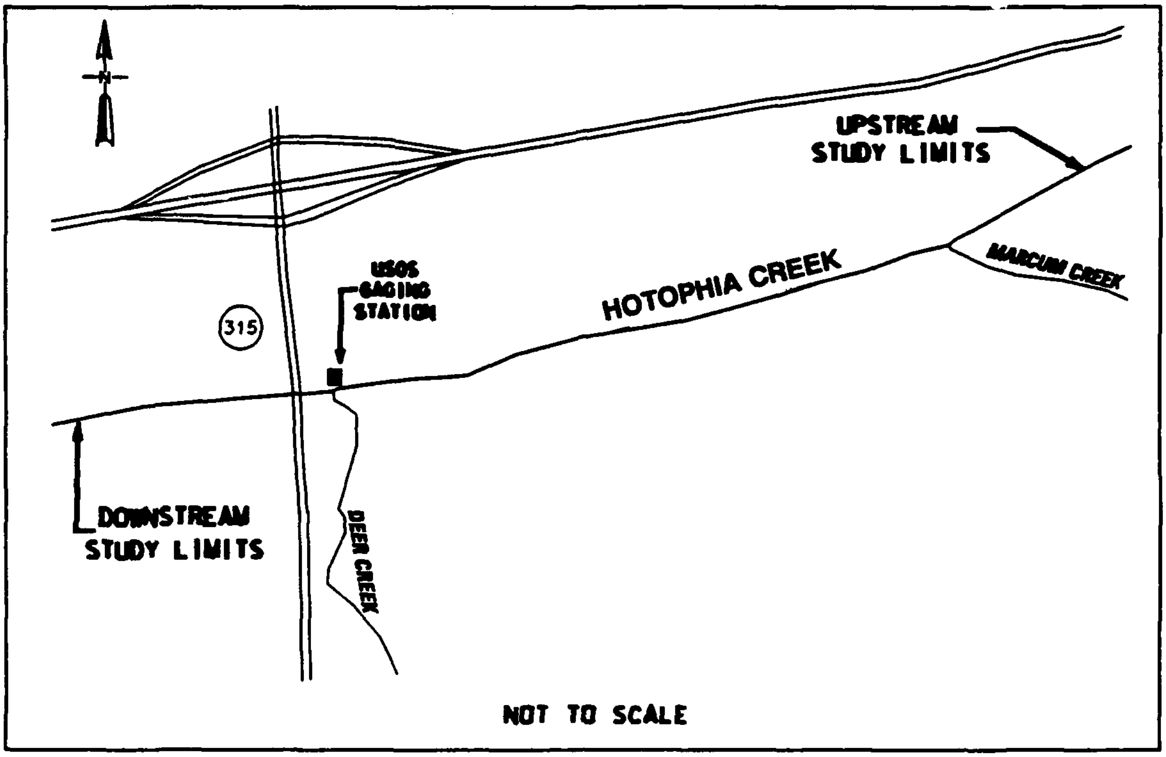


Figure 15. Hotophia Creek (Site 13)

Otoucalofa Creek

Site 14 is on Otoucalofa Creek, east of Water Valley, MS. The study reach is 4,000 ft in length, 2,000 ft upstream and downstream of the Mt. Liberty Church Road bridge, in T11S, R3W, Sections 4 and 5, of the Water Valley quadrangle map as shown in Figure 16. Watershed area at the site is approximately 41 square miles. No stream gauging is presently available; however, this site will be gauged at the bridge in the future.

A low-drop structure is proposed for the future, and presently riprap dikes and longitudinal dikes are constructed throughout the reach. In January 1992 the reach was observed to be actively incising at an elevation below the recently placed stone. This site provides a unique opportunity to observe the stone subjected to severe degradation.

Site 15 is on Sarter Creek, which is a tributary of Otoucalofa Creek upstream of Site 14. Sarter Creek is located on the Paris quadrangle map in T10S, R3W, Sections 34 and 35, and has a watershed area of approximately 6.4 square miles. The study reach is 4,000 ft in length and is almost completely straight as a result of previous channelization, as shown in Figure 17. This site extends downstream of the Highway 315 bridge. The site is unusual in that it has remained relatively unchanged since channelization; however, it is apparent that the incision at Site 14 is moving upstream and, if unchecked, will move up Sarter Creek.

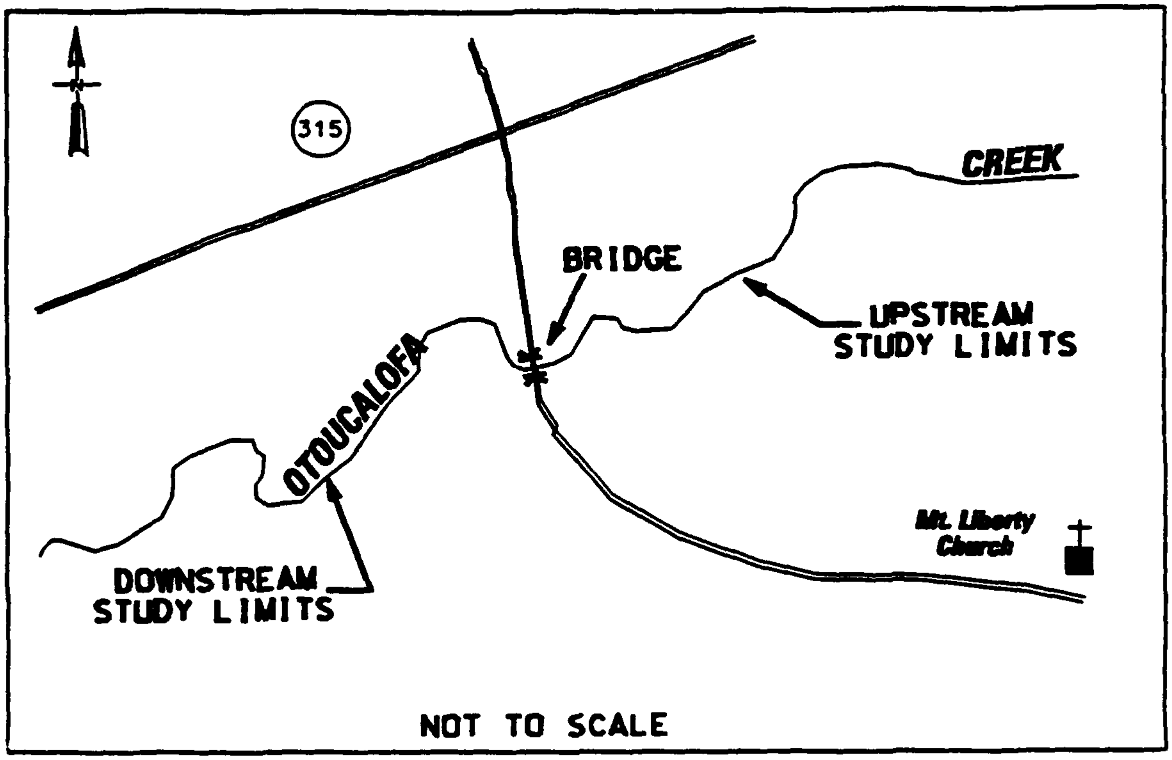


Figure 16. Otoucalofa Creek (Site 14)

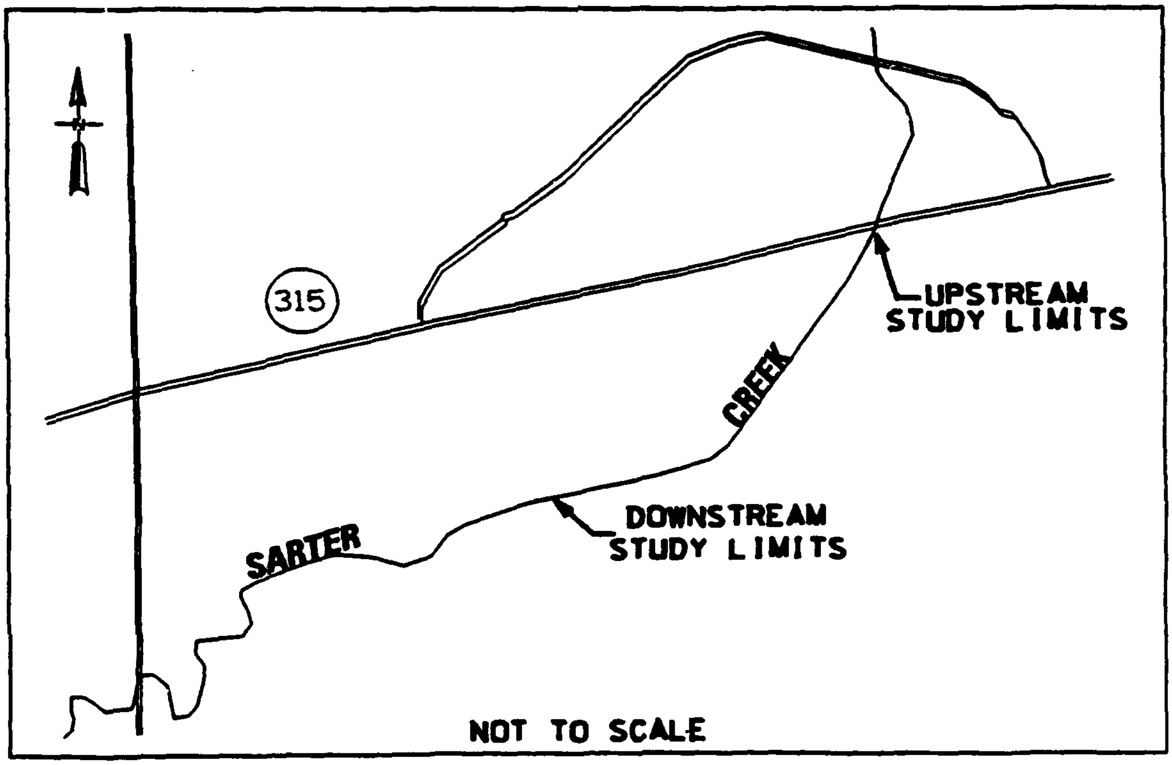


Figure 17. Sarter Creek (Site 15)

Batupan Bogue

Batupan Bogue watershed contains three study sites, Perry Creek, Sykes Creek, and Worsham Creek. A USGS stream gauge is located at the mouth of Batupan Bogue, which has a drainage area of approximately 245 square miles. In 1987 and 1988 WET (1987b) prepared HEC-1 hydrology to match then-existing Federal Emergency Management Agency hydrology, and HEC-2 hydraulics based on 1987 surveyed cross sections. Numerous stabilization structures have been constructed since 1988, and surveys have been conducted in association with planning for those structures.

Site 16 is located on Perry Creek as shown in Figure 18. The study reach begins approximately at the T21N, R4E, Section 1 northern line and continues

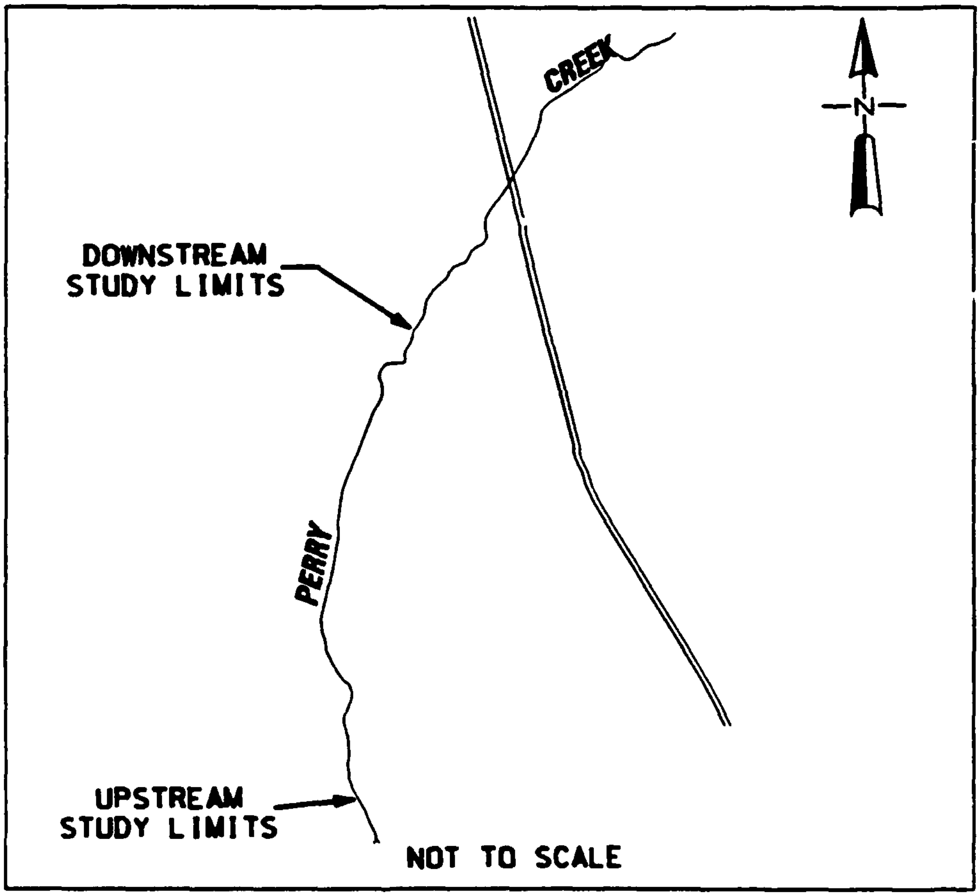


Figure 18. Perry Creek (Site 16)

upstream through Sections 2 and 11. The study reach is located on the McCarley quadrangle map. The entire study reach length is approximately 2 miles. Four low-drop structures are planned for the severely incising channel. This site will allow the investigation of the effects of four structures in series, and the site is unique because within the study reach the channel moves from a deeply incised stream to a stream that might have existed prior to channelization. Plans are to gauge the stream at the I-55 box culvert downstream of the study reach.

Site 17 is located on Sykes Creek as shown in Figure 19. The study reach extends 2,000 ft upstream and downstream of the county road bridge across Sykes Creek located in T21N, R5E, Section 27. This site is found on the McCarley quadrangle map. No gauging is presently available for the approximate 12.3-square-mile watershed area. Gauging is planned for installation at the bridge.

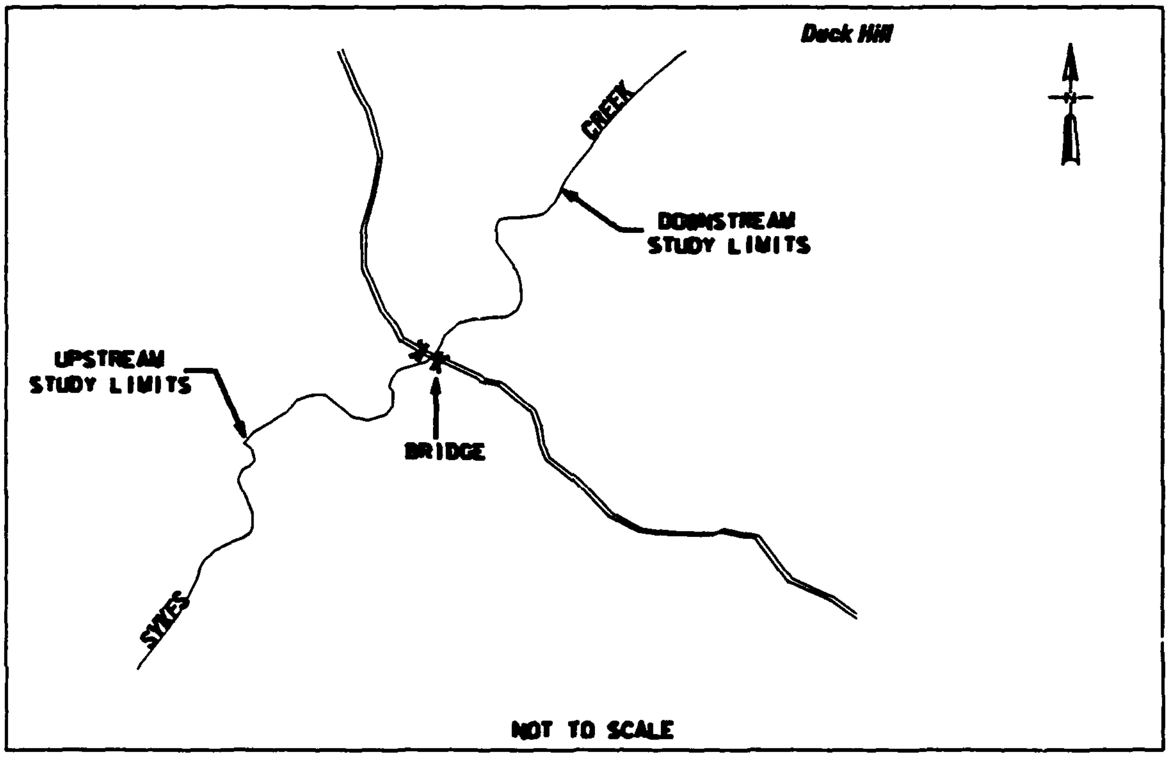


Figure 19. Sykes Creek (Site 17)

Site 18 is a study reach encompassing portions of Worsham Creek, West Fork, and Middle Fork as shown in Figure 20. The site is located on the Duck Hill quadrangle map in T20N, R6E, Sections 14, 15, 16, 21, 22, and 23. Total stream length is approximately 3.5 miles, and the watershed area at the confluence is approximately 19 square miles. The streams are deeply incised and active. Ten low-drop structures are planned in this study reach.

Site 19 is located in the Hickahala Creek watershed on James Wolf Creek. At this location, James Wolf has a drainage area of approximately 11 square miles; however, it is extremely deep and wide. The site is located on the Tyro quadrangle map in T5S, R5W, Section 28. The study reach, shown in

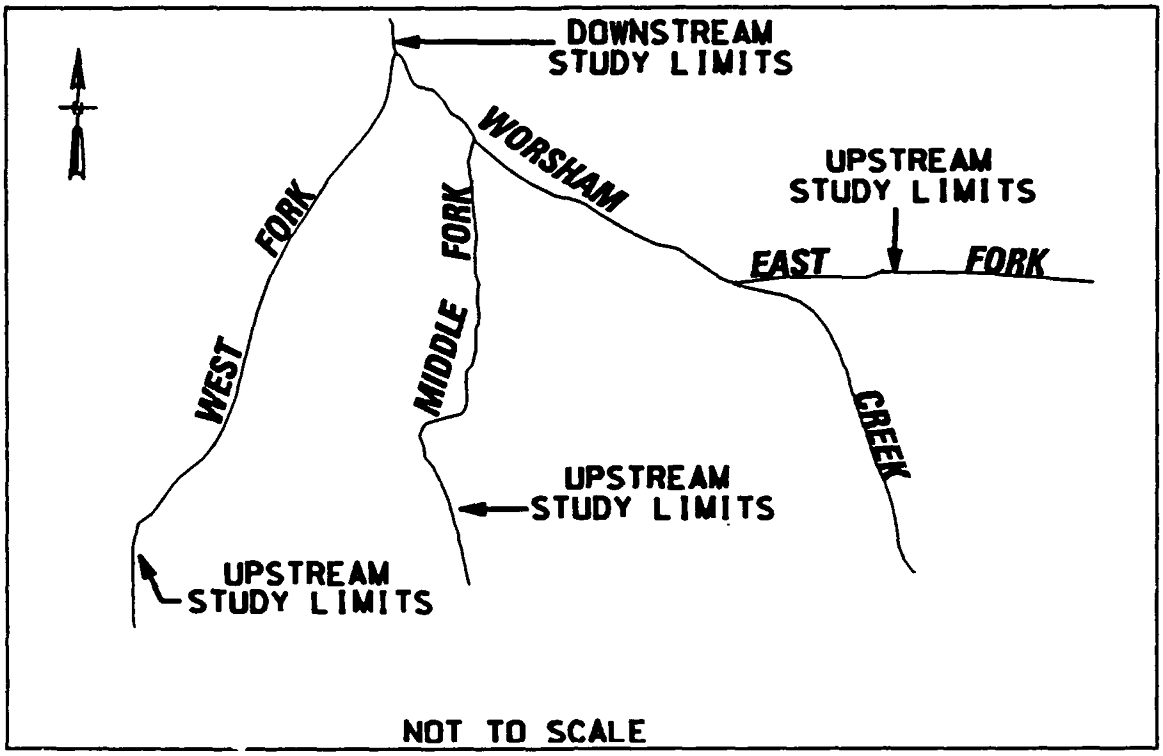


Figure 20. Worsham Creek (Site 18)

Figure 21, extends downstream of the east-west county road for a distance of approximately 4,000 ft, encompassing a low-drop structure. This low-drop structure appears to be stabilizing the bed of the stream; however, the banks remain unstable due to the significant depth. The stream is sand bed, and at low-flow conditions, the channel may be dry. The drop structure on James Wolf Creek has required significant repair since construction. The structure is functioning, and channel aggradation is present upstream. The structure has been selected for monitoring, both because of the success and because of the amount of repair that has been required at the site.

Long Creek

Site 20 is located on Long Creek, T10S, R6W, Sections 4, 5, and 8 on the Oakland quadrangle map, as shown in Figure 22. The site has a watershed area of approximately 11 square miles. Three low-drop structures exist and the fourth is planned for the downstream portion of the reach. The study reach is approximately 2 miles in length, extending downstream from the eastern boundary of Section 4. The site also includes a reach that has been monitored by the Vicksburg District and includes the bank stability sites reported by Biedenharn, Little, and Thorne (1990).

Portions of this reach are very unstable and are presently incising. The reach downstream of the existing structures has a clay bed that is slowly

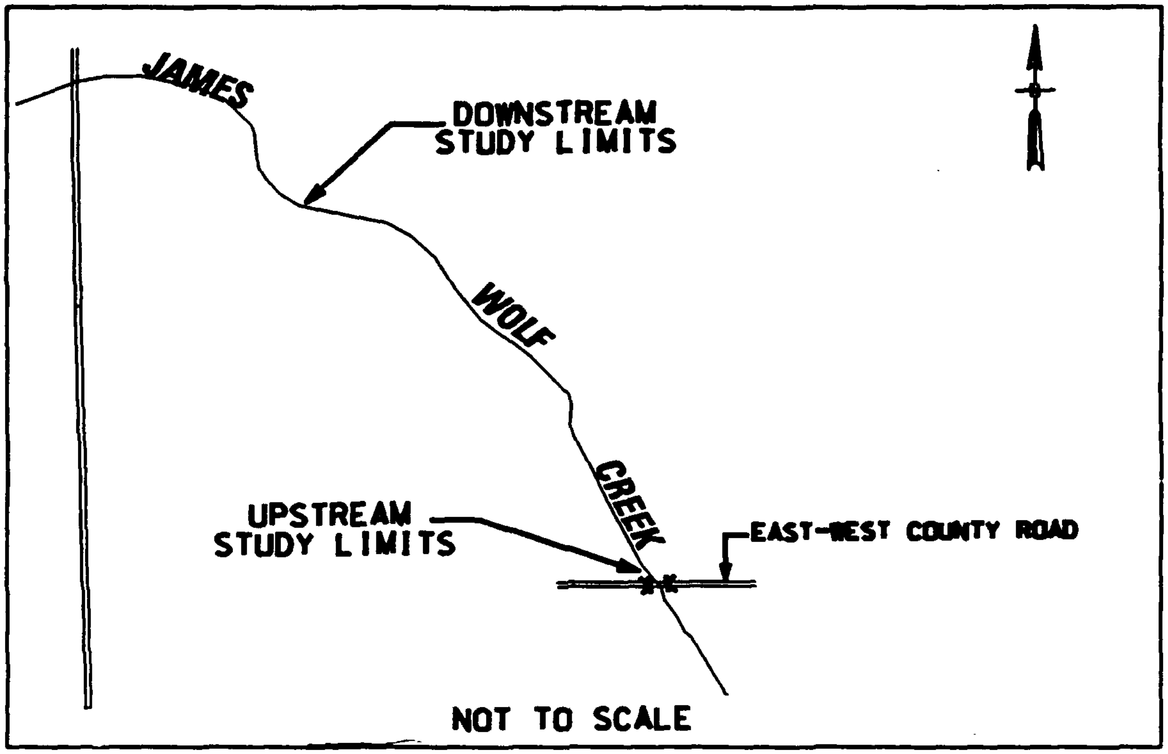


Figure 21. James Wolf Creek (Site 19)

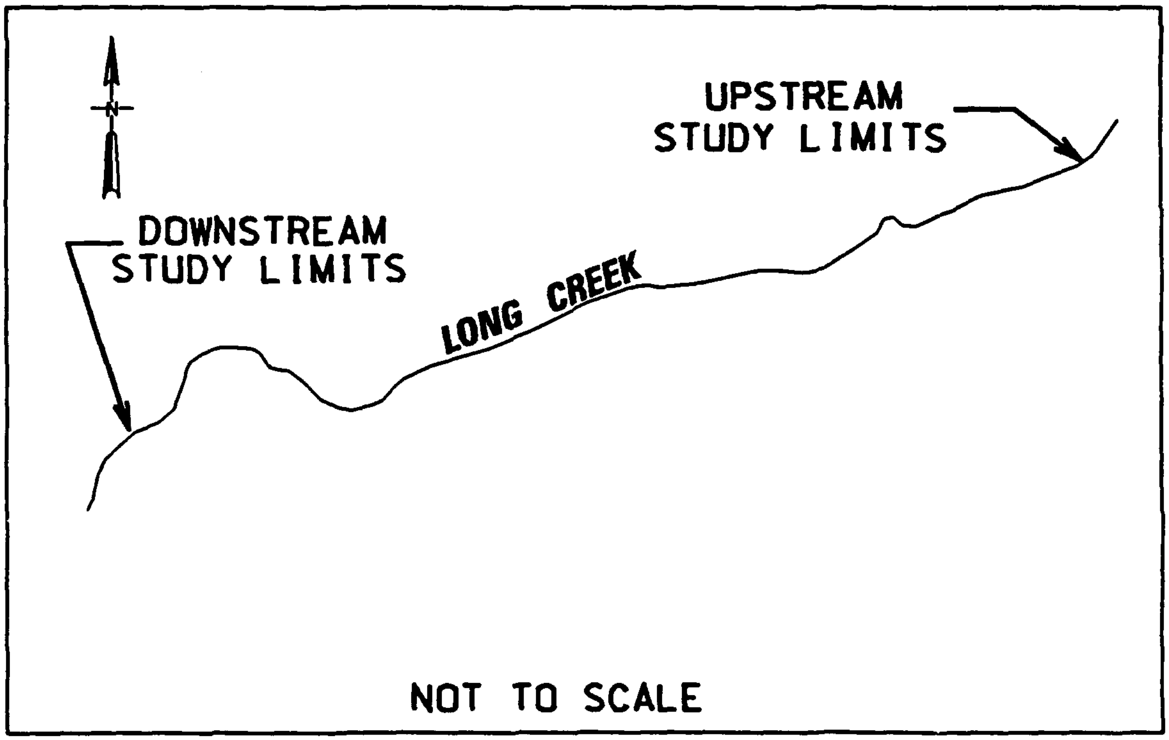


Figure 22. Long Creek (Site 20)

incising. This clay bed has a very narrow, deeply incised channel along some reaches. Based on experience, this narrow channel will widen dramatically as the incision penetrates through the clay layer. Several cross sections were surveyed in the narrow channel, and future comparisons will be important.

Summary

The Colorado State University Monitoring and Analysis of Incised (MAIN) Streams Project is at the halfway point as of 1 June 1992. Field data collection will be complete for 1992 by 15 June 1992. Work *completed* by 1 June includes reduction of survey data for the 20 sites, and analysis of approximately 300 sediment samples.

4 Channel Response, Broad-Based Geomorphic Studies

Purpose and Scope

The purpose of the broad-based geomorphic study is to identify from aerial reconnaissance the channels in the various watersheds that appear to be the most active with regard to bed/bank stability and identify existing structures (grade control and riprap structures) that need repair or rehabilitation. The channels were flown in spring 1992, and aerial videos were made on the main channel and major tributaries in each watershed from a fixed-wing aircraft flying at an altitude of 2,400 ft above the ground surface. The study plan was to use the videos to identify areas of interest (problem and success) and then make a second flight at the same altitude but with the camera lens set to maximum magnification to get better resolution on the pictures. The first flights were completed and the videos reviewed; however, the second flights were not completed in time for inclusion in this report. The general description of channel conditions as observed from the videos are the subject of this part of the report.

Description of Work

The ARS Sedimentation Laboratory in a cooperative agreement with WES assumed the responsibility for obtaining aerial videos of the watersheds. The ARS used Super VHS (SVHS) video equipment that records frames in digital format that can be readily read into the computer database. The camera was mounted vertically to a fixed-winged Cessna 181 aircraft to provide a view of the ground similar to traditional aerial photography. The flight lines were flown at an altitude of approximately 2,400 ft above the ground surface, and the zoom lens on the camera was set at minimum magnification. The horizontal distance on each frame is approximately 2,000 ft and the vertical distance approximately 1,400 ft. This altitude was selected because at lower altitudes, the more sinuous channels were impossible to track with the vertically mounted camera, since the aircraft must be maintained in a level position. Even at this altitude, taping would be possible only for short reaches; and the flight line would have to be broken, the aircraft would circle, and taping resumed on a new line. A small television monitor was mounted on the cockpit to help the pilot anticipate turns, which greatly aided in reducing the flight line breaks on some channels. Approximately 40 hours of flying time was required to complete the job.

Status

Eighty-two creeks were videotaped by ARS personnel during March and April 1992, and the results are on five tapes. ARS prepared a log for each tape describing significant landmarks such as tributaries, highways, railroad crossings, etc., referenced to the elapsed time from start of tape. The time is shown on the tape for easy reference. Table 10 lists creeks that were taped arranged from major watershed to subwatersheds.

Observations

The ARS log sheets for each tape were adapted into tabular format to note observations in viewing the tapes. These observations are summarized in Tables 11-15. The major features of streambed, streambank, riparian vegetation, floodplain use, condition of structures, and general comments were listed and characterized to the extent possible from the tape viewing. The scale of each video frame was too small to ascertain anything more than general characteristics. Furthermore, an early spring in the region resulted in the trees budding out before the flights were completed; consequently, the tapes flown later have reduced visibility of the channel banks because of the vegetation. Also, the early spring precluded any second flights to get a closer look at specific areas because of the reduced visibility.

5 Channel Response, Detailed Geomorphic Study

Detailed geomorphic studies were conducted on the three watersheds that were resurveyed in 1991. These watersheds were Batupan Bogue, Hickahala-Senatobia Creek, and Long Creek. Both the 1985 and 1991 surveys consisted of channel profiles (thalwegs) and cross sections made at half-mile intervals. The surveys were used to determine channel changes from 1985 to 1991. The 1985 surveys had been used by the Vicksburg District in various analyses of the channel systems. The 1991 surveys were used to determine channel changes since 1985. Three basic analyses were conducted on the survey. Channel profiles were compared to determine zones of aggradation or degradation. Channel cross section plots were examined to determine width and depth changes. The complete sets of channel profile and cross-section plots of the Hickahala-Senatobia, Long, and Batupan Bogue watersheds are contained in Appendixes A, B, and C of this report, respectively. The channel cross sections were input into HEC-2, and channel hydraulic parameters were calculated. A general description of the analyses follows.

Channel Profiles

The channel profiles from 1985 and 1991 were digitized. Channel stationing began at the mouth of each channel and increased in the upstream direction along the channel thalweg. No survey baseline was used on either survey, and channel stationing was dependent on the measured distance along the thalweg. Since the thalweg tends to shift over time, the measured distances were often inconsistent between the two surveys. Locations of bridges, culverts, grade control structures, tributary intersections, and other channel features noted on the surveys were used to fit the stationing from the 1991 survey to that from the 1985 survey. Both channel profiles were then plotted on 1985 stationing. These plots are included in Appendixes A, B, and C of this report. Areas of significant channel aggradation or degradation can be located using these plots.

Channel Cross Sections

Channel cross sections from 1991 were plotted with the same cross section from 1985. Where possible, the 1991 cross sections had been surveyed at the same location as the 1985 cross sections. Direct comparisons of width, depth, and area were possible. The 1985 cross-section and overbank information was contained in digital form in the HEC-2 data files. The 1991 cross sections were digitized for input into HEC-2. The data were then manipulated into a paired data form that was input into DSS files. A DSS file was made for each watershed. Additional cross sections were surveyed in 1991 although several channels in the Batupan Bogue basin were surveyed at different locations from those of 1985. Cross sections from 1991 were then matched with the corresponding sections from 1985 and plotted. The cross-section station was determined from the channel profile, and therefore the station number may have changed even though the location did not.

Hydraulic Parameters

Reach by reach, averages of the channel parameters of velocity, width, depth, slope, and discharge were determined. HEC-2 output was used to determine width, slope, velocity, and mean depth. This HEC-2 approach is significantly different from using a true geomorphic approach where the depth, width, and area are measured directly from the cross sections. Using the HEC-2 approach, it would be possible to have the same width and mean depth for two different points in time, but the elevation of the water surface would be significantly different after the channel adjusted vertically. Initially the approach used the 2-year discharge as defined by Vicksburg District studies. This discharge was used as input to the HEC-2 backwater profile for both the 1985 and 1991 cross-section data. If the 2-year event proved to exceed the bank-full discharge significantly, the discharge was decreased by a percentage until the flow stayed in the channel. Previous District studies had defined channel reaches by various methods. These reaches were used in this study where available, but additional reaches were defined as needed. The output from HEC-2 and the reach definitions were input into the SAM.M95 program, which calculated average width, mean depth, velocity, slope, and discharge for the sections in each reach. The actual averages for the reaches as well as the changes from 1985 to 1991 are shown for each watershed in Tables 16-24.

Watersheds

Hickahala-Senatobia Creek Watershed

The Hickahala-Senatobia Creek watershed channel profiles and cross sections were examined for significant changes.

Hickahala Creek. The 1991 Hickahala Creek channel survey started at 1985 sta 450+00, which is near the Arkabutla Reservoir boundary. A small amount of aggradation occurred upstream of this point to near the confluence with Basket Creek. Between sta 800+00 and 1,258+00 a general trend toward degradation occurred. Upstream of grade control structure (GCS) 3 (sta 1,258+48), aggradation may have occurred. The cross sections do not conflict with these findings. Based on the cross-section data, it would appear that very little aggradation or degradation has occurred. Also very few significant width changes have occurred.

Thornton Creek. The 1991 survey shows almost insignificant changes in the profile. Up to 2 ft of aggradation occurred in the lower 1,500 ft of the channel. The cross sections show only insignificant changes.

Steammill Creek. The thalweg profile on Steammill Creek shows about 3 ft of aggradation upstream of the GCS at sta 23+28.

Basket Creek. The 1991 survey shows possible aggradation in the lower 5,000 ft of the channel. Between sta 90+00 and 180+00 degradation occurred but averaged less than 1 ft with the maximum degradation about 2 ft. The cross sections showed no major changes.

James Wolf Creek. The lower 20,000 ft of James Wolf Creek experienced almost no changes since 1985. Up to 4 ft of degradation occurred between sta 200+00 and sta 370+00, however, where a revetted pipeline is located. The channel degraded in the 3,000 ft below GCS 1 but aggraded upstream of the structure.

Martin Dale Creek. The lower end (7,000 ft) of Martin Dale Creek has degraded. However, upstream of this point (sta 70+00 to 130+00), aggradation appears to have occurred in what was a steep reach in 1985. This survey was corrected for stationing but may still need more adjustment. The cross-section data generally confirm the trends, but no cross-sections are available in the aggrading reach.

Whites Creek. The lower 10,000 ft of channel appears to be relatively unchanged. A drop near sta 105+00 is still in the same location but appears to be lower. Between 2 and 3 ft of degradation occurred upstream of sta 150+00. Near sta 160+00 the channel is very steep.

Beards Creek. The lower 10,000 ft of Beards Creek appears to be vertically stable. However, between that point and sta 175+00 the channel seems to have flattened and degraded up to a maximum of 4 ft. The cross sections verify this trend.

Catheys Creek. The profiles from 1985 and 1991 are very similar. The 1991 profile is slightly lower all along the channel.

South Fork Hickahala Creek. Relative to 1985, the 1991 profile shows degradation in the lower 3,500 ft of channel. Upstream of this point aggradation appears to have occurred. The cross sections seem to verify the aggradation.

Senatobia Creek. Downstream of Highway 4 (sta 75+40) aggradation occurred. Upstream of that point changes were noted only from sta 470+00 to 530+00 and from 625+00 to 670+00 where about 2 ft of degradation was noted.

Mattic Creek. Very little change occurred on Mattic Creek. Slight degradation occurred between sta 115+00 and 180+00.

Tolbert Jones Creek. Slight degradation occurred upstream of sta 90+00. A drop shows on the profile near sta 131+00.

Nelson Creek. No change occurred except for the slight degradation from sta 260+00 to 340+00.

Hydraulic parameters for the Hickahala-Senatobia Creek watershed were developed. The 1991 Hickahala Creek cross sections were used in HEC-2 data files. HEC-2 data files with the 1985 cross sections were provided by the Vicksburg District. SLA (1987) developed the hydrology for the Hickahala Creek watershed using HEC-1. SLA also set up HEC-2 files to calculate hydraulic parameters for the channel. The 1991 HEC-2 data files were set up with the same 2-year discharges and Manning's n values as the 1985 HEC-2 files. Two channels, Billys Creek and West Ditch Creek, were not resurveyed in 1991. Hickahala Creek was not resurveyed downstream of about sta 450+00. No 1985 HEC-2 files existed for Nelson Creek and Steammill Creek. The 1985 HEC-2 data files were modified by removing bridge sections since bridge section data were not available for the 1991 survey. The primary focus of the study was to determine channel parameters. Since the 2-year discharge was out of bank on both Hickahala Creek and Senatobia Creek, discharges were reduced to a percentage of the 2-year flow to keep the flows in the channel. The channel discharge was increased by reaches until the 2-year discharge was reached. The 2-year discharge was contained by the channel banks on the other channels in the watershed. SLA (1987) defined reaches for Hickahala Creek, Senatobia Creek, and James Wolf Creek. These reaches were numbered from upstream to downstream. The same reach lengths were used in this study except they were numbered from downstream to upstream. Reaches were also defined for the other channels in the watershed based on channel slope and changes in discharge. These reaches are shown in Figure 23. Table 16 contains the reach parameters discharge, velocity, depth, width, and slope for the watershed. Table 17 shows the changes in reach values from 1985 to 1991. Table 18 shows the range of percentage increases or decreases for parameters in the reaches. Figures 24-26 are plots of the hydraulic geometry relationships (width, depth, and slope) from Engineer Circular (EC) 1110-8-1(FR) (Headquarters, U.S. Army Corps of Engineers (HQUSACE), 1990) with data from the Hickahala Creek watershed. With a

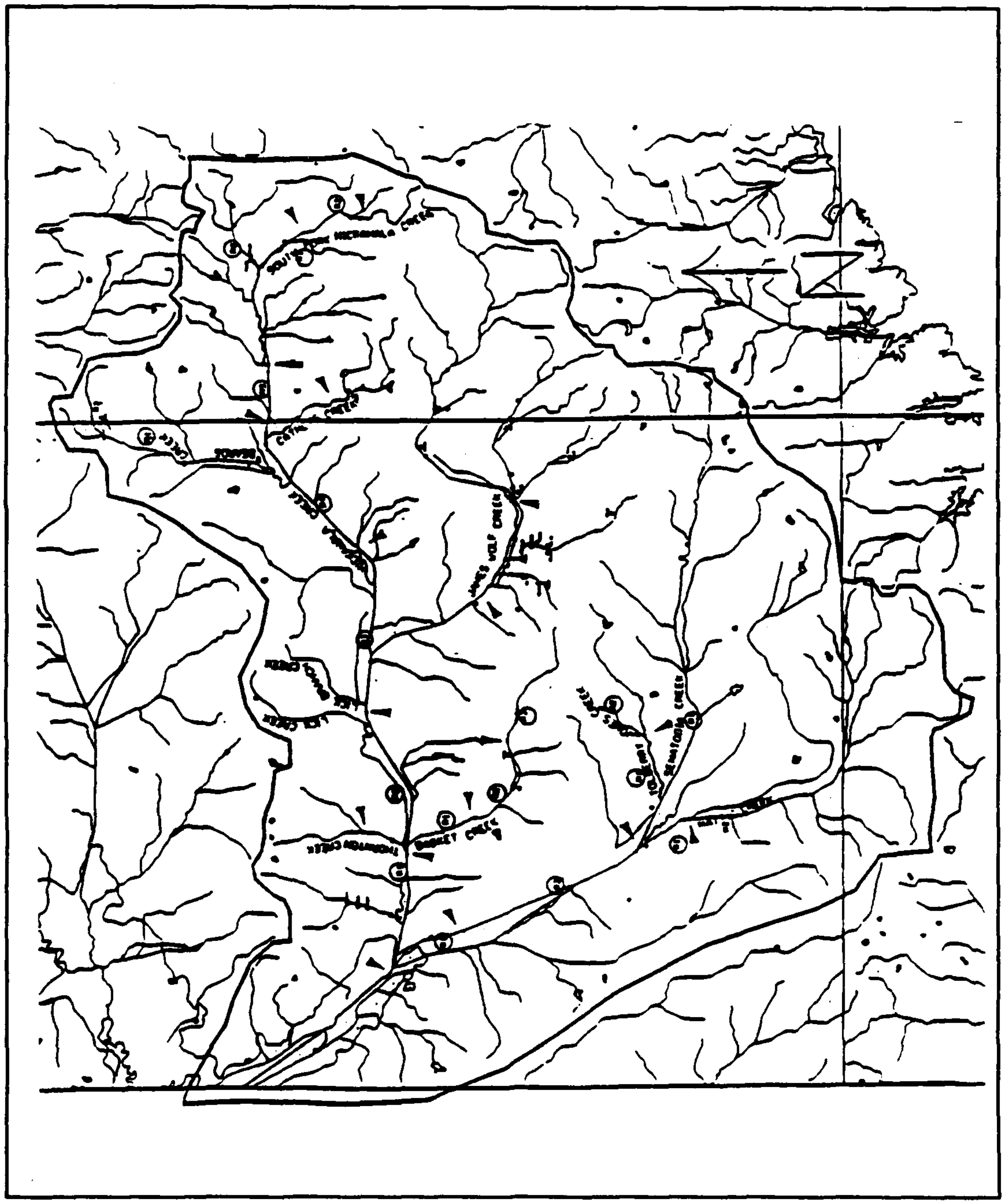


Figure 23. Channels and channel reach locations in the Hickahala-Senatobia Creek watershed

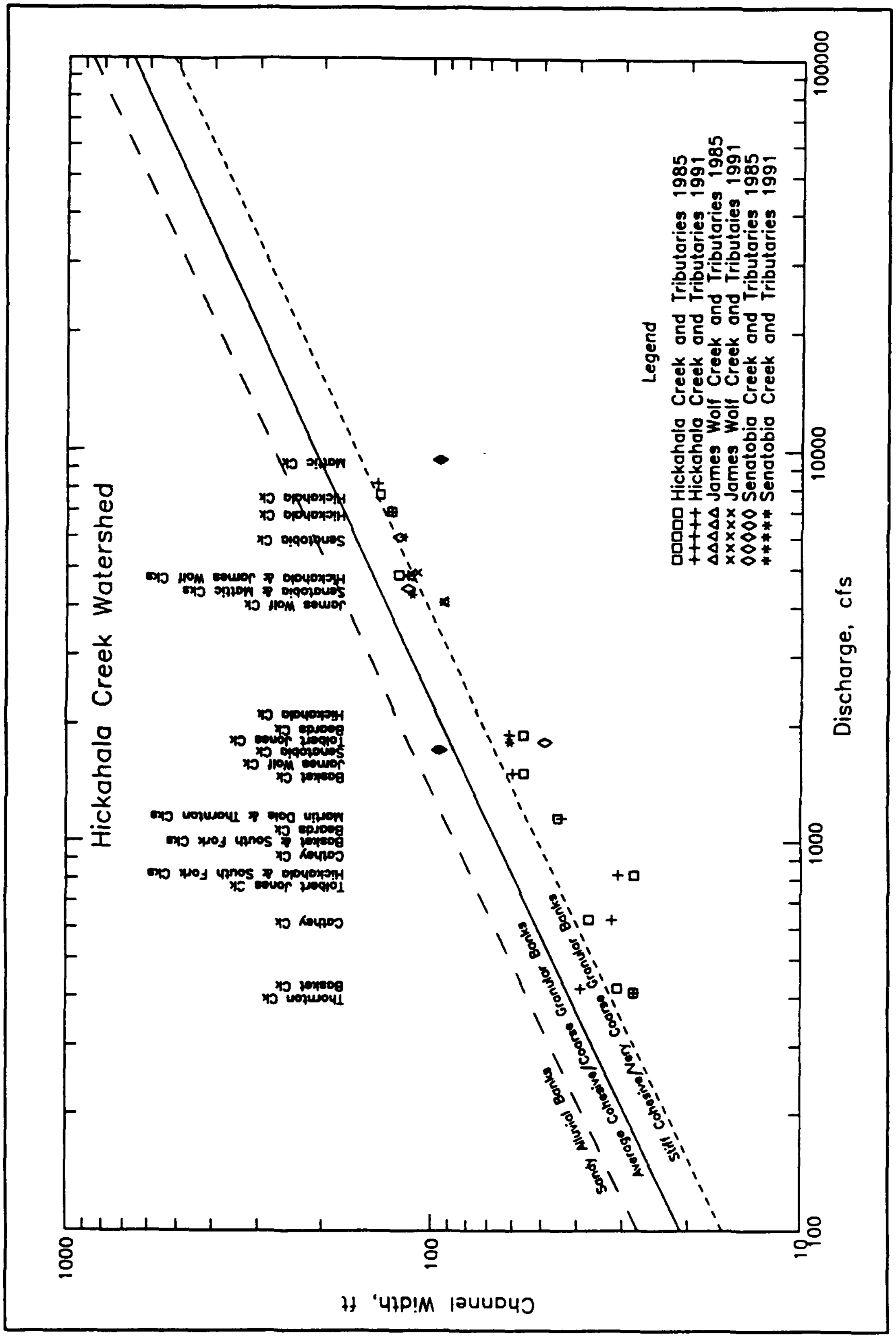


Figure 24. Hydraulic geometry relationships, Hickahala Creek, discharge versus width

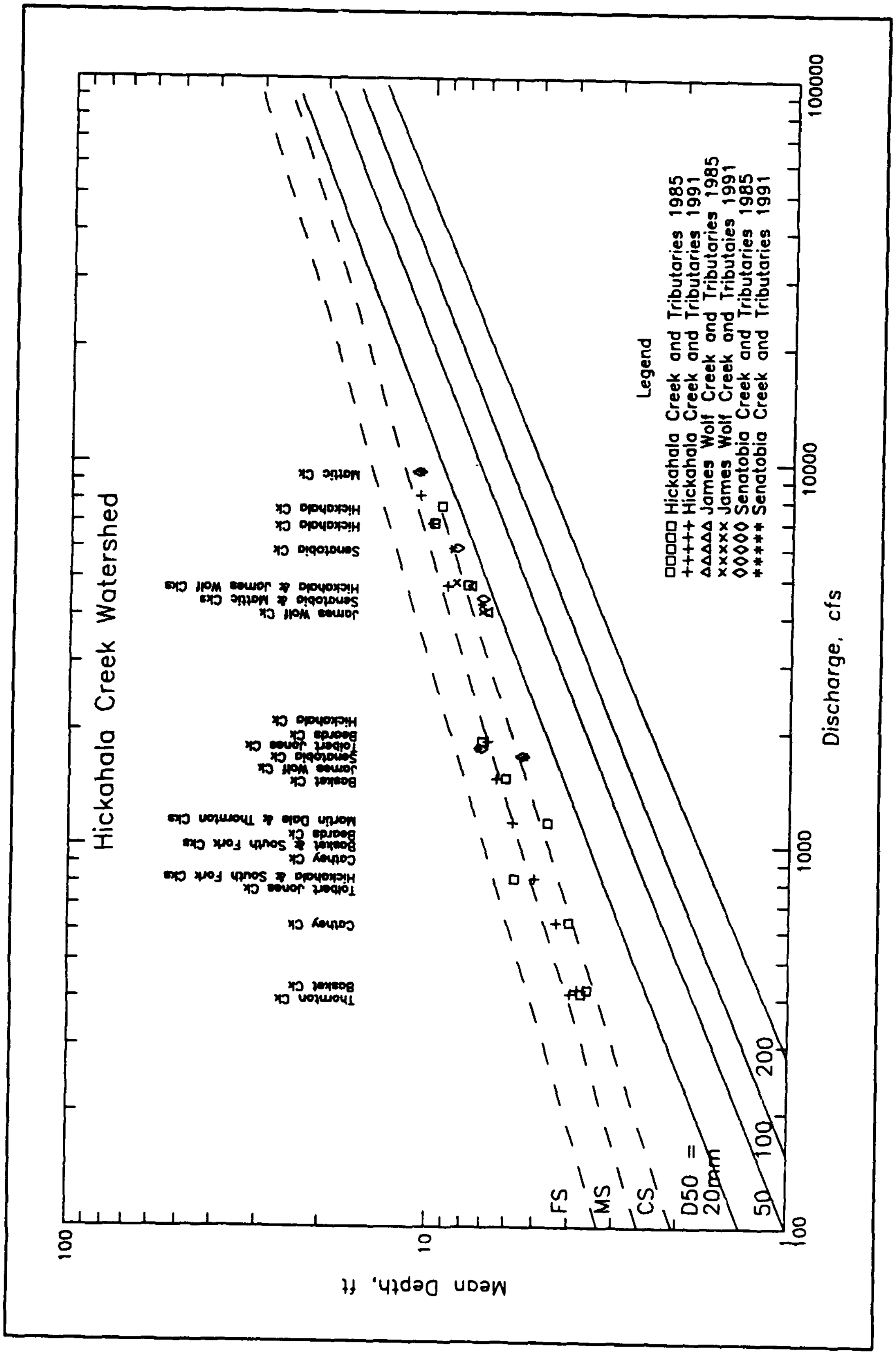


Figure 25. Hydraulic geometry relationships, Hickahala Creek, discharge versus depth

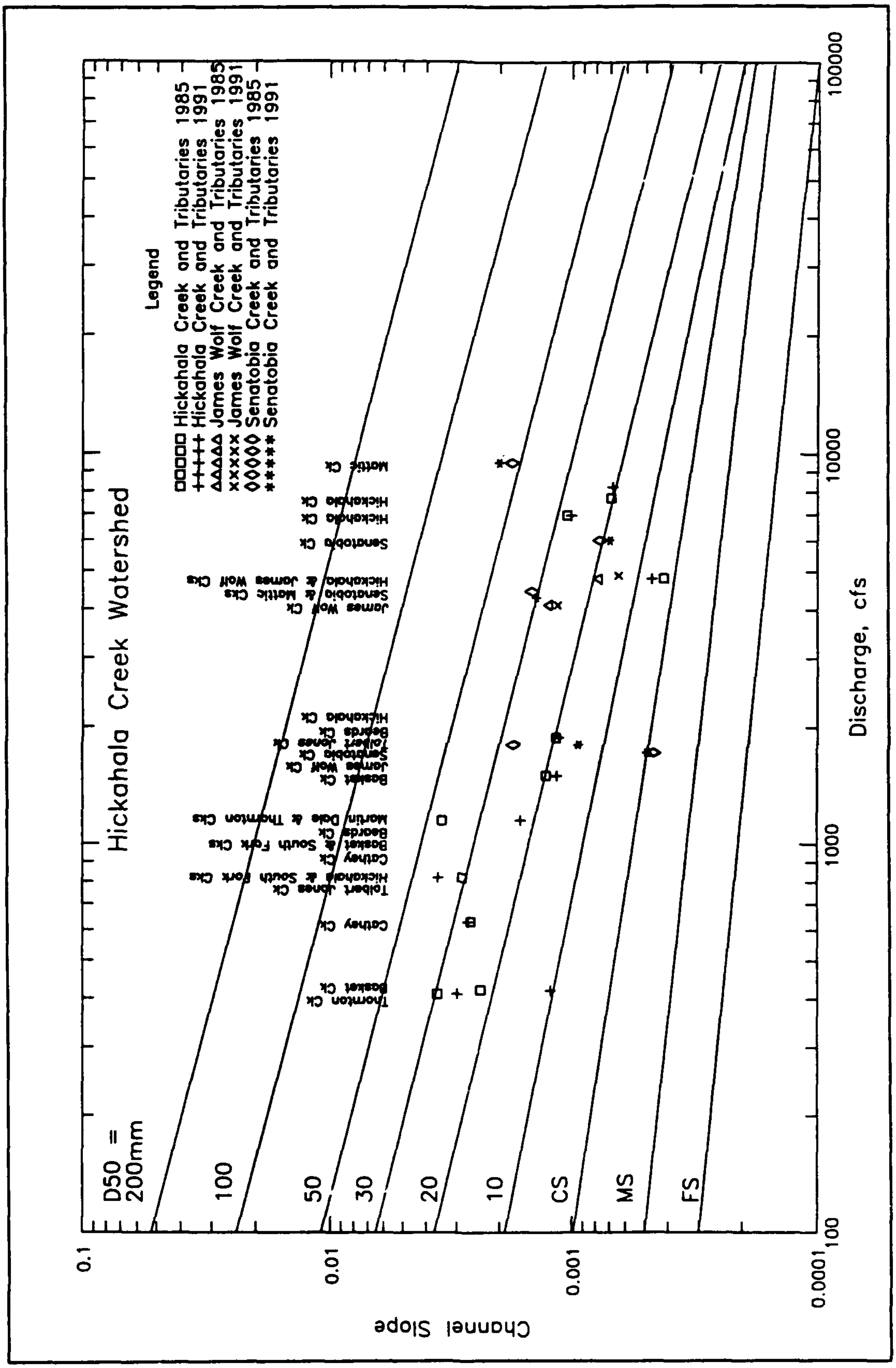


Figure 26. Hydraulic geometry relationships, Hickahala Creek, discharge versus channel slope

few exceptions the channel is narrower than expected for a channel with stiff cohesive banks. SLA (1987) reports that most bed material is fine to medium sand. The channel depths generally plot in the range of medium sand or coarser. The vertical stability of a channel did not seem to have a major impact on where the data plotted. However, all of the degradational reaches are narrower than expected for a channel with resistant banks. The channel slopes are all steeper than expected for a sand bed channel. It should be noted that some of the channel reaches on Hickahala and Senatobia Creeks are not the 2-year event but are the bank-full discharge.

Long Creek Watershed

The profiles and cross sections in the watershed were examined for changes between the two surveys.

Peters Creek. The channel bed appeared to be stable over the lower end of Peters Creek. However, in short reaches aggradation and degradation did occur. Above sta 250+00 up to 3 ft of degradation occurred. The cross sections seem to verify these profile changes. Only small changes in width are shown on the cross sections.

Long Creek. The channel bed degraded in all of the reaches of Long Creek. Some degradation occurred downstream of sta 50+00 but may have been restricted by outcrops near the first bridge. The reach from sta 50+00 to 120+00 that was extremely irregular on the 1985 survey showed much less variation on the 1991 survey even though the channel had degraded several feet. Between 3 and 4 ft of degradation occurred between sta 120+00 and 301+00 where the first grade control structure was located. The bed elevation upstream of this structure is higher than the 1985 elevation, so aggradation has occurred. The impact of the second and third grade control structures is unknown since the bed elevation prior to structure construction is unknown. Cross sections of this channel show the degradational trends. Channel widths changed very little.

Johnson Creek. About 2 ft of degradation occurred downstream of the confluence with Hurt Creek (sta 64+20). About 2 ft of degradation also occurred between sta 100+00 and 150+00. The channel was relatively stable between sta 150+00 and the first grade control structure (sta 301+00). This structure and the next two structures (sta 332+45 and sta 347+80) appear to have checked degradation and may have caused slight aggradation since 1985. Cross-section plots support this information.

Caney Creek. The lower end of Caney Creek experienced between 3 and 4 ft of degradation. This degradation stopped downstream of the first grade control structure at sta 52+13. Very little degradation occurred between this structure and structure 2 at sta 85+81. The profiles show up to 4 ft of degradation between structure 2 and structure 3 (sta 127+10). It is not known when the degradation occurred relative to the construction of the structure. Very few vertical changes occurred upstream of structure 3. The cross sections basically confirm the cross-section information.

Bobo Bayou. The channel profile shows very little change on Bobo Bayou. Between sta 100+00 and 143+00 less than 2 ft of degradation occurred. Very few changes are shown on the cross sections.

Hurt Creek. Only insignificant changes are shown on the profiles of Hurt Creek. A slight amount of aggradation may have occurred upstream of sta 100+00. The 1991 survey stopped at sta 125+00.

Goodwin Creek. Profiles of Goodwin Creek are included even though they were not resurveyed in 1991.

Hydraulic parameters of the channels in the watershed were calculated. Discharges and channel reaches were defined by NWHC (1989). Two sets of discharges were published by NWHC. FTN Consultants of Little Rock, AR, had developed a HEC-1 computer model to determine watershed discharges and HEC-2 models to determine water surface profiles for the 1985 cross sections. SCS had developed a TR-20 hydrologic model. NWHC relied primarily on the TR-20 discharges in their study. HEC-2 models were developed for Bobo Bayou and Peters, Long, Caney, Johnson, and Hurt Creeks for the 1991 survey data using the tributary method. The 1985 HEC-2 models were modified and bridge sections were removed. The 2-year TR-20 discharge was used in these studies. The channel roughness as defined by NWHC and used in the 1985 HEC-2 model was used in the 1991 model. Figure 27 shows the location of the reaches in the Long Creek watershed. Table 19 shows the reach parameters of discharge, velocity, depth, width, and slope for the watershed. Table 20 shows the changes in reach values from 1985 to 1991. Table 21 shows the range of percentage increases or decreases of parameters in the reaches. Figures 28-30 are plots of the hydraulic geometry relationships from EC 1110-8-1(FR) (HQUSACE 1990) with data from the Long Creek watershed. The plots of hydraulic geometry relationships show little consistency in the Long Creek watershed. Channel widths range from the expected width for sandy alluvial banks to much narrower than expected for stiff cohesive banks. Channels in the Long Creek watershed generally have medium to coarse sand bed materials. Channel depths range from those expected for medium sand beds to depths shallower than expected for gravel streams. Channel slopes were all steeper than expected for sand bed streams. Degradation or aggradation did not seem to affect where channel widths or depths plotted.

Batupan Bogue Watershed

Profile and cross-section data exist throughout the watershed. The cross sections from 1985 and 1991 were not taken at the same location on some of the streams, however. This makes direct comparison of cross sections difficult.

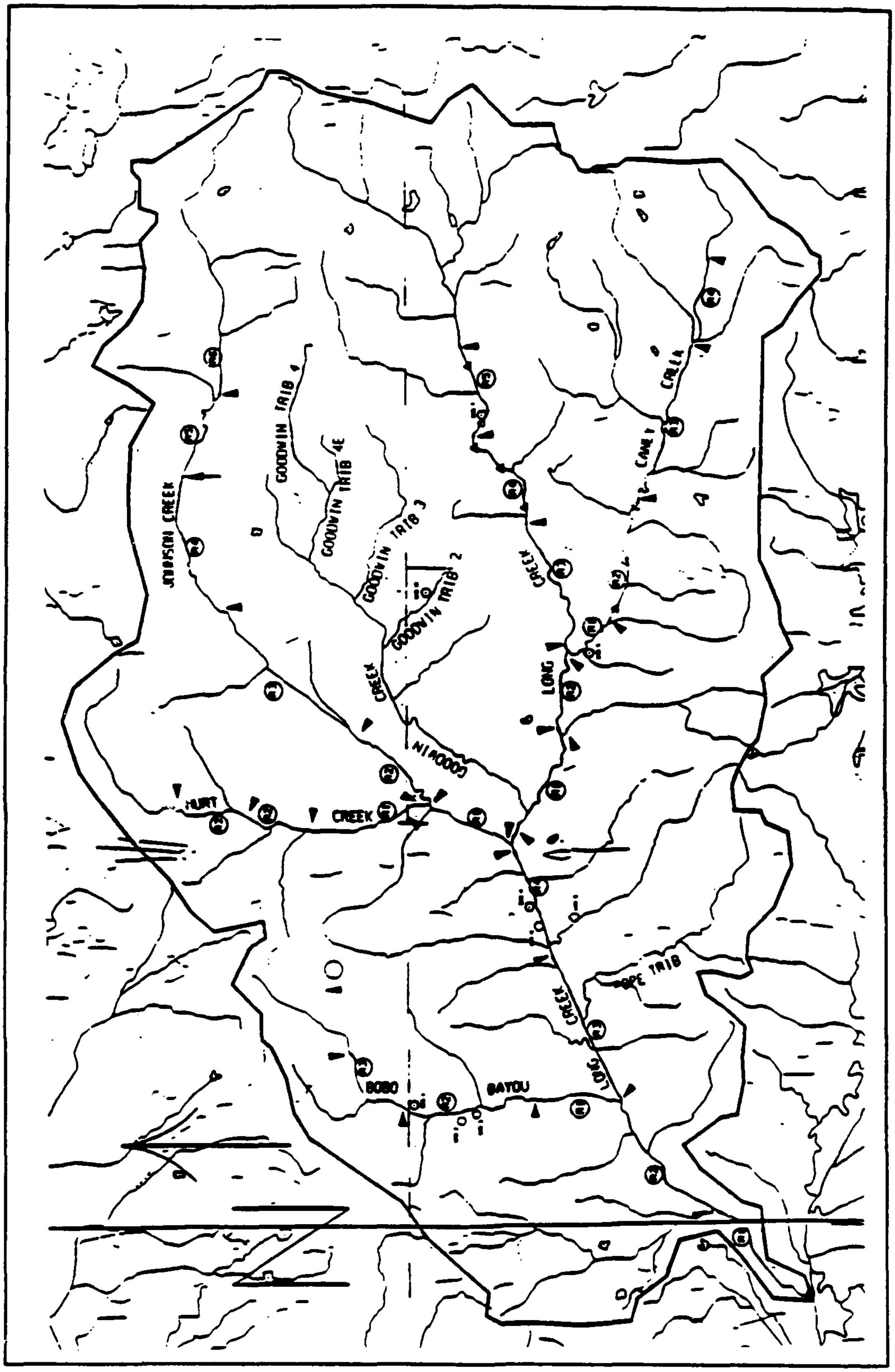


Figure 27. Channels and channel reach locations in the Long Creek watershed

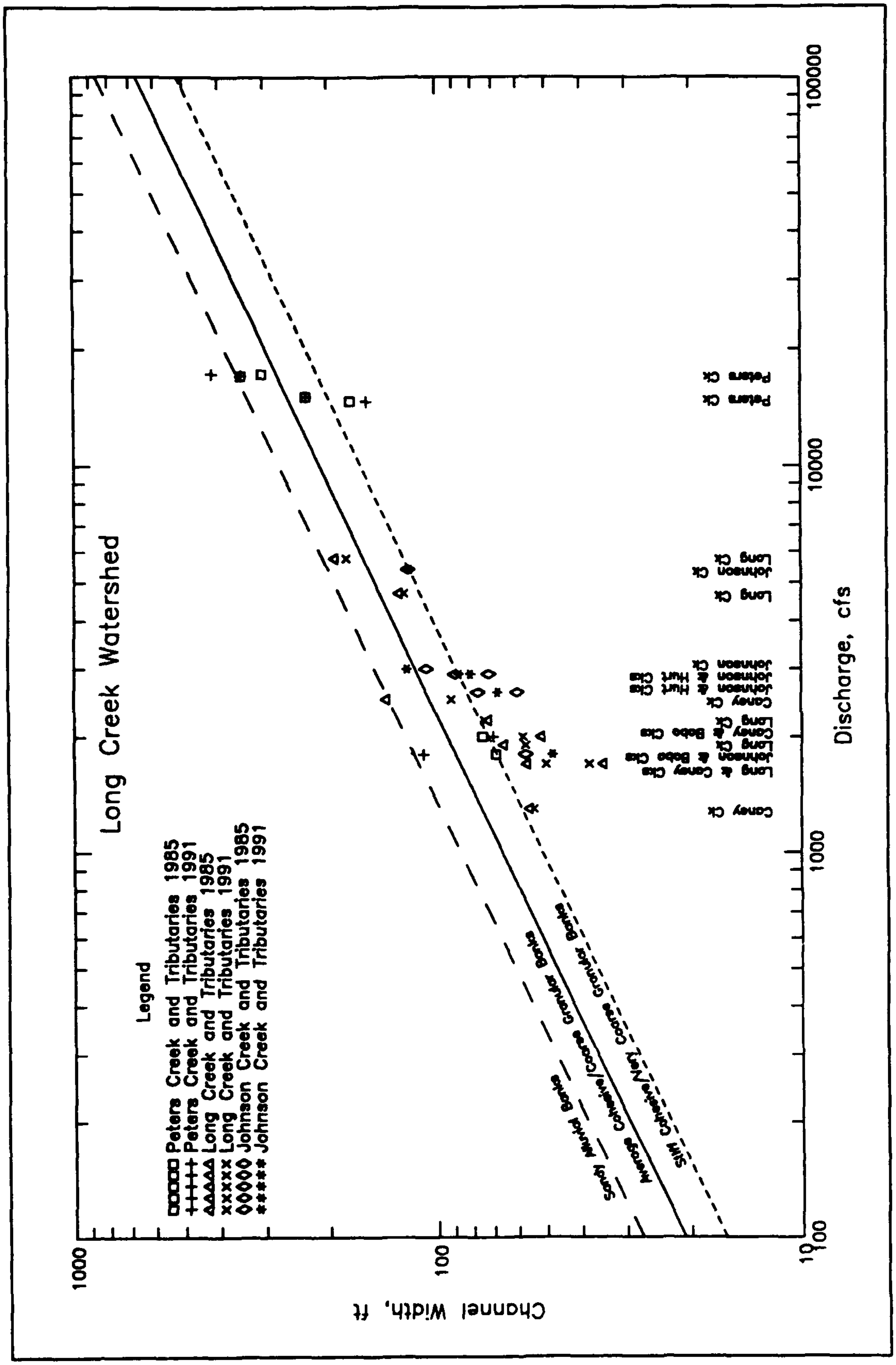


Figure 28. Hydraulic geometry relationships, Long Creek, discharge versus width

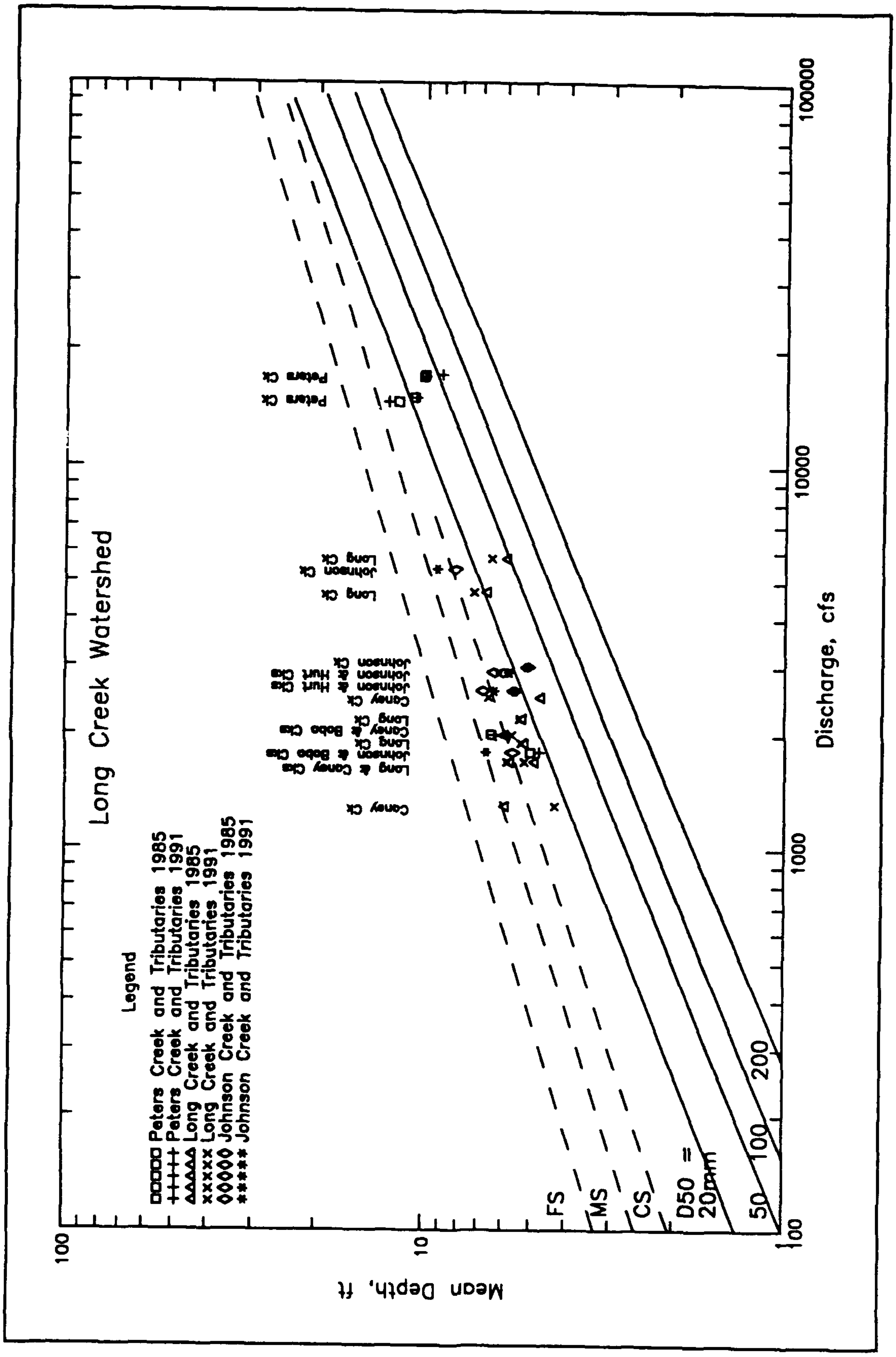


Figure 29. Hydraulic geometry relationships, Long Creek, discharge versus depth

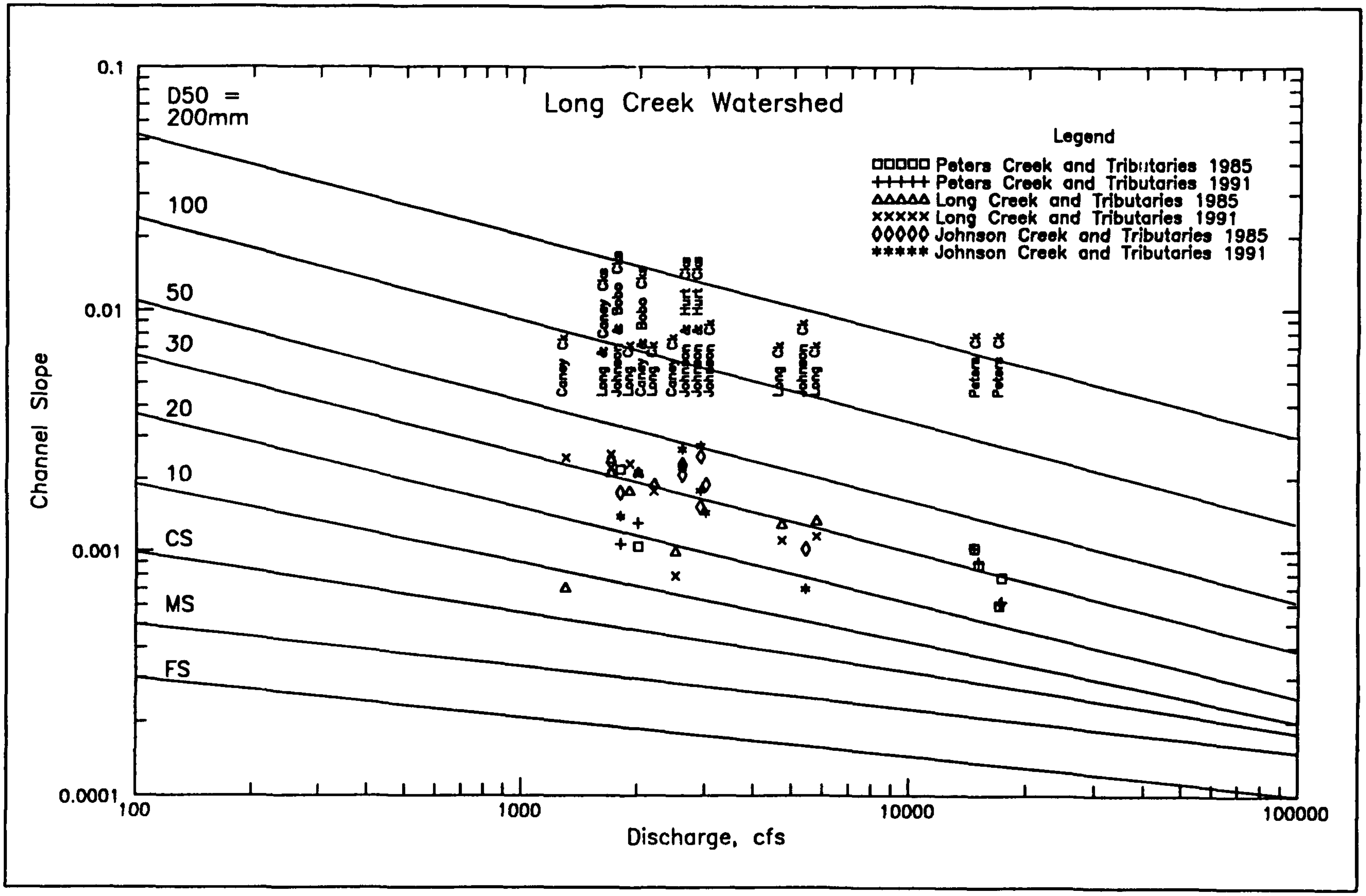


Figure 30. Hydraulic geometry relationships, Long Creek, discharge versus channel slope

Batupan Bogue. No significant aggradational or degradational trends occurred between 1985 and 1991. There appears to be some deepening or movement of scour holes along the lower 25,000 ft of the channel. The stationing of these scour holes indicates that they may be located in revetted bendways. These holes may become relatively permanent features and vary in depth depending on the preceding hydrographs. The cross sections were not surveyed at the same locations, and direct comparisons cannot be made.

Perry Creek. Grade control structures on Perry Creek have controlled channel degradation. From the mouth to structure 1 at sta 45+00 the profile was uniform and relatively stable from 1985 to 1991. From structure 1 to structure 2 at sta 111+00 the channel profile was irregular in both 1985 and 1991. This may be a function of bank protection in bendways. However, some aggradation occurred in the upper end of the reach. Above structure 2, the profile was relatively unchanged between the surveys. The Interstate 55 culvert (sta 297+00) also served as a grade control and stopped 10 ft of degradation. An active reach between sta 395+00 and 425+00 degraded 2 to 3 ft between the surveys. Upstream of sta 425+00 the channel was relatively stable. The cross sections on Perry Creek were not resurveyed at the same locations.

Perry Creek Tributary. This channel was surveyed for the first time in 1991. A drop may occur near the bridge (culvert) at sta 25+60.

Jack Creek. The profile had few changes from 1985 to 1991. Two drops were present between sta 120+00 and 150+00. The cross sections showed very few changes between surveys.

Big Bogue. No major changes occurred on Big Bogue. Upstream of the mouth of Wilkins Creek the profiles show up to 2 ft of aggradation between 1985 and 1991. The amount of aggradation decreased above the Highway 404 bridge, but aggradation still occurred. Generally the 1985 and 1991 cross sections were not surveyed at the same locations.

Eskridge Creek. The channel of Eskridge Creek aggraded up to 2 ft from the mouth to sta 50+00. Slight degradation occurred between sta 150+00 and the grade control structure at sta 213+12. The structure caused aggradation upstream for 2,500 ft. A second grade control structure is located near sta 260+00. The degradation shown in this reach may have occurred before the structure was constructed. The cross sections generally confirm the profile changes.

Sykes Creek. The profile shows only small vertical changes in Sykes Creek. Between 1 and 2 ft of degradation may have occurred between sta 100+00 and 200+00. The cross sections were not surveyed at the same locations but indicate a lack of vertical bed movement.

Worsham Creek. The profile was based on 1991 stationing. The channel on Worsham Creek shows very few changes from 1985 to 1991. Slight degradation occurred downstream of the structure at sta 246+30. The channel elevation also dropped upstream of the structure slightly. The cross sections indicate very little vertical or lateral instability.

West Fork Worsham Creek. Slight aggradation occurred between the channel mouth and sta 20+00. Additional aggradation occurred upstream of the grade control structure at sta 28+90. The profile shows a degrading reach from about sta 65+00 to the structure at sta 82+50. The cross sections confirm the profile information.

East Fork Worsham Creek. The channel downstream of the structure at sta 15+80 is very steep. No significant changes occurred between 1985 and 1991. The cross sections show little change.

Middle Fork Worsham Creek. Very few changes occurred in the vicinity of the lower structure at sta 11+30. The bed profile in the area of the structure at sta 65+70 is very irregular. Between sta 45+00 and 65+00 up to 7 ft of degradation occurred. The cross sections verify the profile information.

Jackson Creek. The profile, which was stable downstream of sta 50+00, shows aggradation from sta 40+00 to sta 160+00. From sta 115+00 to sta 135+00 the aggradation occurred in a reach much steeper than other sections of the channel. Not enough information exists to detect any survey irregularities. The cross section information confirms the profile.

Wilkins Creek. The channel was not surveyed in 1991. The 1985 profile shows a very uniform slope.

Eskridge Creek Tributary. About 2,000 ft of channel was surveyed. The lower end of the channel was very steep.

Little Bogue. Local scour occurred in the reach from sta 8+00 to sta 25+00. This scour could have been in protected bendways. Between 1 and 2 ft of aggradation occurred between sta 140+00 and 300+00. Degradation started at sta 500+00 and continued upstream to near sta 575+00 where a natural control exists. The channel degraded and scoured upstream to the grade control at sta 634+20. Scour also occurred upstream of the structure. Although the cross sections were not surveyed at identical locations on the surveys, the sections verify the profile.

Powell Creek (Pruill). No major profile changes occurred on the channel. Slight aggradation occurred downstream of the bridge at sta 18+60. Some local scour was present at sta 70+00. The cross sections verify these findings.

Mouse Creek. The headcut on Mouse Creek did not move from 1985 to 1991. Up to 3 ft of degradation occurred in the 3,500 ft of channel upstream of the drop. Degradation also occurred in the upper part of the watershed between sta 185+00 and 220+00. The surveyed cross sections show little change.

Caffe Branch. Between 2 and 6 ft of degradation occurred downstream of sta 20+00 between the surveys. Slight degradation continued upstream to sta 50+00. This degradation may have occurred before the structure at sta 24+40 was constructed. The cross sections confirm the trends of the profile.

Campbell Creek. The 1991 survey was used as the base stationing for the channel since the first 6,500 ft of the 1985 survey appeared to be in error. The profiles show 2 to 3 ft of degradation between sta 85+00 and 110+00. The cross sections verify the profiles.

Epison Creek. No changes occurred from the mouth to sta 85+00. About 2 ft of degradation occurred between sta 85+00 and 130+00. Slight aggradation is shown upstream of that location. The cross sections verify these changes.

Crowder Creek. Very little degradation occurred downstream of sta 120+00. The degradation increased upstream to above sta 200+00 with a maximum degradation of 4 to 6 ft occurring near sta 160+00. The cross sections were not surveyed at the same locations in 1991 as in 1985.

Little Mouse Creek. These channel profiles are plotted to 1991 stations since the 1985 stationing appeared to be incorrect. A maximum of 2 ft of degradation occurred along the profile. The cross sections show very little change.

An analysis was conducted to determine channel changes. The cross sections from 1991 were incorporated into HEC-2 data files. Cross sections from 1985 were in files developed by WET[1]. WET prepared a series of reports on the Batupan Bogue Basin for the Vicksburg District. WET (1986) contains the documentation of the hydrology developed for the Batupan Bogue basin from the HEC-1 computer model. Six channels have been surveyed that have no existing hydrology: Campbell Creek, Little Mouse Creek, Middle Fork Worsham Creek, Epison Creek, West Fork Worsham Creek, and Caffe Branch. Two channels that were not resurveyed on which hydrology exists are East Fork Bogue and Wilkins Creek. The channels with hydrology were grouped as tributaries of Batupan Bogue, Little Bogue, or Big Bogue. Initial runs of the HEC-2 model showed that the 2-year discharge caused out-of-bank flows on Batupan Bogue, Big Bogue, and Little Bogue. Since the primary focus of the study was to determine channel parameters, flows on these three channels were reduced to a percentage of the 2-year discharge to keep the water surface elevation below top bank. The only discharges calculated by WET on the tributaries were at their mouth. The 2-year discharge was used to model these channels, but the discharge was not reduced as the watershed size decreased. The 1991 data files were set up using the same Manning's n values as the 1985 data files. WET (1987b) divided Batupan Bogue, Big Bogue, and Little Bogue into reaches as part of the sediment studies based on channel slope

[1] Unpublished data.

from the profiles and the location of major inflows. Upstream of major tributaries, the discharge was not reduced, but those reaches were considered to have discharges in excess of the 2-year flow. Figure 31 shows the location of the reaches in the basin. Table 22 shows the reach parameters of discharge, velocity, depth, width, and slope for the watershed. Table 23 shows the changes in reach values from 1985 to 1991. Table 24 shows the range of percentage increases or decreases of parameters in the reaches. The changes in the channel parameters should be considered with caution since many channels in the basin were not resurveyed at the same location. Figures 32-34 are plots of the hydraulic geometry relationships from EC 1110-8-1(FR) (HQUSACE 1990) with data for the Batupan Bogue watershed. Tributary reaches in which the discharge exceeded the 2-year event are not plotted, and the discharges plotted for Big Bogue, Little Bogue, and Batupan Bogue were 80 percent of the 2-year event. On some channel reaches, the width varied from that expected for a sandy alluvial bank to narrower than expected for stiff cohesive banks. Channel depths varied from those expected for gravel streams to those expected for sand bed streams. Channel slopes were steeper than expected. Also the plots show only the more stable lower end of tributary channels and include few degradational reaches.

Conclusions

Problems encountered in the geomorphic analysis ranged from survey data to analysis methods. The 1991 thalweg profile stationing had to be corrected to the 1985 stationing before the profiles could be compared. On a few profiles there were not enough comparable points to completely correct the stationing. Since cross sections were also identified by stationing, to properly compare cross sections, the difference in stationing between the surveys had to be considered. The cross sections that were the easiest to compare were those that listed the cross section by both the 1985 and 1991 stations. In the future, all cross sections should be listed by current and old station numbers. The stationing of all bridges, power lines, or other such features should be noted on the survey to make adjustments to profile length easier and to eliminate questions about aggradation and degradation zones.

Any two surveys represent only two points in time and not a total history of the channel. An example of this situation is Caney Creek, where significant degradation occurred between the two channel profiles. Several grade control structures were constructed on the channel between the surveys. From only the profile surveys it cannot be determined if the channel bed degraded before or after structure construction, or degraded before structure construction and aggraded after structure construction. In other locations, bed elevation changes might be indicative only of the most recent discharges and sediment loads in the channel and not long-term trends.

In a true geomorphic analysis of channel parameters, the width and depth are measured directly from the cross sections. In this study the HEC-2

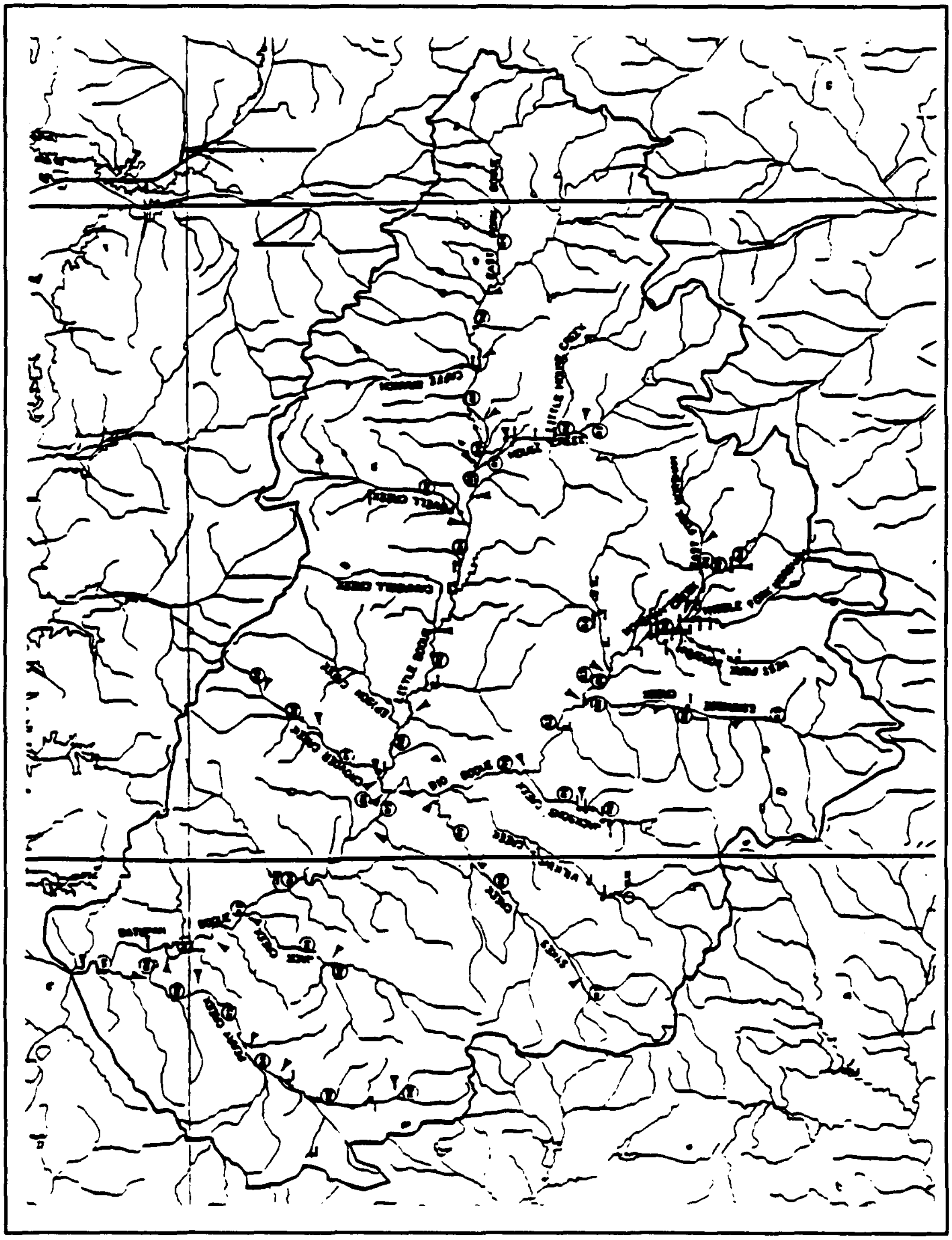


Figure 31. Channels and channel reach locations in the Batupan Bogue Watershed

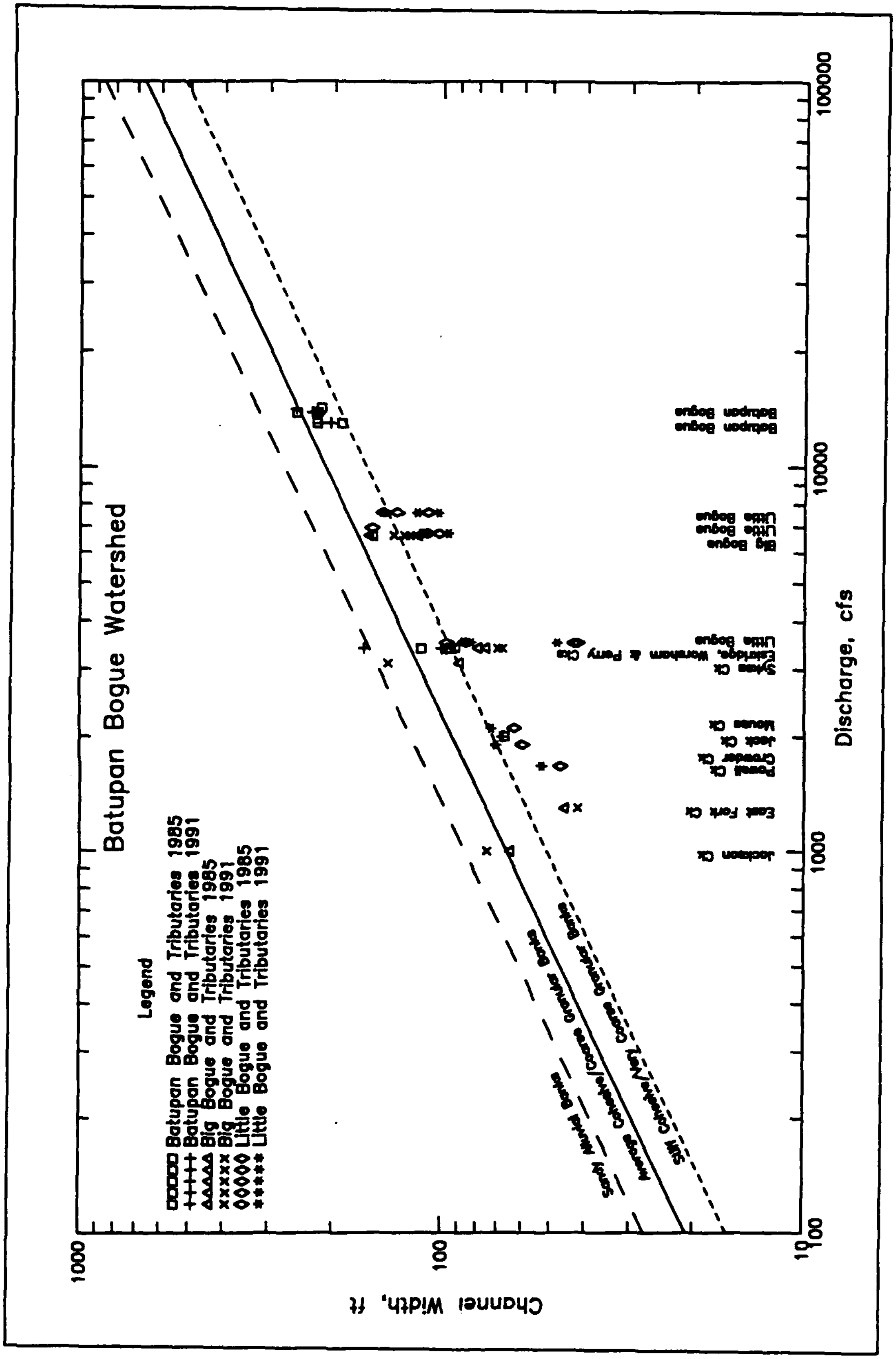


Figure 32. Hydraulic geometry relationships, Batupan Bogue, discharge versus width

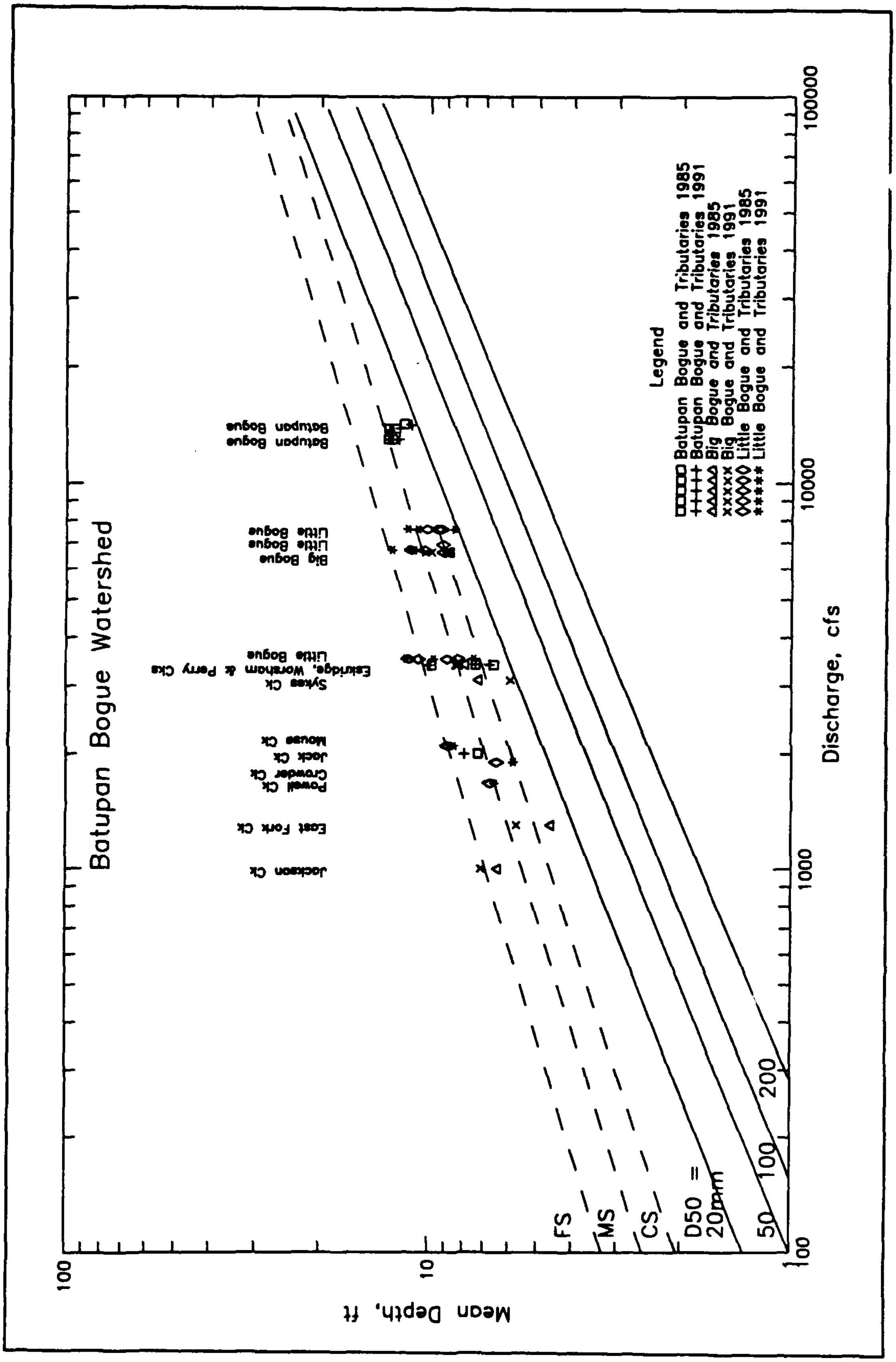


Figure 33. Hydraulic geometry relationships, Batupan Bogue, discharge versus width

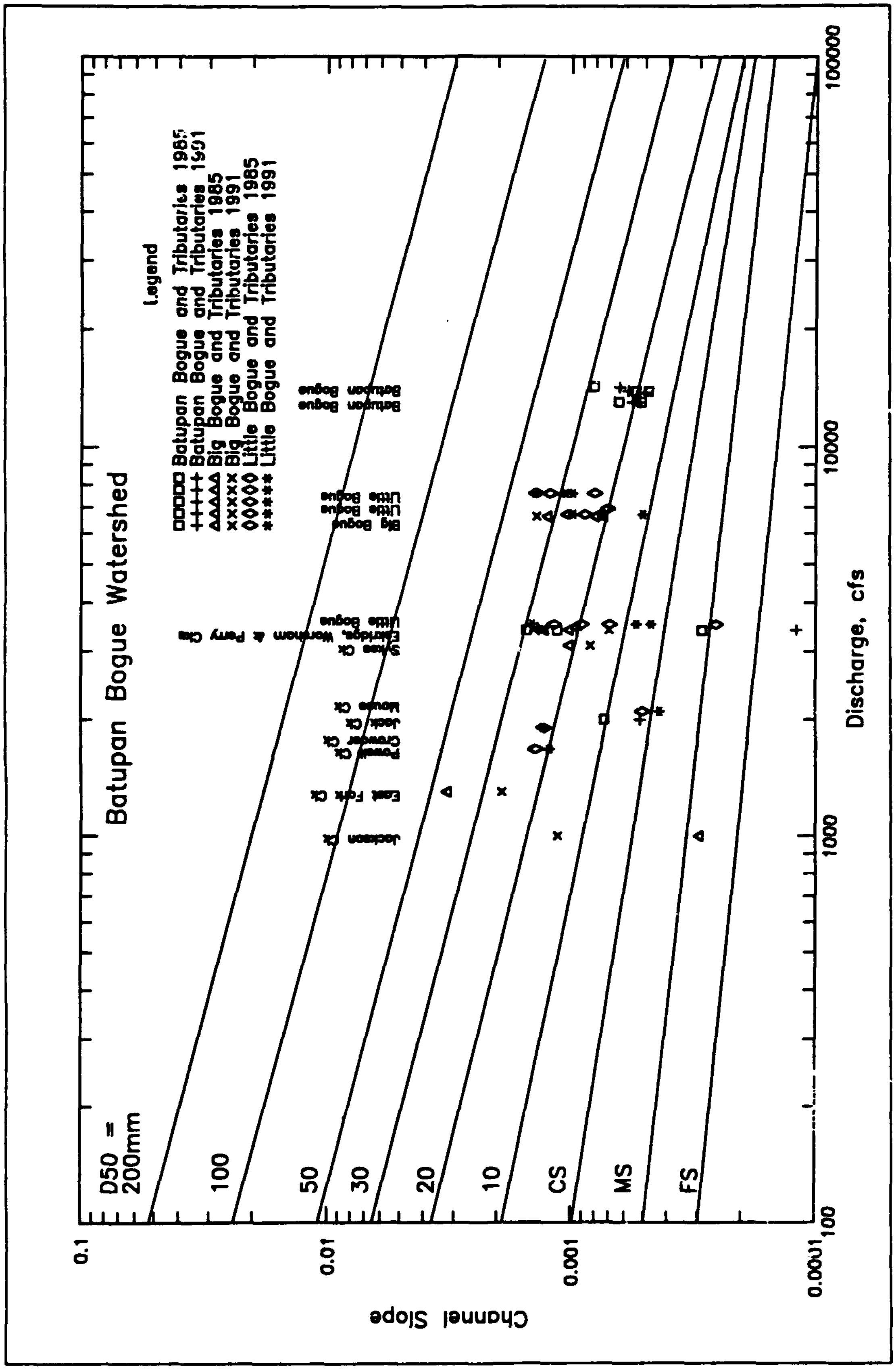


Figure 34. Hydraulic geometry relationships, Batupan Bogue, discharge versus channel slope

backwater profile model was used to determine width, slope, velocity, and mean depth on a reach-by-reach basis for the 1985 and the 1991 survey data. The potential for significant problems exists with this method.

The 2-year discharge or the bank-full discharge, whichever was smaller, was used in this study to calculate channel parameters. The assumption was made that the 2-year discharge was close to the channel-forming discharge. However, this assumption has not been verified in degraded channel systems. The 2-year discharge used in the HEC-2 model was based on HEC-1 or TR-20 data developed on the watersheds for the Vicksburg District. There are practically no hydrologic data to verify these discharges. These numbers must be improved as more data are collected on the DEC watersheds.

The Manning's n value selected for each reach of channel is critical to calculating the proper water surface elevations and the resulting hydraulic parameters. The data collection efforts in the watersheds will increase the knowledge of n values by gathering data on water surfaces and discharges.

The cross sections surveyed in the DEC watersheds are an average of one-half mile apart. If channel changes were to be analyzed only by direct comparison of individual cross sections, this spacing might be adequate. However, this spacing may be inadequate for HEC-2 analysis. Many of the channels in DEC watersheds are steep, and the conveyance changes greatly between cross sections. During the analysis, the HEC-2 program frequently printed warnings that the conveyance changes were outside acceptable limits. The calculated hydraulic parameters would be more accurate if the cross sections were closer together. There are few cross sections at natural drops and at grade control structures. In many of these locations, critical depth of flow is assumed at the first section upstream of a drop; therefore channel averages tend to be biased. Also in consideration of the importance of evaluating the effects of grade control structures, a more intensive monitoring effort should be made in the vicinity of each structure.

Cross sections must be typical for each reach; otherwise trends will not be accurately reflected. Also the cross sections should be monumented so that they can be resurveyed. The 1985 cross-section locations on portions of Batupan Bogue were not repeated in the 1991 survey, and the data were of questionable value for both direct comparisons and HEC-2 analysis. Other cross sections do not appear to be properly located on the watershed maps.

Using HEC-2 to calculate hydraulic parameters might not discover all channel changes between two surveys, however. It would be theoretically possible using the hydraulic approach to have the same width and mean depth for two different points in time but the elevation of the water surface would be significantly different after the channel adjusted vertically. Therefore direct comparisons of channel profiles or cross sections are necessary in addition to the hydraulic analysis.

Additional information for data analysis would include information on the bank material and the bed material at each cross section. For this study, information was used from previous reports. However, this information should be updated and could be gathered at the time of each survey.

6 Hydrology

In the DEC monitoring program, methods are being developed to reduce bank erosion along small streams. A vital part in developing these methods is an accurate estimation of the flow in the streams. Therefore, hydrology methods are being developed for all the watersheds in the DEC Project area.

A method for calculating streamflow must calculate the streamflows not only under present land use patterns, but also under future land use patterns. This will be useful in developing new methods to reduce streambank erosion.

Since this is the goal, the SCS curve number method seems to be an appropriate choice for this study. Also, this method is easily adapted to a GIS system such as the one being developed for the design of riser pipes.

Past Work

The Vicksburg District has set up hydrology models on Long Creek, Hickahala Creek, Coldwater River, Black and Fannegusha Creeks, Hotophia Creek, Batupan Bogue Creek, and Abiaca Creek. Also, hydraulic models have been set up on all these watersheds except for Coldwater River.

SCS has set up some hydrology models on the watersheds in north Mississippi. However, none of the models that the Vicksburg District or the SCS has set up are in a GIS system.

Present Work

A GIS system is being built for the design of riser pipes that can be used to set up the hydrology models. The data in the GIS system will consist of 1:24,000-scale elevation data, detailed channel data in selected reaches, SCS generalized soil type grids, land use grids, aerial photography, slope grids, and SCS curve number grids. Once all the data have been put into the system, the hydrologic parameters needed to put into the HEC-1 program can be calculated.

The GIS system also allows the user to alter the land use grid to reflect some desired land use and calculate the effects on the hydrology. This will be useful in developing methods to reduce streambank erosion as mentioned before.

Work was initiated on the evaluation of the applicability of the two-dimensional hydrology model, CASC2D, to DEC watersheds. The GIS data-base was used in constructing the CASC2D model for the Goodwin Creek watershed. These model results are being compared to results from a one-dimensional Snyder unit hydrograph model, a one-dimensional SCS curve number model, and observed data from Goodwin Creek. Preliminary results indicate potential for more accurate discharge calculations on DEC watersheds with the two-dimensional modeling approach.

Future Work

This work will consist of taking the data in the GIS system, calculating the parameters, and building the HEC-1 models. Presently an extensive gauging operation is being conducted within the DEC watersheds to evaluate the effectiveness of the control structures already in place. Also, discharge rating curves are being developed at key gauging locations. This work will help in adjusting the HEC-1 models, thus allowing for more detailed studies to be done on the causes and solutions to the sediment problems in north Mississippi. Also modeling of selected DEC watersheds using the two-dimensional approach will continue.

7 Stream Gauging

The data collection effort is intended to be in direct support of the other DEC functions. Data being collected consist of water surface elevations and flow rates for the many streams and rivers in the DEC watersheds. The primary use will be as input to hydraulic and hydrologic models, but it will also be used in the analysis of the performance of hydraulic structures.

Raw Data

In its raw form the data are recorded in feet of water relative to some reference point. Depending on the type of instrumentation used, the data must be added or subtracted to a known datum to represent the true water surface elevation. In the case of the flow rate measurements, the data are recorded as velocities associated with known cross-sectional areas. From these, a flow rate is calculated for a given cross section.

Instrumentation Used for Obtaining Water Surface Elevations

Four types of water level measuring instruments are being deployed, as well as nonrecording crest gauges and staff gauges: a Lundahl ultrasonic distance-measuring meter, a Leupold Stevens pressure transducer, a Micro-Tide tide gauge, and a Leupold Stevens float and encoder assembly. It is desirable to use recording instruments so that time-tagged data may be obtained. If small enough data collection intervals are used, it is possible to obtain hydrographs of runoff events that capture the peak flow rates. The nonrecording crest gauges and staff gauges are being employed as checks for the electronic recording instruments, and in some cases, over longer reaches to obtain water surface backwater profiles for single peak events.

Ultrasonic sensor

Ultrasonic instruments have been employed in water surface elevation measurements at least since the Mount Saint Helens eruption with varying degrees of success. The advantage of these instruments is that there is no contact of the device with the water. Difficulties such as the loss of instruments due to floating debris, fouling due to suspended sediment or biomasses, and the need for expensive stilling wells are some of the traditional problems associated with water level measurements that are immediately circumvented by using an ultrasonic sensor. The inherent shortcoming of using an ultrasonic sensor is the instrument's sensitivity to temperature and wind.

The model DCU-10 transducer, manufactured by Lundahl Instruments, Inc., was chosen for this project because of its acceptable specifications. The accuracy is ±0.25 percent of range with no gradient using temperature compensation, which for a distance of 25 ft is 0.0625 ft. The resolution is 0.01 ft over full range. The instrument is very versatile in that there are 29 programmable modes to adapt it to various measurement and deployment configurations. It is encased in a strong stainless steel housing, and the ceramic transducer version is extremely resistant to corrosion. The required power supply is 12-24 V at 95 mA. Temperature is compensated for by an optional integrated thermistor. At calibration this thermistor is activated and allowed to sense the current temperature. That temperature is then used as a reference temperature in the equation

$$d * \left[\left(\frac{t + 273}{273}\right)^{1/2}\right] \tag{1}$$

where d is the measured distance and t is the temperature in degrees Celsius, to make adjustments to the measured distance. A test in a WES laboratory to check the effectiveness of this compensating method showed that the measurements made with compensation were within the manufacturer's specifications. Based on these results, DEC accuracy requirements, and the prior successful employment of these instruments on the U.S. Corps Army of Engineers dredge *Wheeler* (Scott 1992), it was decided to proceed with the deployment of the Lundahl DCU-10 on the DEC watersheds. A mount was designed and built using 1/4-in. steel pipe and off-the-shelf electrical connector boxes and fittings (Figure 35). The mount is intended to provide protection from weather and vandalism. It also provides a convenient means of fastening the sensor to posts, walls, and bridge railings, as well as allowing easy yet secure access to the instrument for field calibration and trouble-shooting if necessary. A Sutron 8200 data logger was selected to power the instrument and record the data because of its competitive price and the many features suited to this application. Specifications for the data logger are in Appendix D. A 24-V solar panel was also installed with a blocking diode to keep the logger internal battery fully charged at all times. The instrument, mount, and logger are shown in Figure 36.

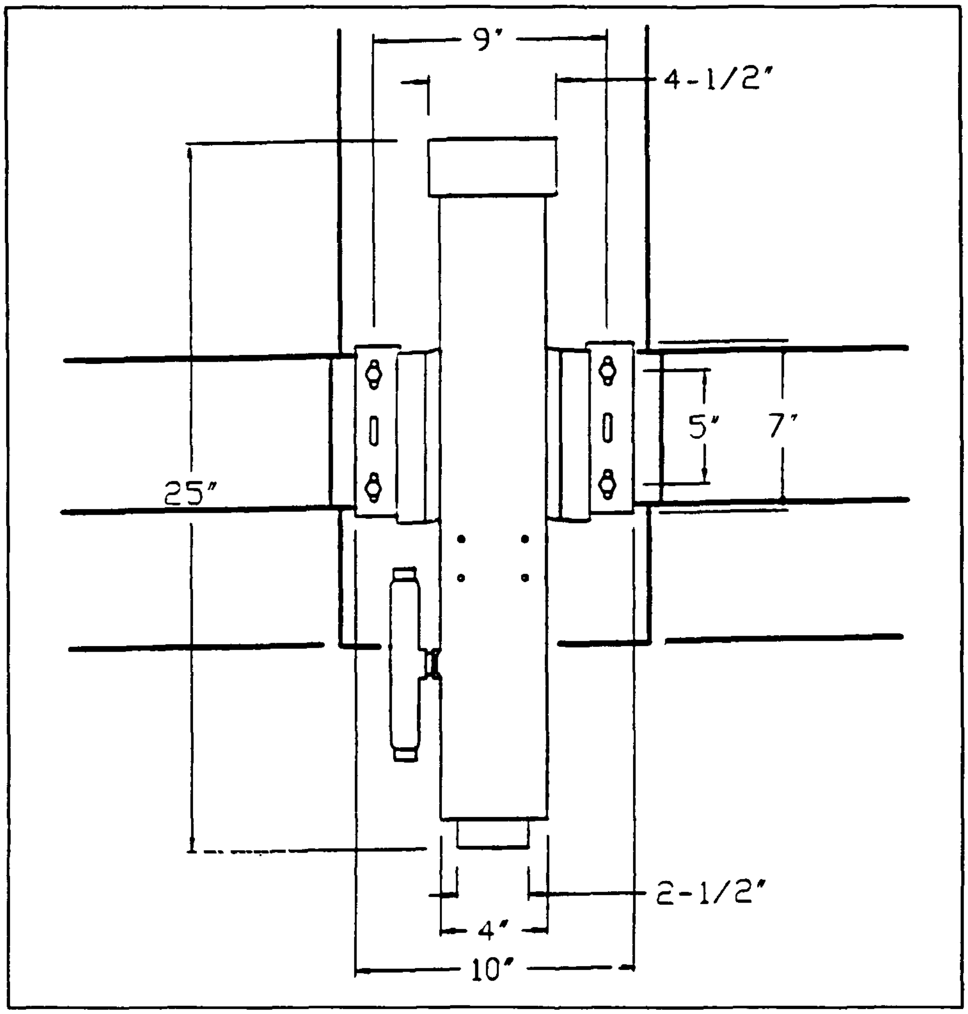


Figure 35. Ultrasonic sensor mount

Pressure transducers

Early in the program it was determined that the installation of ultrasonic meters would not be possible at all locations, since these instruments require a stable, stationary base on which they can be mounted. Thus when bridges, wing walls, or other already existing structures for mounting an ultrasonic instrument were not available, it was decided that a pressure transducer of some sort might provide an acceptable solution. These instruments can be located at the bottom of a stream, and thus are in general less likely to be affected by debris. Also, no stilling well is required. If fouling of the sensor can be avoided, these instruments can provide satisfactory data within the given accuracy constraint. A Leupold and Stevens model 420 level logger in conjunction with the Stevens Submersible Depth Transmitter II (SDT II) was chosen. The manufacturers' stated accuracy and other specifications are shown in Appendix D. In general, errors of 0.06 ft in 25 ft would be the upper limit. The range of the instruments purchased for this project is 25 ft. The

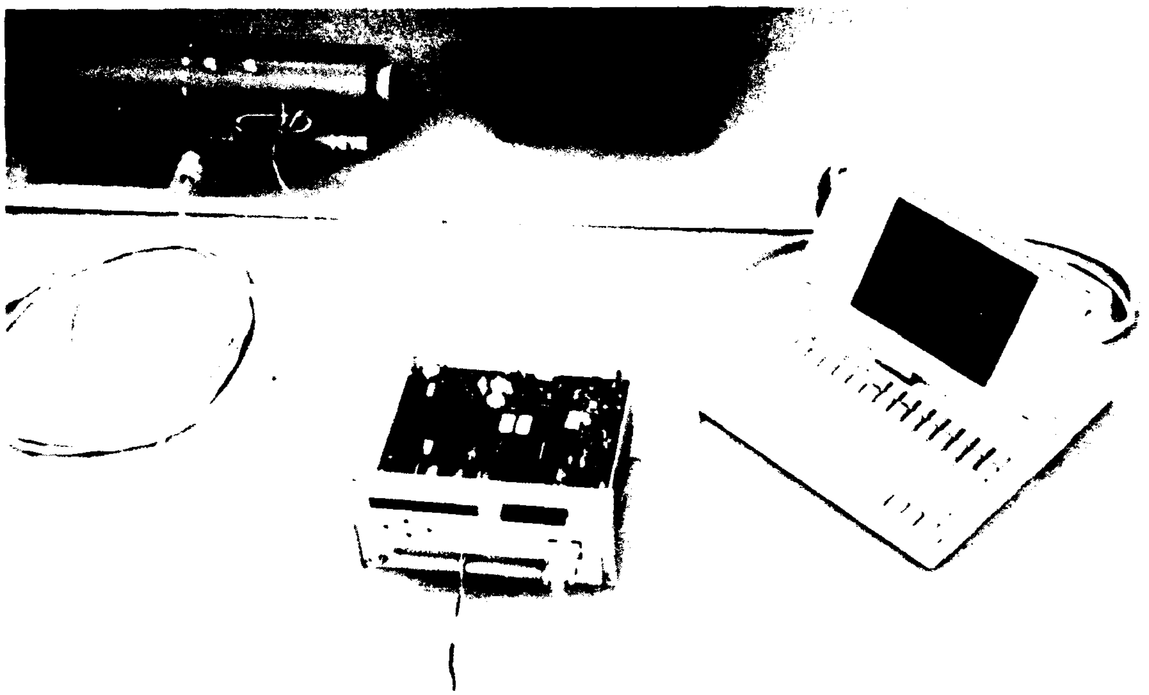


Figure 36. Ultrasonic sensor, mount, logger, and personal computer

transducer is vented to the atmosphere, so there is no need to compensate for changes in atmospheric pressure. To provide protection for the transducer as well as a method for securing it to the channel bottom, 1/4-in.-thick, 2-1/2-in.-diam steel pipe is used. Fittings were designed to allow the instrument to be threaded into or out of the pipe mount to allow for servicing when necessary. The pipe mount is secured to a 5-ft length of angle iron and driven into the creek bed. The signal cable is secured in buried 1/2-in. steel conduit from the instrument in the creek bed, up the bank, and to the logger box assembly. A typical logger box installation is shown in Figure 37. The logger is a dedicated single-channel unit accepting a 4- to 20-mA signal from the transducer, and powered by a 12- to 24-V source (presently a 12-V 6-Ampere hour battery). Using a 64,000-byte data card, and when logging at intervals of 10 min, the 420 logger can log data for approximately 180 days. The logger is housed in a weatherproof enclosure box and mounted to a post. More detailed specifications for the logger can be found in Appendix D.

A second type of submersible pressure transducer was also purchased and tried. It is a fully submersible micro gate used primarily in tidal zones. The unit consists of a data logger, pressure sensor, and battery pack, all enclosed in a waterproof stainless steel cylindrical container. It also can be connected to a personal computer (PC) for instrument configuring and data retrieval. The transducer is not vented to the atmosphere; therefore, the data must be corrected for changes in atmospheric pressure. The accuracy of the sensor is reported to be 0.1 percent, and the memory capability is 22 kilobytes.

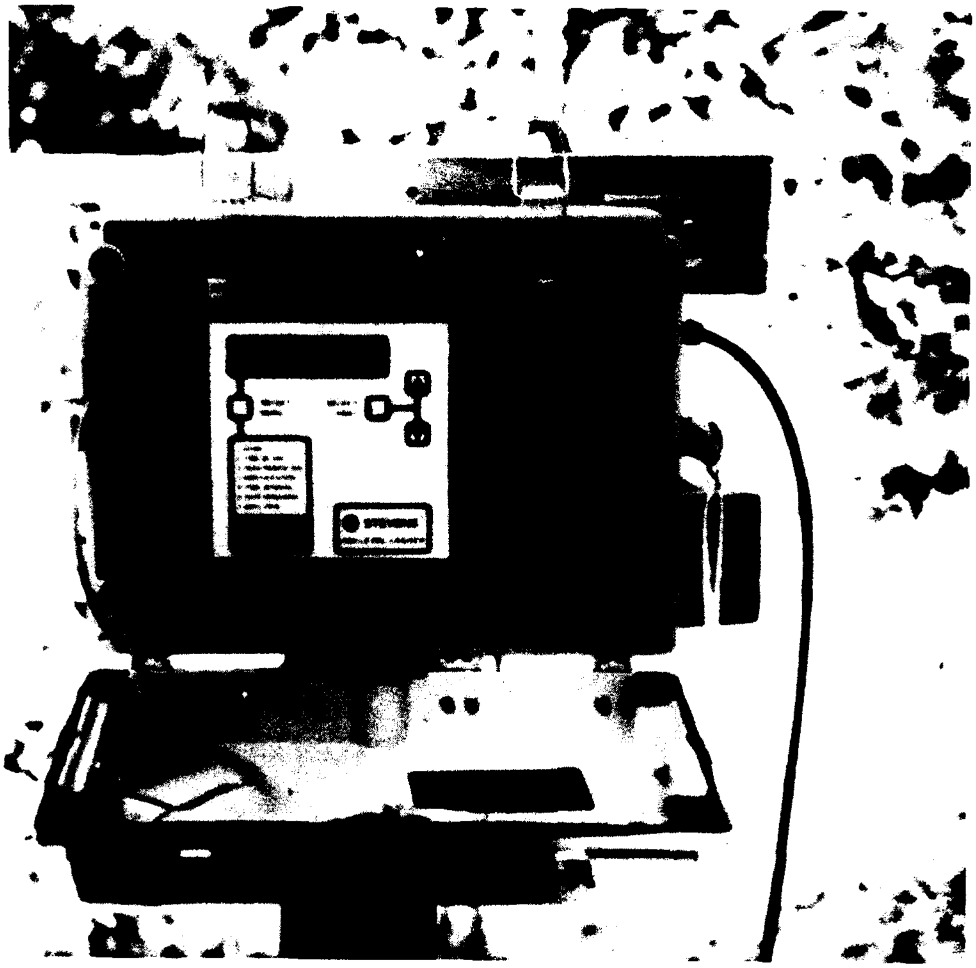


Figure 37. Logger box assembly for pressure transducer

Individual sensor calibration showed maximum errors of 0.016 ft and 0.011 ft for the two units. The cylindrical unit is mounted in a flanged polyvinyl chloride (PVC) pipe and secured to the channel bottom with 4-ft-long 3/4-in. steel rebar. This installation is shown in Figure 38. The submersible unit was purchased from Coastal Leasing, Inc., Cambridge, MA.

Float and Pulley Systems

Two shaft encoders for use with a float and pulley assembly were also purchased with the intent to use them at existing but abandoned stilling wells. The Leupold and Stevens Type A/F logger with compatible encoder was selected. The specifications for this instrument can be found in Appendix D.

Figure 38. Submersible pressure transducer installation

Crest gauges

The crest gauges consist of 2-in. PVC pipes with screw-on caps for the top and bottom. Holes are drilled in the bottom and along the sides to allow waterto move up and down in the pipe as the water level in the creek rises and falls. A cork reservoir is attached to a wooden rod graduated in tenths of a foot and inserted into the PVC pipe. The cork floats up and down with the water inside the pipe and adheres to the wooden rod at the highest level to which the water rose. The crest gauge is usually attached to 3/4-in. iron rebar driven into the creek bed and banks. As mentioned earlier, this type of measurement is not time tagged, and applies to only a single maximum event.

Discharge Measurements

Standard methods of stream gauging will be used on the various DEC streams to obtain flow rate measurements. Both Price AA current meters and Marsh-McBirney electromagnetic current meters are being employed. Measurements are made by wading at low flows, and from bridges and bank-operated cableways at high flows. A design for bank-operated cableways (Figure 39) described in USGS (1991) was built and installed at Long Creek and Hotophia Creek.

Site Locations

At present all 15 of the sites scheduled for instrumentation in FY 92 have been completed. Each site consists of at least one of the previously mentioned types of instrumentation. Table 25 lists the completed sites and the types of instruments used at each. The locations of each site and the instruments deployed are shown in Appendix D.

Progress Through May 1992

This report presents the progress through May 1992 that has been made in the number and location of sites that have been instrumented. For the water level monitoring needs, in addition to the identification of suitable instrument components, the purchasing, assembly, and calibration of the systems also required a considerable initial effort. Once these phases were completed, then the instruments were installed in the field. The first site completed was Long Creek in October 1991, the most recent, Lick Creek in May 1992. A total of 33 crest gauges, 12 ultrasonic sensors, and 17 pressure transducers have been deployed.

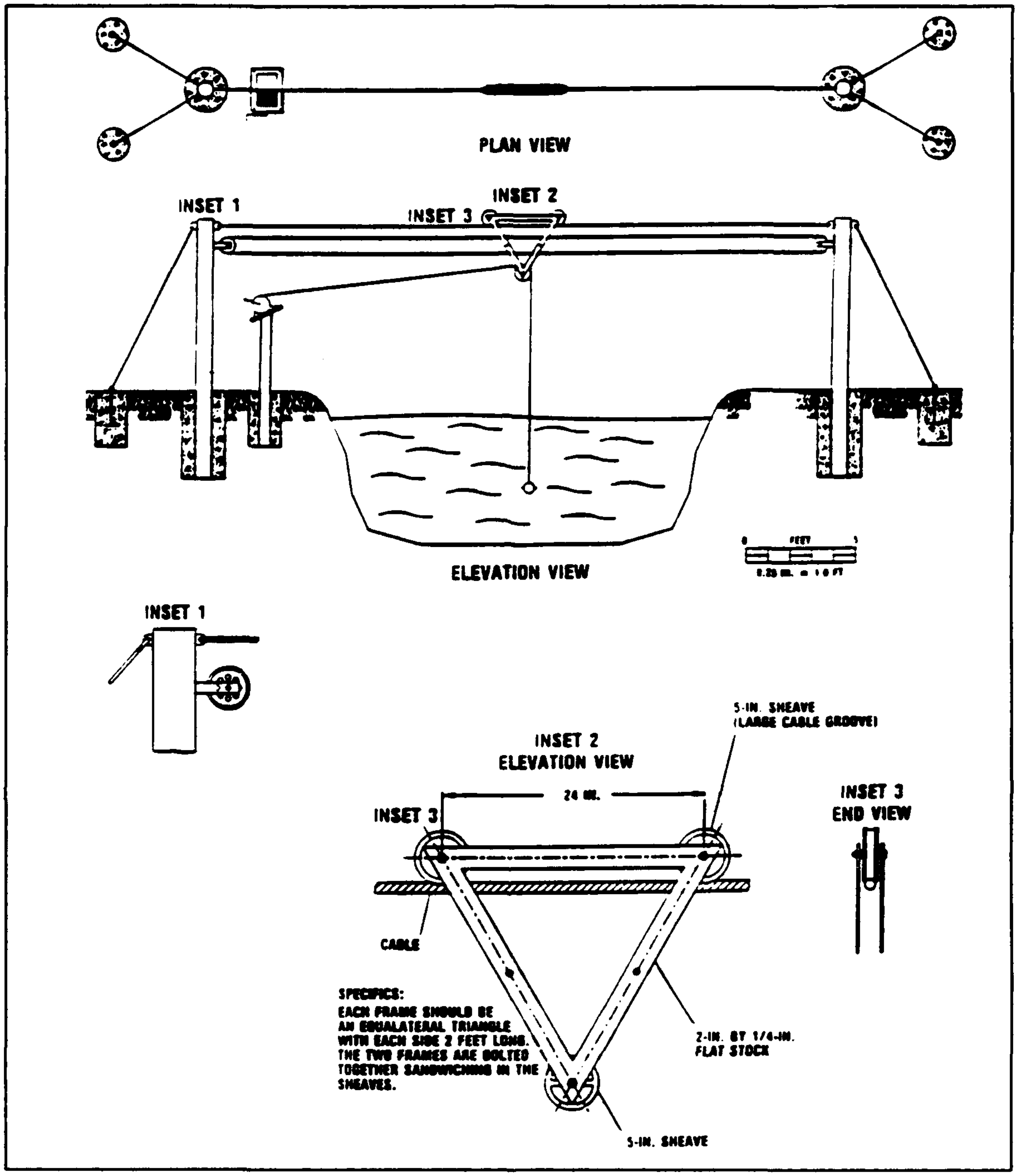


Figure 39. Bank-operated cableways

Preliminary Results

Several aspects of the instrumentation performance should be addressed. First are the performance and reliability of the physical units in the field. To date there have been no malfunctions of any sensor. One Sutron data logger has presented difficulties in retrieving the data via a PC, but otherwise has recorded all data correctly. Several instances of battery failures have been noted with the Leupold Stevens units, but no critical data have been lost. Several crest gauges have been washed out, but were replaced. Overall reliability of the instrument operation has been very good, with very minimal downtime.

The second performance factor being considered is the quality of the collected data. This is more difficult to assess. The ultrasonic instruments do seem to display a diurnal pattern in the collected data, even though temperature compensation is activated. However, the error introduced by this fluctuation appears to be less than 0.05 ft in general. Additionally, it is felt that if an average value of the fluctuations is computed, this value will be very near the true water surface elevation. It is intended that some time during the project actual water surface measurements during a 24-hour period can be made to verify these assumptions.

The data from the Leupold Stevens pressure recorders do not show the same diurnal effects. There are, however, occasional abnormal spikes in some of the data. The cause of these outliers has yet to be determined, but in any case they do not interfere with the normal data trends.

Data from the micro tide submersible instruments were downloaded, but not yet graphed and viewed.

Crest gauge readings have been taken, but since none of the gauges have been surveyed in, the data cannot yet be used in any other than a local sense.

With regard to stream gauging, all sites have been gauged for low flows as of this writing. In addition, bridges have been marked and instruments and crews prepared for gauging activities in the event of a storm with potentially favorable conditions. Also, the two bank-operated cableways have been prepared for similar instances.

The data from which the preliminary data quality assessments were made are of tremendous volume, since readings are being taken at 10-min intervals. Most of the data from all sites through late April have been downloaded, and a good portion of them read into DSS format. However, at this time only a few have been graphed. It is from these few that the preliminary quality assessment was made in the preceding paragraphs. A more complete analysis of the data in terms of quantity and quality, along with any calibration corrections, is planned for the upcoming months.

8 Hydraulic Structures Monitoring

Purpose and Scope

The purpose of this work area is to collect field data on selected structures including riprap bank stabilization structures to evaluate hydraulic performance. The 5-year scope of work set forth that a minimum of six grade control structures would be selected for detailed data collection to evaluate hydraulic performance of the structures. The structures would be selected on the basis of special features to include high drop, low drop, significant upstream flow constriction, limited upstream flow constriction, free flow, and submerged flow. The structures would be instrumented to collect data to evaluate discharge coefficients, energy dissipation, flow velocity distribution, and effects of submergence on performance. All riprap bank stabilization measures in each watershed would be visually monitored and problem areas identified. A minimum of three riprap bank stabilization installations to include riprap blanket revetment, riprap toe protection, and riprap dikes would be selected to evaluate toe and end section scour. Data would be collected during runoff events to measure magnitude and location of maximum scour and the corresponding hydraulic parameters. This work area would also include the construction of a physical model of the low-drop structure in FY 92. The model would be used for research and development to determine if cost-reduction modifications can be made to the structure that either maintain or enhance performance characteristics of the existing structure.

Description of Work for FY 92

During the first three quarters of FY 92 (the period covered by this report), two drop structures were instrumented to include water surface elevation recorders upstream and downstream of the weir and a cableway for measuring flow velocities in the upstream approach. A low-drop structures on Long Creek and a high-drop structure on Hotophia Creek were selected to instrument in FY 92. The types of instruments are described in Chapter 7. Also during this period, three low-drop structures on Worsham Creek and one high-drop structure on Burney Branch Creek were instrumented with recording water surface gauges placed upstream and downstream of the weir. Instrumentation of riprap bank stabilization installations was not planned for FY 92 but will begin in FY 93. A physical model of a 10-ft-drop low-drop structure was constructed in FY 92, and a detailed discussion of that effort is given in Chapter 11 of this report. Aerial videos of the main channel and major tributaries were made, and the general observations from these videos on the existing condition of grade control and bank stabilization structures are reported in Chapter 4 of this report.

Background

Existing Design Guidance

The design criteria presently being used by the Vicksburg District for the design of low-drop grade control structures have evolved from field and laboratory studies. The criteria relative to basic dimensions of the low-drop structures being constructed in the DEC Project were developed from model tests at the ARS Sedimentation Laboratory, Oxford, MS (Little and Murphey 1982), and thus this type of structure is referred to as the ARS type low-drop structure. A low drop is defined as a hydraulic drop with a difference in elevation between the upstream and downstream channel beds, H; a discharge, Q; and a corresponding critical depth, Y_c, such that the relative drop height, H/Y_c, is equal to or less than 1.0. Conversely, a high drop is defined as one with a relative drop height, H/Y_c, greater than 1.0. Design guidance for high-drop structures in the DEC Project is given in the SCS *National Engineering Handbook* (SCS, no date), and is referred to as a Type C high-drop structure.

Low-Drop Structures

A physical model study of an ARS-type low-drop structure was conducted at Colorado State University (CSU), Fort Collins, CO, by WET (1990) to evaluate the performance of the structure under flow conditions not investigated by Little and Murphey (1982), and to determine if cost-reduction modifications to the structure were feasible. WET (1990) concluded that the original design by Little and Murphey (1982) produced an effective structure at low tailwater conditions but was not as effective for high tailwater conditions. WET (1990) reported an improvement in the performance by replacing the baffle plate with seven H-pile baffling devices arranged in two rows. They also observed significant riprap instability in the model study.

During the period when WET (1990) was conducting the model study, a field study was conducted of 32 low-drop structures located throughout the DEC watersheds by Lenzotti and Fullerton Consulting Engineers, Inc., and SLA (1990). The field study revealed that 28 out of 32 structures had satisfactory performance, but riprap instability was noted in many structures. The location of the instability was the same as where the model study had indicated a problem due to hydraulic conditions—immediately below the weir along the bed and side slopes. The field study also indicated riprap instability along the downstream apron and along the downstream side slopes. This problem was attributed to channel degradation downstream of the structure and thus was not a problem in the model because the downstream channel was fixed in concrete. In addition, the field study found that much of the riprap in the structures did not meet design gradation.

As a result of these two studies, another study was conducted at CSU (Abt et al. 1991) to develop riprap sizing criteria for the ARS-type low-drop structures. This study consisted of a field inspection of existing structures and a physical model study.

A field inspection was made of 20 structures in the Yazoo basin to assess the range of conditions under which the structures are designed and operate, to revise data on actual rock size for structures now in place, and to provide a basis of comparison for model and prototype response. Of the total of 20 sites visited, 14 were low drops (2 new with less than a year of service), 3 were Type C high-drop structures, 2 were designed as minimum structure with no drop, and 1 was a highway culvert drop structure. The main conclusions from the field study of low-drop structures were as follows: (a) in the absence of field-measured submergence data, a design value for the unit discharge/d_{50} parameter should not exceed values in the range of 100-120; and (b) existing low-drop structures with a unit discharge/d_{50} in excess of 100 should be monitored closely for potential repair.

Results from the physical model tests indicated that the relationship of the ratio of the unit discharge over the median rock sizes (unit discharge/d_{50}) versus submergence may be used to predict the stability of riprap located at the critical zones of the drop structure. Submergence is defined as the ratio of the difference between the tailwater elevation and weir crest elevation t' and critical depth Y_c, i.e., t'/Y_c. The critical zones occurred at the toe of the stilling basin side slopes immediately downstream of the weir and upstream of the baffle devices. The riprap instability was caused by the plunging jet at the weir that impinges on the riprap. The original ARS low-drop structure was modified to consist of a vertical drop from the weir to stilling basin floor (in the original structure, riprap was placed against the downstream side of the weir on a 1V:5H slope to the basin floor), and model tests indicated a smaller rock size was required for stability just downstream of the weir. Therefore, Abt et al. (1991) recommended application of the modified structure over the original basin.

The purpose of the model constructed at WES in FY 92 was to modify and/or develop guidance regarding both hydraulic design and riprap stability to accommodate a 10-ft drop structure with an H/Y_c greater than 1. Presently, the drop height for the ARS-type sheet-pile structure is limited to 6 ft based on hydraulic and structural considerations. However, due to the potential savings of a sheet-pile structure over a Type C concrete structure, the Vicksburg District has reevaluated and modified the structural design component of the sheet-pile structure to allow higher drops. Consequently, hydraulic performance and riprap sizing criteria are needed for the structure. The details of the physical modeling effort are given in Chapter 11.

Status and Conclusion

FY 92 Progress

The work effort during this reporting period for this task has been directed at field site selection, instrumentation selection, procurement and installation in field sites, and developing data collection procedures. Attention has also been given to analyzing model studies data (WET 1990; Abt et al. 1991), which will serve as the basis for comparison between model and prototype hydraulic performance. However, as of the end of this reporting period, the instrumentation has not been in operation long enough to provide any meaningful data to include in the report.

Field Site Selection and Instrumentation

Two sites have been selected and instrumentation installed to monitor hydraulic parameters necessary to evaluate performance. An ARS-type low-drop structure site was selected on Long Creek (Figure 40) and a Type C high-drop site was chosen on Hotophia Creek (Figure 41). Additional sites will be added to the list over the next 2 years to include all features.

Long Creek Low Drop

The Long Creek ARS-type low-drop structure was constructed in 1987 with a drop of 4.5 ft (Figure 40). The structure includes the feature of a significant upstream flow restriction. The approach channel to the structure was stabilized using a longitudinal stone toe along both channel banks. As reported in the CSU field study (Abt et al. 1991), the weir width is 63 percent of the upstream channel where many other structures in the DEC Project have a weir width of 90 percent to 115 percent of the upstream channel. The structure has been effective in inducing upstream aggradation and related increases in bank stability. The structure is in need of repair because the filter material is exposed in the basin immediately downstream of the weir and the channel immediately downstream of the structure is unstable.

The Long Creek structure was instrumented with recording water surface gauges upstream, downstream, and at the weir crest. Crest stage gauges were also installed near the recording gauges to serve as backup instruments and as calibration checks on the recording gauges. The purpose of the gauges is to record the water surface elevation at 15-min intervals during major storm events so that the effect of submergence on discharge coefficient and energy dissipation may be evaluated. A cableway was installed in the upstream

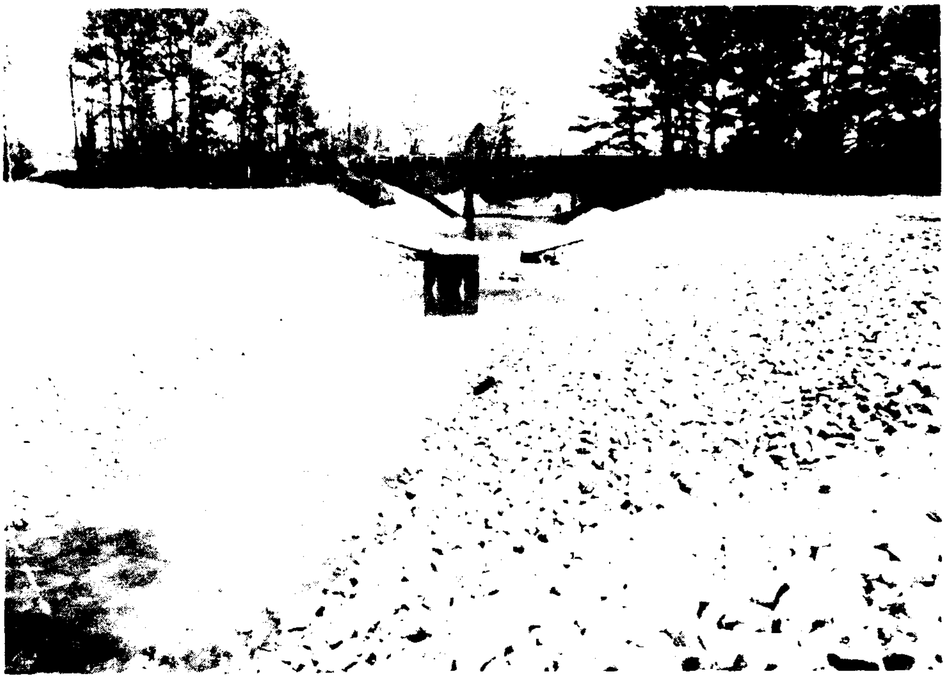


Figure 40. Long Creek low-drop site

Figure 41. Hotophia high-drop site

approach channel to support and traverse the channel with flow velocity meters for stream gauging purposes. During storm events, flow velocity measurements will be made for computing discharge and evaluating discharge coefficients.

The placement of a recording gauge on the weir crest was the result of analyzing model data. Analysis of model data (WET 1990; Abt et al. 1991) indicated a reasonable correlation existed between the ratio of flow depth at the weir crest to critical depth (depth at crest/critical depth) and submergence (Figure 42). Provided a similar correlation is verified in the prototype, the low-drop structures instrumented with recording water surface gauges at the crest and downstream would provide an easy means of using the drop structures as gauging stations with minimum time and cost as compared to standard gauging techniques.

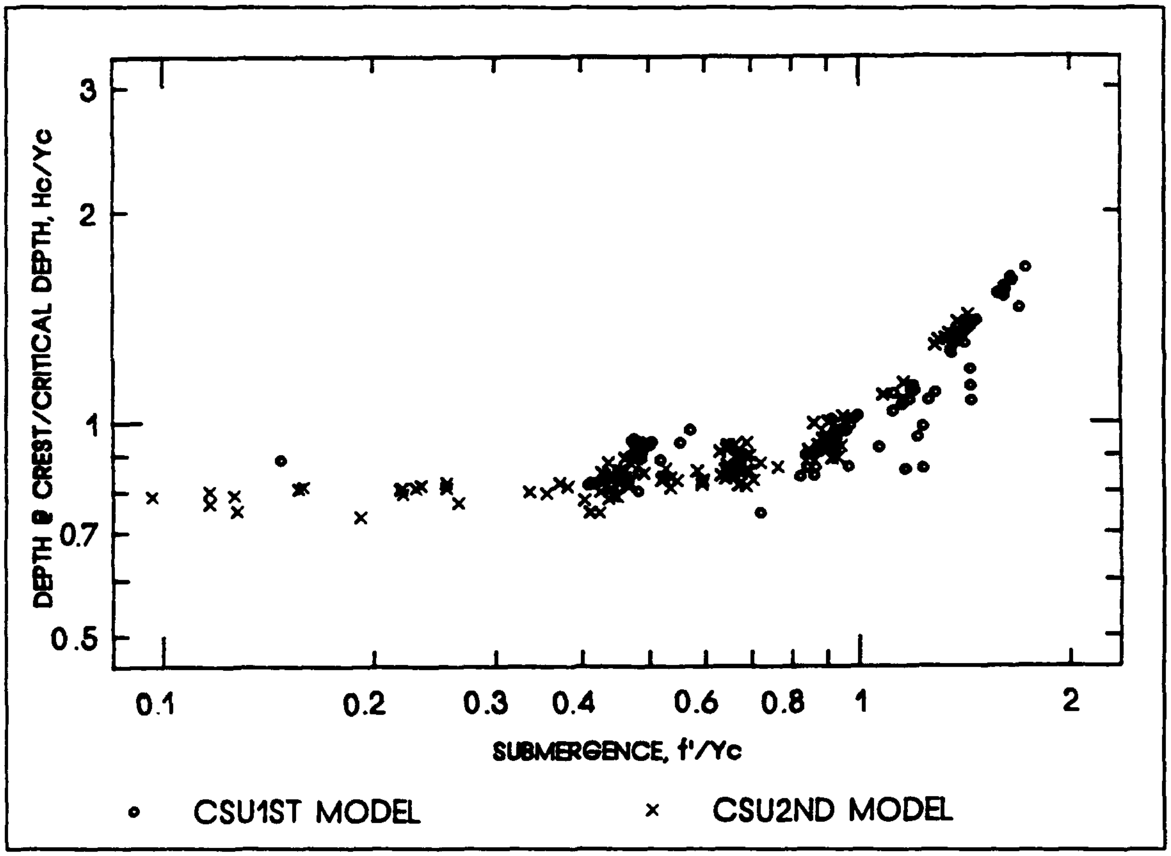


Figure 42. Depth at crest/critical depth versus submergence from model data

Hotophia High-Drop Structure

The high-drop grade control structure, Hotophia Creek Site 2, is located approximately 10 miles upstream of the confluence with the Little Tallahatchie River and is approximately 5,400 ft upstream of Mississippi Highway 315.

The structure is reinforced concrete that consists of a rectangular 60-ft-wide weir that has a 14-ft drop into a 60-ft-long baffled stilling basin. The weir is designed to pass the 100-year discharge of 7,500 cfs. The structure was placed into operation in the fall of 1991.

The structure was instrumented with recording water surface gauges upstream, downstream, and at the downstream end of the stilling basin wall. Similar to the Long Creek low-drop structure, crest stage gauges were also installed near the recording gauges to serve as backup/calibration check instruments and a cableway was installed in the upstream approach channel for stream gauging purposes.

Conclusions

During the first three quarters of FY 92 (period covered in this report) the effort was concentrated in site selection, in selecting and procuring instruments, and in installing the instruments. At this writing, sufficient data have not been collected to analyze and report. The recording water surface elevation gauges have recorded several storm events, but the vertical control and channel cross-sectional geometery survey will not be completed at the instrument locations until the end of June 1992. However, it is anticipated that sufficient data will be obtained, analyzed, and reported in the FY 93 report.

9 Design Tools, Riser Pipe Hydraulic Design

Background

Riser or drop pipes have been used in the DEC watersheds to reduce gully erosion. The original riser pipe design procedures were developed by SCS and require data from several sources: drainage area, flow length, SCS curve number, and rainfall. Soil type and slope are usually taken from county soil surveys maps published by SCS. The SCS curve number can be found in the SCS *National Engineering Handbook* (SCS, no date) and is a function of soil type and land use. The rainfall for the 2- to 100-year storms is published by the National Oceanic and Atmospheric Administration. Drainage area and flow length can be determined from quadrangle maps or aerial photography. A detailed discussion of drop-pipe design is given in Appendix E.

Purpose and Approach

The purpose of developing the riser pipe design system was to reduce the time required to perform hydrologic computations used in the design of riser pipes. The riser pipe design procedures use data stored in the engineering database/GIS to determine the required parameters.

The soil group data in the database were developed from the generalized soil survey maps that are available for each county. In future work the SCS digital line drawing will be used as the source data for soil type or soil group. A soil grid map is shown in Figure 43.

The land use information for the Coldwater River basin in the engineering database/GIS was developed by the Vicksburg District. For the remaining watersheds, the land use data will be developed by ARS. Landsat digital photography will be the source of the land use data. Currently, the database contains land use data for Coldwater, Long Creek, Hickahala-Senatobia, Hurricane-Wolf, and Cane-Mussacuna.

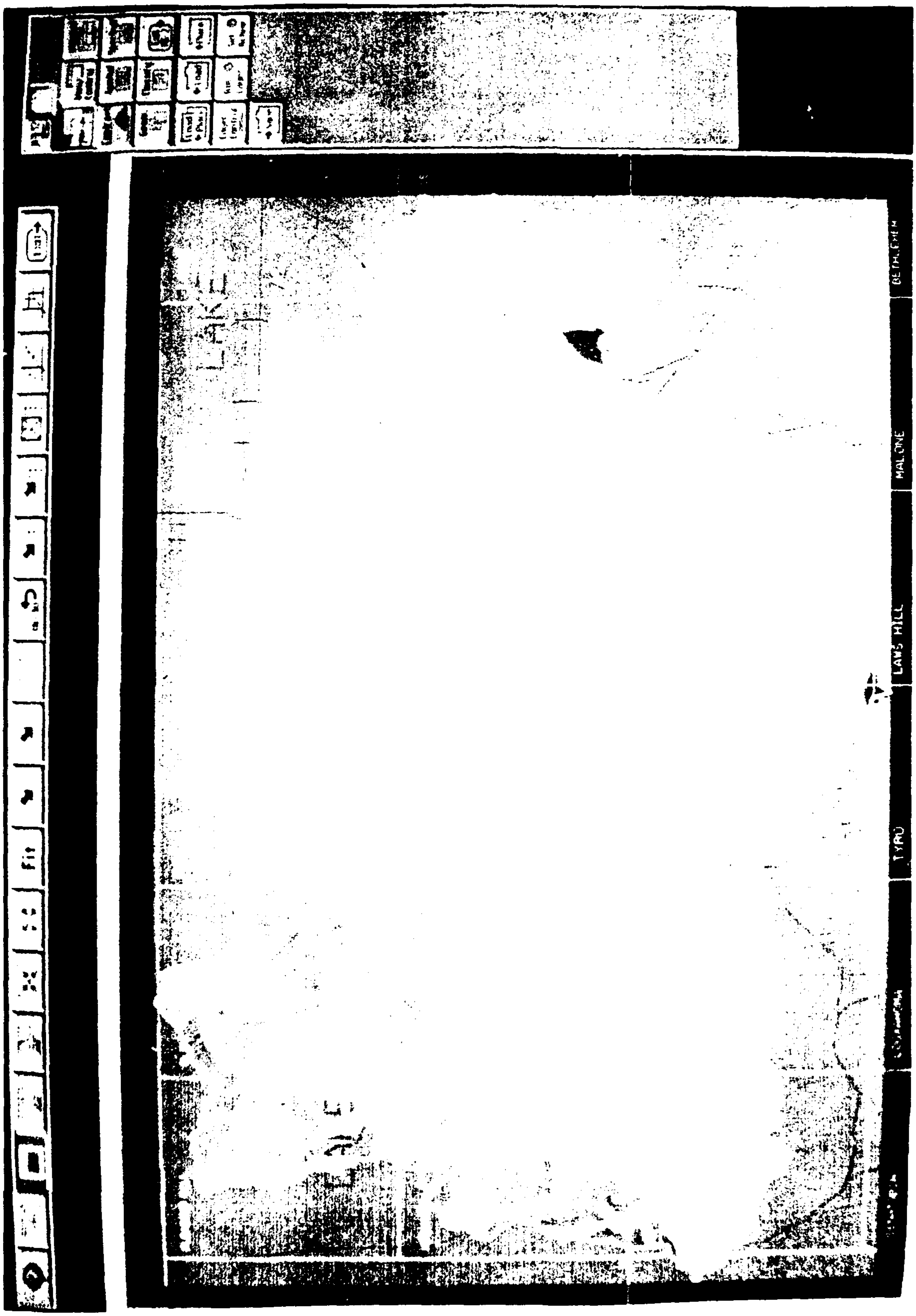


Figure 43. Typical soil grid map for DEC watersheds

The slope grid was developed from USGS DEM's. A majority of the DEC watersheds will use 1:24,000 DEM data. In locations where the 1:24,000 DEM data are not available, the Defense Mapping Agency 1-degree digital elevation data will be used. The DEM data for all of the DEC watersheds have been placed in the engineering database/GIS.

The database contains an SCS curve number grid developed from the soil grid and the land use grid. Curve number grids are available for Coldwater, Long Creek, Hickahala-Senatobia, Hurricane-Wolf, and Cane-Mussacuna.

Drainage area and flow length are calculated using basic MicroStations commands.

Work Flow

A typical work flow to use the engineering database/GIS for performing the hydrologic calculations is as follows:

a. Conduct a site visit and determine drainage patterns, vertical drop from overbank to the channel bottom, and land use. (Recent land use changes may not be in the engineering database.)

b. Use the MGE package on the Intergraph workstation to delineate the drainage area, flow length, and the calculated average curve number.

c. Use the SCS program EFM on a PC to calculate the design flow for the riser pipe. The SCS program for hydrologic calculations and a PC program for the hydraulic design of riser pipes will be ported to the Intergraph workstation in FY 93.

Future Work

Future work on the riser pipe system will be directed toward improving and simplifying the riser pipe design procedure and collecting land use and soil data for the remaining DEC watersheds. WES plans to have the land use, SCS curve number, slope grid, and soil groups for all 15 watersheds in the engineering database by the end of FY 93. During FY 93, a large effort will be placed on hydrologic procedures used in the DEC watersheds. A possible result of this effort may be a less complicated procedure for riser pipe hydrology. The present method appears to more complex than the riser pipe hydraulic design can support. In practice a designer is limited to pipe selection in 0.5-ft increments; also as shown on a typical example in Figure 44, the SCS method is sensitive to slope. Accurately determining the slope for the typical riser pipe design is cost prohibitive.

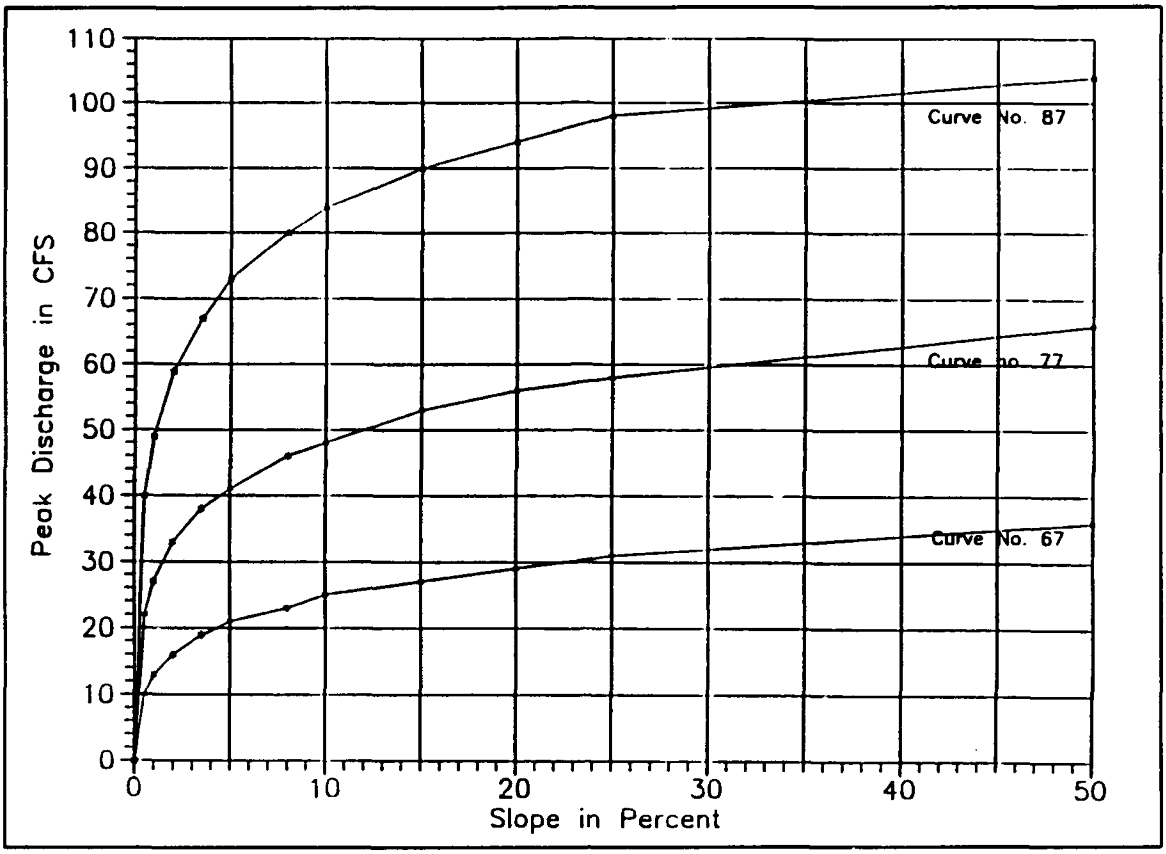


Figure 44. Typical example of discharge versus slope in DEC drainage areas, 25-acre drainage area, 1,600-ft length of flow, curves 67, 77, and 87

10 Design Tools, Proposed Design Procedure For Stabilizing Incised Channels

Background

The six parameters that the hydraulic design engineer deals with are (a) width, (b) depth, (c) slope, (d) hydraulic roughness, (e) bank line migration, and (f) planform. The first four are the focus of this document. They are referred to as channel dimensions. The example presented here demonstrates the application of a design procedure that is presently being developed in the Flood Control Channels Research Program. It is proposed here for testing and evaluation on channels in the DEC. The calculations that are required have been packaged in the computer program "Hydraulic Design of Channels," SAM (Thomas et al., in preparation).

The first step is to select the watershed and the project reach within that watershed. The **Long Creek watershed** was selected because previous studies have been conducted and rather extensive field data are available. The upstream end of the mainstem was selected as the **Project Reach** because two low-drop grade control structures were built in that channel during the time period between the two field surveys.

In this test, the objective is to determine if the low-drop structures will be successful in stabilizing the channel invert against further degradation.

Proposed Design Procedure

The proposed design procedure is summarized in the following ten steps:

a. Locate the watershed on a drainage basin map.

b. Plot bed profile(s) of the stream system.

c. Locate cross sections on the profile plot.

d. Partition the stream profile into reaches.

e. Develop hydrologic data for each reach.

f. Collect and display bed sediment gradations.

g. Choose a **Reference Reach** and calculate stable channel dimensions to verify the procedure.

h. Change the water discharge to that for the project reach, retain the calculated sediment concentrations from the reference reach, and calculate the channel dimensions for the project reach.

i. Reduce the inflowing sediment concentrations for the bed material load as predicted for the future project conditions and calculate a new set of channel dimensions.

j. Test the selected design dimensions using the sediment yield package in SAM to calculate annual yield and single-event yields for single-event flood hydrographs.

The Design Channel Cross Section

The first step in the design process is to formulate the target cross-section type. The possible types have been reduced to the three shown in Figure 45.

Design Parameters

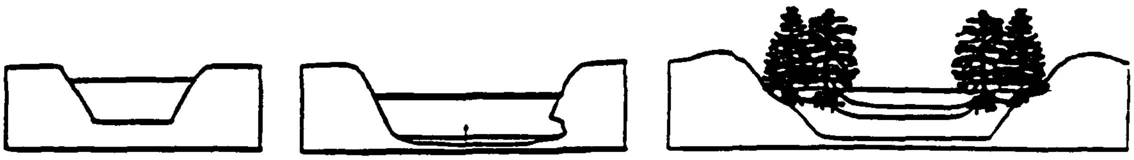
In fixed-bed hydraulics, the channel dimensions themselves are the design parameters. They can be prescribed or optimized using a least-cost criterion. In movable-bed hydraulics, the channel dimensions are not the design parameters, but rather are dependent variables. The design parameters are the independent variables—those the engineer can prescribe. There are three design parameters:

a. Inflowing water discharge.

b. Inflowing sediment concentration.

c. Particle sizes of the inflowing sediment concentration.

These design parameters prescribe the loads on the stream system. Design dimensions are the combinations of width, depth, slope, and hydraulic roughness that will convey those loads through the project reach.



a. Type A: Channel-Forming Discharge is Bank-Full

b. Deeply Incised Channel but Degradation is Arrested

c. Type C: Channel in Depositional Zone

Figure 45. Design channel types

Drainage Basin

The drainage basin is shown in Figure 46. The portion of the creek used in this example, labeled as **design example**, was partitioned into five reaches (NWHC 1989). Drainage area is the primary parameter of interest because it is a key parameter in distributing the water runoff from the subdrainages in the basin.

Figure 47 shows the thalweg profiles from the 1985 and 1991 surveys. These profiles were from the surveys analyzed in the detailed geomorphic studies in Chapter 5, "Channel Response, Detailed Geomorphic Study."

The positions of the 1985 and 1991 cross sections are shown along the abscissa of Figure 47.

To this basic diagram the five reaches defined by NWHC were added, along with the drainage areas for each—also supplied in the NWHC report.

Hydrologic Data

The calculated annual peak discharges for floods having a probability of being equaled or exceeded of 2, 10, and 50 percent, commonly referred to as the 2-, 10- and 50-year floods, respectively, are shown on the scale across the top of Figure 47. These values, which were obtained from the NWHC report, are referred to as the TR-20 results, indicating they were obtained with the SCS rainfall/runoff package, TR-20. The geomorphic study showed the 2-year discharge plotted closest to the classical regime curves for width.

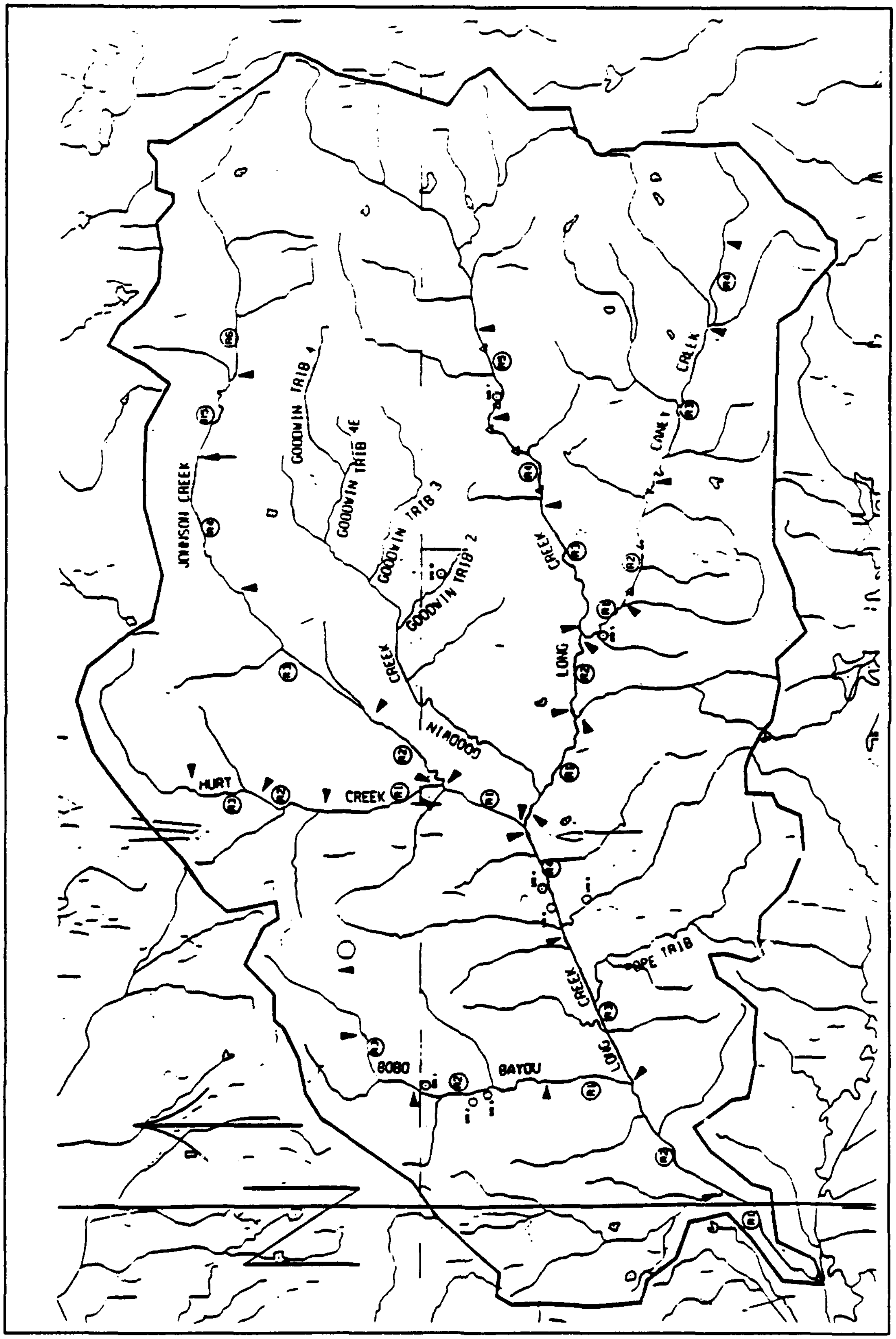


Figure 46. Long Creek drainage basin

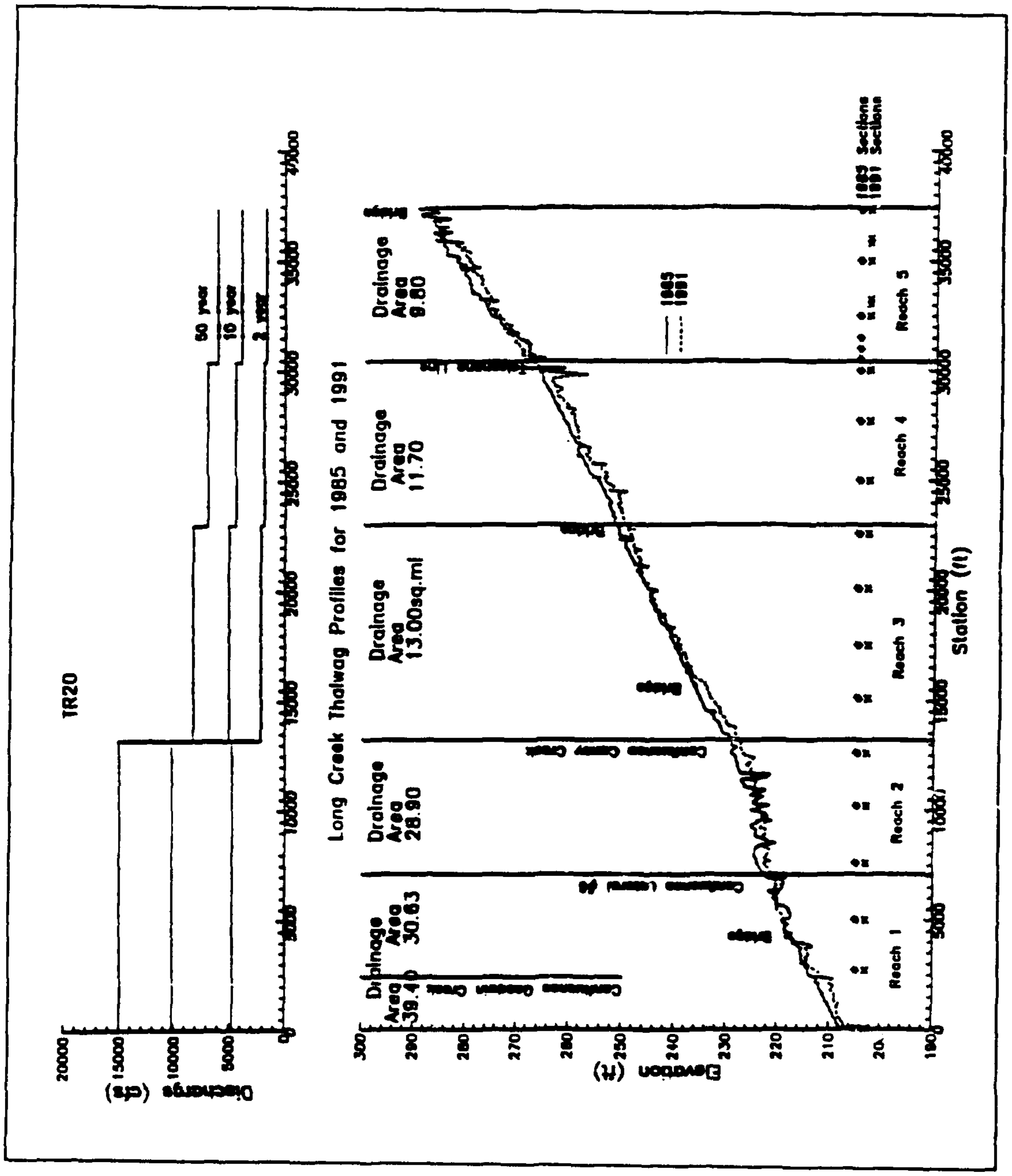


Figure 47. 1985 and 1991 thalweg profiles

Consequently, it was regarded as a reasonable estimate of the channel-forming discharge for the design calculations.

Bed Material Properties

Bed material data were obtained from the Vicksburg District for all the DEC watersheds. The collection was actually done by ARS. The bed material was sampled to a depth of 4 in. Samples were taken along the center line of the channel with supplemental samples taken over a section and composited. The sample locations were marked on a map and later transferred to the channel station scale on the thalweg profile plot.

The bed material data for Long Creek were worked up to produce profile plots of the sediment size (Figure 48). There appears to be no coarsening trend up the watershed as may have been expected, but the incoming tributaries may have an effect.

The D_{15}, D_{50}, and D_{84} values were calculated and plotted in Figure 49. The average D_{15} value is 0.19 mm (range 0.31-0.14 mm), D_{50} average 0.66 (range 5.22-0.20 mm), and D_{84} average 4.98 (range 22.07-0.35 mm). Values for D_{15} and D_{50} are fairly similar the entire length, but D_{84} values vary greatly. That is, there appears to be a coarsening effect from the tributaries entering in reaches 1 and 2. From Caney Creek there is an introduction of the coarser sands and gravels. The confluence of lateral six and Goodwin Creek shows a similar effect. That shows in the D_{50} values, also. The most upstream couple of samples in reach 5 may be the start of the coarsening trend one expects as one moves in the upstream direction.

The SAM Package

The hydraulic design package SAM presently consists of 13 computer programs written for the PC (Figure 50). The analytical method for calculating channel width, depth, slope, and n value, given the three design parameters of water inflow, sediment inflow, and sediment particle size, is in SAM.hyd. Before running that solution, it is important to know the sediment size and concentration. Even when measured field data are available, it is important to calculate the sediment inflow with Brownlie's transport function to determine the concentration for use in the channel dimension calculations. That is because the channel dimension calculations are based on the Brownlie transport function and bed roughness predictor.

The SAM.hyd program solves for the bed roughness when the bed sediment gradation is known. It then composites that value with the hydraulic roughness of the bank and of the floodplain. The total hydraulic loss is calculated, and the results are expressed as an "effective width," "depth," "velocity," and "slope" for sediment transport calculations. Sediment transport computations

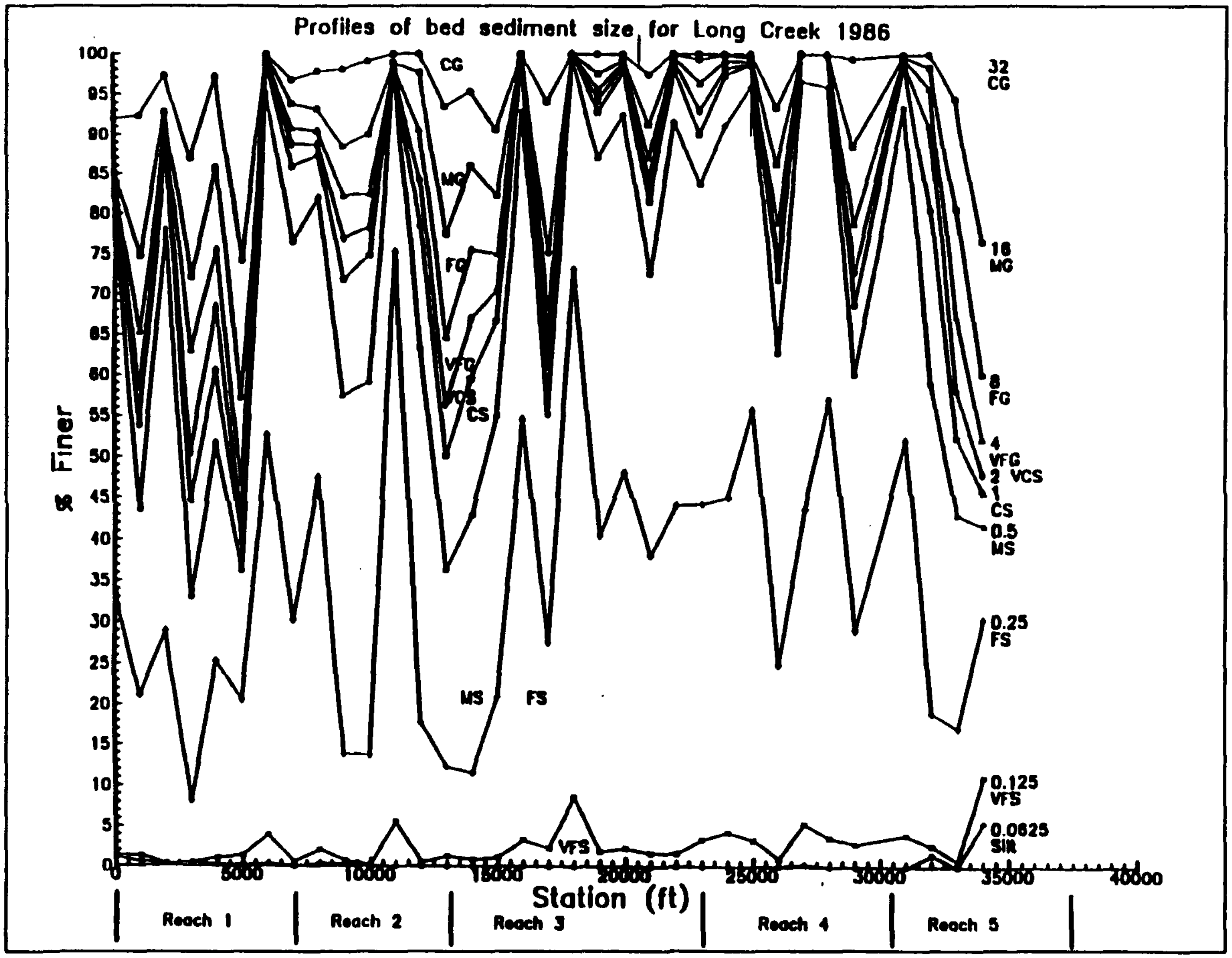


Figure 48. Bed sediment size profile plots for Long Creek, 1986

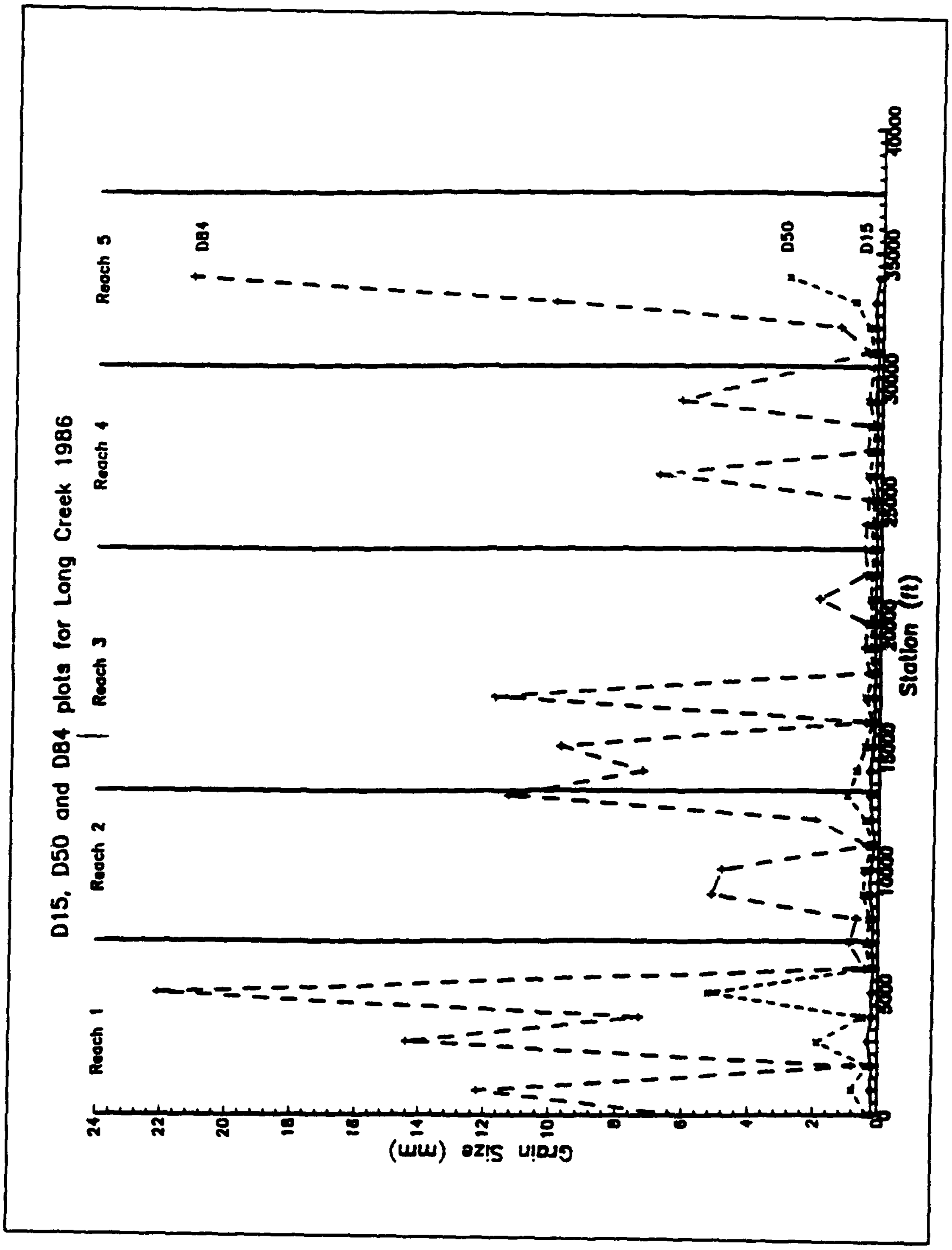


Figure 49. D_{15}, D_{50}, and D_{84} plots for Long Creek, 1986

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HYDRAULIC DESIGN PACKAGE FOR FLOOD CONTROL CHANNELS MENU
                                                          MENU 1 OF 2
                 -> 1 - SAM.hyd  Hydraulic Calculations
                    2 - SAM.sed  Sediment Transport Calculations
                    3 - SAM.yld  Sediment Yield Calculations
                    4 - Plot Hydraulic and Sediment Calculations from SAM
                    5 - PSAM  Prepare SAM.hyd Input Files
                    6 - SAM.m95  Use TAPE95 to Prepare SAM.sed Input File
                    7 - LIST
                    8 - EXIT TO DOS
                       Calculate Hydraulic Parameters
May 28, 1992   9:41:27 am                                 Memory: 488 K
                            Press H for Help
```

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             ******* PAGE 2 MENU ***************
                                                          MENU 2 OF 2
                 -> 1 - COED
                    2 - SAM.aid  Guidance in Transport Function Selection
                    3 - Particle Fall Velocity
                    4 - Curvefit
                    5 - HEC2
                    6 - DIRECTORY
                    7 - EXIT TO DOS

                            Edit a File using COED
May 28, 1992   9:42:12 am                                 Memory: 488 K
                            Press H for Help
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Figure 50. SAM menus

are made in SAM.sed. This provides the sediment concentration for use in the stable channel dimension calculations. Figure 51 shows the complexity of cross section the SAM package is developed to provide.

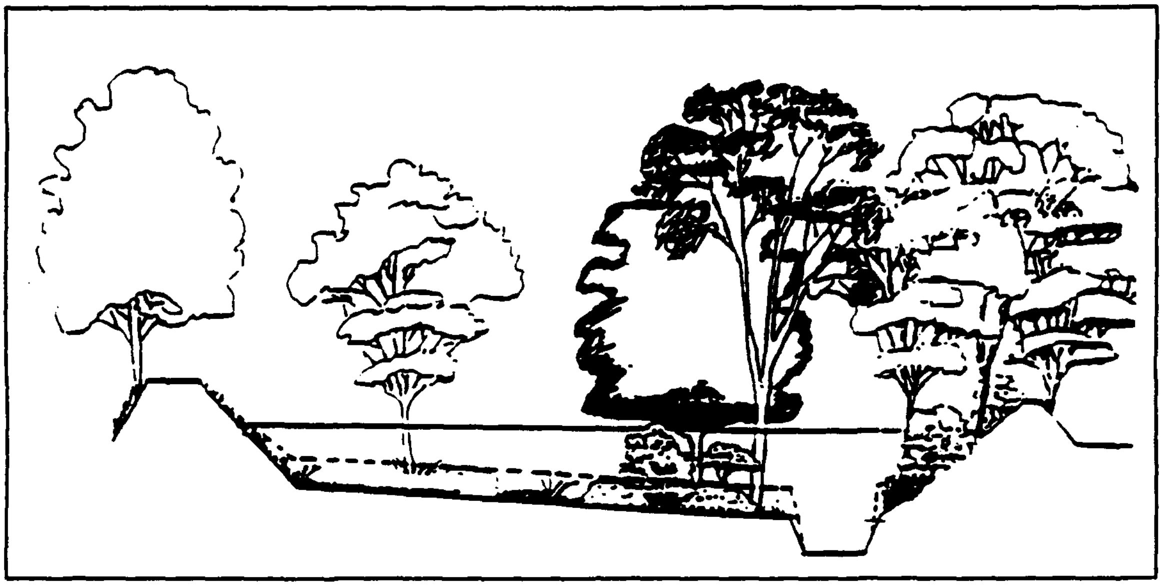

Figure 51. Example of complexity of cross section SAM can provide

Reference Reach

It appears that reaches 1 and 2 are stable in as much as they do not show much aggradation or degradation, but they do have variation within the reach. Reach 3 appears to be the most stable on the whole with little degradation. Reaches 4 and 5 have the most degradation with the structures being in reach 5.

Reach 3 was selected as the reference stable reach. The profiles showed that it did not degrade very much. The upper and lower sections deepened slightly, also seen by profiles, but the center section of the reach did not change much. The probe data collected by NWHC showed that this reach had 4 ft of sediment in the bottom of the channel, another sign of a more stable reach.

The HEC-2 TAPE95 data were processed using the SAM utility, SAM.m95, to calculate the average width, depth, velocity, and slope for the reference reach. These averaged values were then compared to the HEC-2 output to select the cross section that was closest to the average for that reach. In this case section 22600 was selected (Figure 52).

The X1 and GR-data for section 22600 were read into SAM.hyd. Added to this were the TR-20 discharges, the calculated slope from SAM.m95, the estimated roughness elements for the banks, and the bed sediment gradation data. A roughness value was assigned to each "panel," the space between each pair of coordinate points, across the cross section.

Four water discharges were selected for the calculation. A base flow of 100 cfs was the lowest value. A discharge exceeded about 10 percent of the

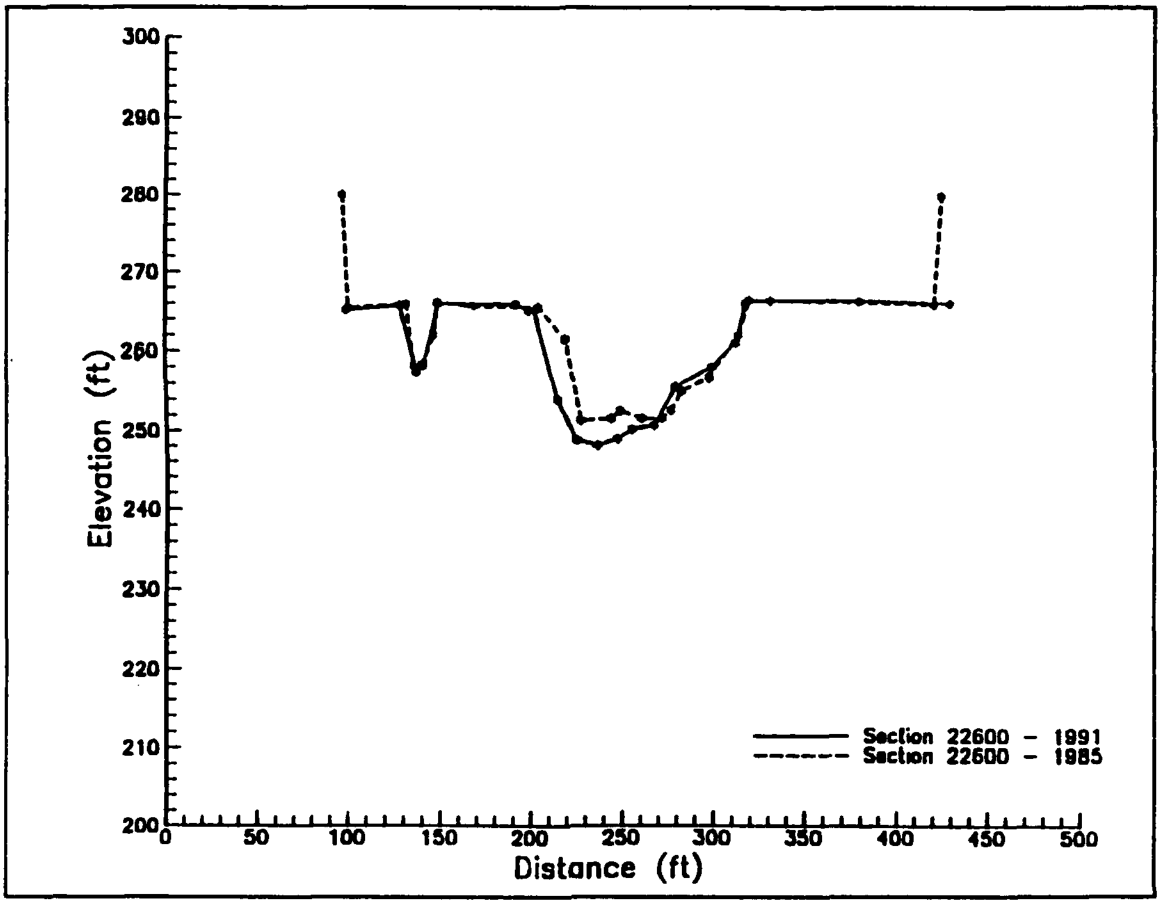

Figure 52. Cross-section comparison, 1985-1991

time, 1,000 cfs, was selected as an intermediate value. The 2-yr and the 10-yr floods were the highest values used.

Given these data, SAM.hyd calculated the water surface elevation and the effective width, depth, velocity, and slope for each prescribed water discharge. Using these effective values, the sediment concentration was calculated with SAM.sed using the Brownlie sediment transport function.

The sediment concentration together with the discharges and the bed sediment gradation (D_{84}, D_{50}, D_{16}) were input to SAM.hyd to calculate stable channel dimensions using the Copeland method (Copeland 1990). The results are the graphs of slope versus width shown in Figure 53.

The validity of the procedure was checked by plotting the effective width and slope, calculated by SAM.hyd using the cross-section 22600 geometry, in Figure 53. The values match the analytical channel dimensions very nicely.

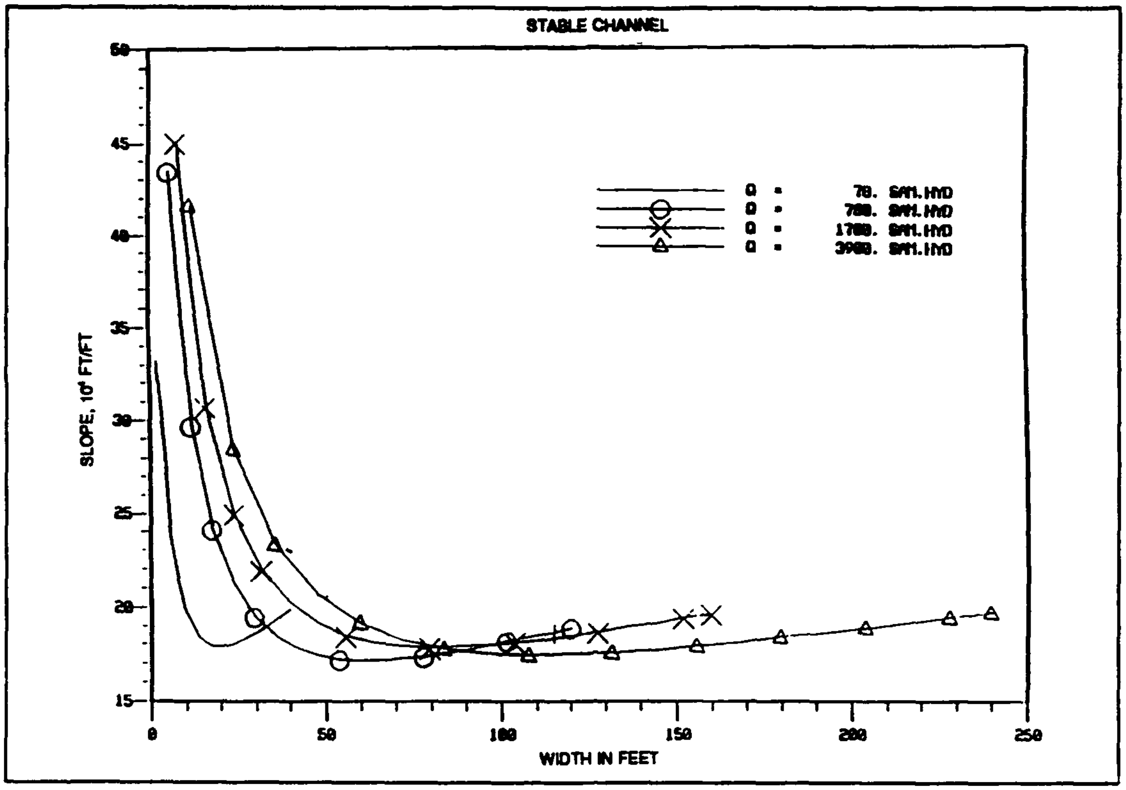

Figure 53. Stable channel, reference reach

Project Reach

Reach 5 was selected as the project reach. There is presently a grade control structure at the downstream end of that reach. The question of interest is, "Will that reach be stable as the result of that grade control structure?"

Using the water discharges for reach 5 and the sediment concentrations calculated for reach 3, Figure 54 was produced. Effective values of width and slope were calculated for reach 5 geometry using the 1985 and the 1991 cross sections. The 1985 values plot well into the unstable region of Figure 54.

In 1985 the channel was very unstable with the slope being too great. In 1991 degradation had reduced the slope as shown in Figure 47. This confirms the design technique for conditions to date. It does not guarantee the values on the design curve are stable values because only the passage of time will verify those values. However, it would have predicted degradation given the slope and width in 1985.

Moreover, the design procedure predicts only a small amount more degradation before this reach attains a stable condition.

The final step in the design procedure is to estimate the percentage of bed material load coming from the reach affected by the proposed project design.

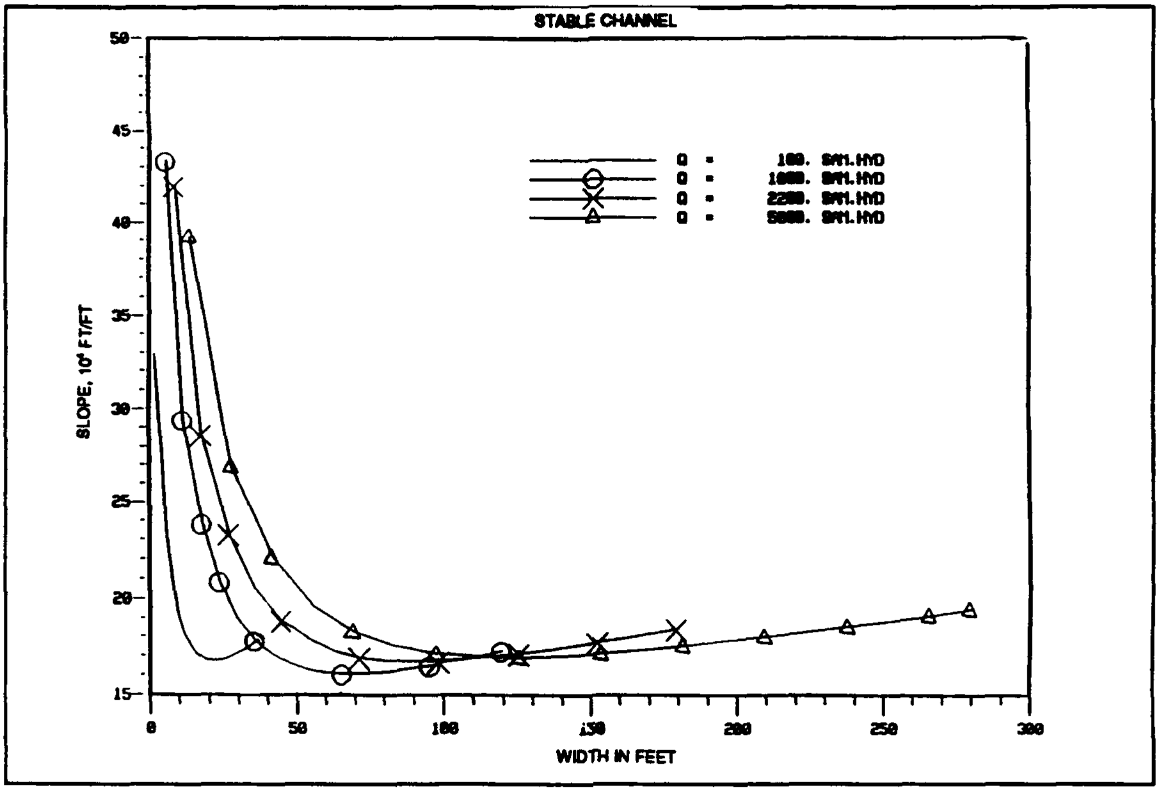

Figure 54. Stable channel, project reach

The inflowing sediment concentration would then be reduced by that percentage because if the project is successful it will eliminate that source of sediment.

In this case, the bed profiles indicate that a significant amount of degradation has occurred in the reach affected by the project. The estimate is that a reduction of 50 percent of the bed material concentration can be expected as a result of the proposed project. That will change the calculated channel dimensions as shown in Figure 55.

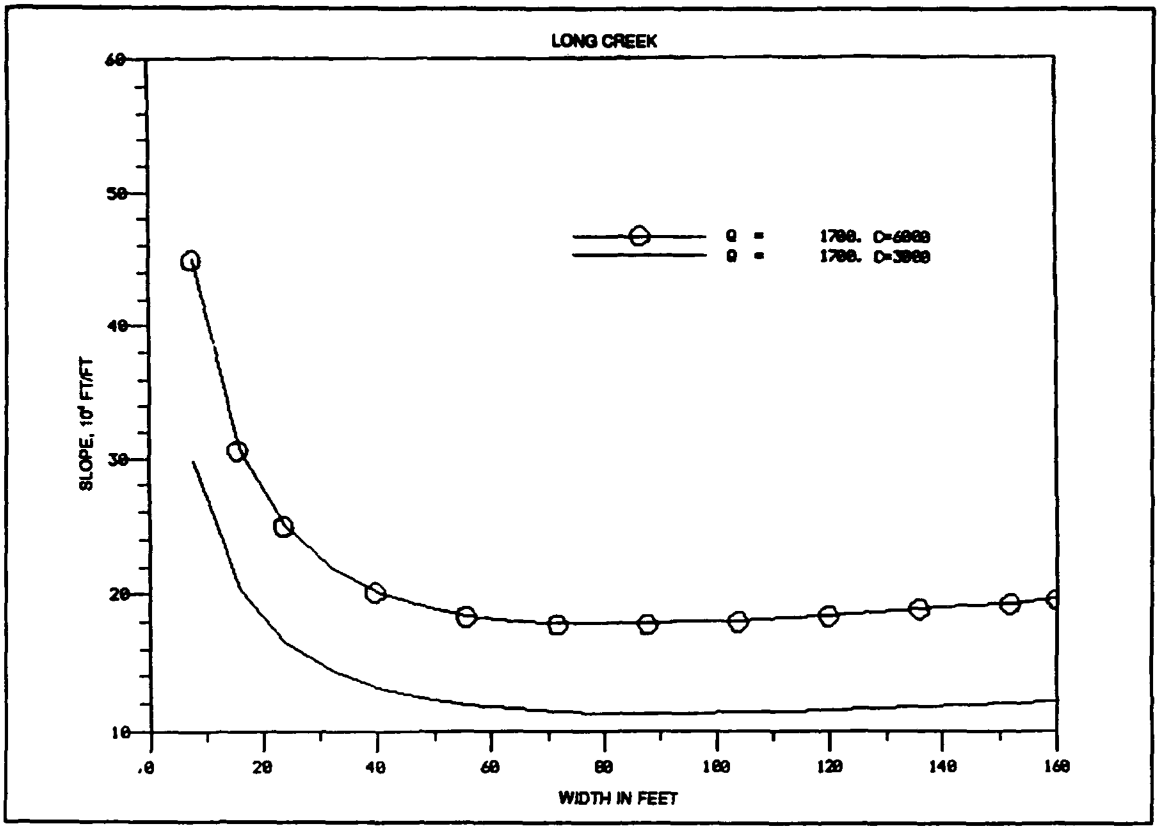

Figure 55. Project-caused change in channel dimensions

11 Physical Model Testing

Riprap Drop Structure Model

Background

Low-drop grade control structures have been used to arrest erosion in incising channels. The concept of the drop structure was originally developed based on an equivalent energy approach. Numerous variations and types of these structures have been constructed both in model studies and in prototype locations.

Sheet-pile grade control structures have been used in the DEC Program to arrest erosion due to headcutting. These structures consist of an upstream approach transition section from the natural channel to the sheet-pile weir, a vertical drop into a riprap stilling basin to dissipate the energy, and a downstream transition. The use of sheet-pile and riprap in low-drop design is an economical alternative to a concrete structure and apron.

Purpose and approach

Current design criteria for a sheet-pile grade control structure limits the drop height to 6 ft. The limits are partially based on hydraulic limitations and partially on structural design limitations of the vertical placement of the sheet-pile cutoff. Due to the potential for savings of a sheet-pile structure as opposed to a concrete drop structure, a reevaluation of structural design components by the Vicksburg District verified the constructability of the higher drop. However, the hydraulic performance and riprap design criteria were not heretofore tested for the ARS-type drop structure nor design criteria developed for sheet-pile riprap drops greater than 6 ft.

Drop structures have typically been classified as either low or high drops according to a ratio of drop height H to critical depth Y_c. Low drops are those with a value of H/Y_c less than or equal to 1. The proposed drop height of 10 ft would change the classification of drop structure for the same design discharge and critical depth of 6 ft by exceeding a ratio of 1. Therefore, based on the disagreement between the actual drop classification and the proposed design criteria, it is necessary to study the performance of this structure.

The purpose of this study is to modify and/or develop guidance regarding both the hydraulic design and the stable riprap design to accommodate a 10-ft drop structure with an H/Y_c ratio greater than 1. The objective of the study is to determine the feasibility of using a higher drop and, if feasible, develop design guidance pertaining to the higher drop. A 1:12-scale physical model will be used to investigate the proposed sheet-pile grade control structure with a 10-ft drop.

Design assumptions

The drop structure design was based on the modified ARS-type structure previously recommended in a study conducted by CSU (Abt et al. 1991). The dimensions were determined from the ARS criteria, the CSU study, and recommendations by the Vicksburg District. The original basin design dimensions and criteria were selected to make results from the CSU model and the WES model comparable (Abt et al. 1991).

Many of the design dimensions are contingent upon the critical depth; therefore, a design discharge of 4,000 cfs was selected. This same design discharge had been used in the previous model by CSU. A channel bottom width and weir length of 40 ft were selected. The weir shape was trapezoidal with 2.5V:1H side slopes. The critical depth based on the weir cross-sectional shape and the discharge was 6.0 ft. All design dimensions that are a function of critical depth were based on 6.0 ft. The channel drop H for design was 10 ft.

The basin design criteria deviated slightly from that developed by Little and Murphey (1982) according to actual prototype structures used in the DEC Program. Specifically, a trapezoidal stilling basin replaced the wider and more rounded planform; the drop was vertical instead of sloping; the baffle plate was not used; and the location of the larger riprap was based on the critical areas identified in the CSU study (Abt et al. 1991).

Drop structure dimensions. The dimensions were determined from the following equations (notation adapted from CSU report). The drop plan and profile dimensions are shown in Figures 56 and 57, respectively:

Given:

a. The design discharge Q of 4,000 cfs.

b. The channel width and weir length B of 40 ft.

c. The stilling basin side slopes S_B of 2.5H:1V.

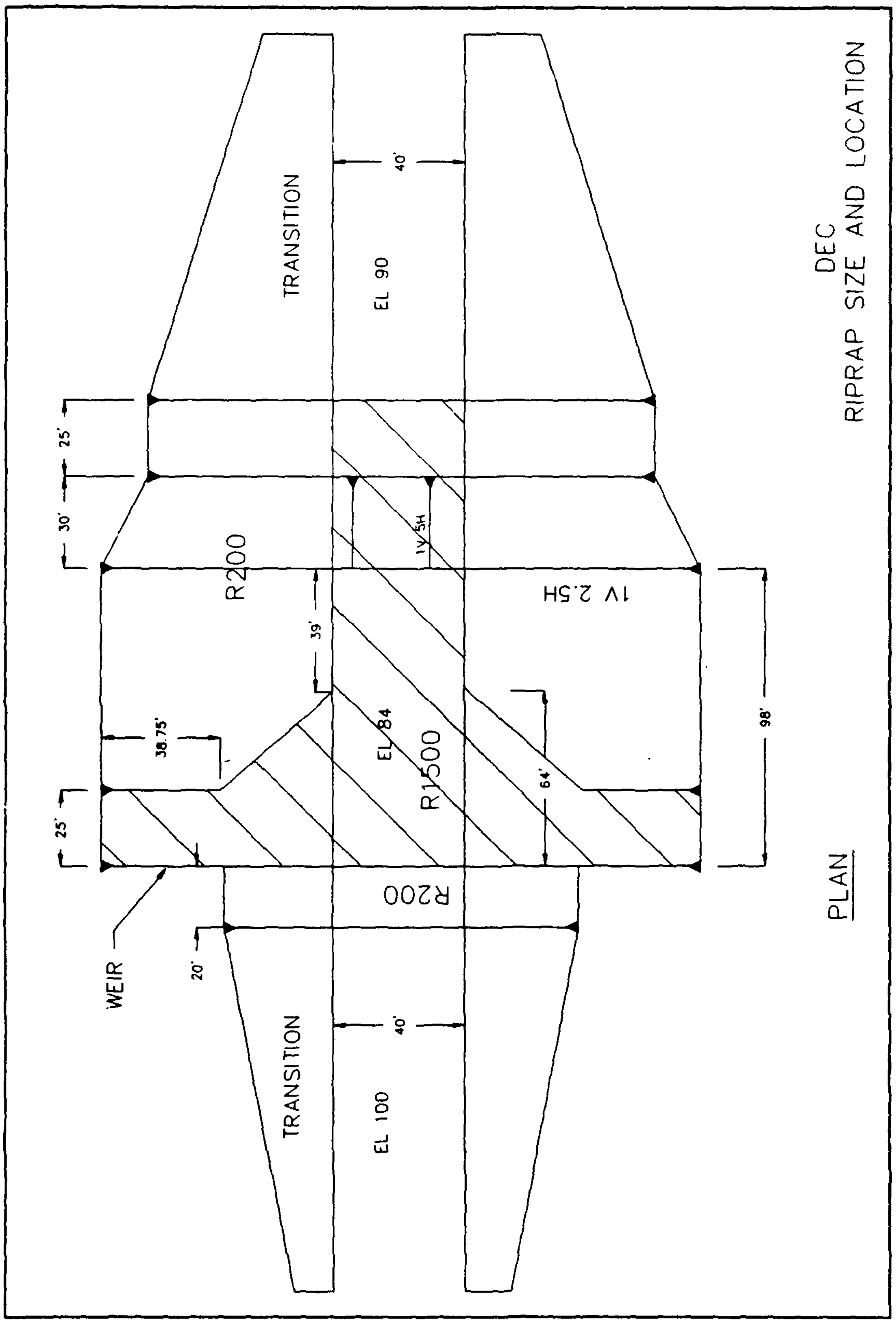

Figure 56. Drop structure plan view

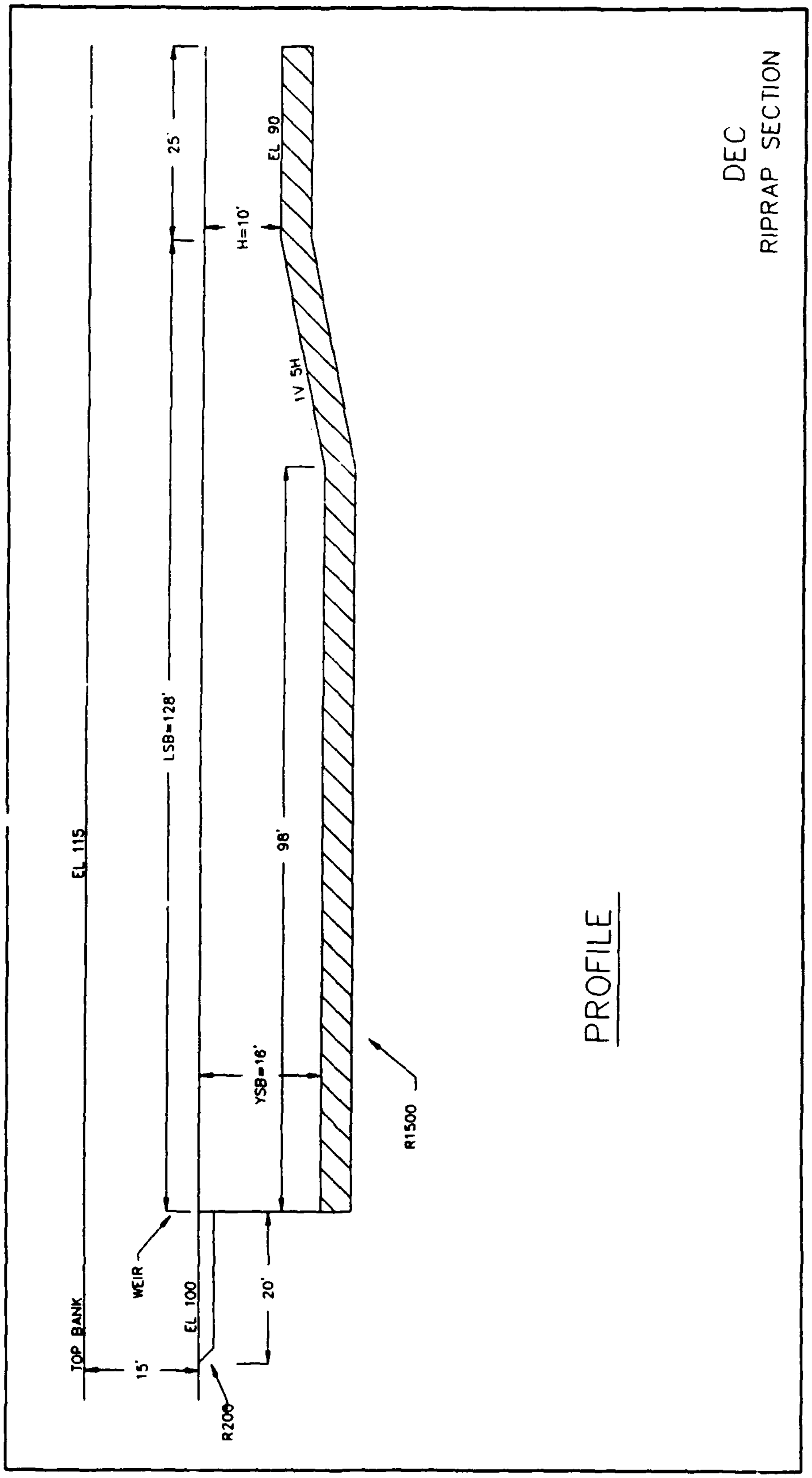

Figure 57. Drop structure profile

d. The end sill slope S_E of 5H:1V.

Calculate:

a. The variable X_B

$$X_B = Y_c\left[3.54 + 4.26\left(\frac{H}{Y_c}\right)\right] \quad (2)$$

b. The stilling basin length L_{SB}

$$L_{SB} = 2X_B \quad (3)$$

c. The stilling basin depth Y_{SB}

$$Y_{SB} = Y_c + H \quad (4)$$

Riprap. The previous study by CSU (Abt et al. 1991) recommended that two gradations of riprap be used in the drop structure design. The larger gradation is placed immediately downstream of the weir and along the basin floor, while the smaller is placed in the remaining side slopes and in the approach. The specific dimensions and placement can be seen in Figures 56 and 57.

Based on guidance from the Vicksburg District, the gradations were selected. The two gradations came from a Lower Mississippi Valley Division document.[1] These gradations are common to the Vicksburg District area. The larger stone is based on a top side weight of 1,500 lb (R1500) and the smaller has a top side weight of 200 lb (R200). The gradations are as follows for specific weight of 155 lb/ft^3:

	Larger Stone Size, lb		Small Stone Size, lb	
Percent Lighter by Weight	Upper	Lower	Upper	Lower
100	1,500	600	200	80
50	650	300	80	40
15	330	100	40	10

[1] Personal Communication, 22 January 1982, U.S. Army Engineer Division, Lower Mississippi Valley, Vicksburg, MS, subject: "Report on Standardization of Riprap Gradation."

The thicknesses, based on highly turbulent flow, for the R1500 and R200 stone were 48 in. and 24 in., respectively.

Model description

The 1:12 scale model, shown in Figure 58, is constructed in a flume approximately 84 ft by 26 ft. It reproduces approximately 400 ft of the prototype approach channel, the weir, 128 ft of stilling basin and end sill, and approximately 320 ft of downstream channel. The upstream and downstream channels were constructed by molding sand and cement mortar to sheet metal templates. The weir was constructed from plywood. The stilling basin was constructed with sand, and graded rock was placed over filter cloth.

The water was supplied by a circulating system and discharges were measured with a venturi meter. Velocities were measured with a propeller type electronic velocity meter. Water surfaces were recorded with piezometers. Tailwater conditions were regulated by adjusting a tailgate until the most downstream piezometer was reading the desired tailwater elevation. Flow conditions were recorded with a video camera. Photos were obtained when riprap displacement occurred in the stilling basin exposing the filter cloth. Failure of riprap was defined as the condition where sufficient displacement occurred to expose filter cloth. Tests were run for 120 min (model).

Model testing

In the previous model study by CSU (Abt et al. 1991), discharges and submergences were varied while data regarding the flow conditions and the stability of the stone were recorded. The testing in this study was designed to evaluate the same conditions: the hydraulic performance of the 10-ft drop and the stability of the riprap in the stilling basin. Submergence T as defined by this study is the height of the tailwater over the weir divided by the critical depth. High submergences can cause undulating flow conditions in the downstream channel while unsubmerged flow or low submergence can cause more turbulence in the stilling basin, generating more scour. Since the main objective of the study was to address the stone size required for a 10-ft drop, the original drop design (based on the dimension criteria in the subparagraph "Riprap") was tested by lowering the submergence at design discharge until a failure was observed.

Riprap failure during this testing occurred in a similar location to that observed in the CSU model (Figure 59). Based on the observed scour pattern and its inclusion of material on the side slopes, the next effort addressed a modification to the weir shape to determine if the scour could be maintained on the basin floor. A rectangular weir was installed and tested to failure (Figure 60). While the rectangular weir did indeed restrict scour to the basin floor, it required a higher submergence to prohibit stone failure.

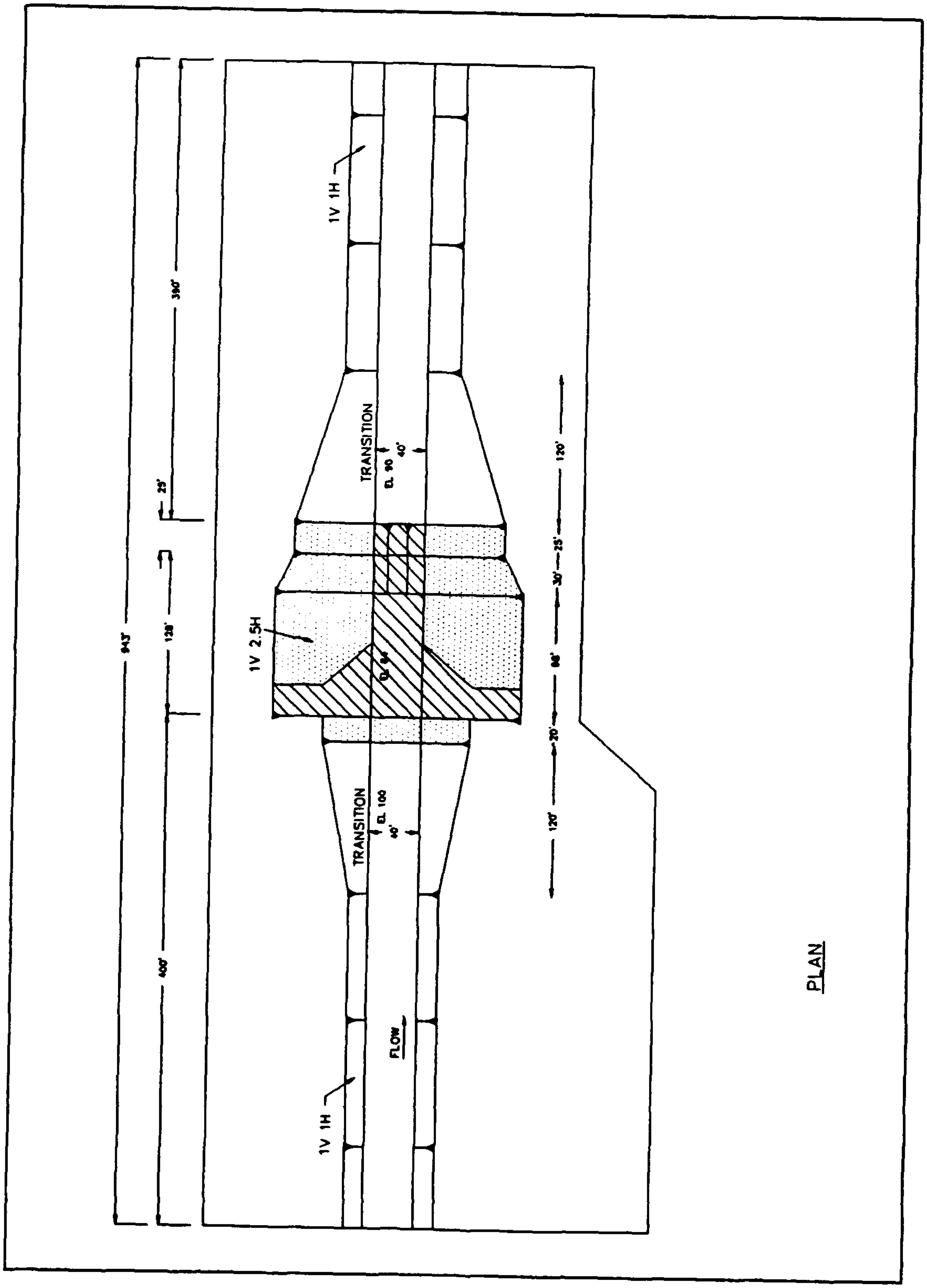

Figure 58. Model layout, plan view

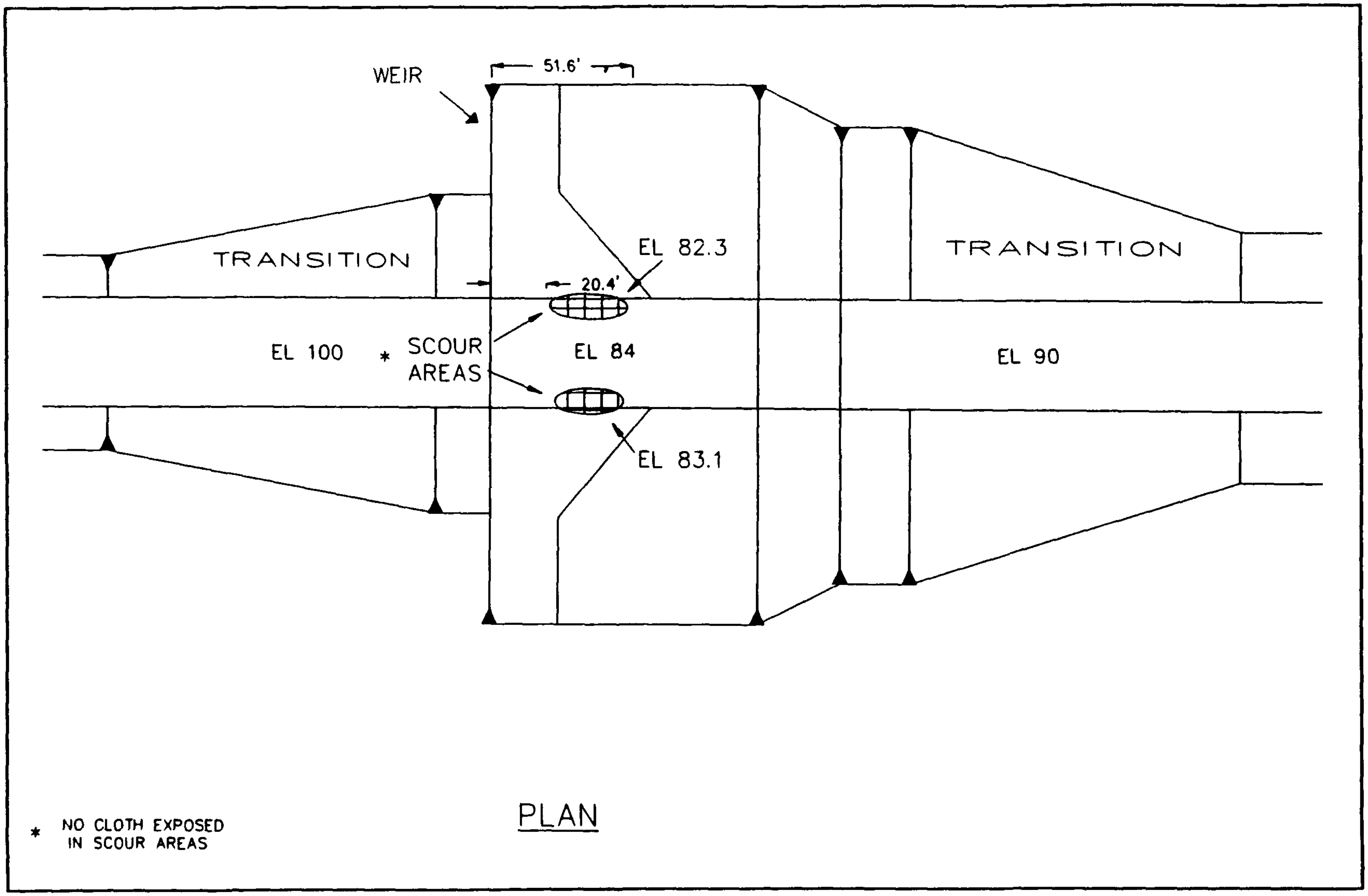

Figure 59. Type 1 design, scour areas, discharge 4,000 cfs, tailwater elevation 102.0 ft

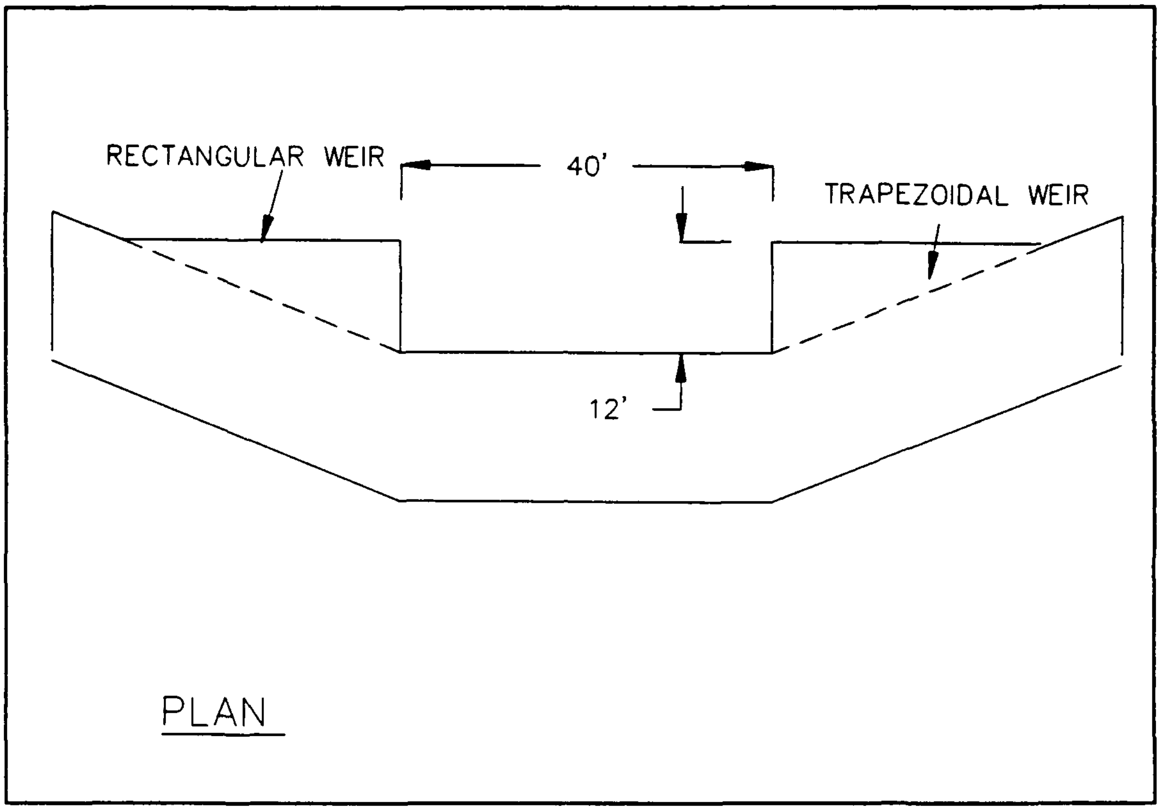

Figure 60. Rectangular and trapezoidal weir dimensions

Since the R1500 stone gradation was the maximum the Vicksburg District felt could be placed in the field, the next testing effort evaluated the use of grout. Testing was continued with discharges of 4,000 cfs and 5,300 cfs. The tailwater was lowered until failure of the nongrouted riprap occurred or a strong hydraulic jump formed over the grouted section. When a hydraulic jump formed over the grouted section, some smaller stones were displaced from the side slopes immediately downstream of the grout, but no filter cloth was exposed.

Conclusions

Results. Initial tests were conducted with the type 1 design basin (Figures 56 and 57) and a discharge of 4,000 cfs. With the trapezoidal weir in place, riprap failure occurred at tailwater elevation 102.0,[1] as shown in Figure 59. The trapezoidal weir was replaced with a rectangular weir (Figure 60), and failure occurred at tailwater elevation 103, as shown in Figure 61.

[1] Elevations (el) cited herein are in feet referred to the National Geodetic Vertical Datum (NGVD).

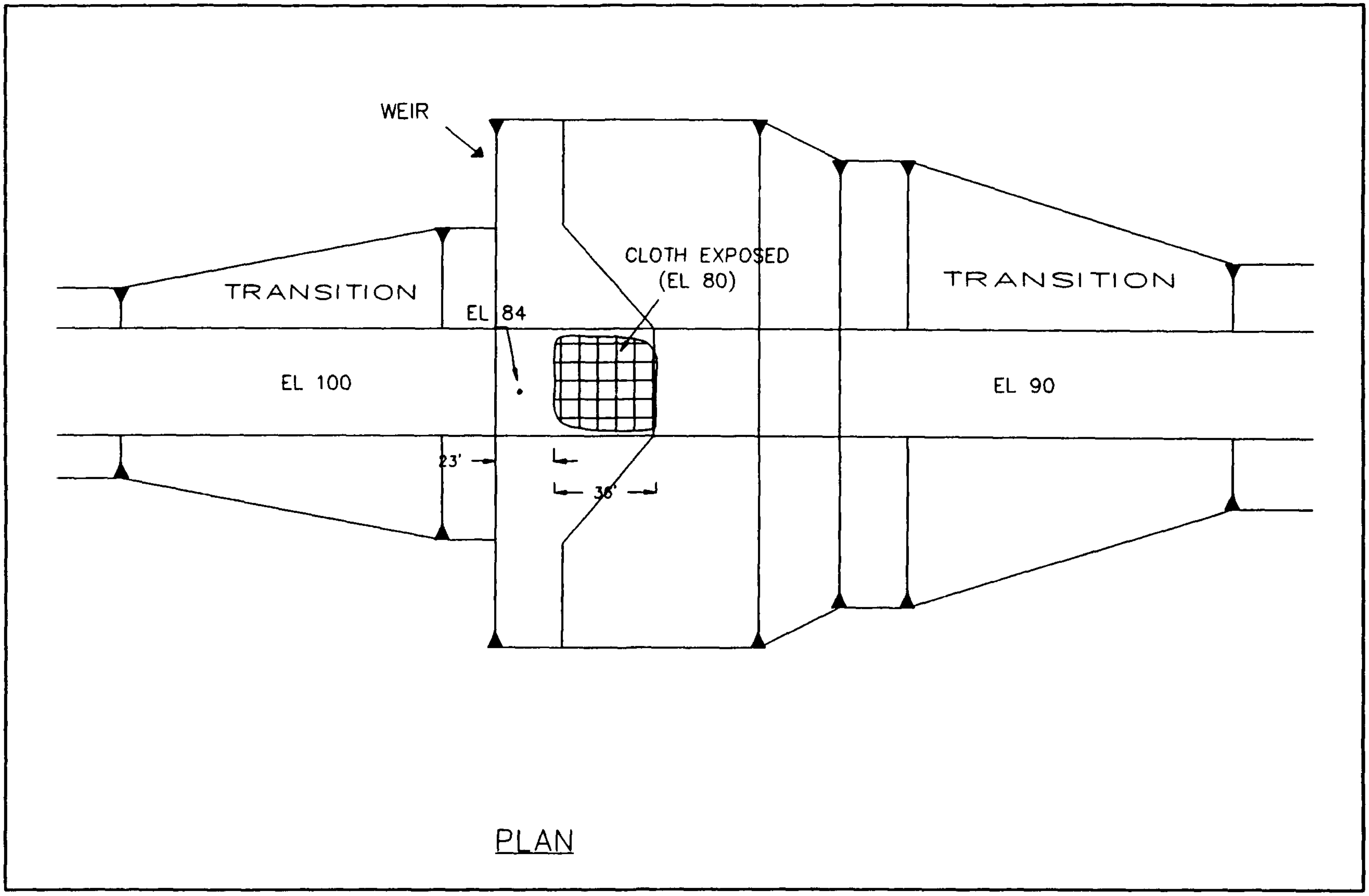

Figure 61. Type 1 design (type 2 weir) scour area, discharge 4,000 cfs, tailwater el 103.0

Testing was continued with a section of grouted riprap downstream of the weir (Figure 62). With a discharge of 4,000 cfs, no failure of riprap occurred. The lowest tailwater elevation tested was 99.0. At this elevation, a strong hydraulic jump was present with good energy dissipation over the grouted area. These tests were conducted with the trapezoidal weir only.

The next tests were conducted with the trapezoidal weir, grouted riprap section, and a discharge of 5,300 cfs. This was the maximum discharge allowable without construction modifications to the model headbay. With a tailwater elevation of 105.0, the plunging flow from the weir caused riprap failure on both side slopes immediately downstream of the grouted riprap, as shown in Figure 63.

In the original basin design (Figure 56), a small section of riprap (20 ft long) was placed immediately upstream of the weir. The area was grouted due to stone failure as the tailwater was lowered. Velocities in this area can exceed 16 fps with a discharge of 4,000 cfs and 18 fps with a discharge of 5,300 cfs.

In general, stable riprap conditions in the ungrouted basin required higher tailwater elevations (submergence) than in the grouted basin. While prototype conditions of depth of flow for that channel size and the 4,000-cfs discharge are on the order of 11 to 12 ft, tailwaters could actually be lower. The results to date indicate that the grouted basin could be a viable option for areas where a 10-ft drop is needed and where low tailwater conditions could occur.

The rectangular weir moved the failure zone off the side slopes and lowered velocities in the approach channel upstream of the weir. Velocities over the rectangular weir were comparable to and, at some tailwater elevations, higher than those measured with the trapezoidal weir. The water surface elevation in the approach channel was higher with the rectangular weir in place. The energy was increased into the stilling basin due to the restricted cross-sectional area of the weir causing riprap failure on the basin floor at a higher submergence than the trapezoidal weir.

Status. A data report will be provided containing all data collected for the conditions tested. It will also provide design recommendations regarding hydraulic performance and riprap stability.

If the 10-ft drop is unsuitable due either to insufficient availability of needed stable stone sizes or to unfavorable hydrodynamic conditions in the approach or downstream channel, more testing should be considered. Furthermore, the testing should evaluate flow conditions above (in addition to the 5,300-cfs flow) and below the design discharge. These efforts are beyond the scope of this study.

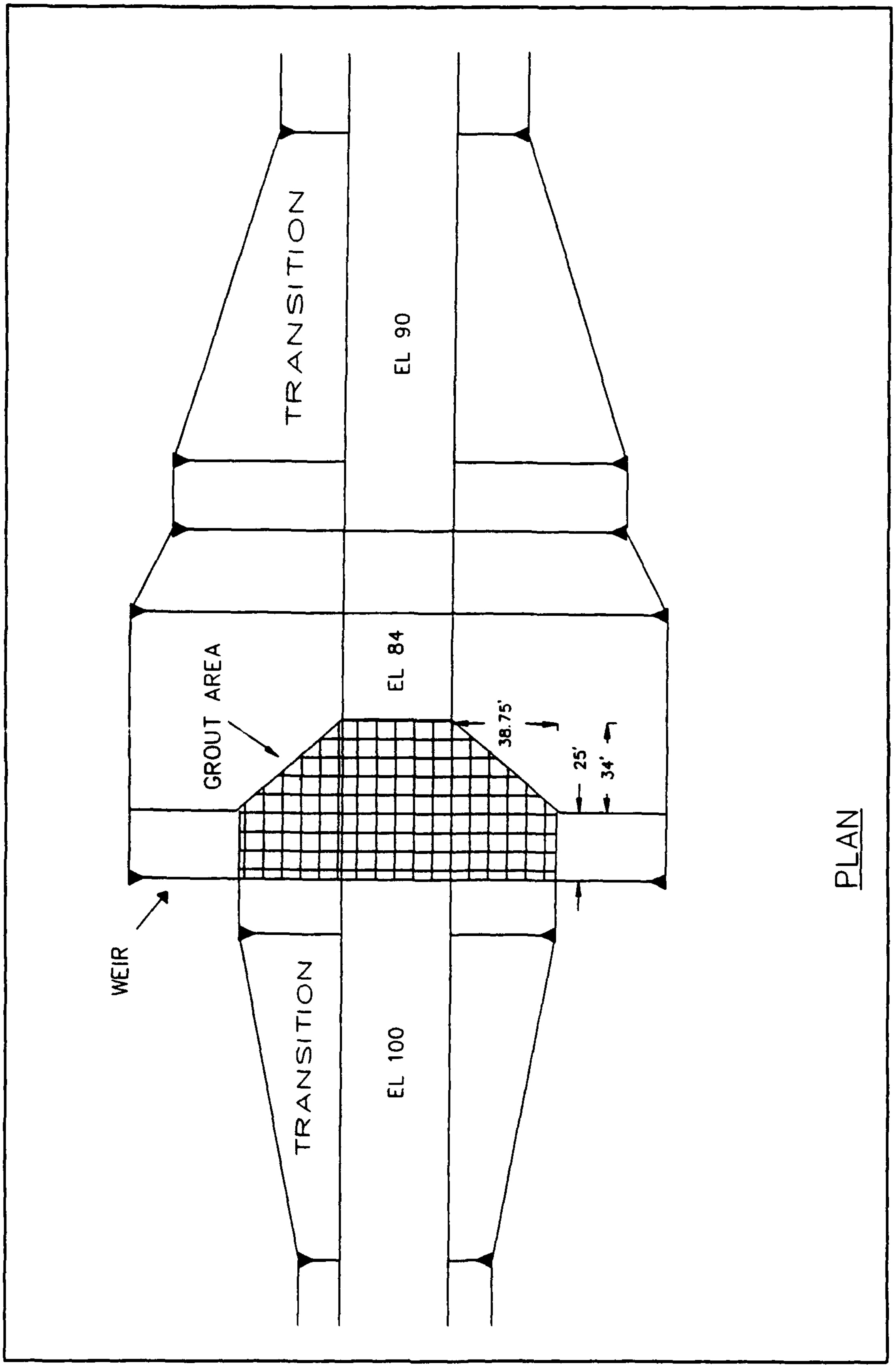

Figure 62. Grouted area, type 1 design

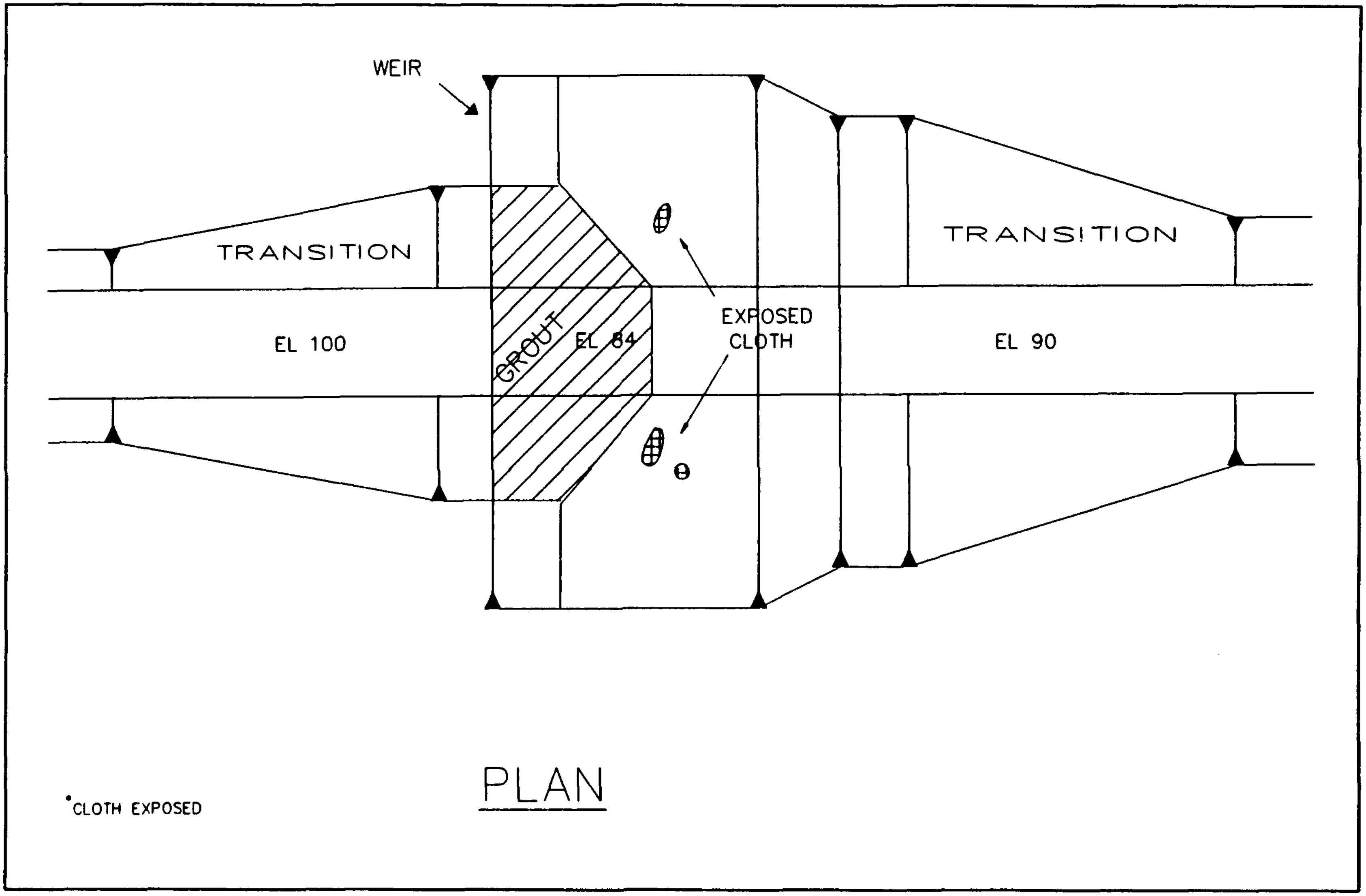

Figure 63. Type 1 design scour areas, discharge 5,300 cfs, tailwater el 105.0

Model Study of Bendway Weirs as Bank Protection

The bendway weir concept was previously developed on a WES movable-bed model study of the Mississippi River conducted for the U.S. Army Engineer District, St. Louis (Derrick and Pokrefke, in preparation). In that case, bendway weirs were developed to eliminate sedimentation problems in the bends of navigable streams where the natural point bar deposition on the inside of the bend encroached into the navigation channel and restricted the channel.

Results of those original tests indicated that bendway weirs would not only widen the channel in a bend, but would also change the way water and sediment moved through the bend by increasing velocities on the inside (convex side) of the bend and lowering velocities on the outside (concave side) of the bend. Thus the resulting currents were more evenly distributed across the channel. The redistribution of currents also allowed bed material to accumulate on the outside of the bend in the deep portion of the channel, which added stability to the revetted bank there. Tests also indicated that there may be an improvement in the channel immediately downstream of the reach with bendway weirs. This change appeared to be a result of the redistribution of water and sediment in the bendway and how, with the weirs in place, water approached the downstream reach.

Since in those previous studies the weirs redistributed the movement of water and sediment through the bendways, it was decided to investigate the use of such weirs for the DEC Project to reduce the concentration of higher velocities on the outside of an unprotected bank and possibly cause the deposition of material on the outside portion of the bend. If this could be accomplished, then the potential for bank failure would be reduced. Such a study would have to address movement of both the bed and bank material. Typically, the composition of streambanks is highly variable from one stream to another and even from one location to another on the same stream. Therefore, the study conducted was not a model study of any particular DEC stream, but rather an investigation in which both the bed and banks were composed of sand and were erodible when subjected to flow. A synopsis of the model study is given in the following sections. A detailed discussion of the model study including test results is presented in Appendix F of this report.

Development of study parameters

Prior to conducting any testing, various parameters had to be developed to allow eventual extrapolation of the results to the DEC Project. Since this was not a study of any particular DEC stream, it was felt that the study had to be similar to the DEC streams; therefore, WES and the Vicksburg District conducted a limited review of pertinent data from some of the DEC streams and set some parameters for this investigation. The DEC data indicated that several streams have a width-to-depth ratio of about 10; therefore, that value was used for the study. The planforms of Fannegusha, Harland, and Black Creeks were analyzed for radius of curvature and degree of bend. The analysis indicated that as in most natural streams there is significant variability in the radii and degree of bend curvature. However, radius of curvatures equal to 2.5 times the top bank width and degree of curvature of 110 deg occurred often enough to be representative for this study. The initial channel planform reflecting the selected radius of curvature and degree of bend and uniform channel cross section used in the model are shown in Figure 64.

The bed and bank material used were fine sand with a uniform size distribution. The sand had a specific gravity of 2.65 and a size distribution with a D_{15} of 0.17 mm, a D_{50} of 0.23 mm, and a D_{85} of 0.30 mm.

Prior to testing, a symmetrical stage hydrograph was developed and the discharge was adjusted in the study reach until reasonable sand movement was obtained for all stages tested. The step hydrograph developed is shown in Figure 65.

Model tests

Since the study was general in nature, no traditional verification to a prototype was possible. Testing included base, Plan 1, Plan 2, and Plan 3 tests. The Plan 1 and Plan 2 weir layouts are shown in Figures 66 and 67, respectively. Plan 3 consisted of hard point design presently in use by the Vicksburg District on the DEC Project. The hard point field consisted of six structures in the same locations in the bendway as the weirs in Plans 1 and 2.

Discussion of results

The study conducted was not of a specific stream within the DEC Project, although it is anticipated that the results obtained will be applied to appropriate DEC streams as a test of the bendway weir concept for bank protection. That application should be closely monitored and evaluated as the channel or channels adjust to the bendway weirs. Modeling of bank recession phenomena is qualitative, since the performance of any improvement plan in the real world will be dependent on the material composition of the streambanks. This study was conducted with fine sand with little or no cohesiveness. All testing was conducted with one repetition of the discharge and stage hydrograph; therefore, the channel configuration and bank recession may have been somewhat different if several repetitions of the hydrograph had been conducted. Since no sediment was introduced above the study reach during the test, stable long-term conditions could not be evaluated.

This study represents a limited effort conducted for the DEC Project to evaluate the potential use of bendway weirs for bank protection. Due to funding and time constraints, only a few options were studied. However, enough was learned from this study to make a reasonable application for a "field

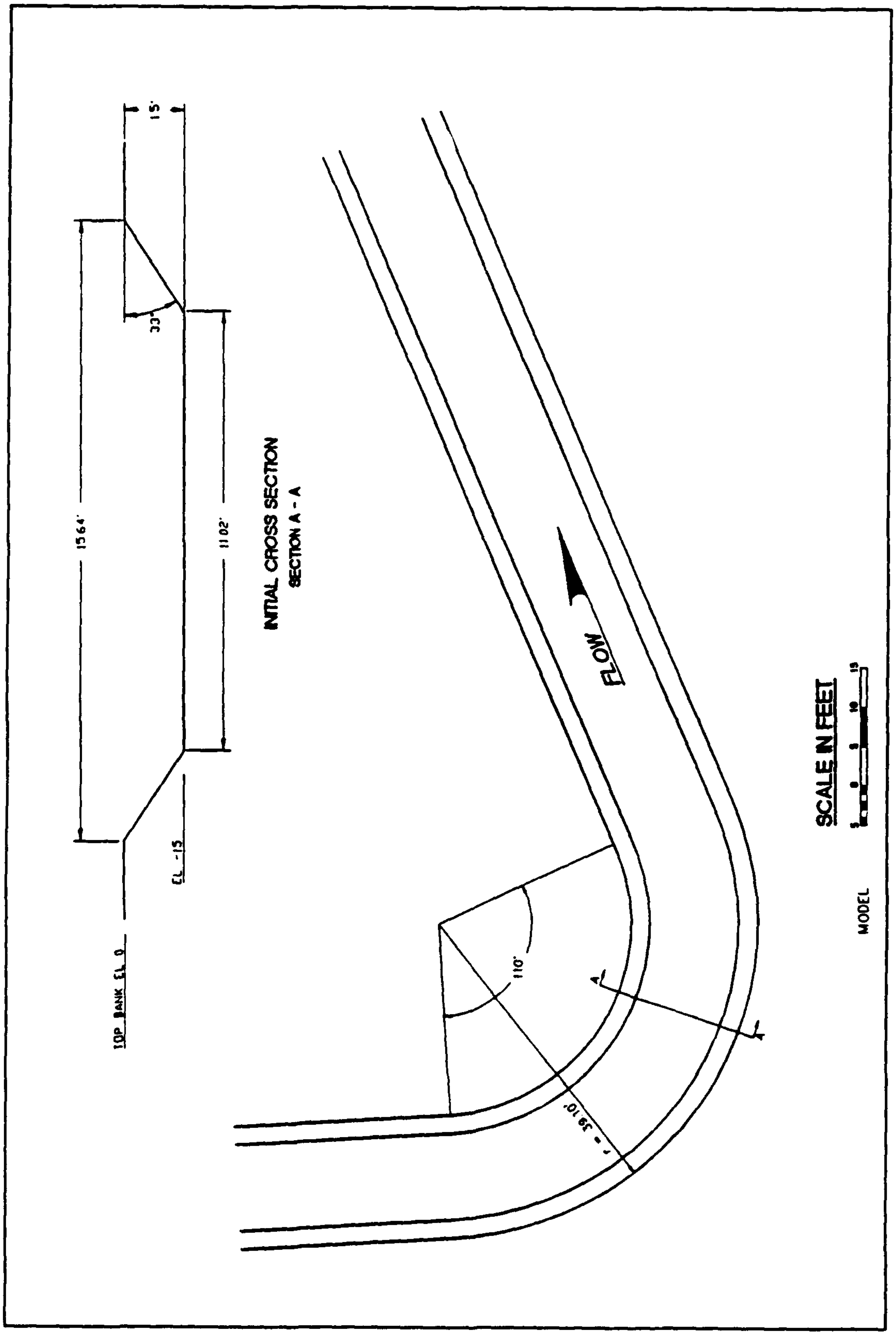

Figure 64. Layout of model bendway weirs

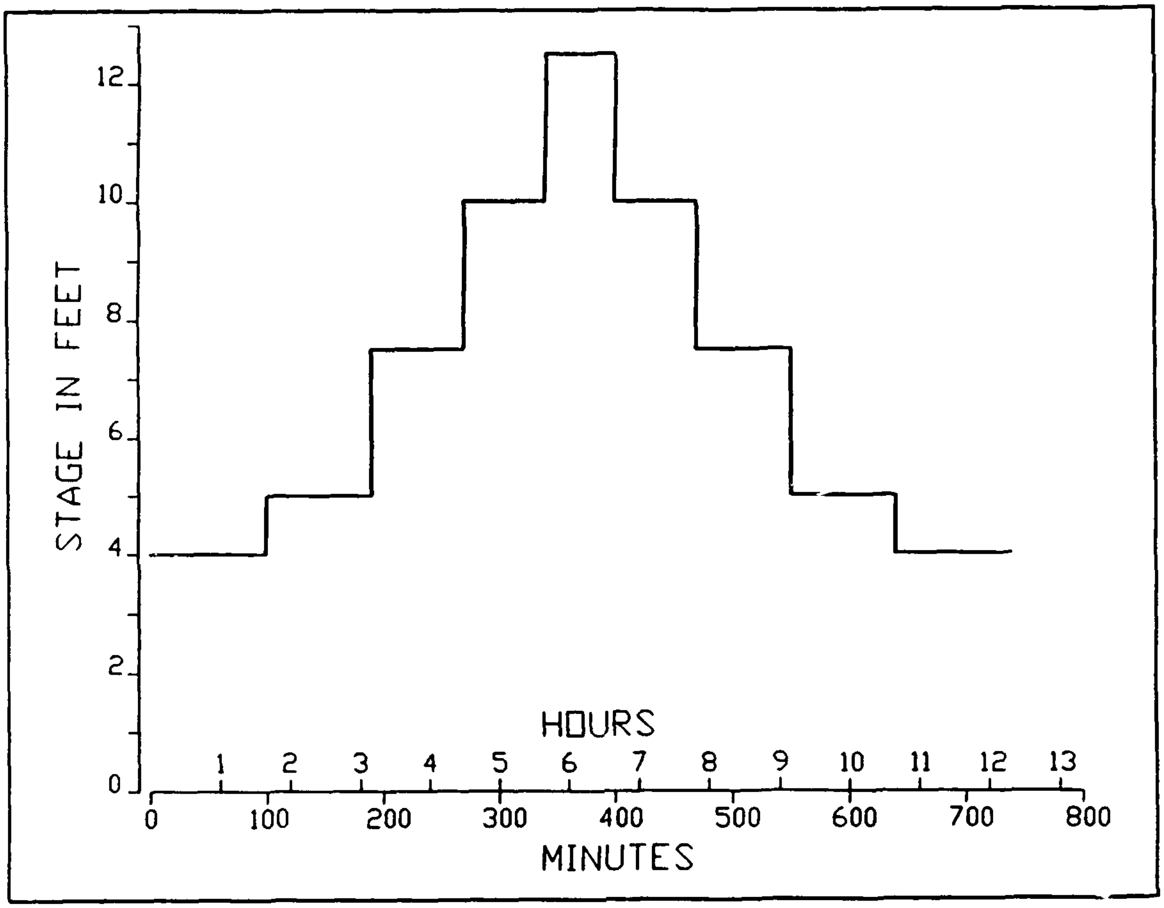

Figure 65. Testing hydrograph for bendway weir testing

demonstration" of the bendway weir concept provided that all involved realize the limited nature of the study.

The following results and conclusions were developed during the study:

a. Within the bendway, Plans 1, 2, and 3 provided essentially equal protection of the bank from recession.

b. Downstream of the bendway, Plan 1 provided more bank protection than Plan 2, which provided more bank protection than Plan 3 (hard points).

c. The bendway weirs in Plan 1 were too long, causing scour on the inside of the bendway.

d. The bendway weirs in Plans 1 and 2 were effective in realigning the flow and moving the higher velocity currents from the bankline toward the center of the channel.

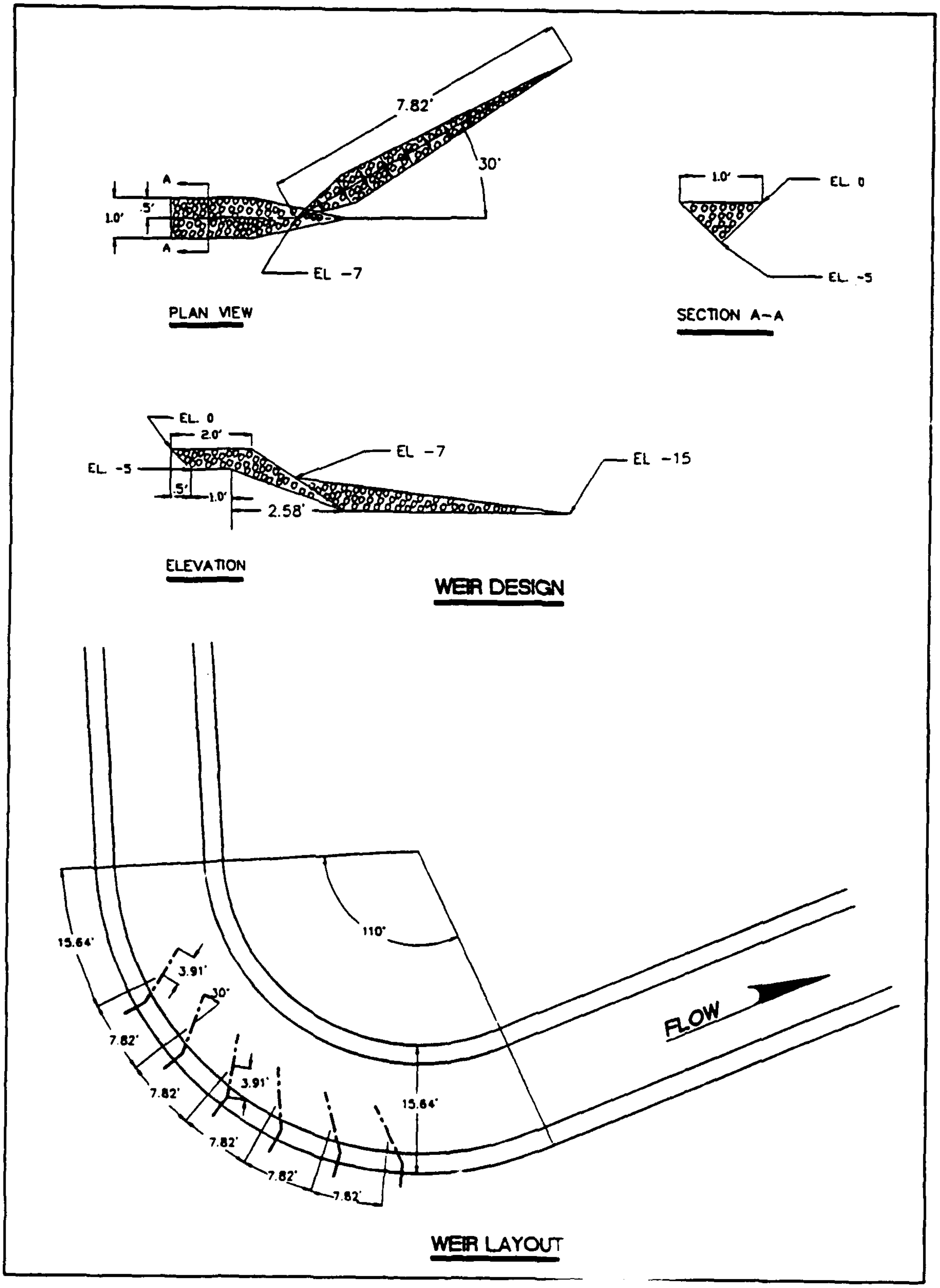

Figure 66. Plan 1 weir layout and design

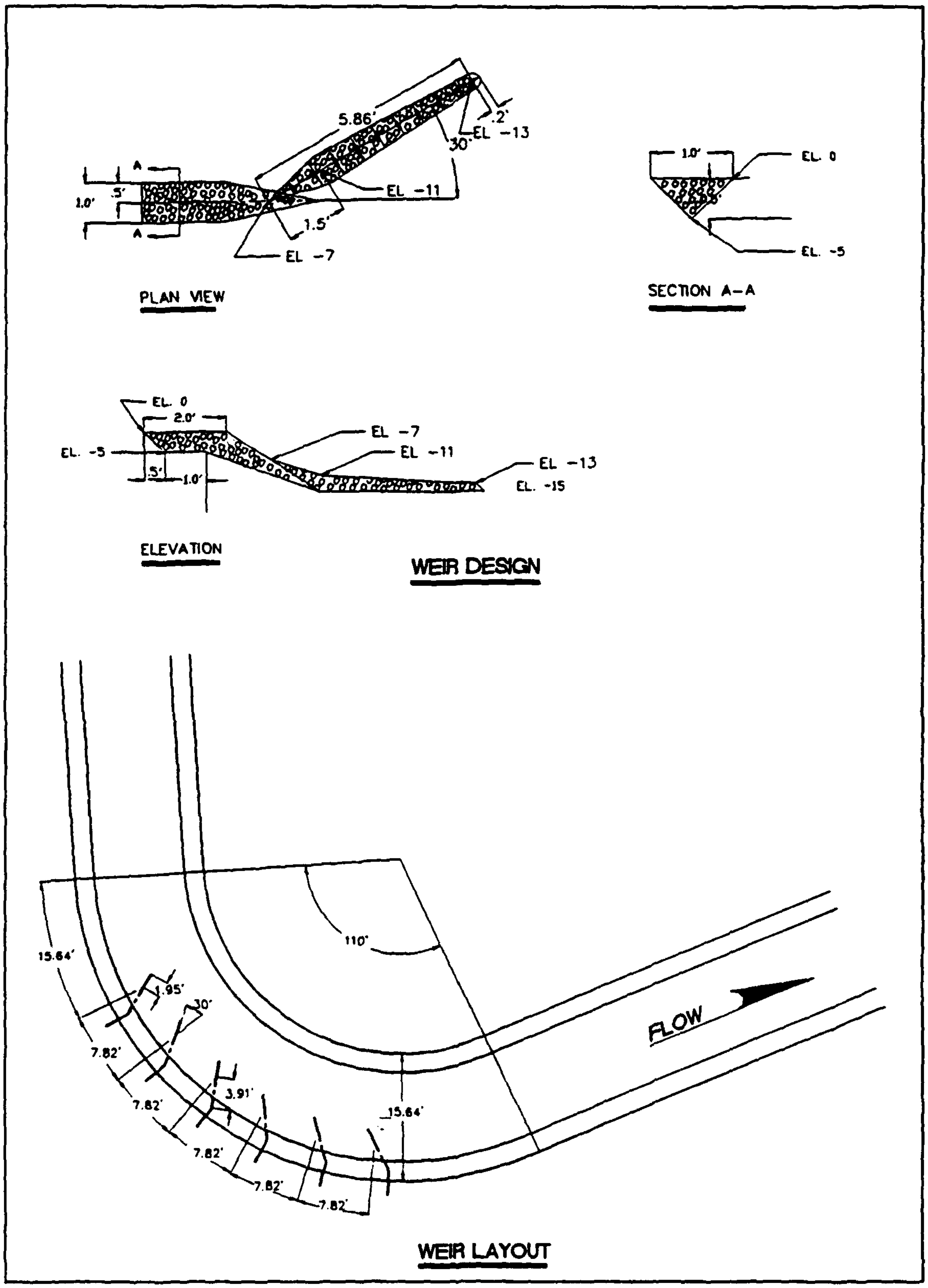

Figure 67. Plan 2 weir layout and design

e. The longest bendway weir length (Plan 1) produced the maximum amount of stream end scour. This additional scour could be attractive environmentally relative to habitat diversity.

12 FY 93 Work Plan

This chapter presents the work areas, funding requirements, and reporting activities for the proposed DEC Program to be conducted by the Hydraulics Laboratory at WES during FY 93.

The purpose of monitoring the DEC Project is to evaluate and document watershed response to the implemented DEC Project. Documentation of watershed responses to DEC Project features will allow the participating agencies a unique opportunity to determine the effectiveness of existing design guidance for erosion and flood control in small watersheds.

This work plan proposes 11 technical areas, described in Chapter 1, for the DEC monitoring program that would effectively monitor the major physical processes of erosion. The following areas are to be monitored and/or addressed:

a. Stream gauging.

b. Data collection and data management.

c. Hydraulic performance of structures.

d. Channel response.

e. Hydrology.

f. Upland watersheds.

g. Reservoir sedimentation.

h. Environmental aspects.

i. Bank stability.

j. Design tools.

k. Technology transfer.

WES is proposing significant activities in nine of the technical areas:

a. Data collection and data management.

b. Hydraulic performance of structures.

c. Channel response.

d. Hydrology.

e. Upland watersheds.

f. Reservoir sedimentation.

g. Bank stability.

h. Design tools.

i. Technology transfer.

The following is a general description of the work to be performed in the nine technical areas and monitoring surveys during FY 93. The specific work tasks discussed in each work area should be viewed as a starting point for planning the FY 93 monitoring program. It is anticipated that the monitoring program will need to be adjusted and changed as data are collected and analyzed and new and different areas of concern develop. To accomplish this, the Hydraulics Laboratory will work closely with Vicksburg District personnel and will schedule quarterly review sessions with the Vicksburg District. Monthly progress reports will also be provided to the District. This will allow the monitoring program to be adjusted as necessary to meet the needs of the DEC Program.

Data Collection and Data Management

The purpose of the data collection and data management work area was described in Chapter 1. For FY 93, the work in this area will focus on placing data collected during FY 92 and FY 93 into the engineering database. All available data from Vicksburg District, ARS, and SCS will be included in the engineering database. Historical data, i.e., pre-FY 92 data, will be added when the data are required for analysis in other technical areas. Historical data will also be placed in the database as time permits. The second area of focus for FY 93 will be the collection of stage and discharge data at the 20 long-term monitoring sites.

Hydraulic Performance of Structures

A minimum of two grade-control structures will be selected for detailed data collection to evaluate hydraulic performance of the structures. The structures will be selected and monitored as described in Chapter 1. The FY 93 focus in this technical area will be to determine the discharge coefficients for the Long and Hotophia Creeks grade control structures. Measurements will be taken of toe and end section scour at a selected dike field. The third task in this technical area will be the development of structure rating curves for all structures included in the long-term monitoring sites.

Channel Response

The channel response monitoring will be continued in FY 93. In addition to the 20 sites undergoing intensive monitoring, two selected sites where no structures are planned are also being monitored. These two sites serve as a control group and will assist in the evaluation of the channel response to the structures. Photo documentation of the structures and channels is being included in the engineering database. Structures and channels in the permanent monitoring set have been instrumented for stage and discharge to facilitate in evaluating channel response, hydrographic analysis, and structural performance. HEC-6 and the computer program SAM being developed in the Flood Control Channels Research Program will be used to predict the stability of channels monitored by this work effort. Some of the funding necessary for the application of SAM to DEC watersheds is being provided by WES research funds.

For FY 93, the channel response technical area accomplishments will be the continued data collection and analysis at the 20 long-term monitoring sites and the addition of two more long-term monitoring sites, bringing the total number of long-term monitoring sites to 22. The sites to be added are located on the lower ends of Abiaca Creek and Hickahala Creek. Detailed geomorphic studies for the watersheds resurveyed in FY 92 will be performed. The computer programs HEC-6 and SAM will be used to model and analyze selected channels.

The channel-forming discharge studies will be performed in parallel with a related Flood Controls Channels Research Program work unit. Presently, the DEC watersheds will provide prototype data that will be used to test design procedures and techniques for the channel-forming discharge concept. Development and documentation of a channel-forming discharge methodology could result in significant design cost savings for local flood control projects, not only for the DEC project but nationwide.

For FY 93, approximately $50,000 will be used to assist in the funding of a physical model study to help determine the existence of a channel-forming discharge. The majority of funding for this model study will be from the Flood Control Channels Research Program.

Hydrology

Hydrological models (HEC-1) of a selected number of watersheds are being developed in FY 92 and similar models of the remaining watersheds will be developed in FY 93. The hydrologic modeling and the hydraulic structures monitoring are being coordinated so that the hydrologic parameters used in HEC-1 can be verified at locations in the watersheds where USGS gauging stations do not exist. Following hydrologic model development of the watersheds, work will concentrate on investigating the utility of using weather radar as a tool in measuring precipitation rates and distribution over a watershed.

For FY 93, the hydrology work unit will concentrate on the development and the updating of HEC-1 models for all the DEC watersheds. The HEC-1 model will then be used to develop flows for selected time periods. Accurate flow data will increase the usefulness of studies being performed in the channel response technical area.

Upland Watersheds

The two areas related to the upland watershed area that require monitoring are (a) system sediment loading (sediment yield) and (b) sediment production from gully formation. Stabilization measures are being installed to reduce erosion, and the purpose of upland watershed monitoring will be to determine if there is a measurable change in the quantity of sediment being transported from each watershed for the next 5 years. Data that have already been collected by USGS and ARS for the past 5 years will be analyzed and interpreted and serve as the baseline for future comparisons. Numerical modeling of the sediment runoff from the watersheds will be incorporated into the data analysis and interpretation process. Sediment production from two or three active gullies will be analyzed by comparing surveys made prior to the design of drop pipes and the survey made just prior to construction of the drop pipes.

For FY 93, the monitoring in the upland watershed technical area will be performed by ARS.

Reservoir Sedimentation

Reservoir sedimentation studies are scheduled to begin in FY 94. Data being collected in the other technical areas will be crucial input into this effort once studies and analysis commence.

Bank Stability

The FY 93 efforts in bank stability include the visual monitoring of all 15 DEC watersheds and reporting the results of this visual monitoring in the FY 93 technical report. It is anticipated that the data for visual monitoring will come from low-level aerial videotaping of the channels. Analysis of data and the initial development of a streambank stability computational method will be performed as blended effort with the Flood Control Channels Research Program. WES will do the hydraulic design, surveys, and layout of a bendway weir design for prototype testing in a selected DEC stream.

Design Tools

In conjunction with ongoing research, WES will continue to develop design tools for the planning and design of stable flood control projects.

Technology Transfer

WES will annually report on the DEC monitoring program using several different formats. For FY 93, the following activities will be included in the technology transfer:

a. A detailed WES technical report on monitoring, data collection, data analysis, and project evaluation.

b. An updated engineering database on the Intergraph system including aerial photos, surveys (channel and structural), and results of numerical studies to be provided to the Vicksburg District.

c. A short executive summary report (5 pages or less).

d. Workshop on Grade Control for Channel Stability with some contribution from Flood Control Structures Research Program.

e. Workshop on the development of an engineering database for hydrologic studies.

Monitoring Surveys

WES will be responsible for the scheduled monitoring surveying for FY 93. Burney Branch and Abiaca Creek are the watersheds scheduled to be surveyed as part of the FY 93 monitoring program. As a result of numerous problems encountered during the detailed geomorphic studies performed in FY 92, alternatives to present surveying techniques will be explored. WES will coordinate with other Corps laboratories to determine if recent advances in surveying or topographic data collections could result in a more complete data set without a substantial increase in cost. Alternatives such as using aerial surveying techniques and development of terrain models that would allow analysis of numerous cross sections will also be investigated.

13 General Assessment After 1 Year

As the result of FY 92 activities, the following assessments are given:

a. Field observations and preliminary analysis of channel surveys have shown the following:

(1) High-drop structures work well for channel rehabilitation.

(2) Low-drop structures are effective for stopping channel headcuts.

(3) Low-drop structures have limited impact on sediment yield and bank caving.

(4) Surveying channel cross sections at half-mile intervals is not adequate for channel response analysis.

(5) Bank stabilization should be used with grade control.

b. Aerial video taping is a promising technique for monitoring channels.

c. The engineering database/GIS appears to be workable and cost effective.

d. The applicability of the engineering database/GIS is interdisciplinary.

e. Computed discharges from the HEC-1 hydrology model appear to be consistently high.

f. Preliminary results from the application of the two-dimensional hydrology model, CASC2D, to the Goodwin Creek watershed indicate potential for more accurate discharge calculations on DEC watersheds than provided by HEC-1.

g. Knowledge gained in the DEC Project Monitoring Program is applicable to flood control and navigation engineering.

h. Both the acoustic water level sensors and the submerged pressure transducers used in field data collection have performed satisfactorily and, with proper maintenance, should continue to do so.

i. Storm-event discharge measurements to be used in developing discharge rating curves have proven extremely difficult to collect.

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Table 1
Riprap Sill Grade Control Structures

STREAM	WATERSHED	COUNTY	QUAD	T,R,S	CONST DATE
BILLY CR	HICK-SEN		SENATOBIA	T5S,R7W,S22	
THORNTON	HICK-SEN		SENATOBIA	T5S,R7W,S23	
BASKET	HICK-SEN		SENATOBIA	T5S,R7W,S25	
W FORK WORSHAM	BATUPAN BOGUE		DUCK HILL	T20N,R6E,S28	FY88

Table 2
Levees

STREAM	WATERSHED	COUNTY	QUAD	T,R,S	CONST DATE
GRENADA, MS	BATUPAN BOGUE		GRENADA	T22N,R5E,S8,9,17,20,21	
LOWER ABIACA CR.	ABIACA		SEVEN PINES	T17N,R1E,S7,8,9,13,14,15,16,17	

Table 3
High-Drop Grade Control Structures

TITLE	STREAM	WATERSHED	COUNTY	QUAD	T,R,S	CONST DATE
SITE 1	LICK CR	COLDWATER		HERNANDO	T2S,R8W,S4	
SITE 1	HOTOPHA	HOTOPHA		SARDIS	T9S,R6W,S1	
SITE 2	HOTOPHA	HOTOPHA		SARDIS	T9S,R6W,S1	FY91
SITE 3	HOTOPHA	HOTOPHA				
SITE 1	MOUSE CR	BATUPAN BOGUE		DUCK HILL	T21N,R7E,S32	FY92

Table 4
Floodwater Retarding Structures

TITLE	STREAM	WATERSHED	COUNTY	QUAD	T,R,S	CONST DATE
SITE 18	OTOUCALOFA	OTOUCALOFA		WATER VALLEY	T10S,R4W,S35	
SITE 18	ABIACA	ABIACA		SEVEN PINES	T16N,R2E,S16	
SITE 27	ABIACA	ABIACA		COILA	T17N,R3E,S9	
SITE 34	ABIACA	ABIACA		SEVEN PINES	T17N,R3E,S29	
SITE 47	BLACK-FANN	BLACK-FANN		LEXINGTON	T14N,R2E,S9	
SITE 52	BLACK-FANN	BLACK-FANN		LEXINGTON	T14N,R1E,S27,28	
SITE 44	BLACK-FANN	BLACK-FANN		LEXINGTON	T14N,R1E,S24	
SITE 45	BLACK-FANN	BLACK-FANN		LEXINGTON	T14N,R2E,S17	
SITE 51	BLACK-FANN	BLACK-FANN		LEXINGTON	T14N,R1E,S5	
SITE 30	BLACK-FANN	BLACK-FANN		DURANT	T15N,R3E,S11	
SITE 31	BLACK-FANN	BLACK-FANN		DURANT	T15N,R4E,S6	
SITE 35	BLACK-FANN	BLACK-FANN		DURANT	T15N,R3E,S27	
SITE 38	BLACK-FANN	BLACK-FANN		LEXINGTON	T14N,R3E,S6	
SITE 13	BLACK-FANN	BLACK-FANN		LEXINGTON	T16N,R2E,S28	
SITE 14	BLACK-FANN	BLACK-FANN		COILA	T17N,R3E,S35,36	
SITE 15	BLACK-FANN	BLACK-FANN		COILA	T17N,R4E,S31	
SITE 18	BLACK-FANN	BLACK-FANN		COILA	T16N,R3E,S1	
SITE 19	BLACK-FANN	BLACK-FANN		DURANT	T16N,R3E,S21	
SITE 20	BLACK-FANN	BLACK-FANN		LEXINGTON	T16N,R3E,S31	
SITE 22	BLACK-FANN	BLACK-FANN		LEXINGTON	T15N,R2E,S1	

Table 5
Channel Improvement

SITE NUMBER	WATERSHED	COUNTY	QUAD	T.R.S	CONST DATE	TYPE
REACH 1	HICK-SEN		CRENSHAW	T4S.R8W.S35		CHANNEL RESTORATION
			SENATOBIA	T5S.R8W.S1.11		
			SENATOBIA	T5S.R7W.S7.18		
REACH 2	HICK-SEN		SENATOBIA	T5S.R7W.S18.17.20.21.22.23.24		CHANNEL RESTORATION
REACH 3	HICK-SEN		SENATOBIA	T5S.R7W.S21.28.33.34		
			SENATOBIA	T6S.R7W.S3.10		
BURNEY BRANCH	BURNEY BRANCH		OXFORD	T8S.R3W.S28.33	FY-88	REALIGN & PAVE
TOWN CREEK	OTOUCALOFA		WATER VALLEY	T11S.R4W.S8.9.4		SNAG & DEBRIS REMOVAL
OTOUCALOFA-1	OTOUCALOFA		WATER VALLEY	T11S.R5W.S12		SNAG & DEBRIS REMOVAL
			WATER VALLEY	T11S.R4W.S7.8.9.16		
			WATER VALLEY	T11S.R4W.S16		
OTOUCALOFA-2	OTOUCALOFA		WATER VALLEY	T11S.R4W.S15.14.11.12		SNAG & DEBRIS REMOVAL
			WATER VALLEY	T11S.R3W.S7		

Table 6
Box Culvert Structures

TITLE	STREAM	WATERSHED	COUNTY	QUAD	T.R.S	FISCAL YEAR
SITE 1	BEARTAIL	COLDWATER R		SENATOBIA	T4S.R8W.S11.12	FY-92
SITE 1	BEARTAIL-TRIB	COLDWATER R		SENATOBIA	T4S.R8W.S11.12	FY-92
SITE 1	BUTTERMILK-TRIB	COLDWATER R		SENATOBIA	T4S.R8W.S33	FY-92
SITE 1	BUTTERMILK-TRIB	COLDWATER R		SENATOBIA	T5S.R8W.S4	FY-92
SITE 2	BEARTAIL-TRIB	COLDWATER R		HERNANDO	T4S.R8W.S12	FY-92
SITE 3	BEARTRAIL	COLDWATER R		HERNANDO	T4S.R8W.S4.9	FY-92

Table 7
Low-Drop Grade Control Structures

LABEL	STREAM	WATERSHED	COUNTY	DWG FILE NO	T.R.S.	QUAD (7.5,15)	CONST DATE	TYPE	WEIR ELEV	DROP HEIGH	STRUC Q	RECUR INT	RIPRAP Q	SUBM @STRE	WEIR LGTH	WEIR SS	LARGE STONE	GROUT
LD-1	NOLEHOE	COLDWATER	DESOTO	---	T1S,R7W,S36	HERNANDO	---											
LD-2	NOLEHOE	COLDWATER	DESOTO	---	T1S,R7W,S36	HERNANDO	---											
LD-1	CHEW	COLDWATER	DESOTO	---	[illegible]	TYRO	---											
LD-1	SENATOBIA	HICK-SEN	TATE	YC-15-144	T5S,R7W,S14	SENATOBIA	FY86	4	258	8	N/A	N/A	N/A	N/A	60	2.5	30	NO
LD-1	HICKAHALA	HICK-SEN	TATE	YYA-15-186	[illegible]	SENATOBIA	FY87	1	300	8	N/A	N/A	N/A	N/A	30	2.5	30	NO
LD-2	HICKAHALA	HICK-SEN	TATE	YC-15-144	[illegible]	SENATOBIA	FY86	4	311	8	N/A	N/A	N/A	N/A	100	2.5	30	NO
LD-3	HICKAHALA	HICK-SEN	TATE	YYA-15-202	[illegible]	TYRO	FY86	1	340	5	1500	5	N/A	N/A	15	2.5	30	NO
LD-1	WHITE'S	HICK-SEN	TATE	YC-15-154	[illegible]	SENATOBIA	FY91	3	300	4	610	5	N/A	N/A	20	2.5	R1000	NO
LD-1	JAMES WOLF	HICK-SEN	TATE	YC-15-142	[illegible]	TYRO	FY88	1	351	5	3500	10	N/A	N/A	30	3	30	NO
LD-4	HICKAHALA	HICK-SEN	TATE	---	[illegible]	TYRO	FY92	3	312	5	3200	10	2800	1	35	2.5	R1500	NO
LD-1	ST HICKAHALA	HICK-SEN	TATE	YC-15-174	[illegible]	TYRO	---	3	348	5	2710	50	2100	0.83	20	2.5	R450	YES
LD-2	WHITE'S	HICK-SEN	TATE	YC-15-176	[illegible]	SENATOBIA	---	3	307	5	1070	50	1070	0.271	15	2.5	R450	YES
LD-1	TOULENT-JONES	HICK-SEN	TATE		[illegible]	SENATOBIA	---											
LD-3	JAMES WOLF	HICK-SEN	TATE		[illegible]	SENATOBIA	---											
LD-1	MARTINDALE	HICK-SEN	TATE	YC-15-175	[illegible]	SENATOBIA	---	2	307	3	2552	50	2552	0.753	15	2.5	R450	YES
LD-6	HICKAHALA	HICK-SEN	TATE	YC-15-173	[illegible]	TYRO	FY92	2	330.5	5	4875	25	2275	1	15	2.5	R450	YES
LD-1	BASKET	HICK-SEN	TATE		[illegible]	SENATOBIA												
LD-7	HICKAHALA	HICK-SEN	TATE	YC-15-173	[illegible]	TYRO	FY92	3	300	5	2400	100	2400	0.507	10	2.5	R450	YES
LD-2	S F HICKAHALA	HICK-SEN	TATE	YC-15-174	[illegible]	TYRO	---	3	300	5	1900	50	1900	0.583	15	2.5	R450	YES
LD-3	S F HICKAHALA	HICK-SEN	TATE	YC-15-176	[illegible]	TYRO	---	3	300	5	1520	50	1520	0.412	15	2.5	R450	YES
LD-1	BEARD'S	HICK-SEN	TATE		[illegible]	SENATOBIA	---											
LD-2	JAMES WOLF	HICK-SEN	TATE		[illegible]	SENATOBIA	---											
LD-1	CATHY	HICK-SEN	TATE		[illegible]	TYRO	---											
LD7-7	HOTOPHA	HOTOPHA	PANOLA	Y-15-182	[illegible]	SARDIS	FY86	1	238	4	8780	10	N/A	N/A	30	3	30	NO
LD7-8	HOTOPHA	HOTOPHA	PANOLA	Y-15-182	[illegible]	SARDIS	FY86	1	257	4.5	4780	10	N/A	N/A	35	3	30	NO
LD-1	MANCUM	HOTOPHA	PANOLA	YYA-15-188	[illegible]	SARDIS	FY86	1	265	8	2071	10	N/A	N/A	30	3	30	NO
LD-1	HILL	HOTOPHA	PANOLA	YLT-15-[illegible]	[illegible]	SARDIS	FY86	1	250	8	850	5	N/A	N/A	20	2.5	30	NO
LD-2	HILL	HOTOPHA	PANOLA	YLT-15-110	[illegible]	SARDIS	FY86	3	340	5	900	5	N/A	N/A	30	2.5	R1000	NO
LD-1	DEER	HOTOPHA	PANOLA	YLT-15-88	[illegible]	SARDIS	FY86	1	271.5	5.5	1850	5	N/A	N/A	30	2.5	30	NO
LD-2	DEER	HOTOPHA	PANOLA	YLT-15-88	[illegible]	SARDIS	FY86	1	270.5	8	1800	5	N/A	N/A	30	2.5	30	NO
LD-1	LONG	LONG	PANOLA	YYO-15-58	[illegible]	OAKLAND	FY87	1	271	4.5	4710	10	N/A	N/A	20	3	30	NO
LD-2	LONG	LONG	PANOLA	YYA-15-180	[illegible]	OAKLAND	FY86	1	277	8	4430	10	N/A	N/A	30	3		NO
LD-3	LONG	LONG	PANOLA	YYO-15-85	[illegible]	OAKLAND	FY86	4	285	8	N/A	N/A	N/A	N/A	30	3		NO
LD-1	CAREY	LONG	PANOLA	YYO-15-58	[illegible]	OAKLAND	FY87	1	243	4.5	7110	10	N/A	N/A	30	3	30	NO
LD-2	CAREY	LONG	PANOLA	YYO-15-85	[illegible]	OAKLAND	FY86	1	250	8	8580	10	N/A	N/A	30	3	30	NO
LD-3	CAREY	LONG	PANOLA	YYO-15-85	[illegible]	OAKLAND	FY86	4	261	8	N/A	N/A	N/A	N/A	25	3	30	NO
LD-1	JOHNSON CR	LONG	PANOLA	YYO-15-85	[illegible]	OAKLAND	FY86	3	270	8	3830	10	N/A	N/A	15	2.5	30	NO
LD-4	LONG	LONG	PANOLA	YYO-15-86	[illegible]	OAKLAND	---	2	258.5	8	4745	50	3400	0.80	25	2.5	R450	YES
LD-5	LONG	LONG	PANOLA		[illegible]	OAKLAND	---											
LD-1	CROWDER	BATUPAN BOGUE	GRENADA	YYA-15-180	[illegible]	DUCK HILL	FY87	1	234	8	1830	10	N/A	N/A	20	3	30	NO
LD-1	CAPPS BR	BATUPAN BOGUE	GRENADA	YYA-15-180	[illegible]	DUCK HILL	FY87	1	272	8	1887	10	N/A	N/A	30	3	30	NO
LD-1	LITTLE BOGUE	BATUPAN BOGUE	MONTGOMERY	YYA-15-180	[illegible]	DUCK HILL	FY87	1	307	8	[illegible]	10	N/A	N/A	30	3	30	NO
LD-1	ESKRIDGE	BATUPAN BOGUE	MONTGOMERY	YYA-15-180	[illegible]	DUCK HILL	FY87	3	300	8	3000	10	N/A	N/A	25	3	30	NO
LD-2	ESKRIDGE	BATUPAN BOGUE	MONTGOMERY	YYA-15-201	[illegible]	DUCK HILL	FY86	1	300	8	3000	8	N/A	N/A	15	2.5	30	NO
LD-1	W FK WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-15-[illegible]	[illegible]	DUCK HILL	FY86	1	300	8	1850	10	N/A	N/A	30	3	30	NO
LD-1	M FK WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-15-[illegible]	[illegible]	DUCK HILL	FY86	1	261	8	1800	10	N/A	N/A	35	3	30	NO
LD-1	WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-15-[illegible]	[illegible]	DUCK HILL	FY86	1	270	8	3000	10	N/A	N/A	25	3	30	NO
LD-1	E F WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-15-[illegible]	[illegible]	DUCK HILL	FY86	1	282	8	1800	10	N/A	N/A	30	3	30	NO
LD-3	W FK WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-15-230	[illegible]	DUCK HILL	FY91	1	304	8	1130	5	N/A	N/A	20	3	R1000	NO
LD-2	M FK WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-15-230	[illegible]	DUCK HILL	FY91	1	283	8	103	8	N/A	N/A	25	3	R1000	NO
LD-3	PERRY CR	BATUPAN BOGUE	GRENADA	YYA-15-240	[illegible]	MCCARLEY	FY92	3	231	5	4800	100	2550	1	20	3	R450	YES
LD-4	PERRY CR	BATUPAN BOGUE	GRENADA	YYA-15-240	[illegible]	MCCARLEY	FY92	3	230	5	3200	100	1775	1	10	3	R450	YES
LD-5	PERRY CR	BATUPAN BOGUE	GRENADA	YYA-15-244	[illegible]	MCCARLEY	FY92	3	251	5	2700	50	2700	0.50	20	2.5	R450	YES
LD-6	PERRY CR	BATUPAN BOGUE	GRENADA	YYA-15-244	[illegible]	MCCARLEY	FY92	3	254	5	[illegible]	50	2400	0.780	15	2.5	R450	YES
LD-[illegible]	CROWDER CR	BATUPAN BOGUE	GRENADA	Y-15-243	[illegible]	MCCARLEY	---	3	225	5	3154	50	2505	0.83	20	2.5	R450	YES
LD-1	CAMPBELL	BATUPAN BOGUE	MONTGOMERY	Y-15-243	[illegible]	MCCARLEY	---	3	240	5	3000	50	3000	0.50	20	2.5	R450	YES
LD-4	W FK WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-15-242	[illegible]	DUCK HILL	---	3	274	5	3000	100	3000	0.505	[illegible]	2.5	R450	YES
LD-3	M FK WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-15-242	[illegible]	DUCK HILL	---	3	275	5	3750	100	3750	0.801	10	2.5	R450	YES
LD-3	WORSHAM	BATUPAN BOGUE	MONTGOMERY	YYA-14-55	[illegible]	DUCK HILL	---	3	275	5	2775	10	1700	1	20	2.5	R1500	NO
LD-1	LITTLE MOUSE	BATUPAN BOGUE	MONTGOMERY	YYA-14-55	[illegible]	DUCK HILL	---	3	272	5	3000	50	1700	0.54	15	3	R1500	NO
LD-2	LITTLE MOUSE	BATUPAN BOGUE	MONTGOMERY	YYA-14-55	[illegible]	DUCK HILL	---	3	280	5	2350	50	2350	0.75	15	2.5	R1500	YES
LD-1	POWELL	BATUPAN BOGUE	MONTGOMERY		[illegible]	DUCK HILL	---											
LD-1	EPISON	BATUPAN BOGUE	GRENADA		[illegible]	DUCK HILL	---											
LD-1	JACKSON	BATUPAN BOGUE	MONTGOMERY		[illegible]	DUCK HILL	---											
LD-1	ABIACA	ABIACA	CARROLL		[illegible]	SEVEN PINES	---											
LD-2	ABIACA	ABIACA	CARROLL		[illegible]	COILA	---											
LD-1	CREEK 102	ABIACA	CARROLL		[illegible]	COILA	---											
LD-1	BLACK CR	BLACK-FANN	HOLMES	Y-15-181	[illegible]	DURANT	FY91	1	240	5	3200	5	N/A	N/A	20	2.5	30	NO
LD-1	TARREY CR	BLACK-FANN	HOLMES	YYA-15-202	[illegible]	DURANT	FY86	1	223	8	3000	5	N/A	N/A	25	2.5	30	NO
LD-2	TARREY CR	BLACK-FANN	HOLMES	YYA-15-202	[illegible]	DURANT	FY86	1	270	8	1000	8	N/A	N/A	15	2.5	30	NO
LD-1	WHITES CR	BLACK-FANN	HOLMES		[illegible]	LEXINGTON	---											
LD-1	FANNEGUSHA	BLACK-FANN	CARROLL		[illegible]	COILA	---											
LD-2	FANNEGUSHA	BLACK-FANN	CARROLL		[illegible]	COILA	---											

Table 8
Bank Stabilization

LABEL	STREAM	WATERSHED	COUNTY	DWG FILE N	T,R,S	QUAD	CONST DATE	DESCRIPTION
BS-9101	BIG BOGUE	BATUPAN BOGUE	GRENADA	YYA-15-241	T21N,R6E,S20&17	DUCK HILL	FY92	B,C,D
	LITTLE BOGUE	BATUPAN BOGUE	MONTGOMERY	YYA-15-241	T21N,R6E,S20&17	DUCK HILL	FY92	B,C,D
BS-9103	CANEY CREEK	LONG	PANOLA	YYO-15-88	T10S,R6W,S18	OAKLAND	FY92	A,B,C,D
BS-9102	HARLAND CREEK	BLACK	HOLMES	Y-15-208	T14N,R1E,S20	LEXINGTON	FY92	A,B,C
ER-9201	HOTOPHA CREEK	HOTOPHA	PANOLA	Y-15-181	T8S,R6W,S18	SARDIS	FY92	A,D
BS-9114	LONG CREEK	LONG	PANOLA	YYA-15-84	T10S,R6W,S7	OAKLAND	FY92	B,C,E
BS-9105	CANEY CREEK	LONG	PANOLA	YYO-15-88	T10S,R6W,S18	OAKLAND	FY92	A,B,C
BS-9115	JOHNSON CREEK	LONG	PANOLA	YYO-15-83	T9S,R7W,S35	SARDIS	FY91	B,C,E
BS-9015	General culvert	BATUPAN BOGUE	CARROL	YYA-15-223	"	DUCK HILL	FY91	A,F,G
	& stream stab.	BATUPAN BOGUE	MONTGOMERY			MECARLEY		
	within watershed	BATUPAN BOGUE	GRENADA					
BS-9112	MARTINDALE CREEK	HICK-SENTOB	TATE	Y-15-185	T5S,R8W,S36	LOOXAHOMA	FY91	B,C,G
BS-9111	JAMES WOLFE CREEK	HICK-SENTOB	TATE	YC-15-183	T5S,R8W,S34	LOOXAHOMA	FY91	C
BS-9113	OTOUCALOFA CK	OTOUCALOFA	YALOBUSHA	YYO-15-85	T11S,R6E,S9	WATER VALLEY	FY91	B,C
BS-9001	GOODWIN CREEK	LONG	PANOLA	YYO-15-81	T10S,R4E,S2	OAKLAND	FY91	A,B,C
BS-9002	TARREY CK	BLACK	HOLMES	Y-15-195	T15S,R3E,S33	DURANT	FY91	A,B,C
BS-9003	HOTOPHA CREEK	HOTOPHA	PANOLA	YLT-15-108	T8S,R7W,S24	SARDIS	FY91	A,B,C
BS-9014	LONG CREEK	LONG	PANOLA	Y-15-198	T10S,R6W,S4	OAKLAND	FY91	B,C
BS-9014	TARRY CREEK	BLACK	HOLMES	Y-15-98	T15N,R3E,S31	LEXINGTON S.	FY91	A,B,C
BS-9014	BLACK CREEK	BLACK	HOLMES	Y-15-98	T15N,R3E,S31	LEXINGTON S.	FY91	A,B,C
BS-9014	BLACK CREEK	BLACK	HOLMES	Y-15-98	T15N,R2E,S35	LEXINGTON S.	FY91	A,B,C
BS-9009	BLACK CREEK	BLACK	HOLMES	Y-15-192	T15N,R2E,S30,25	LEXINGTON S.	FY90	A,B,C
BS-9007	SHORT FORT CREEK	COLDWATER	DESOTO	YC-15-153	T3S,R7W,S9	HERNANDO	FY90	A,B,C
BS-9007	CAMP CREEK	COLDWATER	DESOTO	YC-15-153	T2S,R6W,S19	HERNANDO	FY90	B,C,G
BS-9005	LITTLE BOGUE	BATUPAN	MONTGOMERY	YYA-15-232	T21N,R7E,S27,28	DUCK HILL	FY90	A,B,C
BS-9008	LICK CREEK	COLDWATER	DESOTO	YC-15-151	T2S,R6W,S4	HERNANDO	FY90	A,B,C,G
BS-9004	RED BANKS CREEK	COLDWATER	MARSHALL	YC-15-152	T3S,R4W,S19,20,29	BYHALIA	FY90	A,B,C,G
BS-9006	FANNEGUSHA CREEK	BLACK CREEK	HOLMES	Y-15-193	T16N,R2E,S32,33,34	LEXINGTON	FY90	A,B,C
BS-9001	GOODWIN CREEK	LONG	PANOLA	YYO-15-76	T10S,R3E,S11	OAKLAND	FY90	A,B,C,H
BS-9001	CANEY CREEK	LONG	PANOLA	YYO-15-76	T10Z,R7W,S13	OAKLAND	FY90	A,B,C
BS-8904	SYKES CREEK	BATUPAN BOGUE	MONTGOMERY	YYA-15-228	T21N,R5E,S22	DUCKHILL	FY90	A,B,C
BS-8904	LITTLE BOGUE	BATUPAN BOGUE	GRENADA	YYA-15-228	T21N,R5E,S13	DUCKHILL	FY90	A,B,C
BS-8903	TOLBERT JONES	HICKAHALA	TATE	YC-15-148	T5S,R6W,S17	TYRO	FY90	A,B,C,H
BS-8903	SENATOBIA CREEK	HICKAHALA	PANOLA	YC-15-149	T6S,R6W,S24	SENATOBIA	FY90	A,B,C
BS-8903	OTOUCALOFA	OTOUCALOFA	YALABUSHA	YYA-15-210	T11S,R7E,S4	WATER VALLEY	FY89	A,B,C
BS-8905	BATUPAN BOGUE	BATUPAN BOGUE	GRENADA	YYA-15-207	T21N,R5E,S13	DUCK HILL	FY89	A,B,C
BS-8901	FANNEGUSHA	BLACK CREEK	HOLMES	YYA-15-209	T15N,R1E,S8	LEXINGTON	FY89	A,B,C
BS-8904	HOTOPOHA CREEK	HOTOPHA	PANOLA	YYA-15-211	T8S,R6W,S32	SARDIS	FY89	A,B,C
BS-8902	LONG CREEK	LONG	PANOLA	YYA-15-209	T10S,R4E,S11	OAKLAND	FY89	A,B,C,H
BS-8902	CANEY CREEK	LONG	PANOLA	YYA-15-208	T10S,R43,S11	OAKLAND	FY89	A,B,C
BS-8903	OTOUCALOFA CK	OTOUCALOFA	YALABUSHA	YYO-15-84	T11S,R3W,S5,6	WATER VALLEY E	FY87	A,B,C
BS-8702	HARLAND CREEK	BLACK CREEK	HOLMES	Y-15-180	T14,R1E,S2	HOWARD	FY87	A,B,C
	HARLAND CREEK	BLACK CREEK	HOLMES	Y-15-180	T15N,R1E,S15,14,35	HOWARD	FY87	A,B,C
BS-8602	OTOUCALOFA	OTOUCALOFA	YALABUSHA	YYA-15-189	T11S,R5E,S7,8,9	WATER VALLEY	FY86	A,B,C
BS-8604	JOHNSON CREEK	LONG	PANOLA	YYA-15-172	T7W,R7W,S3	OAKLAND	FY86	A,B,C
BS-8601	BLACK CREEK	BLACK	HOLMES	Y-15-170	T15N,R3E,S31	LEXINGTON S	FY86	A,B,C
BS-8603	BATUPAN BOGUE	BATUPAN BOGUE	GRENADA	YYA-15-188	T22N,R5E,S28	MCCARLEY	FY86	A,B,C
	BATUPAN BOGUE	BATUPAN BOGUE	GRENADA	YYA-15-182	T21N,R5E,S11,13	DUCK HILL	FY85	A,B,C
BS-8409	JAMES WOLF	HICKAHALA	TATE	Y-15-167	T6S,R6W,S27	LOOXAHOMA	FY85	B,C
BS-8408	OTOUCALOFA CK	OTOUCALOFA	YALABUSHA	YYA-15-184	T11S,R6E,S8	WATER VALLEY	FY85	A,B,C
BS-8408	OTOUCALOFA CK	OTOUCALOFA	YALABUSHA	YYA-15-184	T11S,R3W,S5	WATER VALLEY	FY85	A,B,C
BS-8403	PERRY	BATUPAN BOGUE	GRENADA	YYA-15-182	T22N,R5E,S30	MCCARLEY	FY85	A,B,C
BS-8405	HOTOPHA	HOTOPHA	PANOLA	Y-15-161	T8S,R6W,S8	SARDIS	FY85	A,B,C,H
BS-8404	SYKES CREEK	BATUPAN BOGUE	MONTGOMERY	YYA-15-183	T21N,R5E,S23	DUCK HILL	FY85	A,B,C
BS-8407	TOWN CREEK	OTOUCALOFA	YALABUSHA	YYA-15-185	T11S,R4W,S4	WATER VALLEY	FY85	B,C
BS-8402	BATUPAN BOGUE	BATUPAN BOGUE	GRENADA	YYA-15-176	T21N,R5E,S11,13	DUCK HILL	FY85	A,B,C
BS-8401	PERRY	BATUPAN BOGUE	GRENADA	YYA-15-177	T22N,R5E,S31	MCCARLEY	FY85	A,B,C

LEGEND

A	Transverse Dikes
B	Long Peaked Stone Dikes
C	Stone Tiebacks
D	Erosion Control & Willow Plantings
E	Clear & Snag
F	Culvert Protection
G	Grade Control
H	Paving

Table 9
Riser Pipes

LABEL	WATERSHED	COUNTY	T.R.S	QUAD	RISER DIA	CONDUIT DIA
CWD-2	COLDWATER RIVER	DESOTO	T3S.R5W.S7	HERNANDO	66	48
CWD-3	COLDWATER RIVER	DESOTO	T2S.R7W.S33	HERNANDO	42	24
CWD-4	COLDWATER RIVER	DESOTO	T2S.R7W.S33	HERNANDO	66	48
CWD-5	COLDWATER RIVER	DESOTO	T2S.R7W.S33	HERNANDO	36	24
CWD-6	COLDWATER RIVER	DESOTO	T2S.R8W.S22	HORN LAKE	72	48
CWD-7	COLDWATER RIVER	DESOTO	T2S.R8W.S22	HORN LAKE	36	24
CWD-9	COLDWATER RIVER	DESOTO	T2S.R7W.S29	HERNANDO	42	30
CWD-10	COLDWATER RIVER	DESOTO	T2S.R7W.S29	HERNANDO	42	24
CWD-11	COLDWATER RIVER	DESOTO	T2S.R7W.S29	HERNANDO	48	36
CWD-13	COLDWATER RIVER	DESOTO	T3S.R5W.S9	BYHALIA	36	24
CWD-16	COLDWATER RIVER	DESOTO	T2S.R7W.S28	HERNANDO	54	42
CWD-17	COLDWATER RIVER	DESOTO	T2S.R8W.S36	HORN LAKE	54	42
CWD-18	COLDWATER RIVER	DESOTO	T2S.R7W.S34	HERNANDO	30	24
CWD-19	COLDWATER RIVER	DESOTO	T3S.R6W.S34	HERNANDO	42	30
CWD-20	COLDWATER RIVER	DESOTO	T3S.R6W.S27	HERNANDO	30	24
CWD-21	COLDWATER RIVER	DESOTO	T3S.R6W.S21	HERNANDO	48	36
CWD-22	COLDWATER RIVER	DESOTO	T2S.R8W.S27	HORN LAKE	60	48
CWD-23	COLDWATER RIVER	DESOTO	T3S.R8W.S14	HORN LAKE	36	24
CWD-24	COLDWATER RIVER	DESOTO	T3S.R8W.S24	HERNANDO	30	24
CWD-25	COLDWATER RIVER	DESOTO	T3S.R8W.S1	HERNANDO	66	42
CWD-26	COLDWATER RIVER	DESOTO	T3S.R8W.S1	HERNANDO	36	24
CWD-27	COLDWATER RIVER	DESOTO	T3S.R8W.S3	HORN LAKE	48	36
CWD-28	COLDWATER RIVER	DESOTO	T2S.R8W.S22	HORN LAKE	48	30
CWD-29	COLDWATER RIVER	DESOTO	T2S.R8W.S27,34	HORN LAKE	48	36
CWD-30	COLDWATER RIVER	DESOTO	T2S.R8W.S26,35	HORN LAKE	54	30
CWD-31	COLDWATER RIVER	DESOTO	T2S.R8W.S19	HORN LAKE	36	24
CWD-32	COLDWATER RIVER	DESOTO	T2S.R7W.S28	HERNANDO	36	24
CWD-33	COLDWATER RIVER	DESOTO	T3S.R7W.S15	HERNANDO	42	30
CWD-34	COLDWATER RIVER	DESOTO	T3S.R7W.S4	HERNANDO	36	24
CWD-35	COLDWATER RIVER	DESOTO		SENATOBIA	60	42
CWD-36	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-37	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-38	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-39	COLDWATER RIVER	DESOTO		HORN LAKE	54	36
CWD-40	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-41	COLDWATER RIVER	DESOTO		HORN LAKE	30	24
CWD-42	COLDWATER RIVER	DESOTO		HORN LAKE	60	42
CWD-43	COLDWATER RIVER	DESOTO		HORN LAKE	48	36
CWD-44	COLDWATER RIVER	DESOTO		HORN LAKE	48	36
CWD-45	COLDWATER RIVER	DESOTO		HORN LAKE		
CWD-46	COLDWATER RIVER	DESOTO		HORN LAKE	72	42
CWD-47	COLDWATER RIVER	DESOTO		HORN LAKE	30	24
CWD-48	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-49	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-50	COLDWATER RIVER	DESOTO		HORN LAKE	42	30
CWD-52	COLDWATER RIVER	DESOTO		HORN LAKE	30	24
CWD-53	COLDWATER RIVER	DESOTO		HORN LAKE	42	24
CWD-54	COLDWATER RIVER	DESOTO		HORN LAKE		
CWD-55	COLDWATER RIVER	DESOTO		HERNANDO	54	36
CWD-56	COLDWATER RIVER	DESOTO		HERNANDO		
CWD-57	COLDWATER RIVER	DESOTO		HERNANDO	42	30
CWD-58	COLDWATER RIVER	DESOTO		HERNANDO	60	42
CWD-59	COLDWATER RIVER	DESOTO		HERNANDO	42	30
CWD-60	COLDWATER RIVER	DESOTO		HERNANDO	36	24
CWD-61	COLDWATER RIVER	DESOTO		HERNANDO	30	24
CWD-62	COLDWATER RIVER	DESOTO		HERNANDO	30	24
CWD-63	COLDWATER RIVER	DESOTO		HERNANDO	36	24
CWD-64	COLDWATER RIVER	DESOTO		HERNANDO	36	30
CWD-65	COLDWATER RIVER	DESOTO		HERNANDO	42	30
CWD-66	COLDWATER RIVER	DESOTO		HORN LAKE	72	54
CWD-67	COLDWATER RIVER	DESOTO		HORN LAKE	42	30
CWD-68	COLDWATER RIVER	DESOTO		HERNANDO	54	24
CWD-69	COLDWATER RIVER	DESOTO		HERNANDO	36	42
CWD-70	COLDWATER RIVER	DESOTO		HORN LAKE	42	30
CWD-71	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-72	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-73	COLDWATER RIVER	DESOTO		HORN LAKE	30	24
CWD-74	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-75	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-76	COLDWATER RIVER	DESOTO		HORN LAKE	36	24
CWD-77	COLDWATER RIVER	DESOTO		HORN LAKE	54	42
CWD-78	COLDWATER RIVER	DESOTO		HORN LAKE	54	42
CWD-79	COLDWATER RIVER	DESOTO		HORN LAKE	48	24
CWD-80	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	T2S.R7W.S27	HERNANDO		

Table 9 (Continued)

LABEL	WATERSHED	COUNTY	T.R.S	QUAD	RISER DIA	CONDUIT DIA
CWD-81	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	T1S,R7W,S35	HERNANDO		
CWD-82	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.10	HORN LAKE		
CWD-83	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.14	HORN LAKE		
CWD-85	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,7W.10	HERNANDO		
CWD-86	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,7W.12	HERNANDO		
CWD-87	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,7W.12	HERNANDO		
CWD-88	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,5W.9	BYHALIA		
CWD-89	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.13	HERNANDO		
CWD-90	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.1	HERNANDO		
CWD-91	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.1	HERNANDO		
CWD-92	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.33	HERNANDO		
CWD-93	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,82,34	HERNANDO		
CWD-94	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W,27	HERNANDO		
CWD-95	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W,27	HERNANDO		
CWD-96	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W,27	HERNANDO		
CWD-97	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	4S,8W,2	HORN LAKE		
CWD-98	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.36	HORN LAKE		
CWD-99	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.36	HORN LAKE		
CWD-100	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.36	HORN LAKE		
CWD-101	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.25	HERNANDO		
CWD-102	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.25	HERNANDO		
CWD-103	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.36	HERNANDO		
CWD-104	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,8W.11	HORN LAKE		
CWD-105	COLD RIV.CAN-MUS.HUR-WOL	DESOTO	3S,7W.9	HERNANDO		
CWM-1	COLDWATER RIVER	MARSHALL	T3S,R5W,S10	BYHALIA	66	42
CWM-2	COLDWATER RIVER	MARSHALL	T3S,R5W,S10	BYHALIA	36	24
CWM-3	COLDWATER RIVER	MARSHALL	T3S,R5W,S11	BYHALIA	60	42
CWM-5	COLDWATER RIVER	MARSHALL	T3S,R5W,S2	BYHALIA	48	36
CWM-6	COLDWATER RIVER	MARSHALL	T3S,R5W,S2	BYHALIA	42	30
CWM-7	COLDWATER RIVER	MARSHALL	T3S,R5W,S2	BYHALIA	48	36
CWM-8	COLDWATER RIVER	MARSHALL	T3S,R5W,S2	BYHALIA	66	36
CWM-9	COLDWATER RIVER	MARSHALL	T3S,R5W,S2	BYHALIA	72	36
CWM-10	COLDWATER RIVER	MARSHALL	T3S,R5W,S2	BYHALIA	72	48
CWM-11	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	36	24
CWM-12	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	42	30
CWM-13	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	72	48
CWM-14	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	60	42
CWM-15	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	54	36
CWM-17	COLDWATER RIVER	MARSHALL	T2S,R5W,S36	BYHALIA	72	42
CWM-19	COLDWATER RIVER	MARSHALL	T2S,R5W,S36	BYHALIA	24	30
CWM-21	COLDWATER RIVER	MARSHALL	T3S,R4W,S6	BYHALIA	54	36
CWM-22	COLDWATER RIVER	MARSHALL	T3S,R4W,S6	BYHALIA	60	42
CWM-23	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	42	30
CWM-24	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	36	24
CWM-25	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	36	24
CWM-27	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	36	24
CWM-28	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	36	24
CWM-29	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	36	24
CWM-30	COLDWATER RIVER	MARSHALL	T3S,R5W,S1	BYHALIA	54	36
CWM-31	COLDWATER RIVER	MARSHALL	T3S,R4W,S5	BYHALIA	36	24
CWM-34	COLDWATER RIVER	MARSHALL	T2S,R4W,S30	BYHALIA	36	24
CWM-36	COLDWATER RIVER	MARSHALL	T2S,R4W,S30	BYHALIA	30	24
CWM-37	COLDWATER RIVER	MARSHALL	T2S,R4W,S29	BYHALIA	60	42
CWM-41	COLDWATER RIVER	MARSHALL	T2S,R4W,S32	BYHALIA	36	24
CWM-42	COLDWATER RIVER	MARSHALL		BYHALIA	60	36
CWM-43	COLDWATER RIVER	MARSHALL		BYHALIA	60	42
CWM-44	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-45	COLDWATER RIVER	MARSHALL		BYHALIA	60	42
CWM-46	COLDWATER RIVER	MARSHALL		BYHALIA	72	42
CWM-47	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-48	COLDWATER RIVER	MARSHALL		BYHALIA		
CWM-49	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-50	COLDWATER RIVER	MARSHALL		BYHALIA	30	24
CWM-51	COLDWATER RIVER	MARSHALL		BYHALIA	54	42
CWM-53	COLDWATER RIVER	MARSHALL		BYHALIA	60	36
CWM-54	COLDWATER RIVER	MARSHALL		BYHALIA	42	30
CWM-55	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-56	COLDWATER RIVER	MARSHALL		BYHALIA	54	36
CWM-57	COLDWATER RIVER	MARSHALL		BYHALIA		
CWM-58	COLDWATER RIVER	MARSHALL		BYHALIA		
CWM-59	COLDWATER RIVER	MARSHALL		BYHALIA		
CWM-60	COLDWATER RIVER	MARSHALL		BYHALIA		
CWM-61	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-62	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-63	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-64	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-65	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		

Table 9 (Continued)

LABEL	WATERSHED	COUNTY	T.R.S	QUAD	RISER DIA	CONDUIT DIA
CWM-66	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-67	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-68	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-69	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-70	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-71	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-72	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-73	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-74	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-75	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-76	COLDWATER RIVER	MARSHALL		HOLLY SPRINGS		
CWM-77	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-78	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-79	COLDWATER RIVER	MARSHALL		BYHALIA	42	30
CWM-80	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-81	COLDWATER RIVER	MARSHALL		BYHALIA	54	42
CWM-82	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-83	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-84	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-85	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-86	COLDWATER RIVER	MARSHALL		BYHALIA		
CWM-87	COLDWATER RIVER	MARSHALL		BYHALIA	54	36
CWM-90	COLDWATER RIVER	MARSHALL		BYHALIA	36	24
CWM-91	COLDWATER RIVER	MARSHALL		BYHALIA	54	36
CWM-92	COLDWATER RIVER	MARSHALL		TYRO	60	36
CWM-93	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-94	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-95	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-96	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-97	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-98	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-99	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-100	COLDWATER RIVER	MARSHALL		TYRO	36	24
CWM-101	COLDWATER RIVER	MARSHALL		TYRO	36	24
HKL-1	HICKAHALA-SENATOBIA		T5S,R7W,S15	SENATOBIA	30	24
HKL-2	HICKAHALA-SENATOBIA		T5S,R7W,S15	SENATOBIA	72	42
HKL-3	HICKAHALA-SENATOBIA		T5S,R7W,S15	SENATOBIA	48	36
HKL-6	HICKAHALA-SENATOBIA		T5S,R6W,S31	SENATOBIA	48	36
HKL-10	HICKAHALA-SENATOBIA		T6S,R6W,S3	SENATOBIA	48	36
HKL-13	HICKAHALA-SENATOBIA		T6S,R6W,S3	SENATOBIA	72	36
HKL-15	HICKAHALA-SENATOBIA		T6S,R6W,S2	SENATOBIA	36	24
HKL-16	HICKAHALA-SENATOBIA		T6S,R6W,S2	SENATOBIA	60	42
HKL-17	HICKAHALA-SENATOBIA		T6S,R6W,S2	SENATOBIA	36	24
HKL-18	HICKAHALA-SENATOBIA		T6S,R6W,S2	SENATOBIA	42	30
HKL-20	HICKAHALA-SENATOBIA		T6S,R6W,S2	SENATOBIA	48	36
HKL-22	HICKAHALA-SENATOBIA		T5S,R5W,S17	TYRO	42	24
HKL-23	HICKAHALA-SENATOBIA		T5S,R5W,S2	TYRO	60	42
HKL-24	HICKAHALA-SENATOBIA		T5S,R5W,S2	TYRO	72	42
HKL-25	HICKAHALA-SENATOBIA		T6S,R6W,S2	SENATOBIA	80	36
HKL-26	HICKAHALA-SENATOBIA		T6S,R6W,S2	SENATOBIA	48	36
HKL-27	HICKAHALA-SENATOBIA		T6S,R6W,S12	SENATOBIA	54	36
HKL-28	HICKAHALA-SENATOBIA		T6S,R5W,S7	SENATOBIA	48	36
HKL-29	HICKAHALA-SENATOBIA		T5S,R7W,S14	SENATOBIA	72	42
HKL-30	HICKAHALA-SENATOBIA		T5S,R5W,S29	TYRO	54	42
HKL-31	HICKAHALA-SENATOBIA		T5S,R5W,S32	SENATOBIA	42	30
HKL-32	HICKAHALA-SENATOBIA		T5S,R5W,S19	SENATOBIA	42	30
HKL-33	HICKAHALA-SENATOBIA		T5S,R5W,S13	TYRO	72	48
HKL-35	HICKAHALA-SENATOBIA		T5S,R6W,S36	SENATOBIA	80	48
HKL-36	HICKAHALA CREEK		4S,5W,30	SENATOBIA		
HKL-37	HICKAHALA CREEK		4S,5W,30	SENATOBIA		
HKL-38	HICKAHALA CREEK		5S,5W,6	SENATOBIA		
HKL-39	HICKAHALA CREEK		5S,5W,5	TYRO		
HKL-40	HICKAHALA CREEK		5S,5W,12	TYRO		
HKL-41	HICKAHALA CREEK		5S,5W,12	TYRO		
HKL-42	HICKAHALA CREEK		5S,5W,21	TYRO		
HKL-43	HICKAHALA CREEK		5S,5W,27	TYRO		
HKL-44	HICKAHALA CREEK		5S,7W,36	SENATOBIA		
HKL-45	HICKAHALA CREEK		5S,6W,34	SENATOBIA		
HKL-46	HICKAHALA CREEK		5S,6W,35	SENATOBIA		
HKL-47	HICKAHALA CREEK		5S,6W,34	SENATOBIA		
HKL-48	HICKAHALA CREEK		5S,5W,31	SENATOBIA		
HKL-49	HICKAHALA CREEK		5S,5W,31	SENATOBIA		
HKL-50	HICKAHALA CREEK		6S,7W,14	SENATOBIA		
HKL-51	HICKAHALA CREEK		6S,7W,13	SENATOBIA		
HKL-52	HICKAHALA CREEK		6S,7W,15	SENATOBIA		
HKL-53	HICKAHALA CREEK		6S,6W,18	SENATOBIA		
HKL-54	HICKAHALA CREEK		5S,5W,35	TYRO		

Table 9 (Continued)

LABEL	WATERSHED	COUNTY	T.R.S	QUAD	RISER DIA	CONDUIT DIA
HKL-55	HICKAHALA CREEK		5S.5W.12	TYRO		
HKL-56	HICKAHALA CREEK		6S.5W.5	TYRO		
HKL-57	HICKAHALA CREEK		5S.5W.16	TYRO		
HKL-58	HICKAHALA CREEK		5S.5W.16	TYRO		
HKL-59	HICKAHALA CREEK		6S.6W.23	SENATOBIA		
HKL-60	HICKAHALA CREEK		6S.6W.23	SENATOBIA		
HKL-61	HICKAHALA CREEK		5S.6W.5	SENATOBIA		
HTP-1	HOTOPHIA		T9S.R6W.S9	SARDIS	42	30
HTP-2	HOTOPHIA		T9S.R6W.S10	SARDIS	72	48
HTP-3	HOTOPHIA		T9S.R6W.S10	SARDIS	36	24
HTP-4	HOTOPHIA		T9S.R6W.S3	SARDIS	54	36
HTP-6	HOTOPHIA		T9S.R5W.S6	SARDIS	72	48
HTP-7	HOTOPHIA		T9S.R5W.S5	OXFORD	48	30
HTP-8	HOTOPHIA		T9S.R5W.S4	OXFORD	66	48
HTP-9	HOTOPHIA		T9S.R5W.S6	SARDIS	72	36
HTP-10	HOTOPHIA		T9S.R5W.S6	SARDIS	36	24
HTP-11	HOTOPHIA		T9S.R5W.S6	SARDIS	66	48
HTP-12	HOTOPHIA		T8S.R7W.S24	SARDIS	72	36
HTP-14	HOTOPHIA	PANOLA	T8S.R7W.S9	SARDIS	72	54
HTP-17	HOTOPHIA	PANOLA	T8S.R5W.S4	SARDIS	72	48
HTP-18	HOTOPHIA	PANOLA	T8S.R5W.S33	OXFORD	60	42
LNG-1	LONG		T10S.R7W.S6	OAKLAND	48	36
LNG-2	LONG		T10S.R7W.S6	OAKLAND	54	42
LNG-3	LONG		T10S.R7W.S6	OAKLAND	60	36
LNG-4	LONG	PANOLA			60	42
LNG-5	LONG		T10S.R7W.S9	OAKLAND	42	30
LNG-6	LONG	PANOLA			66	42
LNG-7	LONG	PANOLA			36	24
LNG-9	LONG	PANOLA			42	30
LNG-10	LONG	PANOLA			72	48
OTC-1	OTOUCALOFA		T11S.R5W.S14	WATER VALLEY	36	24
OTC-2	OTOUCALOFA		T11S.R5W.S14	WATER VALLEY	42	30
OTC-5	OTOUCALOFA		T11S.R5W.S14	WATER VALLEY	42	30
OTC-33	OTOUCALOFA		T11S.R4W.S1	WATER VALLEY	36	24
OTC-34	OTOUCALOFA		T11S.R4W.S1	WATER VALLEY	36	24
OTC-36A	OTOUCALOFA		T10S.R4W.S36	WATER VALLEY	36	30
OTC-36B	OTOUCALOFA		T11S.R4W.S1	WATER VALLEY	36	24
OTC-38	OTOUCALOFA		T11S.R4W.S12	WATER VALLEY	42	30
OTC-39	OTOUCALOFA		T11S.R4W.S12	WATER VALLEY	42	30
OTC-40	OTOUCALOFA		T11S.R3W.S6	WATER VALLEY	30	24
OTC-41	OTOUCALOFA		T11S.R3W.S6	WATER VALLEY	42	30
OTC-43	OTOUCALOFA		T11S.R3W.S5	WATER VALLEY	30	24
OTC-44	OTOUCALOFA		T11S.R3W.S5	WATER VALLEY	36	24
OTC-47	OTOUCALOFA		T11S.R3W.S3	WATER VALLEY	54	36
OTC-49	OTOUCALOFA		T11S.R3W.S3	WATER VALLEY	60	42
OTC-54	OTOUCALOFA		T11S.R4W.S15	WATER VALLEY	36	30
OTC-60	OTOUCALOFA		T11S.R4W.S21	WATER VALLEY	36	24
OTC-10	OTOUCALOFA		T11S.R4W.S8	WATER VALLEY	36	24
OTC-27	OTOUCALOFA		T11S.R4W.S10	WATER VALLEY	48	36
OTC-36C	OTOUCALOFA		T10S.R4W.S36	WATER VALLEY	8	30
OTC-42	OTOUCALOFA		T11S.R3W.S6	WATER VALLEY	42	24
OTC-57	OTOUCALOFA		T11S.R4W.S11	WATER VALLEY	42	24
OTC-61	OTOUCALOFA		T11S.R5W.S13	WATER VALLEY	36	24
OTC-62	OTOUCALOFA		T11S.R5W.S13	WATER VALLEY	42	24
BTB-4	BATUPAN BOGUE		T20N.R5E.S3	MCCARLEY	66	36
BTB-15A	BATUPAN BOGUE		T21N.R6E.S23	DUCK HILL	42	30
BTB-16	BATUPAN BOGUE		T20N.R5E.S1	DUCK HILL	2-54	2-36
BTB-16A	BATUPAN BOGUE		T20N.R5E.S1	DUCK HILL	36	24
BTB-20	BATUPAN BOGUE		T20N.R5E.S3	MCCARLEY	348	30
BTB-24	BATUPAN BOGUE		T20N.R6E.S3	DUCK HILL	2-66	2-42
BTB-25	BATUPAN BOGUE		T20N.R6E.S3	DUCK HILL	36	24
BTB-26	BATUPAN BOGUE		T20N.R6E.S16	DUCK HILL	48	30
BTB-27	BATUPAN BOGUE		T20N.R6E.S9	DUCK HILL	36	24
BTB-28	BATUPAN BOGUE		T20N.R6E.S9	DUCK HILL	36	24
BTB-29	BATUPAN BOGUE		T20N.R6E.S16	DUCK HILL	48	30
BTB-30	BATUPAN BOGUE		T20N.R6E.S16	DUCK HILL	72	42
BTB-32	BATUPAN BOGUE		T20N.R6E.S16	DUCK HILL	60	36
BTB-33	BATUPAN BOGUE		T20N.R6E.S16	DUCK HILL	54	42
BTB-35	BATUPAN BOGUE		T20N.R6E.S16	DUCK HILL	36	24
BTB-36	BATUPAN BOGUE		T20N.R6E.S16	DUCK HILL	36	24
BTB-37	BATUPAN BOGUE		T20N.R6E.S22	DUCK HILL	36	24
BTB-39	BATUPAN BOGUE		T20N.R6E.S17	DUCK HILL	72	42
BTB-40	BATUPAN BOGUE		T20N.R6E.S2	DUCK HILL	36	24
BTB-41	BATUPAN BOGUE		T20N.R5E.S11	DUCK HILL	72	42
BTB-42	BATUPAN BOGUE		T21N.R5E.S35	DUCK HILL	72	42
BTB-43	BATUPAN BOGUE		T20N.R6E.S3	DUCK HILL	60	30
BTB-44	BATUPAN BOGUE		T20N.R6E.S4	DUCK HILL	66	36

Table 9 (Continued)

LABEL	WATERSHED	COUNTY	T.R.S	QUAD	RISER DIA	CONDUIT DIA
BTB-45	BATUPAN BOGUE		T21N,R7E,S28	DUCK HILL	72	48
BTB-46	BATUPAN BOGUE		T21N,R6E,S20	DUCK HILL	36	24
BTB-47	BATUPAN BOGUE		T20N,R6E,S23	DUCK HILL	66	42
BTB-48	BATUPAN BOGUE		T20N,R6E,S22	DUCK HILL	72	48
BTB-49	BATUPAN BOGUE	GRENADA	T21N,R4E,S1	MCCARLEY	60	42
BTB-50	BATUPAN BOGUE	GRENADA	T21N,R4E,S11	MCCARLEY	42	30
BTB-53	BATUPAN BOGUE	GRENADA	T21N,R5E,S13,18	DUCK HILL	36	24
BTB-55	BATUPAN BOGUE	GRENADA	T21N,R7E,S7,18	DUCK HILL	72	54
BTB-58	BATUPAN BOGUE	GRENADA	T21N,R4E,S3	MCCARLEY	42	30
BTB-59	BATUPAN BOGUE	MONTGOMERY	T21N,R7E,S32	DUCK HILL	72	48
BTB-60	BATUPAN BOGUE	MONTGOMERY	T21N,R7E,S32	DUCK HILL	36	24
BTB-61	BATUPAN BOGUE	MONTGOMERY		DUCK HILL	42	30
BTB-62	BATUPAN BOGUE	MONTGOMERY	T20N,R6E,S3,4	DUCK HILL	60	42
BTB-63	BATUPAN BOGUE	MONTGOMERY	T20N,R6E,S6	DUCK HILL	60	36
BTB-65	BATUPAN BOGUE	MONTGOMERY		DUCK HILL	66	48
BTB-66	BATUPAN BOGUE	MONTGOMERY	T20N,R6E,S22	DUCK HILL	72	48
ABA-1	ABIACA		T17N,R2E,S23	SEVEN PINES	36	24
ABA-3	ABIACA		T17N,R2E,S23	SEVEN PINES	48	36
ABA-6	ABIACA		T18N,R2E,S14	SEVEN PINES	48	30
ABA-16	ABIACA		T18N,R3E,S21	SEVEN PINES	66	48
ABA-17	ABIACA		T17N,R3E,S20	SEVEN PINES	54	36
ABA-18	ABIACA		T17N,R3E,S20	SEVEN PINES	54	42
ABA-19	ABIACA		T17N,R2E,S11	SEVEN PINES	60	48
ABA-20	ABIACA		T17N,R2E,S11	SEVEN PINES	60	48
ABA-21	ABIACA		T18N,R3E,S30	SEVEN PINES	66	48
BFC-2	BLACK-FANNEGUSHA		T15N,R3E,S31	LEXINGTON	48	36
BFC-3	BLACK-FANNEGUSHA		T15N,R3E,S29	LEXINGTON	42	30
BFC-6	BLACK-FANNEGUSHA		T14N,R3E,S5	LEXINGTON	42	30
BFC-7	BLACK-FANNEGUSHA		T14N,R3E,S5	LEXINGTON	48	36
BFC-9	BLACK-FANNEGUSHA		T14N,R2E,S13	LEXINGTON	36	30
BFC-10	BLACK-FANNEGUSHA		T15N,R2E,S22	LEXINGTON	42	30
BFC-12	BLACK-FANNEGUSHA		T14N,R2E,S10	LEXINGTON	60	36
BFC-15	BLACK-FANNEGUSHA		T15N,R2E,S34	LEXINGTON	42	30
BFC-16	BLACK-FANNEGUSHA		T16N,R3E,S15	COILA	[illegible]	30
BFC-18	BLACK-FANNEGUSHA		T16N,R3E,S21	DURANT	48	30
BFC-19	BLACK-FANNEGUSHA		T16N,R2E,S14	LEXINGTON	48	36
BFC-23	BLACK-FANNEGUSHA		T15N,R2E,S34	LEXINGTON	36	30
BFC-24	BLACK-FANNEGUSHA		T14N,R2E,S10	LEXINGTON	60	36
BFC-25	BLACK-FANNEGUSHA		T13N,R2E,S10	VAUGN		
BFC-27	BLACK-FANNEGUSHA		T13N,R1E,S2	VAUGN	42	30
BFC-28	BLACK-FANNEGUSHA		T14N,R3E,S3	DURANT	48	36
BFC-29	BLACK-FANNEGUSHA		T14N,R1E,S34	LEXINGTON	42	30
BFC-30	BLACK-FANNEGUSHA		T14N,R2E,S12	LEXINGTON	60	42
BFC-31	BLACK-FANNEGUSHA		T15N,R3E,S36	DURANT	30	24
BFC-32	BLACK-FANNEGUSHA		T15N,R3E,S29	DURANT	42	30
BFC-33	BLACK-FANNEGUSHA		T15N,R3E,S20	DURANT	30	24
BFC-33A	BLACK-FANNEGUSHA		T15N,R3E,S20	DURANT	54	42
BFC-34	BLACK-FANNEGUSHA		T14N,R2E,S24	LEXINGTON	36	24
BFC-35	BLACK-FANNEGUSHA		T15N,R3E,S33	DURANT	36	24
BFC-36A	BLACK-FANNEGUSHA		T15N,R1E,S34	LEXINGTON	42	30
BFC-36C	BLACK-FANNEGUSHA		T15N,R1E,S34	LEXINGTON	36	24
BFC-36D	BLACK-FANNEGUSHA		T15N,R1E,S35	LEXINGTON	72	42
BFC-38	BLACK-FANNEGUSHA		T16N,R3E,S30	LEXINGTON	60	36
BFC-39	BLACK-FANNEGUSHA		T15N,R3E,S29	LEXINGTON	54	36
BFC-40	BLACK-FANNEGUSHA		T14N,R2E,S8	LEXINGTON	36	24
BFC-43	BLACK-FANNEGUSHA		T14N,R2E,S1	LEXINGTON	42	30
BFC-44	BLACK-FANNEGUSHA		T16N,R2E,S27	LEXINGTON	48	36
BFC-45	BLACK-FANNEGUSHA		T15N,R2E,S36	LEXINGTON	36	24
BFC-46	BLACK-FANNEGUSHA		T17N,R2E,S32	SEVEN PINES	42	30
BFC-47	BLACK-FANNEGUSHA		T16N,R23,S12	SEVEN PINES	42	30
BFC-48	BLACK-FANNEGUSHA		T16N,R3E,S6	SEVEN PINES	36	24
BFC-49	BLACK-FANNEGUSHA		T16N,R2E,S11	SEVEN PINES	54	36
BFC-50	BLACK-FANNEGUSHA		T15N,R2E,S26	LEXINGTON	42	30
BFC-52	BLACK-FANNEGUSHA		T15N,R3E,S21	DURANT	36	24
BFC-53	BLACK-FANNEGUSHA		T13N,R1E,S4	VAUGN	60	30
BFC-54	BLACK-FANNEGUSHA		T16N,R3E,S22	DURANT	42	30
BFC-55	BLACK-FANNEGUSHA		T14N,R2E,S8	LEXINGTON	42	24
BFC-56	BLACK-FANNEGUSHA		T15N,R3E,S11	DURANT	48	36
BFC-57	BLACK-FANNEGUSHA		T15N,R2E,S34	LEXINGTON	36	24
BFC-58	BLACK-FANNEGUSHA		T14N,R1E,S30	LEXINGTON	48	36
BFC-59	BLACK-FANNEGUSHA		T13N,R2E,S17	VAUGN	48	36
BFC-60	BLACK-FANNEGUSHA		T13N,R1E,S3	LEXINGTON	72	36
BFC-61	BLACK-FANNEGUSHA		T15N,R3E,S29	LEXINGTON	60	38
BFC-62	BLACK-FANNEGUSHA		T15N,R3E,S12	DURANT	42	30
BFC-63	BLACK-FANNEGUSHA		T15N,R3E,S28	DURANT	30	24
BFC-64	BLACK-FANNEGUSHA		T16N,R2E,S36	LEXINGTON	60	42
BFC-65	BLACK-FANNEGUSHA		T16N,R3E,S22	DURANT	54	38

Table 9 (Concluded)

LABEL	WATERSHED	COUNTY	T,R,S	QUAD	RISER DIA	CONDUIT DIA
BFC-66	BLACK-FANNEGUSHA-CHICOPA		T15N,R2E,S13	LEXINGTON	38	24
BFC-67	BLACK-FANNEGUSHA-CHICOPA		T15N,R1E,S21	LEXINGTON	60	42
BFC-68	BLACK-FANNEGUSHA-CHICOPA			LEXINGTON		
BFC-69	BLACK-FANNEGUSHA-CHICOPA			LEXINGTON		
BFC-70	BLACK-FANNEGUSHA-CHICOPA			LEXINGTON		
BFC-71	BLACK-FANNEGUSHA-CHICOPA			LEXINGTON		
BFC-72	BLACK-FANNEGUSHA-CHICOPA			LEXINGTON		
BFC-73	BLACK-FANNEGUSHA-CHICOPA			LEXINGTON		
BFC-74	BLACK-FANNEGUSHA-CHICOPA			DURANT		
BFC-75	BLACK-FANNEGUSHA-CHICOPA			LEXINGTON		
BFC-76	BLACK-FANNEGUSHA-CHICOPA			VAUGHN		
BFC-77	BLACK-FANNEGUSHA-CHICOPA			LEXINGTON		
BFC-78	BLACK-FANNEGUSHA-CHICOPA			COILA		
BFC-79	BLACK-FANNEGUSHA-CHICOPA			COILA		

(Sheet 6 of 6)

Table 10
Aerial Videotapes of DEC Watersheds, USDA-ARS-NSL Flights Spring 1992

Main Stem (Fourth-Order Tributary)	Third-Order Tributary	Second-Order Tributary	First-Order Tributary
Hotophia Creek (Tributary to Little Tallahatchie River)	Harris Creek Mill Creek Deer Creek Marcum Creek		
Long Creek (Tributary to Yocona River)	Bobo Bayou Johnson Creek Hurt Creek Goodwin Creek Caney Creek		
Toby Tubby Creek (Tributary to Little Tallahatchie River)	East Goose Creek West Goose Creek		
Burney Branch (Tributary to Yocona River)	Burney West #1 Burney West #2		
Coldwater (Tributary to Tallahatchie River)	Hickahala Creek	Hickahala N. Fork Hickahala S. Fork Cathey Creek James Wolf Creek Senatobia Creek	
	Hurricane Creek	Wolf Creek Panther Creek	
	Mussacuna Creek		
	Cane Creek	Secret Creek	
	Beartail Creek Grays Creek Camp Creek Pigeon Creek	Cuffawa Creek Byhalia Creek Redbanks Creek	
Otoucalofa Creek (Tributary to Yocona River)	Susie Perry Creek Johnson Creek Town Creek Greasy Creek Moore Creek Gordon Creek Otoucalofa S.#1	Spring Creek	
	Mill Creek Smith South Sarter Creek Hanna Creek Smith Creek Shippy Creek		
Batupan Bogue (Tributary to Yalobusha River)	Big Bogue Creek	Eskridge Creek Jackson Creek Wilkens Creek Sykes Creek	

(Continued)

Table 10 (Concluded)			
Main Stem (Fourth-Order Tributary)	**Third-Order Tributary**	**Second-Order Tributary**	**First-Order Tributary**
	Jack Creek Perry Creek Little Bogue Creek	Caffe Branch Crowder Creek Epison Creek Campbell Creek Powell Creek Mouse Creek	
Black Creek (Tributary to Yazoo River)	Harland Creek	Moccasin Creek Williams Creek	Butterworth Creek
	Fannegusha Creek	Bophumpa Creek Tchula Lake	Millstone Bayou Spring Branch Chicopa Creek
	Abiaca Creek	Coila Creek	
Pelucia Creek (Tributary to Yazoo River)	Ashley Creek		

Table 11
Log of Aerial Videotape 1

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-2	Notophia Creek	0:00:00									
			0:00:29	Mouth Notophia Cr. on Tallhatchie River	0	Sand bed with dunes meandering	Sloping mostly stable except on outer bank of meanders sinuous	Mostly woody with some grass & Narrow buffer zone	Cultivated with a little woodland	Can't Tell	Large point bars and some media bar growth
			0:00:58	Bridge - Hwy 35	7,100						
		0:01:13									
		0:01:14									
			0:01:25	Mouth Notophia Cr. on Tallhatchie River	0	As Above					
			0:01:54	Bridge - Hwy 35	7,100						
		0:02:07									
		0:02:08									
			0:02:16	Bridge - Hwy 35	7,100						
		0:02:35									
		0:02:36									
			0:02:53	Back on Notophia Cr.	10,500	Sand bed w/dunes meandering channel	Sinuous bank line	Woody relatively wide buffer zone	Cultivated	N/A	Channel narrow here - stage
		0:03:27									
		0:03:28									
			0:03:53	Back on Notophia Cr.	12,000	Sand bed with dunes	Steep banks some unstable sections	Woody wide buffer zone	Woodland & some cultivation	N/A	Evidence of bar growth tending to unstable
		0:04:37									
		0:04:38									
			0:05:04	Back on Notophia Cr.	19,500	Sand bed low sinuosity some knick points?	Unstable steep banks with ______ bank line	Grassy/shrubs narrow buffer zone	Cultivated	N/A	Unstable
		0:05:46									
		0:05:47									
			0:05:51	Mouth Harris Cr. on Notophia Cr.	27,000	Sand meandering	Mostly stable banks sloping unprotected	Woody (wide buff. zone) Grassy (narrow buff. zone)	Pasture with some cultivation	Can't Tell	No apparent problem
			0:06:09	Bridge - Hwy 6	30,300						
			0:06:17	Bridge-Grvl.Rd. Sec.9	31,900						
			0:06:24	Structure	32,300						
		0:06:50									
		0:06:51									
			0:06:57	Mouth Hill Cr. on Notophia Cr.	35,000	Sand bed sinuous	Mostly stable steep banks unprotected	Woody narrow buffer zone	Woodland & Cultivation	Can't Tell	Channel narrows - vegetation encroachment
			0:07:34	Bridge-Grvl.Rd.Sec10&11	42,800						
			0:07:56	Structure	47,300	Sand - straight	Stable	Woody, wide buffer zone	Woodland	O. K.	Narrow, stable channel
			0:08:00	Bridge-Hwy 315	48,000						
			0:08:01	Mouth Deer Cr. on Notophia Cr.	48,100	Sand? (Can't really tell) low sinuosity	Vertical unprotected tending to unstable	Woody, narrow buffer zone	Pasture	O. K.	Tending to unstable
			0:08:25	Structure	53,700						
			0:08:28	Mouth Marcum Cr. on Notophia Cr.	53,900						

Table 11 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-2	Notophia Creek (Continued)	0:09:10									
		0:09:11									
			0:09:12	Back on Notophia Cr.	57,500	Sand meandering	Steep slope stable unprotected structure	Woody & shrubs narrow buffer zone	Pasture	Can't Tell	
			0:09:35	Bridge-Grvl.Rd.Sec.32&35	62,400						
		0:09:50				Meandering	Sloping stable Unprotected	Woody with variable buffer zone	Pasture	.	
		0:09:51									
			0:09:53	Back on Notophia Cr.	64,000	Can't Tell bed mat.					
		0:10:26									
		0:10:27									
			0:10:45	Back on Notophia Cr.	68,500		Can't Tell -	Channel obscured by vegetation growth. (woody veg.)			
			0:10:56		71,800						
		0:11:08	-------	End Notophia Cr.							
4-2	Harris Cr.	0:11:09									
			0:12:34	Mouth Harris Cr. on Notophia Cr.	0 (27,000)	Sand bed meandering channel	Sinuous bankline sloping stable banks	Woody veg, some grasses/ shrubs narrow	Woody & Cultivated	Can't Tell	No apparent problem
			0:12:39	Structure	1,000						
			0:12:49	Bridge-Hwy 6	2,800						
			0:13:00	Bridge-Pvd.Rd.Sec.7&8	4,700						
		0:14:00									
		0:14:01									
			0:14:02	Structure	1,000		As Above				
			0:14:08	Bridge-Hwy 6	2,800						
			0:14:18	Bridge-Pvd.Rd.Sec.7&8	4,700						
		0:15:06									
		0:15:07									
		0:15:33	-------	End Harris Cr.							
4-2	Hill Cr.	0:15:34									
			0:15:49	Mouth Hill Cr. on Notophia Cr.	0 (35,000)	Sand bed highly sinuous	Sinuous bank line Unstable banks on outer bank	Woody & shrub veg narrow buffer zone	Woodland & pasture	Can't Tell	Unstable
			0:15:54	Structure	1,500						
			0:16:07	Structure							
			0:16:08	Bridge-Grvl.Rd.Sec.9&16	3,900						
		0:16:30									
		0:16:31									
			0:16:46	Structure	3,800	Sandy gravel sinuous	Stable banks - no other details (obscured by trees)	Woody veg narrow buffer zone	Pasture	Can't Tell	No apparent problem
			0:16:47	Bridge-Grvl.Rd.Sec.9&16	3,900						
			0:17:02	Bridge-Grvl.Rd.Sec.15	7,800						
			0:17:26	Gravel Rd.Sec.22	11,200						
		0:17:29	-------	End Hill Cr.							
4-2	Deer Cr.	0:17:30									
			0:17:41	Mouth Deer Cr. on Notophia	0 (48,100)	Sandy with dunes & bars meandering	Unprotected banks mostly stable, but erosion on meander bends	Woody veg with thin buffer zone	Cultivated	Can't Tell	Large pt. bars on meanders
			0:17:47	Structure	1,500						
			0:17:50	Structure	2,000						
			0:17:57	Bridge-Grvl.Rd.Sec.12	3,900						

Table 11 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-2	Deer Cr. (Continued)	0:07:58\ 0:07:59									
			0:18:11	Structure	2,000		As Above				
			0:18:20	Bridge-Grvl.Rd.Sec.12	3,900						
		0:18:27 0:18:28									
			0:18:33	Bridge-Grvl.Rd.Sec.12	3,900		Channel & structure obscured by veg - can't tell				
		0:19:06 0:19:07									
			0:19:33	Bridge-Grvl.Rd.Sec.12	3,900		"	"	"		
		0:20:27 0:20:28									
			0:20:31	Deer Cr. Res.	10,000						
		0:21:08	-------	End Deer Cr.							
4-2	Marcum Cr.	0:21:09									
			0:21:26	Mouth Marcum Cr. on Hotophia	0 (53,800)	Bed obscured by veg.	Steep, unstable banks (unprotected)	Grassy - no buffer zone	Pasture & cultivation	Can't Tell	Unstable reach
			0:21:37	Structure	3,800						
			0:21:52	Bridge-Grvl.Rd.Sec.6&7	4,600						
		0:21:57 0:21:58									
			0:22:09	Bridge-Grvl.Rd.Sec.6&7	4,600	Sandy bed sinuous	Stable protected	Grassy - no buffer zone	Pasture	Can't Tell	Not sure
			0:22:32	Res.							
		0:22:48	-------	End Marcum Cr.	-						
4-3	Long Cr.	0:22:49									
			0:23:23	Mouth Long Cr. on Yocona River	0	Sandy braided bar & dune forms	Sloping banks - mostly stable	Grassy & woody - thin buffer zone	Cultivation	Can't Tell	Heavy in channel deposition & bar formation
			0:24:48	Bridge-Pvd.Rd.Sec.18	16,000						
			0:24:53	Bobo Bayou-Right	18,000	Sandy bed mat with bar deposition low sinuosity - braided?	Some bank protection little bank erosion (bank line ___)	Thin buffer ___ of woody & shrub veg.	Cultivation	Can't Tell	Potential problem of in-channel deposition
			0:25:42	Bridge-R.R.	28,200						
			0:25:50	Bridge-Hwy 51-Sec.9	30,100						
			0:26:11	Bridge-I 55	34,500						
			0:26:14	Johnson Cr.-Left	35,000						
		0:26:18 0:26:19									
		0:26:24 0:26:25				Sandy bed with bar deposition	Bank protection (greynes) stable banks.	Woody veg thin buffer	Cultivation	O.K.	In-channel deposition
			0:29:50	Back on Long Cr.	6,500						
			0:30:35	Bridge-Pvd.Rd.Sec.18	16,000						
			0:30:47	Bobo Bayou-Right	18,000						
			0:31:32	Bridge-R.R.	28,200		As Above				
			0:31:41	Bridge-Hwy 51-Sec.9	30,100						
			0:32:01	Bridge-I 55	34,500		As Above				
			0:32:04	Johnson Cr.-Left	35,000						
		0:32:10 0:32:11					As Above				
			0:32:57	Bridge-I 55	34,500						

Table 11 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-3	Long Cr. (Continued)		0:32:59	Johnson Cr.-Left	35,000	Sand bed bar deposition Shale outcrop?	Sloping banks stable dyke bank protection	Woody veg thin buffer zone	Cultivated	Can't Tell	Sand spoil dumps or bank
			0:33:12	Goodwin Cr.-Left	37,400						
			0:33:21	Bridge-Pvd.Rd.Sec.11	39,800						
			0:34:03	Caney Cr.-Left	49,000						
			0:34:16	Bridge-Pvd.Rd.Sec.12	51,800						
		0:34:30									
		0:34:31									
			0:34:32	Back on Long Cr.	40,000	Sand bed with meandering course	Dyke protection some erosion on bendway	Woody veg. wide buffer	Cultivated	Can't Tell	Tending to unstable
			0:35:04	Caney Cr.-Left	49,000						
			0:35:14	Bridge-Grvl.Rd.Sec.12	51,800						
			0:35:45	Bridge-Pvd.Rd.Sec.7&8	58,900						
		0:36:09									
		0:36:10									
			0:36:14	Back on Long Cr.	62,500	Sand bed sinuous course some sand bar deposition in bendways	Some instability on bend way - degraded outer banks? - bank failure at culvert?	Woody veg - medium buffer zone	Pasture	Can't Tell	Potential problem on outer bank erosion
			0:36:33	Structure	66,000						
			0:36:34	Bridge-Pvd.Rd.Sec.4&5	66,100						
		0:36:39									
		0:36:40									
			0:36:46	Structure	66,000						
			0:36:47	Bridge-Pvd.Rd.Sec4&5	66,100						
			0:36:58	Structure	68,000						
		0:37:05									
		0:37:06									
			0:37:16	Structure	68,000						
			0:37:29	Structure	71,500		Can't Tell - Channel obscured by veg.				
			0:37:34	Bridge-Grvl.Rd.Sec.3&4	72,500						
		0:37:38									
		0:37:39									
			0:37:40	Structure	71,500		"	"			
			0:37:45	Bridge-Grvl.Rd.Sec.3&4	72,500						
		0:38:29									
		0:38:30									
		0:39:19									
		0:39:20									
		0:39:45									
		0:39:46									
			0:40:40	Bridge-Grvl.Rd.Sec.25,26 35&36	88,500						
		0:40:51					Can't Tell - Channel obscured by veg.				
		0:40:52									
			0:41:23	Hwy 315	95,100						
			-------	End Long Cr.							
		0:41:25									
4-3	Bobo Bayou	0:41:26									

Table 11 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-3	Bobo Bayou		0:41:40	Mouth Bobo Bayou Cr.	0	Can't Tell -	"	"			
	(Continued)			on Long Cr.	(18,000)						
			0:42:03	Bridge-Grvl.Rd.Sec.7	5,100	Sand bed some	Unstable bank	Woody veg	Woodland &	Can't Tell	-
		0:42:46				erosion some		wide buffer	cultivation		
		0:42:47				bar deposition					
			0:43:00	Bridge-Grvl.Rd.Sec.7	5,100						
		0:43:43		Bridge-Grvl.Rd.Sec.6&31	14,000						
		0:44:08									
		0:44:09				Can't Tell - Channel obscured by veg.					
			0:44:35	Bridge-Grvl.Rd.Sec.31&32	19,400						
		0:44:48	-------	End Bobo Bayou							
4-3	Johnson Cr.	0:44:49									
			0:45:10	Mouth Johnson Cr.	0	Sand bed with	Sloping banks	Woody veg	Cultivated &	-	
				on Long Cr.	(35,000)	bar & dune forms	some unstable	wide buffer	land use		
			0:45:28	Bridge-Grvl.Rd.Sec.3	4,100	meandering	unprotected				
			0:45:37	Hurt Cr.-Right	6,100						
		0:46:03									
		0:46:04									
			0:46:07	Bridge-Grvl.Rd.Sec.3	4,100						
			0:46:12	Hurt Cr.-Right	6,100						
			0:46:39	Bridge-Pvd.Rd.Sec.35	13,200	Sandy/gravel pt.	Can't tell - veg	Woody veg	Woodland &	Can't Tell	-
			0:47:33	Bridge-Grvl.Rd.Sec.25&30	25,000	bar deposition	obscured	wide buffer	pasture		
			0:47:55	Structure-Sec.19		meandering					
			0:48:01	Bridge-Pvd.Rd.Sec.19&20	32,400						
		0:48:03									
		0:48:04									
			0:48:36	Structure-Sec.19							
			0:48:44	Bridge-Pvd.Rd.Sec.19&20	32,400	Sandy meandering	Some unstable	Shrubs -	Cultivation	Can't Tell	Potential problem with
			0:48:49	Structure-Sec.20		deposition on	banks - sapping	narrow buffer			bank blow outs
			0:48:55	Structure-Sec.20	36,100	inner banks	or gullying				
		0:49:06									
		0:49:07									
			0:49:08	Bridge-Pvd.Rd.Sec.19&20	32,400	Sandy bed	Stable	Shrubs -	Cultivation	Can't Tell	
			0:49:12	Structure-Sec.20			unprotected	narrow buffer			
			0:49:18	Structure-Sec.20	36,100						
			0:49:45	Bridge-Grvl.Rd.Sec.21&28	43,000	Can't Tell - Obscured by veg.					
		0:50:25									
		0:50:26									
			0:50:49	Bridge-Grvl.Rd.Sec.21&28	43,000						
		0:51:30									
		0:51:31									
		0:51:55					"	"			
		0:51:56									
			0:52:20	Bridge-Grvl.Rd.Sec.23	54,300						
			0:52:39	Hwy 315							
		0:53:03	-------	End Johnson Cr.							
4-3	Hurt Cr.	0:53:37				Faulty camera filter					

Table 11 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item B	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-3	Hurt Cr. (Continued)		0:54:55	Mouth Hurt Cr. on Johnson Cr.	0 (6,100)		Faulty camera filter				
			0:55:33	Bridge-Pvd.Rd.Sec.27&34	7,900						
			0:55:53	Bridge-Pvd.Rd.Sec.27 (Eureka Rd.)	12,500						
			0:56:14	Bridge-Grvl.Rd.Sec.22	17,200						
		0:56:27	-------	End Hurt Cr.							
4-23	Goodwin Creek	0:56:28					* *				
			0:56:56	Mouth Goodwin Cr. on Long Cr.	0 (37,500)						
			0:57:02	Station 1							
			0:57:11	Bridge-Grvl.Rd.Sec.2&11	3,800						
			0:57:41	Sta.2&Eureka Rd.Sec.2&35	11,700						
		0:57:58									
		0:57:59									
			0:58:09	Sta.2&Eureka Rd.Sec.2&35	11,700						
		1:00:06									
		1:00:07									
			1:00:31	Station 3&4 Sec.31 Bridge-Grvl.Rd.	21,000						
			1:00:48	Left Goodwin to Sta.6	24,800						
			1:00:58	Sta.6 - Sec.30							
		1:01:05									
		1:01:06									
			1:01:29	Sta. 4 - Sec.31	20,400						
			1:01:51	Bridge-Pvd.Rd.Sec.31&32 Sta.7							
		1:01:57									
		1:01:58		Sta.6							
			1:02:23		24,800						
			1:02:34	Bridge-Pvd.Rd.Sec.31&32	27,100						
			1:02:34	Sta.5	28,500						
		1:03:01									
		1:03:02									
			1:03:20	Back on Goodwin Cr.	29,300						
			1:03:52	Sta. 8&9 - Sec.29							
		1:04:02									
		1:04:03									
			1:04:24	Sta. 8&9 - Sec.29							
			1:04:45	Sta. 12	39,500						
		1:05:14	-------	End Goodwin Cr.							
4-23	Caney Cr.	1:05:15					* *				
			1:05:40	Mouth Caney Cr. on Long Cr.	0 (49,000)						
			1:06:00	Grvl.Rd.Sec.13-Bridge out	4,500						
			1:06:05	Structure-Sec.18							
			1:06:24	Structure-Sec.18							

Table 11 (Concluded)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-23	Caney Cr. (Continued)	1:06:29									
		1:06:30					Faulty camera filter				
			1:06:38	Grvl.Rd.Sec.13-Bridge out	4,500						
			1:06:42	Structure-Sec.18							
			1:06:57	Structure-Sec.18							
			1:07:15	Structure-Sec.17 Bridge-Pvd.Rd.	12,500						
			1:08:15	Bridge-Grvl.Rd.Sec.21&22	24,500						
		1:08:28	-------	End Caney Cr.							
4-23	Toby Tubby Cr.	1:08:29									
		1:10:15					" "				
		1:10:16									
			1:10:57	Mouth Toby Tubby Cr. on Sardis Lake							
		1:11:49									
		1:11:50									
		1:11:56									
		1:11:57									
			1:13:05	Bridge-Old Sardis Rd.Sec.33&34							
		1:13:32									
		1:13:33									
			1:13:41	Bridge-Old Sardis Rd.Sec.33&34							
			1:14:10	Bridge-Grvl.Rd.Sec.3 End Tape #1							

Table 12
Log of Aerial Videotape 2

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-24	Hickahala Creek	0:00:00					Unprotected few				
			0:00:35	Mouth Hickahala	0	Sand (obscured by	signs of erosion	Woody in wide	Woodland	-	Appears stable
				on Arkabutla Res.		high water)		buffer zone			
			0:01:00	Trib.-Right							
			0:01:32	Bridge-Pvd.Rd.Sec.36	10,200	Low sinuosity					
			0:01:35	Ditch-Left							
			0:02:27	Sand Plug							
			0:02:50	Bridge-Hwy 51 & R.R.							
		0:02:55									
		0:02:56		Bridge-Hwy 51 & R.R.		Obscured by high	Unprotected	Woody in wide	Woodland	-	No apparent problem
			0:03:32	Bridge-I 55	34,000	water	mostly stable	buffer zone			
			0:03:44	Senatobia Cr.-Left	36,000	Low sinuosity					
			0:04:22	Bridge-Pvd.Rd.Sec.22	43,900						
			0:04:28	Trib.-Left							
			0:04:42	Pipeline (2)	47,400						
			0:04:44	Thornton Cr.-Right	48,000						
			0:04:48	Basket Cr.-Left	48,600						
		0:05:35		(Breakoff)	54,400						
		0:05:36									
			0:05:56	Back on Hickahala Cr.	54,400	Sand/gravel bed	Sloping banks	Woody narrow	Cultivated &	No apparent	Some bar deposition -
			0:06:49	Lick Cr.-Right	64,000	material	unprotected	buffer zone	pasture	problems	leading to sinuous thalweg
			0:07:02	Lick Br.-Left	66,000	Low sinuosity	mostly stable				
			0:07:28	Structure-Sec.17	71,000						
			0:07:32	James Wolf-Left	72,000						
		0:07:58									
		0:07:59		Resume Hickahala	70,000	Sandy bed low	Discontinuous	Woody narrow	Cultivation	Can't Tell	Some bar deposition
			0:08:14	James Wolf-Left	72,000	sinuosity	bank protection	buffer zone			scalloped bank line
			0:08:53	Hwy 305	80,200		some erosion				indicated some erosion
			0:09:09	Ditch-Left	82,900						
			0:09:22	Ditch-Left	84,000						
			0:10:26	Bridge-Hwy 306	96,000	Sandy bed low	Discontinuous	Narrow woody	Cultivated some	Can't Tell	No apparent problem
			0:10:34	Beards Cr.-Right	97,500	sinuosity	bank protection	veg buffer	pasture		
			0:10:52	Low Drop Structure	101,000		little erosion	zone			
			0:10:53	Bridge-Pvd.Rd.	101,200						
			0:10:57	Cathey Cr.-Left							
			0:11:11	Ditch-Right	104,600	Sandy bed low	Unprotected	Woody & shrub	Pasture	Good	No apparent problem
			0:11:33	Low Drop Structure	108,800	sinuosity	sloping, stable	veg. narrow			
			0:11:40	Bridge-Grvl.Rd.	110,000			buffer zone			
			0:12:23	Bridge-Grvl.Rd.	119,300						
			0:12:38	Low Drop Structure	121,700		Can't Tell - Channel obscured by vegetation				
4-24	Hickahala Creek		0:12:45	Trib.-Left							
	N. Fork		0:12:49	Low Drop Structure	123,800		No other details - Channel obscured by veg.			O.K.	

Table 12 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item 2	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-24	Nickahala Creek N. Fork (Continued)		0:12:53	Bridge-Grvl.Rd.	124,400					O.K.	
		0:13:04 0:13:05									
			0:13:23	Low Drop Structure	123,800		As Above				
			0:13:26	Bridge-Grvl.Rd.	124,400						
			0:13:34	Drop Pipe-Left&Right	126,000		No Details - Channel obscured by vegetation				
			0:13:59	Low Drop Structure	129,700						
		0:14:01 0:14:02									
			0:14:16	Low Drop Structure	129,700		No Details - Channel obscured by vegetation (Drop structure looked O.K.)				
			0:14:25	Farm Rd.-Plank Bridge	131,200						
			0:14:53	Off on ditch to Rt.(east)	137,400						
			0:15:12	Pvd.Rd.-Hwy 309							
		0:15:17	-------	End Nickahala N. Fork							
4-24	Nickahala S.Fk	0:15:18									
			0:15:29	Structure below fork	121,700						
			0:15:34	Trib.-Left	123,000						
			0:15:37	Low Drop Structure (dirt work only)	+400'from fork						
			0:16:08	Bridge-Grvl.Rd.			No Details - Channel obscured by vegetation				
		0:16:14 0:16:15									
			0:16:24	Bridge-Grvl.Rd.							
			0:16:29	Low Drop site above Rd.	+1,200						
		0:16:56 0:16:57									
			0:17:12	Low Drop Structure-Sec.13 (Under construction)		Sandy meandering channel	Stable	Woody narrow buffer zone	Cultivated	O.K.	No apparent problem
Co.			0:17:27	Culverts-Hwy 4	1000'W. Marshall						
		0:17:33	-------	End Nickahala S. Fork							
4-24	Cathey Cr. (NOI)	0:17:34									
			0:17:47	Nickahala & S. Fk. cross Sec. 10&15-Hwy 4	115,000						
		0:19:01	-------	End							
4-24	James Wolf Canal	0:19:02									
			0:19:23	Structure on Nickahala	71,000	Sand bed low sinuosity	Sloping stable unprotected	Woody & shrub with grass (narrow zone)	Pasture	Can't Tell	No apparent problem
			0:19:26	James Wolf Trib.							
			0:20:23	Bridge-Hwy 4	11,100						
			0:21:25	Bridge-Sec.35	22,500	Sandy/gravel (?) low sinuosity	Protected in parts stable	Woody in narrow buffer zone	Cultivated	-	Stable
			0:21:47	James Wolf-Martin Dale Fk (Ford on ditch to N.D.)	26,500						
		0:21:57 0:21:58									
			0:22:28	James Wolf-Martin Dale Fk (J.W. turns to left)	26,500	Sandy/gravel bed low sinuosity	Protected in parts. Erosion	Woody in narrow buffer	Cultivated	Can't Tell	Tending to instability - sinuous thalweg develop-

Table 12 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-24	James Wolf Canal (Continued)		0:23:24 0:23:38 0:23:51	Rock Stabilizer Farm Ford Bridges(2)-Hwy 306	36,500 38,500 40,700	point bar deposition	on impinging low sites	zone. Some grass			ment with associated bank erosion
		0:24:03 0:24:04									
			0:24:09 0:24:21 0:24:49 0:25:10	Thyatira Bridges(2)-Hwy 306 Bridges-Pvd.Rd.Sec.28&29 Drop Structure	 40,700 46,300 49,700	Sandy bed meandering point bar deposits	Mostly stable & unprotected	Woody & grassy veg in narrow buffer zone	Cultivated	Can't Tell	Potential problem with bank erosion as sinuosity
		0:25:16 0:25:17									
			0:25:28 0:25:41 0:25:52 0:26:11 0:26:20 0:27:08 0:27:19	Drop Structure Bridge(concrete)-Drt.Rd. took N. Fk. J.W. (about 3500' above N.Fk.) Iron Bridge-Drt.Rd. (N.Fk.J.W.Btwn Sec.34&35) Bridge-Drt.Rd.Sec.25 2nd Bridge-Drt.Rd.Sec25	49,700 52,700 55,200 +3,500' +5,200 above J.W. <1.5mi.	Sandy bed meandering	Erosion on outer banks. Protection in some areas	Woody veg narrow buffer	Cultivated	Can't Tell	Unstable
		0:27:25 0:27:26 0:27:45 0:27:58	-------	End James Wolf Canal (Bar code Check) (False start-misaligned (Bar code check)							
4-24	Senatobia Creek	0:28:20									
			0:28:32 0:28:39 0:29:18 0:31:08	Hickahala passing under I 55 Mouth Senatobia Cr. on Hickahala Cr. Bridge-Hwy 4 Structure	34,000 0 (34,000) 7,500 28,400	Sandy bed low sinuosity some clay outcrops (knickpoints?)	Sloping. Erosion & scour on some locations unprotected	Trees, ______ & grass in narrow buffer	Cultivated	-	Potentially unstable? Media bar development
			0:31:14 0:31:16 0:32:03	Senatobia-Nelson Fork (Old bridge) Bridges(2)-Grvl.Rd. (new concrete) Bridge-Pvd.Rd.Sec.19&24	29,300 29,600 30,200 39,400	Sandy bed with bar - almost a braided pattern	Unprotected some erosion	Trees & shrubs in narrow corridor	Cultivated	-	Unstable? Bar deposition in channel
		0:32:44 0:32:45									
			0:33:37	Bridge-Grvl.Rd.	51,200	Sand/gravel meandering	Protected stable	Woody & grass in narrow buffer	Cultivated	Can't Tell	"
		0:33:48 0:33:49									
			0:33:57 0:34:20 0:34:38 0:34:54 0:34:53	Bridge-Grvl.Rd. Ford Ford Bridge-Grvl.Rd. Bridge-Grvl.Rd.	51,200 56,000 60,000 62,900 74,900	Sandy bed meandering Bar development on inner banks of bends	Protection in bendways erosion on some bendways vertical banks	Woody & grass veg in narrow buffer	Cultivated	Can't Tell	"
		0:34:34 0:34:35									
			0:36:52	Bridge-Grvl.Rd.	74,900						

Table 12 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item @	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-24	Senatobia Creek	0:37:28									
	(Continued)	0:37:29									
			0:37:39	Ford	79,900		Too Little to Look At				
			0:37:39	Reservoir at Headwater	87,000						
		0:38:26	-------	End Senatobia Cr. (Sec.21 Range5W T.6S)							
4-24	Hurricane Creek	0:38:27									
			0:39:28	Mouth Hurricane Cr.							
				Delta extending into Arkabutla res.			Too high to pick out much detail				
			0:40:54	Bridge-Hwy 304							
			0:41:26	Bridge-Pvd.Rd.Sec.7&8							
			0:43:44	Bridge-Pvd.Rd.Sec.26&35		Sand bed					
			0:44:03	Bridge-R.R.-Sec.36		with pt. bare	Too high to pick out much more detail				
			0:44:21	Bridge-Hwy 51		meandering	(Narrow wooded buffer in cultivated flood plain)				
			0:44:28	Bridge-I 55							
			0:46:06	Bridge-Pvd.Rd.Sec.27&28							
		0:46:21	-------	End Hurricane Cr.							
4-24	Mussacuna Creek	0:46:22									
			0:46:53	Mouth Mussacuna Cr.-on Coldwater River							
		0:47:29									
		0:47:30					Too high for detail of any worth				
			0:47:59	Sec.28-Left Mussacuna							
				followed trib. N.E. to Hernando							
			0:49:27	(Hwy mentioned on voice track is not Hwy 51)							
		0:49:33									
		0:49:34									
			0:49:58	Back on Mussacuna Cr.			Too high for detail				
			0:50:41	Bridge-Pvd.Rd.Sec.26&27							
		0:50:[illegible]									
		0:50:[illegible]									
			0:51:08	Bridge-Pvd.Rd.Sec26&27							
				(same as @ 0:50:41)			Channel obscured				
			0:51:47	Bridge-Grvl.Rd.Sec.25&26							
			0:52:26	Hwy 51							
		0:52:32	-------	End Mussacuna Cr.							
4-24	Cane Creek	0:52:33									
			0:52:54	Mouth Cane Creek-on Coldwater River		Sand/clay bed	Moderate bank	Woody narrow	Cultivated	Can't Tell	
			0:54:09	Crossing-Sec.3&4		some pt. bar	erosion	buffer			
			0:54:45	Bridge-Pvd.Rd.Sec.34&35		deposition					
			0:55:04	Left Cane Cr.-followed trib. N.E.							
				to Hwy 51, Sec.35 (Not South of							
				Senatobia-should be South of Hernando)							
		0:56:57	-------	End Cane Cr.							
4-24	Secret Creek	0:56:58									
			0:57:08	Mouth Cane Cr.							
			0:57:37	Mouth Secret Cr.-on Cane Cr.							
			0:58:32	Bridge-Pvd.Rd.Sec.10&11							
			0:58:52	Bridge-Grvl.Rd.Sec.11							

Table 12 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-26	Secret Creek (Continued)	0:59:09					No detail can be seen				
		0:59:10									
			0:59:27	Bridge-Grvl.Rd.Sec.11							
			0:59:33	Bridge-Pvd.Rd.Sec.11							
			0:59:51	Pvd.Rd.							
		0:59:56	-------	End Secret							
4-25	Wolf Creek	0:59:57									
			1:01:36	Mouth Wolf Cr.-on Hurricane Cr.							
			1:02:21	Bridge-Hwy 301			No detail				
		1:02:35	-------	End Wolf Cr.							
4-25	Panther Creek	1:02:36									
			1:03:01	Mouth Panther Cr.-on Hurricane							
		1:04:01									
		1:04:02					No detail				
			1:04:06	Back on Panther Cr.							
			1:04:32	Bridge-Hwy 304							
		1:05:47									
		1:05:48									
			1:06:08	Back on Panther Cr.			Channel obscured by vegetation				
			1:07:20	Bridge-Pvd.Rd.Sec.283							
		1:07:38	-------	End Panther Cr.							
4-25	Coldwater River	1:07:39									
			1:08:32	Mouth Coldwater River-on Tallahatchie River		Meandering details of bed obscured by high flow	Banks obscured	Woody in wide buffer	Woodland	Can't See	
			1:09:33	Bridge-Hwy 51							
			1:10:13	Bridge-R.R.							
		1:10:23									
		1:10:24									
			1:10:41	Bridge-R.R.			As Above				
			1:10:45	Bridge-I 55							
		1:11:33									
		1:11:34									
			1:11:44	Back on Coldwater River			As Above				
		1:12:20									
		1:12:21									
			1:12:45	Back on Coldwater River			As Above				
		1:13:15									
		1:13:16									
			1:14:05	Channel Jumped out							
		1:14:24									
		1:14:25									
			1:14:38	Channel Jumped out (same as 1:14:05)							
			1:14:51	Short Cr.-Right			As Above				
			1:16:14	Bridge-Pvd.Rd.Sec.30							
			1:17:49	Coldwater-Right							
		1:17:50									
		1:20:27		Coldwater-Right							

Table 12 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-25	Coldwater River	1:21:06									
	(Continued)	1:21:07									
			1:21:20	Back on Coldwater			As Above	Tortuous meander bends			
			1:21:31	Bridge-Hwy 305							
		1:21:45									
		1:21:46									
			1:22:43	Bridge-Hwy 304			Channel obscured by vegetation				
		1:23:07									
		1:23:08									
			1:23:21	Back on Coldwater			Channel obscured by veg.				
			1:23:40	Bridge-Pvd.Rd.Sec.25&36							
		1:25:11									
		1:25:12									
			1:26:15	Bridge-Hwy 78			No details due to altitude and obscuration				
			1:26:20	Bridge-Old Hwy 78 & R.R.							
		1:27:18									
		1:27:19									
			1:27:39	Trib.-Right			Channel obscured				
			1:28:01	House on Grvl.Rd.Sec.10							
		1:28:06									
		1:28:07									
			1:28:12	Trib.-Right			Detail obscured				
			1:28:58	Pipeline							
		1:29:13									
		1:29:14									
			1:29:25	Pipeline			As Above				
			1:29:46	Byhalia Rd.							
		1:29:49									
		1:29:50									
			1:30:23	Bridge-Byhalia Rd.							
			1:30:46	Pipeline			As Above				
			1:31:14	Bridge-Grvl.Rd.-Nonconnah Cr.Rd.							
			1:31:18	Pipeline							
		1:31:27									
		1:31:28									
			1:31:36	Bridge-Grvl.Rd.-Nonconnah Cr.Rd.							
			1:32:08	Lee Cr./Coldwater Fork			As Above				
			1:32:57	Bridge-Victoria Rd.Sec.15&16							
		1:33:13									
		1:13:14									
			1:33:24	Bridge-Victoria Rd.Sec.15&16							
			1:34:47	Bridge-Pvd.Rd.Sec.19&24							
			1:35:12	Ditch-Left			As Above				
			1:36:00	Pwr Line (not pipeline)							
			1:36:41	Bridge-Hwy 311							
		1:37:02									
		1:37:03									

Table 12 (Concluded)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item B	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-25	Coldwater River		1:37:20	Bridge-Hwy 311							
	(Continued)		1:39:30	Bridge-Hwy 7			As Above				
		1:39:46	-------	End Coldwater River							
4-25	Holly Springs	1:39:47									
	Experiment	1:40:27					As Above				
	Station	1:40:28									
			1:41:21	*End Tape #2*							

Table 13
Log of Aerial Videotape 3

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-25	Beartail Creek	0:00:00									
			0:00:50	Hwy 55							
			0:01:03	Mouth Beartail Cr. on Coldwater River							
			0:01:44	Bridge-Pvd.Rd.Sec.15							
			0:02:53	Bridge-Pvd.Rd.Sec.19&24			Detail can't be seen - Too high / veg obscures				
			0:03:16	Buttermilk Cr.-Left							
			0:03:30	Little Beartail-Left			Though some signs of unstable banks on one or two meander bends				
			0:04:01	Bridge-Pvd.Rd.Sec.16							
			0:04:30	Bridge-Grvl.Rd.Sec.10&15							
			0:04:45	Bridge-Hwy 305							
			0:04:57	Pipeline							
			0:05:14	Bridge-Grvl.Rd.Sec.11&12							
		0:05:31	-------	End Beartail Cr.							
4-25	Grays Creek	0:05:32									
			0:06:07	Mouth Grays Cr. on Coldwater River			As above but banks appear stable as far as I can tell				
			0:07:01	Bridge-Pvd.Rd.Sec.34&35							
		0:09:25	-------	End Grays Cr.							
4-25	Camp Creek	0:09:26									
			0:10:12	Mouth Camp Cr. on Coldwater River			Too high for detail				
			0:10:36	Bridge-Pvd.Rd.Sec.25							
			0:12:45	Bridge-Hwy 304							
			0:12:52	Bean Patch Cr.-Right	Close ups	Sand bed straight, low p. bar deposition	Steep unstable banks protected at structures	Woody in narrow buffer	Cultivated	Can't Tell	In channel deposits & unstable banks => unstable channel
			0:13:12	Camp Cir.Cr.							
			0:15:01	Bridge-Pvd.Rd.Sec.7&8							
			0:15:48	Hole Hoe Cr.-Right							
			0:15:59	Bridge-Grvl.Rd.Sec.6							
			0:16:25	Ford-Sec.32			Too high to see much detail				
			0:16:47	Culvert-Hwy 78							
			0:17:22	Bridge-Hwy 78 & R.R.							
			0:17:24	Bridge-Hwy 305							
		0:18:18	-------	End Camp Cr.							
4-25	Pigeon Roost Cr.	0:18:19									
			0:18:44	Mouth Pigeon Roost Cr. on Coldwater River		Low sinuosity sand bed creek with dunes	Some bank protection, banks mostly appear stable some evidence of alternate bar deposition	Woody/grass narrow buffer zone	Pasture & woodland	Can't Tell	No apparent problem at present. Potential problem with alternate bar deposition?
			0:19:15	Bridge-Hwy 305							
			0:19:46	Byhalia Cr.-Right							
			0:20:05	Bridge-Pvd.Rd.Sec.13							
			0:20:09	Red Banks Cr.-Right							
			0:21:28	Bridge-Grvl.Rd.Sec.5&32							

Table 13 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-25	Pigeon Roost Cr. (Continued)		0:23:10	Bridge-Grvl.Rd.Sec.2		Sand. Low sinuosity dune bed in channel bar deposits	Protected appear mostly stable	Grassy. moderate buffer zone	Pasture. Wood cultivated	Can't Tell	Again potential problem with in channel alternate bar deposition
			0:23:50	Bridge-Hwy 309							
			0:25:05	Cuffawa Cr.-Left							
			0:26:10	Bridge-Pvd.Rd.Sec.11&12 (P.R.Sta.#17 Red Banks/Marianna Rd.)			Too high to see much detail				
			0:26:37	Bridge-Grvl.Rd.Sec.7&12 (Mt. Moriah Church Rd.)							
		0:27:06									
		0:27:07									
			0:27:28	Back on Pigeon Roost Cr.			Too high too see much detail				
			0:27:53	Bridge-Pvd.Rd.Sec.17							
		0:28:34									
		0:28:35									
			0:28:57	Bridge-Marianna/Holly Springs Rd.Sec.17 (Not Old Hwy 4 as stated on voice track) (Took N. Fork on to Nunnally Cr. to N.S.)			Too high to see details				
		0:29:45									
		0:29:46									
			0:29:59	Chew Cr.-Right			Can hardly see creek!				
		0:30:46									
		0:30:47									
			0:32:13	Hwy 78			Creek obscured				
		0:32:16	-------	End Camp Cr.							
4-25	Cuffawa Creek	0:32:17									
			0:32:40	Mouth Cuffawa Cr. on Pigeon Roost Cr.		Sand bed pt. bar deposits in channel deposits	Can't tell if protected	Woody narrow buffer	Cultivated	Can't Tell	Possible knickpoints/scour hole @ - 34.12? Potentially unstable -> unstable
			0:33:28	Bridge-Grvl.Rd.Sec.9&16							
			0:34:19	Bridge-Grvl.Rd.Sec.21&28 (P.R.Sta.#32)			Major bank instability just upstream of bridge -> Potential problem				
			0:34:41	Ford-Sec.28							
			0:36:22	Bridge-Hwy 4 @Chulahoma (P.R.Sta.#35)			Too high - Can't see any detail. (On close up signs of vertical, unstable banks)				
			0:36:37	Bridge-Grvl.Rd. to Laws Hill							
		0:36:41									
		0:36:42									
			0:36:53	Fork			Too high - No detail				
			0:36:56	Bridge-Grvl.Rd. to Laws Hill							
		0:37:18									
		0:37:19									
		0:37:43				Sand bed meandering	Can't tell if banks prot. signs of widening in some bendways. Steep vertical banks	Woody. narrow buffer	Cultivated	Can't Tell	Unstable bendways
		0:37:44									
			0:38:07	Back on Cuffawa Cr.							
		0:38:32									
		0:38:33									
			0:38:50	Back on Cuffawa Cr.							
			0:39:59	Bridge-Grvl.Rd.Sec.13&14							
		0:40:07	-------	End Cuffawa Cr.							
4-25	Byhalia Creek	0:40:08									

Table 13 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-25	Byhalia Creek (Continued)		0:40:28	Mouth Byhalia Cr. on Pigeon Roost Cr.		Sand bed low sinuosity	Banks protected? sloping banks Can't tell stability, though no signs of much scalloping	Sparse-moderate woody veg in narrow buffer	Cultivated	Can't Tell	-
			0:40:10	Structure							
			0:41:26	Bridge-Pvd.Rd.Sec.7							
			0:42:30	Bridge-Grvl.Rd.Sec.9							
			0:43:45	Bridge-Hwy 309							
			0:44:12	Hwy 78							
		0:44:15	-------	End Byhalia Cr.							
4-25	Red Banks Creek (Continued)	0:44:16									
			0:44:34	Mouth Red Banks Cr. on Pigeon Roost Cr.			Too high to tell much detail. Major destabilized bend at 46.12 - Sediment source from pond on floodplain (through connecting ____)				
			0:45:26	Bridge-Pvd.Rd.Sec.29830							
			0:47:42	Bridge-Hwy 309		Sand	Sloping stabilized by groynes	Sparse grass R.B. woody L.B. narrow buffer	Cultivated	Groynes filling up with sand	
			0:48:10	Structure-Sec. 19			Sand deposition upstream of structure				
			0:48:21	Structure-Sec. 19			Bank protection all along these _______, together with in channel deposition				
			0:49:35	Bridge-Grvl.Rd.Sec.21822							
		0:49:47									
		0:49:48									
			0:49:54	Fork-Red Banks Cr.-Right							
			0:51:10	Pvd.Rd -Sec.24			Too high - No detail				
		0:51:14									
		0:51:15									
			0:51:35	Fork-Red Banks Cr.-Right		Sand bed meandering pt. bar deposits	Too much to tell details of banks	Woody veg in narrow corridor	Cultivated left bank. Wood/cultivated right bank	Can't Tell	-
			0:53:22	Bridge-Pvd.Rd.Sec.13818 (Intersects Hwy 78)							
		0:54:44	-------	End Redbanks							
		(0:54:44 to	0:56:20	testing equipment)							
4-30	Otoucalofa Creek	0:56:20		Bar code check		Sand bed low sinuosity	Sloping stable unprotected	Woody in variable buffer zone	Pasture woodland	-	-
			0:56:27	Mouth Otoucalofa Cr. on Yocona River-Sec.34	0						
			0:57:45	Susie Perry Cr.-Left	18,000						
			0:58:02	Pwr. Line-Sec.7	21,500	Sand bed low sinuosity	Sloping stable (most) protected in parts	Narrow buffer some woody mostly grass/shrub	Urban & Cultivated	Seem O.K.	-
			0:58:15	Bridge-Hwy 7-Sec.7	23,600						
			0:58:16	Johnson Cr.-Left	24,000						
			0:58:26	Town Cr.-Right	26,500						
			0:58:37	Bridge-Old Hwy 7-Sec.8	28,600						
			0:58:40	Bridge-Old R.R.-Sec.8	29,500						
			0:59:05	Bridge-Pvd.St.Sec.1689	33,800						
		0:59:13									
		0:59:14									
			0:59:20	Bridges-Old Hwy 7-Sec.8	28,600	Sand bed low sinuosity	Sloping banks can't tell if protected some erosion	Narrow buffer sparse woody mostly shrub/grass	Cultivated right bank pasture left bank.	Can't Tell	-
			0:59:25	Bridge-Old R.R.-Sec.8	29,500						
			0:59:43	Bridge-Pvd.St.Sec.1689	33,800						

Table 13 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Otoucalofa Creek (Continued)		1:00:28	Bridge-Pvd.Rd.Sec.14	43,200	Sand bed low sinuous	Protection on some banks vertical banks (unstable) on unprotected	Narrow buffer of woody veg	Cultivated right bank woodland left	Can't Tell	Unstable banks
			1:00:52	GreasyCr.-Right-Sec.11&12	47,800						
			1:01:41	Moore Cr.-Right-Sec.6&7	57,500						
		1:01:50									
		1:01:51									
			1:01:52	Moore Cr.-Right-Sec.6&7	57,500	Sandy bed meandering. Pt. bar deposition	Vertical, unstable banks on bends	Narrow buffer of woody veg	Cultivated	Can't Tell	Channel migration problems?
			1:01:56	Gordon Branch	59,500						
		1:02:04									
		1:02:05									
			1:02:07	Gordon Branch	59,500						
			1:02:19	Otoucalofa South#1-Left	63,600						
			1:02:45	Bridge-Pvd.Rd.Sec.5	72,800						
			1:02:59	Mills Cr.-Sec.33&34	75,700						
			1:03:20	Smith South-Left-Sec.33&34	79,800						
			1:03:25	Hanna Cr.-Right	80,000						
			1:03:53	Ford							
			1:04:00	Sarter Cr.-Right-Sec.34	86,400						
		1:04:20									
		1:04:21		Bar code check							
			1:04:43	Back on Otoucalofa Cr.	88,500						
		1:05:12									
		1:05:13									
			1:05:14	Back on Otoucalofa Cr.			Too high				
			1:05:45	Bridge-Grvl.Rd.Sec.31&36	106,800						
		1:06:02									
		1:06:03									
			1:06:13	Back on Otoucalofa							
			1:06:19	Dickey Cr.-Right	109,500		Channel obscured				
			1:06:45	Shippy Cr.-Right	115,000						
			1:06:58	Bridge-Drivers flat-sec.6	117,300						
		1:07:28									
		1:07:29									
			1:07:30	Bridge-Drivers flat-sec.6	117,300						
			1:07:46	Farm Rd.-Sec.8	121,900						
			1:08:01	Bridge-Driveway-Sec.8	125,500		Too high - Channel obscured				
			1:08:18	Bridge-Grvl.Rd.Sec.9	129,200						
			1:08:40	Pipeline	134,000						
			1:08:46	Driveway(old Hwy 9)							
		1:08:59									
		1:09:00									
			1:09:05	Pipeline	134,000						
			1:09:11	Driveway(old Hwy 9)			As Above				
			1:09:15	Bridge-Hwy 9W-Sec.15	135,900						
		1:09:36	....	End Otoucalofa Cr.							
4-30	Susie Perry Creek	1:09:37									
			1:09:49	Mouth Susie Perry Cr. on Otoucalofa Cr.	0 (18,000)						

Table 13 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Susie Perry Cr. (Continued)		1:10:16	Bridge-Hwy 32-Sec.12	6,500						
		1:10:22									
		1:10:23	.				As Above				
			1:10:34	Bridge-Hwy 32-Sec.12	6,500						
			1:10:59	Bridge-Pvd.Rd.Sec.15	11,500						
			1:11:31	Bridge-Pvd.Rd.Sec.24	17,000						
		1:11:37	-------	End Susie Perry Cr.							
4-30	Johnson Creek	1:11:38									
			1:11:48	Mouth Johnson Cr. on Otoucalofa Cr.	0 (24,000)						
			1:12:10	Bridge-Hwy 32-Sec.1788	6,000		As Above				
			1:12:29	Bridge-Old Hwy 7-Sec.17	8,100						
			1:12:37	Old R.R.	9,600						
		1:13:01									
		1:13:02									
			1:13:50	Bridge-Pvd.Rd.Sec.29	20,300		Too high - Channel obscured				
		1:14:11	-------	End Johnson Cr.							
4-30	Town Creek	1:14:12									
			1:14:27	Mouth Town Cr. on Otoucalofa Cr.	0 (26,500)						
			1:14:47	Bridge-Old Hwy 7-Sec.8	3,900		As Above				
			1:14:53	Bridge-Hwy 315-Sec.4	5,100						
		1:15:08									
		1:15:09									
			1:15:31	Bridge-Pvd.St.Sec.4	10,000						
		1:15:59	-------	End Town Cr.							
4-30	Greasy Creek	1:16:00									
			1:16:16	Mouth Greasy Cr. on Otoucalofa Cr.	0 (47,800)						
			1:17:03	Bridge-Grvl.Rd.Sec.1	5,000						
		1:17:24					As Above				
		1:17:25									
			1:17:35	Bridge-Grvl.Rd.Sec.1	9,000						
			1:18:20	Bridge-Pvd.Rd.Sec.25	17,900						
		1:18:21	-------	End Greasy Cr.							
4-30	Moore Creek	1:18:22									
			1:18:38	Mouth Moore Cr. on Otoucalofa Cr.	0 (57,500)						
			1:18:59	Bridge-Hwy 315-Sec.6	4,000						
		1:19:13					As Above				
		1:19:14									
			1:19:27	Bridge-Hwy 315-Sec.6	4,000						
			1:19:42	Sand Cr.-Right	7,000						
		1:20:06	-------	End Moore Cr.							
4-30	Gordon Branch	1:20:07									
			1:20:15	Mouth Gordon Branch on Otoucalofa Cr.	0 (59,500)		As Above				

Table 13 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item @	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Gordon Branch		1:20:30	Bridge-Grvl.Rd.Sec.7	3,000						
	(Continued)	1:20:52	-------	End Gordon Branch							
4-30	Otoucalofa S.#1	1:20:53									
			1:21:05	Mouth Otoucalofa South #1	0						
				on Otoucalofa Cr.	(63,600)		As Above				
			1:21:27	Bridge-Pvd.Rd.Sec.5	4,500						
			1:21:33	Driveway-Sec.4&5	5,400						
4-30	Otoucalofa S.#1		1:21:34	Spring Cr.-Left	5,500						
	(Continued)	1:22:03	-------	End Otoucalofa South #1							
		1:22:04									
4-30	Spring Creek		1:22:15	Mouth Spring Creek			Can't see detail				
				on Otoucalofa South #1	(5,500)						
		1:22:55									
		1:22:56									
		1:23:30	-------	End Spring Cr.							
4-30	Wills Creek	1:23:31									
			1:23:41	Mouth Wills Cr.	0						
				on Otoucalofa Cr.	(75,700)		As Above				
			1:23:52	Bridge-Hwy 315-Sec.33	2,300						
		1:24:47	-------	End Wills Cr.							
4-30	Smith South	1:24:48									
			1:24:51	Mouth Smith South	0						
				on Otoucalofa Cr.	(79,800)		As Above				
			1:25:11	Bridge-Pvd.Rd.Sec.3	4,200						
		1:25:40									
		1:25:41									
			1:25:47	Bridge-Pvd.Rd.Sec.3	4,200						
			1:26:21	Pipeline-Sec.11	12,800		As Above				
			1:26:44	Grvl.Rd.Sec.11&12	18,000						
		1:26:46									
4-30	Sarter Creek	1:26:47									
			1:26:54	Mouth Sarter Cr.	0		As Above				
				on Otoucalofa Cr.	(86,400)						
		1:27:08									
		1:27:09									
			1:27:19	Mouth Sarter Cr.	0						
		1:27:42									
		1:27:43									
			1:27:44	Back on Sarter Cr.	3,300						
			1:27:57	Bridge-Hwy 315-Sec.33	5,200						
			1:28:04	Bridge-Grvl.Rd.	6,800						
			1:28:11	Left Sarter-got on trib.			As Above				
		1:28:34									
		1:28:35									
			1:28:47	Bridge-Grvl.Rd.Sec.26	9,400						
			1:29:18	Bridge-Hwy 9W-Sec.23	15,400						
			1:29:23	Bridge-Driveway	16,200						

Table 13 (Concluded)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item 8	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Sarter Creek		1:29:43	Grvl.Rd.Sec.13	20,000		Channel obscured				
	(Continued)	1:29:45	-------	End Sarter Cr.							
4 30	Hanna Creek	1:29:46									
			1:29:57	Mouth Hanna Cr.	0						
				on Otoucalofa	(80,000)		As Above				
			1:30:15	Bridge-Hwy 315-Sec.33	4,900						
		1:30:25	------	End Hanna Cr.							
4-30	Smith Creek	1:30:26		(Missed Mouth on	(109,500)						
				Otoucalofa)							
4-30	Smith Creek		1:30:28	Bridge-Hwy 9W-Sec.31	2,000		As Above				
	(Continued)		1:30:34	Bickey Cr.	2,900						
			1:30:37	Bridge-Grvl.Rd.Sec.31	3,500						
		1:31:10	-------	End Smith Cr.							
4-30	Shippy Cr.	1:31:11									
			1:31:22	Mouth Shippy Cr.	0						
				on Otoucalofa	(114,000)		As Above				
			1:31:35	Bridge-Grvl.Rd.Sec.5	4,000						
			1:31:52	Bridge-Hwy 9W-Sec.5	7,100						
		1:32:37	-------	End Shippy Cr.							
		1:32:38									
				End Tape #3							

(Remaining tape-flying downstream on Otoucalofa.)

Table 14
Log of Aerial Videotape 4

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	[illegible] Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Batupan Bogue	0:00:00									
			0:02:17	Mouth Batupan Bogue	0	Sand bed w/dunes & bars on inner banks meandering	Sloping, unprotected moderate erosion	Woody veg. in narrow buffer	Urban	-	Not sure. Heavy in channel bar deposition
		0:02:43									
		0:02:44									
			0:02:49	Back on Batupan Bogue							
			0:03:02	Bridge-Hwy 8-Sec.17	8,000						
		0:03:35									
		0:03:36									
			0:03:37	Back on Batupan Bogue		Sand bed with bars meandering	Sloping, stable, unprotected(?) banks moderate erosion	Woody veg wide buffer	Pasture	-	Heavy in channel bar deposition
		0:04:18									
		0:04:19									
			0:04:24	Back on Batupan Bogue							
		0:04:40				Sand bed with bars meander -> braided	Some bank erosion	Woody veg. narrow buffer	Urban	-	Potential braiding transition?
		0:04:41									
			0:04:44	Back on Batupan Bogue							
		0:05:25									
		0:05:26									
			0:05:30	Bridge-Pvd.Rd.Sec.28	26,700	Sand bed with bars meandering	Moderate bank erosion	Woody veg wide buffer	Woodland	-	Moderate in channel deposition
			0:05:52	Jack Cr.-Left-Sec.33	30,500						
		0:06:15									
		0:06:16									
			0:06:17	Back on Batupan Bogue		Sand bed meandering (braided?)	Sloping unprotected stable, except on bends	Woody wide buffer	Cultivated	-	In channel bar deposition
			0:07:55	Bridge-Pvd.Rd.Sec.14	52,500						
			0:08:14	Little Bogue-Right	56,400						
		0:08:37	-------	End Batupan Bogue							
4-30	Big Bogue Creek	0:08:38									
			0:08:53	Mouth Big Bogue Creek	0						
			0:09:21	Sykes Cr.-Left	8,100						
			0:09:28	Bridge-Grvl.Rd.Sec.24	9,500		Too high - Detail is obscured				
			0:09:31	Wilkens Cr.-Left	10,000						
			0:10:00	Old Military Bridge site Sec.25	15,100						
			0:10:36	Jackson Cr.-Left-Sec.36	20,600						
		0:10:57									
		0:10:58									
			0:11:02	Back on Big Bogue Cr.			Detail obscured				
			0:11:33	Bridge-Hwy 404-Sec.31	28,500						
		0:11:39									
		0:11:40									
			0:11:42	Back on Big Bogue Cr.			Detail obscured				
			0:11:52	Bridge-Hwy 404-Sec.31	28,500						
		0:12:19									
		0:12:20									

Table 14 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Big Bogue Creek		0:12:31	Back on Big Bogue Cr.							
	(Continued)		0:12:42	Mouth Worsham Cr.	0		Detail obscured				
		0:13:03	-------	End Big Bogue Cr.	(35,000)						
4-30	Worsham Creek	0:13:04									
		0:13:52									
		0:13:53									
			0:13:58	Back on Worsham Cr.							
			0:14:26	Bridge-Grvl.Rd.Sec.9	15,400		As Above				
			0:15:01	Structure	21,000						
			0:15:02	Bridge-Pvd.Rd.Sec.16&21	21,500						
		0:15:07									
		0:15:08									
			0:15:28	Structure	21,000						
			0:15:30	Bridge-Pvd.Rd.Sec.16&21	21,500		As Above				
			0:16:03	Structure-Sec.21	26,500						
		0:16:10									
4-30	Middle Fk.Worsham	0:16:11									
			0:16:17	Middle Fk. Worsham-Sec.15							
			0:16:22	Structure #1-Sec.22							
			0:16:23	Bridge-Pvd.Rd.Sec.22			As Above				
			0:16:38	Structure #2-Sec.22 (Under construction)							
			0:16:47	Structure #3-Sec.22							
		0:17:02	-------	End Middle Fk. Worsham							
4-30	East Fk.Worsham	0:17:03									
			0:17:11	East Fk. Worsham Cr.							
			0:17:37	Structure #1-on East Fk.							
			0:17:38	Bridge-Pvd.Rd.Sec.22			As Above				
			0:17:49	Structure #2-on East Fk.							
			0:18:17	Bridge-Grvl.Rd.Sec.24							
			0:18:29	Bridge-Driveway-Sec.13							
		0:18:39	-------	End Worsham Cr.							
4-30	Eskridge Creek	0:18:40									
			0:18:52	Mouth Eskridge Cr.	0						
				on Big Bogue	(35,000)		As Above				
			0:19:14	Bridge-Pvd.Rd.Sec.8	5,400						
			0:20:49	Structure-Sec.20	20,000	Sand bed	Steep -> vertical	Woody in	Cultivated	Can't Tell	Seems relatively stable
			0:20:52	Bridge-Pvd.Rd.Sec.20&29	20,900	meandering	banks no	narrow buffer			
			0:21:13	Structure-Sec.20&29	24,000		protection				
			0:21:14	Bridge-Driveway	24,100						
			0:21:35	Bridge-Driveway	24,300						
		0:22:12	-------	End Eskridge Cr.							
4-30	Jackson Creek	0:22:13									
			0:22:27	Mouth Jackson Cr.	0						
				on Big Bogue	(20,600)						
			0:22:31	Bridge-Hwy 31-Sec.36	1,600		Channel obscured by veg & high altitude				

(Sheet 2 of 6)

Table 14 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item 0	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Jackson Creek (Continued)		0:22:41	Bridge-Driveway	3,000						
			0:22:54	Bridge-Hwy 404-Sec.36	5,200						
			0:23:35	Pwr Line							
		0:23:43	-------	End Jackson Cr.							
4-30	Wilkins Creek	0:23:44									
			0:24:04	Mouth Wilkens Cr. on Big Bogue	0 (9,900)						
		0:24:13									
		0:24:14									
			0:24:21	Mouth Wilkens Cr.	0		As Above				
			0:24:50	Bridges-Hwy51&R.R.Sec.25	7,200						
		0:25:15									
		0:25:16									
			0:25:29	Bridges-Hwy51&R.R.Sec.25	7,200						
			0:26:30	Bridge-Hwy 4-Sec.35	18,500						
		0:27:07									
		0:27:08									
			0:27:15	Back on Wilkens Cr.							
		0:27:52									
		0:27:53									
			0:28:02	Back on Wilkens Cr.							
			0:28:09	Fork to west (Right)	27,700						
			0:28:56	Bridge-Grvl.Rd.	36,700		Channel obscured by vegetation				
			0:29:09	Bridge-I 55							
		0:29:13	-------	End Wilkens Cr. (through pond)							
4-30	Sykes Creek	0:29:14									
			0:29:29	Mouth Sykes Cr. on Big Bogue	0 (8,100)	Sand-bed meandering	Sloping stable unprotected	Woody in wide buffer	Cultivated	Can't Tell	Some in channel deposition
			0:30:08	Bridge R.R.-Sec.23	7,600						
			0:31:00	Bridge-Hwy 51-Sec.23	7,800						
			0:31:11	Bridge-Grvl.Rd.Sec.27	20,800		Detail obscured by veg & altitude				
			0:32:06	Bridge-Hwy 404-Sec.33	29,800						
			0:32:26	Bridge-Hwy 55	32,700						
		0:32:53	------	End Sykes Cr.							
4-30	Jack Creek	0:32:54									
			0:33:07	Mouth Jack Cr. on Batupan Bogue	0 (30,500)						
			0:33:34	Bridge-R.R.-Sec.33	7,400						
			0:33:40	Bridge-Hwy 51-Sec.33	9,000		As Above				
		0:34:16									
		0:34:17									
			0:34:28	Back on Jack Cr.							
		0:36:05	-------	End Jack Cr.							
4-30	Perry Creek	0:36:06									
			0:36:15	Mouth Perry Cr. on Batupan Bogue	0 (13,700)						
			0:36:33	Structure	4,000						

Table 14 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Perry Creek (Continued)		0:36:36	Bridge-Pvd.St.	5,000						
			0:36:48	Bridge-Pvd.St.	8,000						
		0:37:06									
		0:37:07									
			0:37:19	Bridge-Pvd.St.	5,000						
			0:37:32	Bridge-Pvd.St.	8,000						
			0:37:45	Structure	12,000						
			0:38:04	Bridge-Hwy 51-Sec.29	15,000						
		0:38:06					As Above				
		0:38:07									
			0:38:24	Back on Perry Cr.							
			0:38:34	Bridge-Hwy 51-Sec.29	15,000						
			0:38:41	Bridge-Pvd.St.	16,800						
			0:39:08	Bridge-Pvd.Rd.	21,400						
		0:39:14									
		0:39:15									
			0:39:38	Bridge-Pvd.Rd.	21,400						
			0:40:21	Bridge-I 55-Sec.36	29,500						
		0:42:03	-------	End Perry Cr.							
4-30	Little Bogue Cr.	0:42:04									
			0:42:47	Mouth Little Bogue Cr. on Batupan Bogue Cr.	56,400						
		0:43:08									
		0:43:09									
			0:43:20	Back on Little Bogue Cr.			Not much detail - Too high				
			0:43:38	Bridge-Pvd.Rd.Sec.18	63,100						
		0:43:39									
		0:43:40									
			0:43:45	Back on Little Bogue Cr.							
			0:43:54	Bridge-Pvd.Rd.Sec.18	63,100		As Above				
		0:44:30									
		0:44:31									
			0:44:42	Back on Little Bogue Cr.			As Above				
			0:45:10	Bridge-Pvd.Rd.Sec.20&21	75,900						
		0:45:52									
		0:45:53									
			0:45:56	Back on Little Bogue Cr.			" "				
			0:46:14	Campbell Cr.-Right	83,000						
		0:46:43									
		0:46:44									
			0:46:47	Back on Little Bogue Cr.							
			0:47:48	Powell Cr.-Right	98,900						
			0:48:17	Mouse Cr.-Left	108,500		As Above				
			0:48:39	Bridge-Grvl.Rd.Sec.29	110,400						
		0:49:22									
		0:49:23									
			0:49:34	Bridge-Grvl.Rd.Sec.28	117,800						

Table 14 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Little Bogue Cr. (Continued)		0:49:47	Caffe Cr.-Left	122,000		As Above				
			0:49:51	Structure	123,500						
		0:50:09									
		0:50:10									
			0:50:18	Structure	123,500	Sand bed meandering	Protected vertical outer sloping inner outer unstable	Woody & shrub veg in narrow buffer	Cultivated	Seems O.K.	Not sure
			0:50:53								
		0:50:45	------	End Little Bogue Cr.							
4-30	Caffe Branch	0:50:46									
			0:50:53	Mouth Caffe Branch on Little Bogue Cr.	0 (122,000)						
			0:51:06	Structure	2,000		Detail unavailable				
			0:51:09	Bridge-Grvl.Rd.Sec.21	2,900						
			0:52:06		21,000						
		0:52:27	-------	End Caffe Branch	21,000						
4-30	Crowder Creek	0:52:28									
			0:52:54	Mouth Crowder Cr. on Little Bogue Cr.	0						
			0:52:59	Bridge-Military Rd.Sec.18	2,200						
			0:53:10	Bridge-Military Rd.Sec.7	5,200						
			0:53:23	Bridge-Military Rd.Sec.7	8,000		No detail - Too high				
			0:53:59	Structure-Sec.5	15,000						
			0:54:52	Bridge-Pvd.Rd.	23,900						
		0:54:54	-------	End Crowder Cr.							
4-30	Epison Creek	0:54:55									
			0:55:34	Mouth Epison Cr. on Little Bogue Cr.	0 (66,100)		Detail obscured by vegetation				
			0:55:56	Bridge-Pvd.Rd.Sec.17	5,100						
		0:56:06									
		0:56:07									
			0:56:08	Bridge-Pvd.Rd.Sec.17	5,100		As Above				
		0:56:28									
		0:56:29									
			0:56:45	Back on Epison Cr.			As Above				
			0:57:01	Sec.9	13,700						
		0:57:06	-------	End Epison Cr.							
4-30	Campbell Creek	0:57:07									
			0:57:08	Mouth Campbell Cr. on Little Bogue Cr.	0 (83,000)		As Above				
			0:57:45	Bridge-Pvd.Rd.Sec.23	8,700						
		0:57:51									
		0:57:52									
			0:57:53	Back on Campbell Cr.							
			0:58:03	Bridge-Pvd.Rd.Sec.23	8,700		As Above				
			0:58:50	Bridge-Military Rd.							
			0:59:23	Pvd.Rd.Sec.2	23,500						
		0:59:26	-------	End Campbell Cr.							

Table 14 (Concluded)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item B	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
4-30	Powell Creek	0:59:27									
			0:59:41	Mouth Powell Cr.	0						
				on Little Bogue Cr.	(98,800)		As Above				
			0:59:49	Bridge-Grvl.Rd.Sec.24	2,000						
			1:00:23	Bridge-Grvl.Rd.Sec.18&19	8,400						
			1:01:39	Sec.6	22,400						
		1:01:43	-------	End Powell Cr.							
4-30	House Creek	1:01:44									
			1:01:51	Mouth House Cr.	0						
				on Little Bogue Cr.	(106,000)						
			1:02:00	Bridge-Hwy 404-Sec.30	1,900						
			1:02:22	Structure-Sec.32	6,000						
				(under construction)			Channel obscured by vegetation				
		1:02:34									
		1:02:35									
			1:02:53	Structure-Sec.32	6,000						
				(under construction)							
			1:03:21	Bridge-Grvl.Rd.Sec.5	11,200						
			1:04:33	Beat 3 Lake	26,000						
		1:05:02	-------	End House Cr.							
				End Tape #4							

(Sheet 6 of 6)

Table 15
Log of Aerial Videotape 5

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
5-1	Black Creek	0:00:00									
			0:01:22	Black Cr.-Sec.30-R.R.Bridge T1N-R1W (Parker Bayou)		Sand bed meandering low obscured bed morphology	Some protection difficult to tell details of morphology & stability	Woody wide buffer	Woodland	Can't Tell	-
			0:01:31	Bridge-Hwy 40E.-Sec.29 (Mouth Tipton Bayou)							
		0:02:20									
		0:02:21									
			0:02:26	Back on Black Cr.							
			0:03:44	Boer Lake entrance-Right-Sec.23W			Can't Tell - Too High				
			0:04:33	Beginning new dredbed channel							
			0:05:05	Bridge-Tolarville Rd.Sec.12							
		0:06:43									
		0:06:44									
		0:07:57									
		0:07:58									
			0:08:03	Back on Black Cr.		Sand bed meanders note - tight bends pt. bars	Can't tell if banks protected. Vertical (unstable?) banks on outer bends	Woody on narrow buffer	Cultivated	Can't Tell	-
		0:08:43									
		0:08:44									
			0:08:50	Back on Black Cr.							
			0:09:04	Bridge-Pvd.Rd.Sec.27 (1000 ft. South of Howard)	17,200						
			0:09:41	Harland Cr.-Left	24,300						
		0:09:51									
		0:09:52									
			0:09:54	Back on Black Cr.							
		0:10:24									
		0:10:25									
			0:10:32	Back on Black Cr.							
		0:11:45									
		0:11:46									
		0:12:11									
		0:12:12									
			0:12:15	Back Black Cr.		Sand bed sinuous course lateral & media bar deposits	Vertical unprotected banks on bendways	Woody veg in wide buffer	_____ woodland pasture & cultivated	Can't Tell	-
		0:12:59									
		0:13:00									
			0:13:01	Back on Black Cr.							
		0:14:22									
		0:14:23									
			0:14:45	Back on Black Cr. Sec.28-T15N-R2E							
			0:15:20	Owens Branch-Sec.34-Right	74,100	Sand bed bar deposits meander	Erosion in outer bank (protection? failed)	Woody - wide buffer	Woodland	Structures failed	Unstable bends
		0:15:52									
		0:15:53									
			0:16:02	Back on Black Cr.							

Table 15 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
5-1	Black Creek (Continued)	0:16:17 0:16:18									
			0:16:19	Back on Black Cr.							
			0:16:45	Bridge-Hwy 7-Lexington	85,500						
		0:16:57 0:16:58 0:17:07 0:17:08					Too high to see				
			0:17:15	Back on Black Cr.							
			0:17:50	Terrey Cr.-Left	95,000						
		0:18:01 0:18:02									
			0:18:08	Back on Black Cr.							
			0:18:15	Terrey Cr.-Left	95,000		Too high to see				
			0:18:20	Bridge-Hwy 12	95,900						
		0:18:33 0:18:34									
			0:18:48	Back on Black Cr.							
			0:19:34	Bridge-Grvl.Rd.Sec.21	115,600	Sand bed mean-dering pt. bar deposits	Can't tell details	Woody - narrow buffer on outer bank	Cultivated & urban	Can't Tell	Unstable bends
		0:19:57 0:18:58									
			0:20:00	Back on Black Cr.							
			0:20:12	Bridge-Grvl.Rd.Sec.21	115,600	Sand-bed mean-dering pt. bar deposits	Some protection on bends. Verti-cal banks. Potential stable	Woody & grass veg in narrow buffer	Cultivated	Can't Tell	Unstable bends
		0:21:04 0:21:05									
			0:21:07	Back on Black Cr.							
		0:21:45 0:21:46									
			0:21:47	Bridge-Drt.Rd.	129,100						
			0:22:24	Bridge-Pvd.Rd.Sec.11	141,500		Too high to see				
			0:23:10	Structure							
			0:23:22	Bridge-Pvd.Rd.	159,200						
		0:23:31 0:23:32									
			0:23:50	Structure							
			0:24:04	Bridge-Pvd.Rd.	159,200		Channel obscured				
		0:24:05	-------	End Upper end of Black Cr.							
5-1	Harland Creek	0:24:06									
			0:24:28	Mouth Harland Cr. on Black Cr.	0 (24,200)		Too high for any useful detail				
			0:24:59	Bridge-Drt.Rd.	7,800						
		0:25:00 0:25:01									
			0:25:22	Bridge-Drt.Rd.	7,800	Sand bed mean-dering pt. bar deposits on inner bends	Vertical banks on outer bends un-stable here	Woody in narrow buffer	Some cultivation with woodland	Can't Tell	
		0:26:03 0:26:04									

Table 15 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item 0	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
5-1	Harland Creek (Continued)		0:26:17	Back on Harland Cr.		Sand bed tortuous meanders severe pt. bar deposits	Erosion on outer banks of bends	Mostly grass some trees	Pasture & wood	Can't Tell	Tortuous meander bends unstable-erosion of outer banks also very tight bends, note
			0:26:44	Williams Cr.-Right	18,000						
			0:27:20	Bridge-Grvl.Rd.Sec.11	25,400						
			0:28:20	Bridge-Grvl.Rd.Sec.14&15	38,800						
		0:28:34									
		0:28:35									
			0:29:10	Back on Harland Cr.							
			0:29:53	Bridge-Grvl.Rd.Sec.27 (Tolarville/Eulogy Rd.)	53,100		Channel appears similar in character to downstream reaches, detail obscured by vegetation				
			0:31:14	South Fk.Harland-Left	70,000						
		0:31:22									
		0:31:23									
			0:31:27	South Fk.Harland-Left	70,000						
			0:31:42	Bridge-on South Fk. Harland			As Above				
		0:31:43									
		0:31:44									
			0:31:56	Back on Harland Cr.							
		0:32:22									
		0:32:23									
			0:32:57	Bridge-Pvd.Rd.Sec.4 on South Fk. Harland		Sand bed pt. bars meander	Outer banks unstable	Woody in narrow buffer	Pasture	Can't Tell	Major widening in bend-ways. Channels unstable here
			0:34:24	Bridge-Grvl.Rd.Sec.11							
		0:34:33		End of South Fork Harland Cr.							
		0:34:34									
5-1	Downstream on Harland Creek		0:34:50	Going <u>Downstream</u> on South Fk. Harland @ Bridge-Grvl.Rd.Sec.11							
			0:36:15	Bridge-Pvd.Rd.Sec.4-on South Fk.Harland			See above notes on S. Fk. Harland				
			0:36:46	South Fk. Harland joining 70,000 Harland Cr.							
			0:37:34	Bridge-Grvl.Rd.Sec.27 (Tolarville/Eulogy Rd.)	53,100						
		0:37:38	-------	End Harland Cr.							
5-1	Moccasin Creek	0:37:39									
			0:37:51	Mouth Moccasin Cr. on Harland Cr.	0 (35,200)		Detail obscured by height & vegetation				
			0:38:17	Bridge-Grvl.Rd.Sec.13							
			0:39:34	Pipeline-Sec.19							
		0:39:40	-------	End Moccasin Cr.							
5-1	Williams Creek	0:39:41									
			0:39:59	Mouth Williams Cr. on Harland Cr.							
			0:41:13	Bridge-Pvd.Rd.Sec.7							
5-1	Butterworth Creek		0:41:31	Left Williams-got on Butterworth Cr.			As Above				
			0:41:40	Pipeline-Sec.17							
			0:42:45	Bridge-Pvd.Rd.Sec.21							
		0:42:47	-------	End Butterworth Cr.							

Table 15 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
5-1	Fannegusha Creek	0:42:48									
			0:43:07	Bridge-Pvd.Rd.Sec.12			No real detail of any worth				
			0:44:12	Beginning of channel-Sec.32							
		0:45:04									
		0:45:05									
			0:45:19	Back on Fannegusha Cr.							
			0:45:55	Old R.R. Grade			As Above				
			0:46:08	Bridge-Pvd.Rd.Sec.28							
		0:46:31									
		0:46:32									
			0:46:47	Back on Fannegusha Cr.							
		0:47:54									
		0:47:55					As Above				
			0:48:00	Back on Fannegusha Cr.							
			0:48:17	Bridge-Hwy 12-Sec.14							
		0:49:12									
		0:49:13									
			0:49:26	Back on Fannegusha Cr.							
			0:50:36	Bridge-Drt.Rd.Sec.6							
		0:51:14					As Above				
		0:51:15									
			0:51:22	Back on Fannegusha Cr.							
			0:51:58	Ford-Sec.32							
		0:52:15									
		0:52:16									
			0:52:24	White Cr.-Sec.33-Right		Sand bed meandering	Can't tell details - some erosion in bendways	Woody moderate buffer	Cultivated	Can't Tell	Can't tell much detail
			0:53:29	Bophumpa Cr.-Left							
		0:53:37									
		0:53:38									
			0:54:44	Bridge-Hwy 17-Sec.25			Too high - No detail				
		0:55:13									
		0:55:14									
			0:55:21	Bridge-Hwy 17-Sec.25							
			0:56:19	Little Fannegusha-Left							
		0:56:54									
		0:56:55									
			0:57:15	Bridge-Grvl.Rd.Sec.8							
			0:59:22	Bridge-Grvl.Rd.Sec.1							
			1:00:01	Bridge-Grvl.Rd.Sec.31,36,1&6			Not much to see from this height				
			1:00:23	Little Cr.-Sec.31-Left							
		1:00:43									
		1:00:44									
			1:00:53	Little Cr.-Sec.31-Left							
		1:01:52	-------	End Fannegusha Cr.							
5-1	Bophumpa Creek	1:01:53									
			1:03:00	Mouth Bophumpa Cr. on Fannegusha Cr.							

(Sheet 4 of 6)

Table 15 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item #	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
5-1	Bophumpa Creek	1:03:39					Can't tell detail				
	(Continued)	1:03:40									
			1:04:09	Bridge-Hwy 17-Sec.36							
			1:04:47	Bridge-Grvl.Rd.Sec.31							
		1:05:49	-------	End Bophumpa Cr.							
5-1	Millstone Bayou	1:05:50									
			1:06:12	Mouth Millstone Bayou-Sec.29&30 on Tchula Lake							
			1:06:22	Bridge-R.R.&Hwy 49-Sec.29							
		1:06:38					Not much detail				
		1:06:39									
			1:06:40	Bridge-R.R.&Hwy 49-Sec.29							
		1:07:28									
		1:07:29									
			1:07:37	Back on Millstone Bayou							
		1:08:24									
		1:08:25									
			1:08:46	Spring Branch-Sec.15-Left							
			1:09:17	Bridge-Grvl.Rd.Sec.10			Not much detail available				
			1:09:38	End Millstone Bayou							
		1:10:22	-------	End Millstone Bayou							
4-1	Spring Branch	1:10:23									
			1:10:27	Mouth Spring Branch-Sec.15 on Millstone Bayou							
			1:12:16	Bridge-Grvl.Rd.Sec.7			As Above				
		1:12:24									
5-1	Chicopa Creek	1:12:25									
			1:12:35	Bridge-Grvl.Rd.Sec.7							
			-------	End Spring Branch							
				Beginning of Chicopa Cr.			Channel obscured				
			1:13:20	Chicopa Res.-Sec.8							
		1:13:21	------	End Chicopa Creek							
5-1	Abiaca Creek	1:13:22									
			1:13:40	Bridge-R.R.							
			1:13:44	Bridge-Hwy 49-Sec.18			Not much detail				
			1:16:08	Bridge-Grvl.Rd.Sec.13							
		1:17:30									
		1:17:31									
			1:17:44	Back on Abiaca Cr.			As Above				
5-1	Coila Creek		1:18:34	Left Abiaca-got on Coila							
			-------	End Abiaca Creek							
			1:18:40	Bridge-Pvd.Rd.Sec.4							
		1:19:16									
		1:19:17									
			1:19:25	Back on Coila Cr.							
			1:20:34	Bridge-Pvd.Rd.Sec.36 (Matthews Com.)							

Table 15 (Continued)

Date	Stream Name	Elapsed Tape Start/Stop	Time Item @	Description/Location	ARS Range (Feet)	Bed	Bank	Vegetation	Flood Plain Land Use	Condition of Structural Elements	Notes/Comments
5-1	Coila Creek (Continued)		1:20:49	Bridge-Grvl.Rd.			As Above				
		1:20:53									
		1:20:54									
			1:21:00	Bridge-Pvd.Rd.Sec.36							
			1:21:17	Flood Control Res.-Sec.31							
		1:22:58									
		1:22:59									
		1:23:38	______	End Coila Creek							
5-1	Pelucia Creek	1:23:40									
			1:23:53	Mouth Pelucia Cr. on Yazoo River							
			1:24:00	Bridge-R.R.-Sec.32							
			1:24:16	Bridge-Hwy 49-Sec.32							
			1:25:14	Bridge-Pvd.Rd.Sec.34 (under construction)		Sand/silt bed straight but in channel bar deposits	Banks appear to be stable	Grass/shrubs	Urban	-	Sand sources from construction works => Potential problem
			1:26:48	Bridge-Pvd.Rd.Sec.31							
			1:29:53	Bridge-Pvd.Rd.Sec.23 (Airport Rd.)							
		1:30:50									
		1:30:51									
			1:30:58	Back on Pelucia Cr.							
		1:31:23									
		1:31:24									
			1:31:50	Back on Pelucia							
			1:32:08	Bridge-Grvl.Rd.Sec.30 (Ferguson gravel pit)			Channel too small to get detail				
		1:32:46									
		1:32:47									
		1:33:42									
		1:33:43									
		1:34:06									
		1:34:07									
			1:34:29	Bridge-Drt.Rd.Sec.29832							
		1:34:47									
		1:34:48					Channel obscured by veg.				
			1:36:08	Bridge-Hwy 17-Sec.35							
		1:36:53	-------	End Pelucia Cr.							
5-1	Ashley Creek	1:36:54									
			1:37:31	Gee Lake Dam							
			1:38:02	Bridge-Grvl.Rd.Sec.31							
			1:38:39	Bridge-Grvl.Rd.Sec.32							
		1:38:43					Channel obscured by veg.				
		1:38:44									
			1:39:07	Hwy 35							
			1:39:36	Hwy 82-Sec.22(?)							
		1:39:36	-------	End Ashley Cr. End Tape #5							

(Sheet 6 of 6)

Table 16
Reach Parameters for Hickahala-Senatobia Creek Watershed

Channel	Reach	Discharge cfs	Velocity fps	Depth, ft	Width, ft	Slope
Hickahala Creek and Tributaries, 1985						
Hickahala	1[1]	4,800	4.02	7.88	123	0.000420
	2[2]	6,957	5.52	9.80	129	0.001050
	3	7,690	5.08	9.33	139	0.000690
	4	4,712	6.03	7.82	100	0.001150
	5	2,155	5.00	6.17	70	0.001600
	6	838	4.90	4.76	36	0.004260
Thornton	1	1,148	5.38	4.64	45	0.003431
	2	410	3.89	3.71	28	0.003606
Basket	1	1,500	4.43	6.08	56	0.001280
	2	1,045	4.22	5.28	47	0.001587
	3	420	3.78	3.57	31	0.002393
Beards	1	1,879	4.71	7.12	56	0.001170
	2	1,070	6.16	5.57	31	0.002780
Cathey	1	935	4.51	4.75	44	0.002330
	2	630	4.27	4.01	37	0.002630
South Fork	1	1,035	5.04	5.49	37	0.002970
	2	820	5.06	5.71	28	0.002840
Hickahala Creek and Tributaries, 1991						
Hickahala	1[1]	4,800	4.62	8.96	116	0.000470
	2[2]	6,957	5.44	9.92	129	0.001010
	3	8,219	5.38	10.73	141	0.000680
	4	4,427	6.19	7.58	94	0.001210
	5	2,155	5.02	5.98	72	0.001680
	6	942	4.34	5.23	41	0.002940
Thornton	1	1,148	4.31	5.80	44	0.001633
	2	410	3.70	3.98	28	0.002978
Basket	1	1,500	3.89	6.45	60	0.001157
	2	1,045	4.13	5.63	45	0.001562
	3	420	2.82	3.82	39	0.001224

(Sheet 1 of 3)

[1] 40 percent 2-year discharge.
[2] 55 percent 2-year discharge.

Table 16 (Continued)

Channel	Reach	Discharge cfs	Velocity fps	Depth, ft	Width, ft	Slope
Hickahala Creek and Tributaries, 1991 (Continued)						
Beards	1	1,879	4.52	6.85	61	0.001140
	2	1,070	5.47	5.90	33	0.002040
Cathey	1	935	4.67	5.39	37	0.002110
	2	630	4.57	4.36	32	0.002700
South Fork	1	1,035	4.77	5.58	39	0.002600
	2	820	5.22	5.03	31	0.003570
James Wolf and Tributaries, 1985						
James Wolf	1	4,776	5.40	7.67	115	0.000786
	2	4,100	6.37	6.89	93	0.001262
	3	1,628	4.32	5.47	69	0.001780
Martin Dale	1	1,180	5.45	4.72	46	0.003440
James Wolf and Tributaries, 1991						
James Wolf	1	4,880	5.23	8.49	109	0.000645
	2	4,100	6.21	7.13	93	0.001148
	3	1,629	4.28	5.59	68	0.001695
Martin Dale	1	1,180	5.42	4.79	46	0.003330
Senatobia Creek and Tributaries, 1985						
Senatobia	1[3]	1,720	3.30	5.47	95	0.000460
	2[4]	5,990	5.72	8.46	122	0.000770
	3	4,435	5.35	7.10	116	0.001470
Mattic	1	9,440	8.76	10.79	95	0.001780
	2	4,380	5.62	11.06	67	0.001050
Tolbert Jones	1	1,800	5.12	7.15	49	0.001750
	2	780	3.03	6.59	39	0.000680
Senatobia Creek and Tributaries, 1991						
Senatobia	1[3]	1,720	3.35	5.37	96	0.000490
	2[4]	5,990	5.57	8.71	119	0.000700
	3	4,282	5.26	7.15	113	0.001410
Mattic	1	9,440	9.22	10.66	95	0.002010
	2	4,380	5.30	10.67	72	0.000980

(Sheet 2 of 3)

[3] 10 percent 2-year discharge.
[4] 35 percent 2-year discharge.

Table 16 (Concluded)						
Channel	Reach	Discharge cfs	Velocity fps	Depth, ft	Width, ft	Slope
Senatobia Creek and Tributaries, 1991 (Continued)						
Tolbert Jones	1	1,800	3.81	7.28	61	0.000940
	2	780	4.29	4.69	39	0.002150
						(Sheet 3 of 3)

Table 17
Change in Reach Values for Hickahala-Senatobia Creek Watershed from 1985 to 1991

Channel	Reach	Velocity, cfs	Depth, ft	Width, ft	Slope
Hickahala Creek and Tributaries					
Hickahala	1	0.60	1.08	-7	0.000050
	2	-0.08	0.12	0	-0.000040
	3	0.30	1.40	2	-0.000010
	4	0.16	-0.24	-6	0.000060
	5	0.02	-0.19	2	0.000080
	6	-0.56	0.47	5	-0.001320
Thornton	1	-1.07	1.16	-1	-0.001798
	2	-0.19	0.27	0	-0.000628
Basket	1	-0.54	0.37	4	-0.000123
	2	-0.09	0.35	-2	-0.000025
	3	-0.96	0.25	8	-0.001169
Beards	1	-0.19	-0.27	5	-0.000030
	2	-0.69	0.33	2	-0.000740
Cathey	1	0.16	0.64	-7	-0.000220
	2	0.30	0.35	-5	0.000070
South Fork	1	-0.27	0.09	2	-0.000370
	2	0.16	-0.68	3	0.000730
James Wolf and Tributaries					
James Wolf	1	-0.17	0.82	-6	-0.000141
	2	-0.16	0.24	0	-0.000114
	3	-0.04	0.12	-1	-0.000085
Martin Dale	1	-0.03	0.07	0	-0.000110
Senatobia Creek and Tributaries					
Senatobia	1	0.05	-0.10	1	0.000030
	2	-0.15	0.25	-3	-0.000070
	3	-0.09	0.05	-3	-0.000060
Mattic	1	0.46	-0.13	0	0.000230
	2	-0.32	-0.39	5	-0.000070
Tolbert Jones	1	-1.31	0.13	12	-0.000810
	2	1.26	-1.90	0	0.001470

Note: Changes were calculated by subtracting the 1985 data from the 1991 data.

Table 18
Percentage Change in Reach Parameters for Hickahala-Senatobia Creek Watershed

Channel	Reach	Discharge, cfs	Velocity, fps	Depth, ft	Width, ft	Slope
Hickahala Creek and Tributaries						
Hickahala	1	4,800	+	+	-	+
	2	6,957	~	~	~	~
	3	8,218	+	+	~	~
	4	4,427	~	~	-	+
	5	2,155	~	~	~	+
	6	942	-	+	+	---
Thornton	1	1,148	-	++	~	----
	2	410	~	+	~	-
Basket	1	1,500	-	+	+	-
	2	1,045	~	+	~	~
	3	420	--	+	++	---
Beards	1	1,879	~	~	+	~
	2	1,070	-	+	+	~
Cathey	1	935	~	+	-	-
	2	630	+	+	-	~
South Fork	1	1,035	-	~	+	-
	2	820	~	-	+	++
James Wolf and Tributaries						
James Wolf	1	4,880	~	+	-	-
	2	4,100	~	~	~	-
	3	1,629	~	~	~	~
Martin Dale	1	1,180	~	~	~	~
Senatobia Creek and Tributaries						
Senatobia	1	1,720	~	~	~	+
	2	5,990	~	~	~	-

(Continued)

Note:

~	Between -5 and +5% change
+	Between +5 and +20% change
-	Between -5 and -20% change
++	Between +20 and +35% change
--	Between -20 and -35% change
+++	Between +35 and +50% change
---	Between -35 and -50% change
++++	Greater than 50% change
----	Greater than -50% change

Table 18 (Concluded)

Channel	Reach	Discharge, cfs	Velocity, fps	Depth, ft	Width, ft	Slope
Senatobia Creek and Tributaries (Continued)						
Senatobia (Continued)	3	4,282	~	~	~	~
Mattic	1	9,440	+	~	~	+
	2	4,380	-	~	+	-
Tolbert Jones	1	1,800	--	~	++	—
	2	780	+++	--	~	++++

Table 19
Reach Parameters for Long Creek Watershed

Channel	Reach	Discharge cfs	Velocity fps	Depth, ft	Width, ft	Slope
Peters Creek and Tributaries, 1985						
Peters	1	17,000	4.85	10.11	347	0.000600
	2	17,200	5.66	10.56	288	0.000770
	3	15,000	6.12	10.73	229	0.000880
	4	14,600	7.10	11.89	173	0.001030
Bobo	1	2,000	4.15	6.44	75	0.001040
	2	1,800	5.11	5.06	69	0.002180
Peters Creek and Tributaries, 1991						
Peters	1	17,000	4.87	10.05	347	0.000610
	2	17,200	5.85	10.01	294	0.000680
	3	15,000	6.17	10.62	229	0.000900
	4	14,600	7.39	12.67	156	0.001030
Bobo	1	2,000	4.57	6.29	70	0.001300
	2	1,800	3.44	4.78	109	0.001070
Long Creek and Tributaries, 1985						
Long	1	5,767	5.07	5.89	193	0.001340
	2	4,700	5.46	6.72	128	0.001300
	3	2,200	5.67	5.33	73	0.001910
	4	1,900	5.43	5.28	66	0.001780
	5	1,700	6.06	4.95	57	0.002420
Caney	1	2,500	3.79	4.74	139	0.001000
	2	2,000	6.44	5.96	52	0.002130
	3	1,700	6.31	5.79	35	0.002130
	4	1,300	3.71	5.96	56	0.000710
Long Creek and Tributaries, 1991						
Long	1	5,767	5.00	6.47	178	0.001150
	2	4,700	5.29	7.25	123	0.001110
	3	2,200	5.49	5.38	74	0.001770
	4	1,900	6.23	5.36	57	0.002290
	5	1,700	6.44	5.25	50	0.002530
Caney	1	2,500	4.19	6.58	91	0.000790

(Continued)

Table 19 (Concluded)						
Channel	Reach	Discharge cfs	Velocity fps	Depth, ft	Width, ft	Slope
Long Creek and Tributaries, 1991 (Continued)						
Caney (Continued)	2	2,000	6.15	5.65	58	0.002090
	3	1,700	6.50	5.86	38	0.002220
	4	1,300	5.56	4.30	54	0.002450
Johnson Creek and Tributaries, 1985						
Johnson	1	5,400	5.51	8.17	120	0.001020
	2	3,000	5.47	5.13	107	0.001880
	3	2,900	5.46	6.00	89	0.001520
	4	2,600	6.08	5.58	77	0.002070
	5	1,800	5.62	5.66	57	0.001740
Hurt	1	2,900	6.34	6.35	72	0.002470
	2	2,600	6.38	6.82	60	0.002280
Johnson Creek and Tributaries, 1991						
Johnson	1	5,400	4.94	9.19	119	0.000700
	2	3,000	4.81	5.16	121	0.001440
	3	2,900	5.78	5.79	87	0.001780
	4	2,600	6.86	5.58	68	0.002640
	5	1,800	5.63	6.70	48	0.001390
Hurt	1	2,900	6.22	5.75	81	0.002730
	2	2,600	6.00	6.34	68	0.002220

Table 20
Changes in Reach Parameters for Long Creek Watershed from 1985 to 1991

Channel	Reach	Velocity, fps	Depth, ft	Width, ft	Slope
Peters Creek and Tributaries					
Peters	1	0.02	-0.06	0	0.000010
	2	0.19	-0.55	6	0.000110
	3	0.05	-0.11	0	0.000020
	4	0.29	0.78	-17	0.000000
Bobo	1	0.42	-0.15	-5	0.000260
	2	-1.67	-0.28	40	-0.001110
Long Creek and Tributaries					
Long	1	-0.07	0.58	-15	-0.000190
	2	-0.17	0.53	-5	-0.000190
	3	-0.18	0.05	1	-0.000140
	4	0.80	0.08	-9	0.000510
	5	0.38	0.30	-7	0.000110
Caney	1	0.40	1.84	-48	-0.000210
	2	-0.29	-0.31	6	-0.000040
	3	0.19	0.07	3	0.000090
	4	1.85	-1.66	-2	0.001740
Johnson Creek and Tributaries					
Johnson	1	-0.57	1.02	-1	-0.000320
	2	-0.66	0.03	14	-0.000440
	3	0.32	-0.21	-2	0.000260
	4	0.78	0.00	-9	0.000570
	5	0.01	1.04	-9	-0.000350
Hurt	1	-0.12	-0.60	9	0.000260
	2	-0.38	-0.48	8	-0.000060

Note: Changes were calculated by subtracting the 1985 from the 1991 data.

Table 21
Percentage Change in Reach Parameters for Long Creek Watershed

Channel	Reach	Discharge, cfs	Velocity, fps	Depth, ft	Width, ft	Slope
Peters Creek and Tributaries						
Peters	1	17,000	~	~	~	~
	2	17,200	~	-	~	+
	3	15,000	~	~	~	~
	4	14,600	~	+	-	~
Bobo	1	2,000	+	~	-	++
	2	1,800	--	-	++++	----
Long Creek and Tributaries						
Long	1	5,767	~	+	-	-
	2	4,700	~	+	~	-
	3	2,200	~	~	~	-
	4	1,900	+	~	-	++
	5	1,700	+	+	-	~
Caney	1	2,500	+	+++	--	--
	2	2,000	~	-	+	~
	3	1,700	~	~	+	~
	4	1,300	+++	--	~	++++
Johnson Creek and Tributaries						
Johnson	1	5,400	-	+	~	--
	2	3,000	-	~	+	--
	3	2,900	+	~	~	+
	4	2,600	+	~	-	++
	5	1,800	~	+	-	--
Hurt	1	2,900	~	-	+	+
	2	2,600	-	-	+	~

Note:
- ~ Between -5 and +5% change
- + Between +5 and +20% change
- - Between -5 and -20% change
- ++ Between +20 and +35% change
- -- Between -20 and -35% change
- +++ Between +35 and +50 change
- --- Between -35 and -50% change
- ++++ Greater than 50% change
- ---- Greater than -50% change

Table 22
Reach Parameters for Batupan Bogue Watershed

Channel	Reach	Discharge cfs	Velocity fps	Depth ft	Width ft	Slope	Percent of 2-Year Discharge[1]
Batupan Bogue and Tributaries, 1985							
Batupan Bogue	1	14,196	5.52	11.75	216	0.000811	70
	2	13,860	4.81	13.01	221	0.000547	70
	3	13,860	4.40	12.49	252	0.000485	70
	4	12,989	5.23	13.07	190	0.000643	70
	5	12,989	4.61	12.72	222	0.000518	70
Perry	1	3,400	3.05	9.81	114	0.000290	
	2	3,400	5.00	7.39	92	0.001140	
	3	3,400	5.35	6.59	96	0.001520	
	4	3,400	4.75	5.64	127	0.001470	>
	5	3,400	7.66	6.23	71	0.003340	>
	6	3,400	6.48	6.29	83	0.002360	>
Jack	1	2,000	3.99	7.31	67	0.000730	
	2	2,000	6.40	6.64	47	0.002140	>
Batupan Bogue and Tributaries, 1991							
Batupan Bogue	1	14,140	4.96	11.26	253	0.000637	70
	2	13,860	5.00	12.12	229	0.000588	70
	3	13,686	4.81	12.94	219	0.000498	70
	4	12,989	4.93	12.90	204	0.000526	70
	5	12,989	4.91	12.19	217	0.000562	70
Perry	1	3,400	1.99	9.95	164	0.000120	
	2	3,400	4.59	7.42	100	0.000950	
	3	3,400	5.17	6.78	97	0.001360	
	4	3,400	5.44	7.44	84	0.001330	>
	5	3,400	5.16	5.67	116	0.001730	>
	6						No Data
Jack	1	2,000	3.56	7.99	68	0.000520	
	2	2,000	6.02	6.53	51	0.001940	>

(Sheet 1 of 4)

[1] > = greater than 2-year discharge.

Table 22 (Continued)							
Channel	Reach	Discharge cfs	Velocity fps	Depth ft	Width ft	Slope	Percent of 2-Year Discharge
Little Bogue and Tributaries, 1985							
Little Bogue	1	7,600	6.84	10.15	109	0.001392	80
	2	7,600	6.03	9.25	133	0.001224	80
	3	7,600	4.96	9.46	145	0.000804	80
	4	6,940	4.56	9.16	156	0.000711	80
	5	6,720	5.95	10.31	110	0.001031	80
	6	6,720	5.84	11.25	102	0.000885	80
	7	3,520	3.17	11.41	97	0.000255	80
	8	3,520	4.83	8.32	86	0.000907	80
	9	3,520	5.01	10.71	43	0.000695	80
	10	3,520	5.74	8.88	42	0.001172	80
Crowder	1	1,900	4.90	6.50	60	0.001290	
	2	1,900	6.74	5.52	51	0.003050	>
	3	1,900	6.28	5.39	33	0.002730	>
Powell	1	1,675	5.23	6.77	47	0.001400	
Mouse	1	2,100	3.78	8.86	63	0.000510	
	2	2,100	6.32	6.71	49	0.002060	>
	3	2,100	5.53	5.84	65	0.001900	>
Little Bogue and Tributaries, 1991							
Little Bogue	1	7,600	6.12	8.50	146	0.001410	80
	2	7,600	6.48	11.47	102	0.001060	80
	3	7,600	6.01	10.76	117	0.000990	80
	4	6,720	5.33	11.05	114	0.000750	80
	5	6,720	6.21	11.32	96	0.000990	80
	6	6,720	4.81	12.70	110	0.000510	80
	7	3,520	4.15	9.71	87	0.000540	80
	8	3,520	5.68	7.49	83	0.001440	80
	9	3,520	4.32	11.57	48	0.000470	80
	10						No Data
Crowder	1	1,900	4.59	5.84	71	0.001308	
	2	1,900	5.97	5.64	56	0.002321	>
	3	1,900	6.53	5.31	47	0.003010	>

(Sheet 2 of 4)

Table 22 (Continued)

Channel	Reach	Discharge cfs	Velocity fps	Depth ft	Width ft	Slope	Percent of 2-Year Discharge
Little Bogue and Tributaries, 1991 (Continued)							
Powell	1	1,675	4.82	6.59	53	0.001230	
Mouse	1	2,100	3.40	8.52	73	0.000433	
	2	2,100	6.31	7.21	46	0.001870	>
	3	2,100	5.53	5.76	66	0.001940	>
Big Bogue and Tributaries, 1985							
Big Bogue	1	6,640	6.14	9.27	117	0.001266	80
	2	6,640	4.74	8.79	156	0.000809	80
	3	6,640	4.60	8.94	160	0.000748	80
Sykes	1	3,100	4.72	7.32	90	0.001030	
	2	3,100	6.04	7.02	73	0.001770	>
Jackson	1	1,000	2.36	6.49	65	0.000300	
	2	1,000	5.01	4.07	45	0.002530	>
Eskridge	1	3,400	5.15	8.28	80	0.001030	
	2	3,400	6.31	7.66	70	0.001720	>
	3	3,400	8.10	7.47	56	0.002940	>
Worsham	1						No Data
	2	3,400	5.63	7.97	76	0.001300	
	3	3,400	7.44	7.68	60	0.002390	>
	4	3,400	9.54	7.31	37	0.004200	>
East Fork	1	1,300	6.17	4.61	46	0.003240	
Big Bogue and Tributaries, 1991							
Big Bogue	1	6,640	6.19	8.74	123	0.001390	80
	2	6,640	4.96	9.85	136	0.000760	80
	3	6,640	5.01	10.25	127	0.000740	80
Sykes	1	3,100	3.71	5.93	141	0.000837	
	2	3,100	5.30	6.46	90	0.001525	>
Jackson	1	1,000	1.86	7.17	75	0.001133	
	2	1,000	2.46	5.66	54	0.002710	>
Eskridge	1	3,400	5.79	8.39	70	0.001280	
	2	3,400	5.78	8.37	70	0.001290	>
	3	3,400	8.52	7.47	53	0.003250	>

(Sheet 3 of 4)

Table 22 (Concluded)

Channel	Reach	Discharge cfs	Velocity fps	Depth ft	Width ft	Slope	Percent of 2-Year Discharge
Big Bogue and Tributaries, 1991 (Continued)							
Worsham	1	3,400	4.28	8.43	93	0.000700	
	2	3,400	6.03	8.29	68	0.001420	
	3	3,400	7.45	7.55	60	0.002450	>
	4	3,400	8.28	8.20	40	0.002710	>
East Fork	1	1,300	5.48	5.71	42	0.001920	

(Sheet 4 of 4)

Table 23
Changes in Reach Parameters for Batupan Bogue Watershed

Channel	Reach	Velocity, fps	Depth, ft	Width, ft	Slope
Batupan Bogue and Tributaries					
Batupan Bogue	1	-0.56	-0.49	37	-0.000174
	2	0.19	-0.89	8	0.000041
	3	0.41	0.45	-33	0.000013
	4	-0.30	-0.17	14	-0.000117
	5	0.30	-0.53	-5	0.000044
Perry	1	-1.06	0.14	50	-0.000170
	2	-0.41	0.03	8	-0.000190
	3	-0.18	0.19	1	-0.000160
	4	0.69	1.80	-43	-0.000140
	5	-2.50	-0.56	45	-0.001610
	6	No Data			
Jack	1	-0.43	0.68	1	-0.000210
	2	-0.38	-0.11	4	-0.000200
Little Bogue and Tributaries					
Little Bogue	1	-0.72	-1.65	37	0.000018
	2	0.45	2.22	-31	-0.000164
	3	1.05	1.30	-28	0.000186
	4	0.77	1.89	-42	0.000039
	5	0.26	1.01	-14	-0.000041
	6	-1.03	1.45	8	-0.000375
	7	0.98	-1.70	-10	0.000285
	8	0.85	-0.83	-3	0.000533
	9	-0.69	0.86	5	-0.000225
	10	-5.74	-8.88	-42	-0.001172
Crowder	1	-0.31	-0.66	11	0.000018
	2	-0.77	0.12	5	-0.000729
	3	0.25	-0.08	14	0.000280
Powell	1	-0.41	-0.18	6	-0.000170
Mouse	1	-0.38	-0.34	10	-0.000077

(Continued)

Note: Changes were calculated by subtracting 1985 data from 1991 data.

Table 23 (Concluded)

Channel	Reach	Velocity, fps	Depth, ft	Width, ft	Slope
Little Bogue and Tributaries (Continued)					
Mouse (Continued)	2	-0.01	0.50	-3	-0.000190
	3	0.00	-0.08	1	0.000040
Big Bogue and Tributaries					
Big Bogue	1	0.05	-0.53	6	0.000124
	2	0.22	1.06	-20	-0.000049
	3	0.41	1.31	-33	-0.000008
Sykes	1	-1.01	-1.39	51	-0.000193
	2	-0.74	-0.56	17	-0.000245
Jackson	1	-0.50	0.68	10	0.000833
	2	-2.55	1.59	9	0.000180
Eskridge	1	0.64	0.11	-10	0.000250
	2	-0.53	0.71	0	-0.000430
	3	0.42	0.00	-3	0.000310
Worsham	1				No Data
	2	0.40	0.32	-8	0.000120
	3	0.01	-0.13	0	0.000060
	4	-1.26	0.89	3	-0.001490
East Fork	1	-0.69	1.10	-4	-0.001320

Table 24
Percentage Changes in Reach Parameters for Batupan Bogue Watershed

Channel	Reach	Discharge, cfs	Velocity, fps	Depth, ft	Width, ft	Slope
Batupan Bogue and Tributaries						
Batupan Bogue	1	14,140	-	~	+	--
	2	13,860	~	-	~	+
	3	13,686	+	~	-	~
	4	12,989	-	~	+	-
	5	12,989	+	~	~	+
Perry	1	3,400	--	~	+++	----
	2	3,400	-	~	+	-
	3	3,400	~	~	~	-
	4	3,400	+	++	~	-
	5	3,400	--	-	++++	---
	6					No Data
Jack	1	2,000	-	+	~	--
	2	2,000	-	~	+	-
Little Bogue and Tributaries						
Little Bogue	1	7,600	-	-	++	~
	2	7,600	+	++	--	-
	3	7,600	++	+	-	++
	4	6,720	+	++	--	+
	5	6,720	~	+	-	~
	6	6,720	-	+	+	---
	7	3,520	++	-	-	++++
	8	3,520	+	-	~	++++
	9	3,520	-	+	+	--
	10					No Data

(Continued)

Note:
~ Between -5 and +5% change
+ Between +5 and +20% change
- Between -5 and -20% change
++ Between +20 and +35% change
-- Between -20 and -35% change
+++ Between +35 and +50% change
--- Between -35 and -50% change
++++ Greater than 5-% change
---- Greater than -50% change

Table 24 (Concluded)						
Channel	**Reach**	**Discharge, cfs**	**Velocity, fps**	**Depth, ft**	**Width, ft**	**Slope**
		Little Bogue and Tributaries (Continued)				
Crowder	1	1,900	-	-	+	~
	2	1,900	-	~	+	--
	3	1,900	~	~	+++	+
Powell	1	1,675	-	~	+	-
Mouse	1	2,100	-	~	+	-
	2	2,100	~	+	-	-
	3	2,100	~	~	~	~
		Big Bogue and Tributaries				
Big Bogue	1	6,640	~	-	+	+
	2	6,640	~	+	-	-
	3	6,640	+	+	--	~
Sykes	1	3,100	--	-	++++	-
	2	3,100	-	-	++	-
Jackson	1	1,000	--	+	+	++++
	2	1,000	----	+++	++	+
Eskridge	1	3,400	+	~	-	++
	2	3,400	-	+	~	--
	3	3,400	+	~	-	+
Worsham	1					No Data
	2	3,400	+	~	-	+
	3	3,400	~	~	~	~
	4	3,400	-	+	+	---
East Fork	1	1,300	-	++	-	---

Table 25
DEC Gage Instrumentation Completed for FY 92

Site	Installation Date	Crest Gauge	Recording Gauge	Location	Basin
2	22 Jan 92	—	2	Fannegusha	Black
3	23 Jan 92	2	1 (04/17/92)	Abiaca	Abiaca
4	23 Jan 92	2	—	Abiaca	Abiaca
5	02 Feb 92	2	1	Coila	Abiaca
7	16 Dec 91	2	2	Nolehoe	Coldwater
8	16 Dec 92	4	1 (05/22/92)	Lick	Coldwater
9	16 Dec 92	4	1 (02/12/92)	Red Banks	Coldwater
11	05 Feb 92	2	2	Hickahala	Hickahala
12	25 Feb 92	2	2	Burney	Burney
13	22 Oct 91	2	3	Hotophia	Hotophia
15	21 May 92	2	1	Sarter	Otoucalofa
16	14 Apr 92	—	2	Perry	Batupan
18	15 Jan 92[1]	4	6	Worsham	Batupan
19	04 Feb 92	2	2	James Wolf	Hickahala
20	01 Oct 91	3	3	Long	Long
	Total	33	29		
	Deployed and Operational	33	29		
	Lost or Destroyed	2	1		
	Replaced	2	1		

[1] Instruments at West Fork of Worsham Creek were installed prior to 20 Nov 92, others at the approximate date shown.

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13. ABSTRACT *(Maximum 200 words)*
The purpose of monitoring the Demonstration Erosion Control (DEC) Project is to evaluate and document watershed response to the implemented DEC Project. Documentation of watershed responses to DEC Project features will allow the participating agencies a unique opportunity to determine the effectiveness of existing design guidance for erosion and flood control in small watersheds. The monitoring program includes 11 technical areas: stream gaging, data collection and data management, hydraulic performance of structures, channel response, hydrology, upland watersheds, reservoir sedimentation, environmental aspects, bank stability, design tools, and technology transfer.

This report includes detailed discussion of the eight technical areas that were investigated by the U.S. Army Engineer Waterways Experiment Station during Fiscal Year 1992, i.e., all of these areas except upland watersheds, reservoir sedimentation, and environmental aspects.

In the area of data collection and data management, installation of continuous stage gauge instrumentation at 33 sites and crest gages at an additional 42 sites was completed and data collection initiated. The initial
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development of the engineering database on Intergraph workstations was completed and made available to the U.S. Army Engineer District, Vicksburg, for testing.

In the area of hydraulic performance of structures, a model study to determine the feasibility of a low-drop structure using a 10-ft drop was conducted. Selected high- and low-drop structures were instrumented with stage gauges. The stage data will be used in calculating discharge coefficients for rating curves.

In the area of channel response, the first detailed topographic survey of the 20 long-tem sites was completed. The initial broad-based geomorphic studies of 10 watersheds and detailed geomorphic studies of 3 watersheds were completed.

In the area of hydrology, development of HEC-1 hydrology models for 10 watersheds was initiated. The evaluation of the CASC2D hydrology model using the Goodwin Creek watershed was initiated.

In the area of bank stability, a model study to determine the applicability of the bendway weir concept for bank stabilization was conducted.

In the area of design tools, a riser pipe design system housed on the engineering database (Intergraph) was developed, tested, and made available for District use on the Coldwater River watershed.

In the area of technology transfer, a video report on the DEC Project was completed, and a second video report on channel degradation processes was initiated.