US Army Corps of Engineers®
Memphis District

GRAND PRAIRIE REGION AND BAYOU METO BASIN, ARKANSAS PROJECT

BAYOU METO BASIN, ARKANSAS

GENERAL REEVALUATION REPORT

VOLUME 10

APPENDIX D

ENVIRONMENTAL ANALYSES

NOVEMBER 2006

US Army Corps of Engineers®
Memphis District

GRAND PRAIRIE REGION AND BAYOU METO BASIN, ARKANSAS PROJECT

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BAYOU METO BASIN, ARKANSAS PROJECT
GENERAL REEVALUATION REPORT (GRR) INDEX

BAYOU METO BASIN, ARKANSAS, PROJECT

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SECTION I

PUBLIC INVOLVEMENT

Part A. Public Scoping

DEPARTMENT OF THE ARMY
MEMPHIS DISTRICT CORPS OF ENGINEERS
167 NORTH MAIN STREET B-202
MEMPHIS TN 38103-1894

Reply to
Attention of:

August 8, 2000

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Dear Meeting Participant:

In February, 2000, the Memphis District, U.S. Army Corps of Engineers, conducted public "scoping" meetings to discuss environmental issues relating to the Bayou Meto Basin, Arkansas, general reevaluation. Our records show you expressed interest in following the study's progress. With this mailing, we are providing a copy of the Post Scoping Document containing summary information gained from the scoping meetings.

Fiscal Year 2000 funds are being utilized to continue work on the general reevaluation. Major activities that are ongoing include agricultural water supply delivery system design, formulation and evaluation of alternatives for flood control, environmental analyses and assessments, formulation of environmental features, economic analyses, and public involvement and coordination activities. Fiscal year 2001 funds will be used to continue the general reevaluation effort. A draft EIS is scheduled for June 2002. Please contact Erwin Roemer (901-544-0704), Edward Lambert (901-544-0707), or myself (901-544-0745) if you have questions or need additional information.

Sincerely,

Ken Bright

Ken Bright
Project Manager

Enclosure

SCOPING MEETINGS

List of Attendees (not including Corps staff)

Bayou Meto Basin, Arkansas, General Reevaluation

England, AR, 15 February 2000:

Steve Frick, 1902 S. Main St., Stuttgart, AR
Kenneth Colbert, 101 E. Capitol Suite 350, Little Rock, AR 72201
Nancy Smith, P.O. Box 229, Stuttgart, AR 72160
Mike Smith, P.O. Box 229, Stuttgart, AR 72160
Buck Mayhue, 9079 South Grand, Stuttgart, AR 72160
Landis Brantley, Jr., 603 E. Howard, England, AR
Gary Canada, 105 Cherry, England, AR 72046
Jean C. Edwards, 8607 Earl Chadick Rd., Sherrill, AR 72152
Neil Compton, P.O. Box 149, Coy, AR 72037
Ken Orlich, P.O. Box 187, Keo, AR 72083
Henry Langston, P.O. Box 41, Scott, AR 72142

Lonoke, AR, 16 February 2000:

Deborah Ryckeley, 1500 Museum Street Suite 105, Conway, AR 72032
Bill Mathis, 212 West Cherry, Lonoke, AR 72086
Delilah Mathis, 212 West Cherry, Lonoke, AR 72086
Ellen McNulty, 7809 Cross Road, Pine Bluff, AR 71603
Phillip McNulty, 7809 Cross Road, Pine Bluff, AR 71603
Neal Anderson, No. 2 Cricket Lane, Lonoke, AR 72086
Don F.McKenzie
Field Representative, Wildlife Management Institute
2396 Cocklebur Road, Ward, AR 72176
Don Vaught, P.O. Box 879, Hazen, AR, 72064
Annetta Beauchamp, 804 Columbia Street, Helena, AR 72342
Richard Prewitt, P.O. Box 250417, Little Rock, AR 72225
Billi Fletcher, 403 Palm Street, Lonoke, AR 72086
Bob Bevis, 3002 Hwy. 15 South, Scott, AR 72142

DEPARTMENT OF ARMY
MEMPHIS DISTRICT, CORPS OF ENGINEERS
MEMPHIS, TENNESSEE

POST SCOPING DOCUMENT

Bayou Meto Basin, Arkansas, General Reevaluation Study

from meetings February 15 and 16, 2000
England and Lonoke, Arkansas

Introduction With Comment on Project Background

The U.S. Army Corps of Engineers (USACE) is studying the Bayou Meto Basin in Arkansas. This area includes portions of Lonoke, Jefferson, and Prairie counties. The majority of the project area is in the southern two-thirds of Lonoke County and in Jefferson County east of the Arkansas River. It is being jointly conducted by the USACE Memphis District, the USACE Vicksburg District, and the Natural Resources Conservation Service. The purpose of the study is to develop a project to provide flood control, agricultural water supply, groundwater protection and conservation, waterfowl management, and environmental enhancement and restoration. Under provisions of the National Environmental Policy Act (NEPA), a draft environmental impact statement (EIS) is being prepared. NEPA requires an open and thorough process of studying the environment, including opportunities for public participation. The purpose of NEPA "scoping" is to help determine what will be covered, and in what detail, for the study. The public and other known or potentially interested parties were invited to NEPA scoping meetings in England, Arkansas, on February 15, 2000, and in Lonoke, Arkansas, on February 16, 2000.

Detailed information is included in a series of Exhibit attachments to this summary document: (1) Notice of Public Meetings and mailing list, (2) Handout and agenda used for meetings, (3) List of attendees, (4) Meetings' Presentation Comments offered by Project Biologist, and (5) Meetings' Presentation Comments offered by Project Manager, (6) Information Pamphlet dated February 2000.

Why a Post-scoping Document is Issued

The present document is a way to provide written feedback particularly to those who participated in the above mentioned Scoping Meetings. While NEPA does not require production of this written update, we think that for a study with a high level of interest it provides a useful way to document the current status of the scoping process.

Summary of Input from the Scoping Events

Approximately 23 persons visited the two Scoping Meetings. At both meetings the Memphis District staff led introductory remarks, project overview, and explanation of NEPA and the Scoping process. Following the presentations, concerns were discussed through dialogue among the Corps staff and members of the audience. This facilitated improved understanding of audience interests, input, and so forth. Comments were documented by use of flip charts and markers.

Topics of interest identified at the England, Arkansas, meeting included: water quality, wetlands, Bayou Meto State Wildlife Management Area, minimum pool elevations, Superfund site(s), the balance between stream flow and flood control, and project effects on flooplain regulations and insurance. There is a desire to continue to use existing streams for irrigation, and to maintain minimum pools in Bayou Meto. What would be the impacts of minimum pools on Bayou Meto? Regarding the Superfund site, how might the project affect this location and might the project help remedy site problems? What is the balance between stream restoration and flood control? The best use should be made of available data to support design of a balanced, multiple use project.

At the Lonoke, Arkansas, meeting a number of topics and questions were identified. Topics included mussels, water quality, water management, wetlands evaluation, and restoration of the Little Bayou Meto channel. Will the project cause downstream flooding? How large would right-of-way requirements be, particularly at Little Bayou Meto and Cross Bayou Meto. Will private homes be affected by the project? Buffer strips along project features were recommended to enhance the environment and reduce maintenance. Zebra mussels at on-farm systems should be evaluated. What role do native mussels play in the project? Significant archeological resources may exist along Barker's Bayou. What will be the short term and long term maintenance for receiving streams? Use of the Stream Obstruction Removal Guidelines (American Fisheries Society 1983) was recommended regarding that. Additional on-farm storage and conservation were suggested. Participant(s) would like to see ways explored for providing off-line storage and environmental enhancement, with stress on careful environmental planning. Water quality should be monitored. Water management plans including irrigation, recreation, and fishery topics, were suggested for Old River Lakes and Bear Skin Lake. What would be the wetland impacts along existing streams? Would there be loss of bottomland hardwoods due to stress? What are the affects of locks and dams on flooding? Any weir designs, including locations, should be carefully planned. Could the Little Bayou Meto channel be restored? Any channel cleanout should utilize techniques for minimal damage. It would be desirable to have no changes to natural stream alignments. Continued close coordination with interested parties is sought, including the possibility of a specific meeting on flood control in mid-Summer 2000.

Summary of Overall Project Status

The initial scoping interaction reported here was successful in that a number of important topics or areas of concern were identified. The broader scoping activities (of which the public meetings are but a part) continue. This includes future meetings among a project Environmental Planning Team consisting of members representing the Corps of Engineers, the Natural Resources Conservation Service, the Environmental Protection Agency, the U.S. Fish & Wildlife Service, the Arkansas Game and Fish Commission, The Arkansas Natural Heritage Commission, The Arkansas Soil and Water Commission, the Arkansas Department of Environmental Quality, Ducks Unlimited, Inc., and the Arkansas Nature Conservancy.

Future Key Steps in the Study

-Additional meetings of an inter-agency Environmental Team.

-Produce Environmental Assessment (EA) documentation for interim study of waterfowl conservation and environmental restoration features in the Bayou Meto State Wildlife Management Area (Cannon Brake/Lower Vallier Separable Element).

-Complete all engineering and related studies to evaluate a range of alternative measures for flood control, groundwater protection/conservation, agricultural water supply, waterfowl management and other environmental restoration/enhancement.

-Complete all technical studies supporting an Environmental Impact Statement (EIS), including hydraulics/hydrology analysis, environmental resources such as study of wetlands, fisheries and mussels, etc.

-Produce draft EIS report.

-Public review of draft EIS.

-Complete and distribute final EIS.

-Target date (approximate) for study completion is September 2003.

For Additional Information and How to Contact Us

By telephone: Mr. Ed Lambert or Erwin Roemer
at 800-317-4156, extensions 0707 or 0704 respectively,
or Mr. Ken Bright, Project Manager, at extension 0745.

By telefax: 901-544-3955 or 901-544-4041

By regular mail:

ATTN CEMVM-PM-E (Roemer)
Environmental and Economic Analysis Branch
USACE, Memphis District
167 North Main St., B-202
Memphis, TN 38103-1894

By email: Erwin.J.Roemer@mvm02.usace.army.mil

NOTICE OF PUBLIC SCOPING MEETINGS

Eastern Arkansas Region Comprehensive Study
Bayou Meto Basin, Arkansas, General Reevaluation

The U.S. Army Corps of Engineers will host two public scoping meetings to discuss significant environmental issues relating to the Bayou Meto Basin, Arkansas, General Reevaluation. Findings from each meeting will be used to prepare a draft environmental impact statement for the Bayou Meto Basin Project.

The scoping process identifies significant issues related to the proposed action and invites participation of affected federal, state, and local agencies; affected Indian tribes; and other interested organizations and parties to determine the scope and depth of significant issues to be analyzed during the general reevaluation. The scoping process also eliminates issues that are not significant.

The Eastern Arkansas Region Comprehensive Study, completed in 1990, indicated that a feasible plan of improvement may exist for the Bayou Meto Basin. The Bayou Meto Basin Project general reevaluation will focus on developing a plan of improvement that provides flood control, agricultural water supply, groundwater protection and conservation, waterfowl management, and environmental enhancement and restoration. Irrigation and flood-control features will be designed to avoid or minimize adverse environmental impacts, and a major emphasis will be placed on the formulation of environmental features.

Both public scoping meetings will begin at 5:30 p.m. The first meeting will be held on February 15, 2000, at the England Elementary School, 400 East DeWitt Street, England, Arkansas. The second meeting will be held on February 16, 2000, at the Lonoke Primary School, 800 Lincoln Street, Lonoke, Arkansas.

Interested individuals who are unable to attend the scoping meetings may provide comments and questions concerning this proposed action by writing to USACE Memphis District, ATTN: CEMVM-PM-E (Lambert), 167 North Main Street, Room B-202, Memphis, Tennessee 38103-1894. The Memphis District should receive comments no later than March 31, 2000. For additional information concerning the meetings, contact Ken Bright, Project Manager, at 901-544-0745 or Edward Lambert, Project Biologist, at 901-544-0707.

AGENDA

SCOPING MEETINGS
Bayou Meto Basin, Arkansas
General Reevaluation

Welcoming Remarks - Ken Bright

Project Overview – Ken Bright

NEPA and Scoping Process – Edward Lambert

Breakout Sessions – 5 facilitated groups

Recap Breakout Findings – Each facilitator

Closing Remarks – Edward Lambert

SCOPING MEETINGS

For the Preparation of
A Draft Environmental Impact Statement
for the
Bayou Meto Basin, Arkansas, General Reevaluation

Time and Location of Meetings:

February 15, 2000	5:30 p.m.	England Elementary School, England, Arkansas
February 16, 2000	5:30 p.m.	Lonoke Primary School, Lonoke, Arkansas

Preparation of DEIS: A draft environmental impact statement (DEIS) is being prepared for the Bayou Meto Basin, Arkansas, General Reevaluation. The purpose of this study is to develop a project that provides flood control, agricultural water supply, groundwater protection and conservation, waterfowl management, and environmental enhancement and restoration. The DEIS will describe the existing conditions of the project area and will forecast future without-project conditions. Alternative plans of improvement will be formulated during the general reevaluation, and the DEIS will analyze impacts (positive and negative) associated with each plan. Comparisons of costs, benefits, and impacts will be made among alternative plans; and alternative plans will be compared to the "no action" alternative (future-without project conditions). Listed below are completed and scheduled milestones for the general reevaluation.

- A notice of intent to prepare a DEIS was published in the *Federal Register* on February 4, 2000.
- The DEIS should be completed by the fall of 2002

Purpose of Public Scoping Process: As a result of the National Environmental Policy Act (NEPA) of 1969, as amended, the Council on Environmental Quality (CEQ) was created in the Executive Office of the President. One of CEQ's responsibilities was "to formulate and recommend national policies to promote the improvement of the quality of the environment." CEQ prepared "Regulations for Implementing the Procedural Provisions of NEPA." These regulations require that public scoping be initiated before an environmental impact statement is prepared. The scoping process identifies significant issues related to the proposed action and invites participation of affected federal, state, and local agencies; affected Indian tribes; and other interested organizations and individuals to determine the scope and depth of significant issues to be analyzed. The scoping process also eliminates issues that are not significant.

In addition to providing input at the meetings, individuals may provide comments or questions concerning the proposed action by writing to USACE Memphis District, ATTN: CEMVM-PM-E (Lambert), 167 North Main Street, Room B-202, Memphis, TN 38103-1894. The Memphis District should receive written comments no later than March 31, 2000.

Purpose of the Project: The Eastern Arkansas Region Comprehensive Study, completed in 1990, indicated that a feasible plan of improvement may exist for the Bayou Meto Basin. The Bayou Meto Basin General Reevaluation will focus on developing a plan of improvement that provides flood control, agricultural water supply, groundwater protection and conservation, waterfowl management, and environmental enhancement and restoration. Irrigation and flood-control features will be designed to avoid or minimize adverse environmental impacts, and a major emphasis will be placed on the formulation of environmental features.

Meeting Agenda:
- Welcoming Remarks
- Project Overview
- NEPA and Scoping Process
- Breakout Sessions
- Recap Breakout Findings
- Closing Remarks

Project Sponsor: Bayou Meto Irrigation District, 501-676-7420

Project Manager: Ken Bright, 901-544-0745 or 1-800-317-4156 (ext. 0745)

Project Biologist: Edward Lambert, 901-544-0707 or 1-800-317-4156 (ext. 0707)

SCOPING MEETINGS

Bayou Meto Basin, Arkansas, General Reevaluation
15 & 16 February 2000

SLIDE 1 – NEPA AND THE PUBLIC SCOPING PROCESS (Introduction)

GOOD EVENING, MY NAME IS EDWARD LAMBERT. I AM THE PROJECT BIOLOGIST FOR THE BAYOU METO BASIN PROJECT.

WE APPRECIATE YOU FOLKS COMING OUT TONIGHT, AND I CAN ASSURE YOU THAT ANY INPUT WE GET FROM YOU WILL BE VALUABLE TO US.

SLIDE 2 – NATIONAL ENVIRONMENTAL POLICY ACT

THE NATIONAL ENVIRONMENTAL POLICY ACT, OR NEPA, IS THE BASIC NATIONAL CHARTER FOR ENVIRONMENTAL PROTECION.

IT REQUIRES FEDERAL AGENCIES TO PREPARE ENVIRONMENTAL ASSESSMENTS OR ENVIROINMENTAL IMPACT STATEMENTS FOR MOST FEDERAL ACTIONS OR PROJECTS. NEPA ALSO REQUIRES THAT ENVIRONMENTAL INFORMATION RELATATIVE TO A FEDERAL ACTION BE MADE AVAILABLE TO THE PUBLIC. SINCE THIS PROJECT IS CONSIDERED A MAJOR FEDERAL ACTION, A DRAFT ENVIRONMENTAL IMPACT STATEMENT WILL BE PREPARED AND DISTRIBUTED FOR PUBLIC REVIEW AND COMMENT.

THE ULTIMATE GOAL OF NEPA IS TO FOSTER GOOD DECISIONS BY FEDERAL AGENCIES. THE COMMENTS RECEIVED ON THE DRAFT EIS WILL BE CONSIDERED.

SLIDE 3 – NEPA

THE NATIONAL ENVIRONMENTAL POLICY ACT AND SUBSEQUENT REGULATORY GUIDANCE FOR ITS IMPLEMEMTATION REQUIRE US, AS SOON AS PRACTICAL AFTER THE DECISION HAS BEEN MADE TO PREPARE AN EIS, TO PUBLISH A NOTICE OF INTENT TO PREPARE AN EIS IN THE FEDERAL REGISTER AND TO INITIATE A SCOPING PROCESS. THE NOTICE OF INTENT FOR THE BAYOU METO BASIN PROJECT WAS PUBLISHED IN THE FEDERAL REGISTER ON FEBRUARY 4, 2000.

SLIDE 4 – SCOPING PURPOSE

THE PURPOSE OF THIS SCOPING MEETING TONIGHT IS TO ALLOW US, WITH YOUR ASSISTANCE, TO IDENTIFY EARLY ON THE SCOPE OF SIGNIFICANT ISSUES AND CONCERNS THAT NEED TO BE ADDRESSED IN OUR ENVIRONMENTAL IMPACT STATEMENT.

AGAIN, YOUR INPUT IS KEY AND THE PRIMARY REASON FOR HAVING THESE SCOPING MEETINS IS TO PROVIDE YOU WITH AN OPPORTUNITY TO VOICE YOUR CONCERNS AND TO INFORM US OF THE SIGNIFICANT ISSUES THAT YOU WOULD LIKE TO SEE ADDRESSED.

SLIDE 5 – SCOPING IMPORTANCE

THE SCOPING PROCESS IS KEY TO:

- CLARIFYING THE SIGNIFICANT ISSUES TO BE ANALYZED IN DEPTH, AND

- PREPARING A CONCISE EIS.

SLIDE 6 – SCOPING CONSIDERATIONS

THESE ARE SOME BROAD CONSIDERATIONS FOR SCOPING THAT MAY AID YOU IN PROVIDING INPUT TO US.

- ***ENVIRONMENTAL STUDIES*** - WHAT STUDIES TO YOU THINK ARE NEEDED?
- ***SINGIFICANT RESOURCES*** - WHAT ARE THE SIGNIFICANT RESOURCES IN THE PROJECT AREA? WE HAVE IDENTIFIED SOME—BUT THERE CERTAINLY COULD BE OTHERS.
- ***ISSUES/CONCERNS*** - WHAT ARE THE MAJOR ISSUES AND CONCERNS THAT SHOULD BE ANALYZED? AND,
- ***WHAT ALTERNATIVES SHOULD BE EVALUATED?***

SLIDE 7 – SIGNIFICANT RESOURCES

THESE ARE SOME OF THE RESOURCES WITHIN THE PROJECT AREA THAT WE HAVE ALREADY IDENTIFIED AS BEING SIGNIFICANT. IF YOU KNOW OF OTHERS, PLEASE TELL US TONIGHT. THE LIST OF RESOURCES DISPLAYED ON THE SCREEN IS NOT RANKED IN ORDER OF IMPORTANCE.

- ***AGRICULTURAL LANDS*** – CERTAINLY, AGRICULTURAL LANDS ARE IMPORTANT. THE FLOOD CONTROL AND WATER SUPPLY COMPONENTS WILL BE DESIGNED TO BENEFIT AREA FARMERS.
- ***GROUNDWATER*** – I THINK WE ALL KNOW BY NOW WHAT A PRECIOUS RESOURCE GROUNDWATER IS.
- ***RIVERS AND STREAMS*** – RIVERS AND OTHER STREAMS ARE HOME TO AQUATIC FORMS OF LIFE, AND IT IS IMPORTANT THAT WE PROTECT THEM. THEY ALSO REPRESENT SOURCES OF IRRIGATION WATER.

- ***AQUATIC RESOURCES*** – WE WILL BE ANALYZING PROJECT IMPACTS TO PROJECT AREA FISHERIES; WE HAVE ALREADY INITIATED SOME FISH SAMPLING. RESOURCE AGENCIES HAVE ALSO RECOMMENDED THAT WE DO A MUSSEL SURVEY OF THE PROJECT AREA STREAMS.

- ***WILDLIFE*** – WE WILL BE ANALYZING PROJECT EFFECTS ON WILDLIFE.

- ***WATERFOWL*** – THE SEASONALLY FLOODED, FORESTED WETLANDS AND CROPLAND WITHIN THE BAYOU METO BASIN PROVIDE IMPORTANT WINTERING HABITAT FOR MIGRATORY WATERFOWL.

- ***WETLANDS*** – IN ADDITION TO THE WELL-KNOWN WILDLIFE VALUES OF WETLANDS, WETLANDS ARE ALSO SIGNIFICANT IN PROVIDING FLOOD-FLOW ALTERATION, SEDIMENT REMOVAL AND STABILIZATION, AND TOXICANT REMOVAL.

- ***CULTURAL RESOURCES*** – CULTURAL RESOURCES SURVEYS WILL BE CONDUCTED TO IDENTIFY POTENTIALLY SIGNIFICANT HISTORIC AND PRE-HISTORIC SITES WITHIN THE PROJECT AREA.

- ***ENDANGERED SPECIES*** – WE WILL BE COORDINATING CLOSELY WITH THE U.S. FISH & WILDLIFE SERVICE IN ORDER TO DETERMINE WHETHER ANY ENDANGERED OR THREATENED SPECIES, OR THEIR CRITICAL HABITATS, EXIST WITHIN THE PROJECT AREA. IF ANY ENDANGERED OR THREATENED SPECIES INHABIT THE PROJECT AREA, POTENTIAL PROJECT EFFECTS ON THE SPECIES WILL BE DETERMINED.

- ***STATE AND FEDERAL HOLDINGS*** – PROJECT EFFECTS ON PUBLIC LANDS WILL BE ANALYZED. BAYOU METO WMA IS LOCATED WITHIN THE SOUTHERN PORTION OF THE PROJECT AREA, AND A MAJOR EMPHASIS WILL BE PLACED ON DEVELOPING AN ENVIRONMENTAL ENHANCEMENT PLAN FOR THE WMA.

- ***TERRESTRIAL HABITAT*** – HABITAT TYPE IS THE SINGLE-MOST IMPORTANT DETERMINANT OF WILDLIFE SPECIES COMPOSITION. THE BOTTOMLAND HARDWOOD FORESTS IN THE PROJECT AREA REPRESENT VERY IMPORTANT WILDLIFE HABITAT.

- ***WATER QUALITY*** – THE BASELINE WATER QUALITY OF PROJECT AREA STREAMS WILL BE DETERMINED, AND PROJECT EFFECTS ON WATER QUALITY WILL BE EVALUATED.

SLIDE 8 – ENVIRONMENTAL PLANNING TEAM

WE HAVE ESTABLISHED AN ENVIRONMENTAL PLANNING TEAM TO PROVIDE ADVICE AND TO HELP US IN PLAN FORMULATION AND IN THE DEVELOPMENT OF ENVIRONMENTAL FEATURES. THE TEAM IS MADE UP OF REPRESENTATIVES FROM THE FOLLOWING ORGANIZATIONS.

- CORPS
- NATURAL RESOURCES CONSERVATION SERVICE
- BAYOU METO IRRIGATION DISTRICT – THE LOCAL SPONSOR
- U.S. FISH AND WILDLIFE SERVICE
- EPA
- ARKANSAS SOIL AND WATER CONSERVATION COMMISSION
- ARKANSAS GAME AND FISH COMMISSION
- ARKANSAS NATURAL HERITAGE COMMISSION
- ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY
- DUCKS UNLIMITED

SLIDE 9 – BREAKOUT SESSIONS

THAT CONCLUDES BY PRESENTATION. NOW IT IS YOUR TURN TO SPEAK. WE ARE NOW GOING TO BREAK YOU UP INTO SMALL GROUPS FOR WHAT WE CALL "BREAKOUT SESSIONS." EACH GROUP WILL BE FACILITATED. LET ME STRESS THAT ALL COMMENTS ARE IMPORTANT; AND IT IS IMPORTANT THAT EACH ONE OF YOU PROVIDE YOUR VIEWS, CONCERNS, AND SIGNIFICANT ISSUES RELATIVE TO THIS PROJECT.

ONCE THE BREAKOUT SESSIONS ARE COMPLETED WE WILL RECONVENE HERE, AND EACH FACILITATOR WILL SUMMARIZE THE DISCUSSIONS FROM HIS/HER GROUP. AFTER THIS RECAP, WE WILL ADJOURN. REMEMBER THAT YOU CAN STILL SEND WRITTEN COMMENTS TO US—OUR ADDRESS IS IN THE SCOPING MEETING HANDOUT. COMMENTS SHOULD REACH OUR OFFICE BY MARCH 31, 2000. ALSO, IF YOU HAVE ALREADY PREPARED WRITTEN COMMENTS, YOU CAN GIVE THEM TO US TONIGHT.

NOW LET ME EXPLAIN THE GROUND RULES FOR THE BREAKOUT SESSIONS....

NOW, EVERYONE HAS A NUMBER ON THE BACK OF HIS OR HER SCOPING MEETING HANDOUT...

US Army Corps
of Engineers

Bayou Meto Basin, Arkansas
General Reevaluation

NEPA and the Public Scoping Process

15 & 16 February 2000

National Environmental Policy Act

- Basic national charter for environmental protection
- Provides environmental information to public
- Ultimate goal - foster good decisions

NEPA

- Notice on Intent
  - February 4, 2000
- Scoping

Scoping Purpose

- Determine Scope of Significant Issues and Concerns
- Eliminate Issues That Are Not Significant

Scoping Importance

- The Scoping Process Is Key to:
  - Clarifying the significant issues to be analyzed in depth
  - Preparing a concise EIS

Scoping Considerations

- Environmental Studies
- Significant Resources
- Issues/Concerns
- Alternative Plans

Significant Resources

- Agricultural Lands
- Groundwater
- Rivers and Streams
- Aquatic Resources
- Wildlife
- Waterfowl
- Wetlands
- Cultural Resources
- Endangered Species
- Public Holdings
- Terrestrial Habitat
- Water Quality

Environmental Planning Team

- Corps
- NRCS
- Bayou Meto Irrigation District
- U.S. Fish & Wildlife Service
- EPA
- Arkansas Soil & Water Conservation Comm.
- Arkansas Game & Fish Comm.
- Arkansas Natural Heritage Comm.
- Arkansas Dept. of Environmental Quality
- Ducks Unlimited

Breakout Sessions

- Small Groups
- Facilitators
- EVERYONE'S Input Is Important
- Recap Breakout Sessions

US Army Corps of Engineers

Bayou Meto Basin, Arkansas

General Reevaluation

Project Briefing & Status Report
Environmental Scoping Meetings

15 & 16 February 2000

Authorization

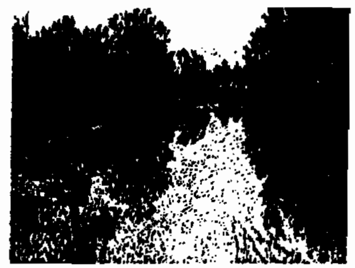
- Grand Prairie Region and Bayou Meto Basin, AR Project
  - Conditionally Reauthorized By WRDA of 1996
    - Project Scope
      - Flood Control
      - Groundwater Protection & Conservation
      - Agricultural Water Supply
      - Waterfowl Management
- Bayou Meto Basin, Arkansas General Reevaluation
  - FY98 Appropriations Act
    - Directed Corps to Initiate General Reevaluation
  - FY99 & FY00 Appropriations Acts: Provided Funding to Continue Reevaluation

Project Features

- Environmental Features
  - Aquifer Preservation
  - Wetlands Restoration
  - Waterfowl Conservation & Management
  - Bottomland Hardwoods Restoration
  - Water Control in Wildlife Management Area
  - Fisheries Enhancement

Bayou Meto Basin, Arkansas Project

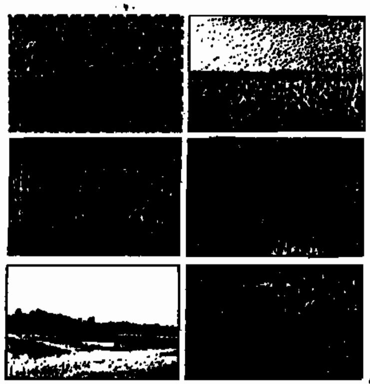
Project Features



- Flood Reduction
  - Channel Restoration
  - Pumping Station(s)
  - Water Level Control Structures

Bayou Meto Basin, Arkansas Project

Project Accomplishments



- Aquifer Protection & Conservation
- Conservation & Management of Existing Water Resources
- Supplemental Supply of Agricultural Irrigation Water
- Water Supply for Flooding for Waterfowl Conservation & Management
- Fisheries Restoration & Enhancement
- Environmental Restoration & Enhancement in Wildlife Management Area
- Flood Reduction

Bayou Meto Basin, Arkansas Project

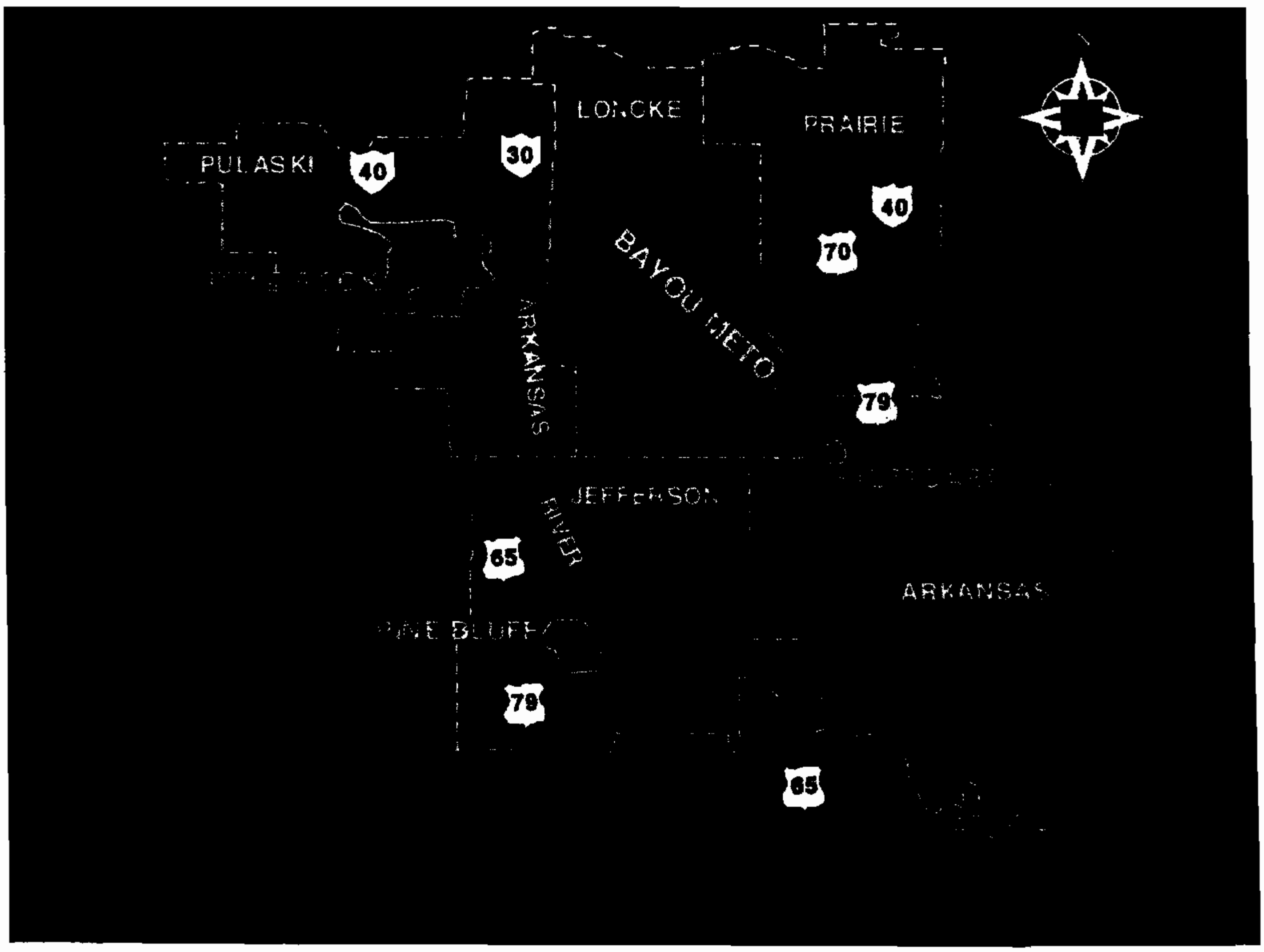
Status of GRR

- FY 2000
  - Formulate and Evaluate Alternative Plans Improvement for Flood Control
  - Conduct Hydrology and Hydraulics Water Supply Delivery System Design
  - Conduct Environmental Data Collection and Analyses and Formulate Environmental Features
  - Initiate Economic Data Collection & Analyses
  - Conduct Detailed Planning, Engineering, and Design for Cannon Brake - Lower Vallier Separable Element
  - Continue Public Involvement and Coordination Activities

Bayou Meto Basin, Arkansas Project

INFORMATION PAMPHLET

BAYOU METO BASIN, ARKANSAS GENERAL REEVALUATION



FEBRUARY 2000

BAYOU METO BASIN, ARKANSAS
General Reevaluation

Introduction

This pamphlet provides information concerning the water resource problems in eastern Arkansas and more specifically those in the Bayou Meto Basin. A discussion of these problems along with the past and current efforts to address these problems is provided.

Background

Groundwater is the lifeblood of eastern Arkansas. The economy of the region and its people are dependent upon it. Now one of the most serious and far reaching problems that faces the eastern Arkansas region is groundwater depletion. The alluvial aquifer, which provides essentially all the water used for agricultural irrigation, has been exhausted to only the perennial yield in parts of the area, and will be completely lost if measures to protect and conserve this resource are not taken. Depletion of the alluvial aquifer will change agriculture as it is presently practiced in the region. The resulting economic losses will be catastrophic. Other water resources problems include agricultural flooding and impaired drainage in some areas and loss of environmental resources.

In response to the concerns of state and local interests, the U.S. House of Representatives Committee on Public Works and Transportation adopted a resolution in September 1982 authorizing the Corps of Engineers to investigate the feasibility of water conservation and water supply improvements in the alluvial valley of eastern Arkansas. As a result of this legislation, the Corps of Engineers conducted the *Eastern Arkansas Region Comprehensive Study* (EARCS). The EARCS area included all or part of 24 counties in eastern Arkansas -- a 13,400 square mile area which represents 25 percent of the land area of the state. Studies were conducted by the Memphis District, U. S. Army Corps of Engineers in participation with the U. S. Geological Survey, Arkansas Soil and Water Conservation Service, and other Federal and state agencies to identify the critical problem areas and to determine the engineering, economic, and environmental feasibility of alternative plans of improvement. These studies indicated that feasible plans of improvement exist for five separate project areas within the study area. The plans of improvement consisted of water supply and conservation plans for the Grand Prairie, Little Red River, Black River, White River, and Bayou Meto areas.

Because of the seriousness of the problems and the potential for catastrophic economic losses, Congress directed the Corps of Engineers to select and develop implementation plans for one area which would serve as a demonstration project for agricultural water supply. The Grand Prairie area was selected as the demonstration site. The final general reevaluation report (GRR) was approved on 1 November 1999. The final Environmental Impact Statement (EIS) was released and the comment period ended on 31 January 2000. The selected plan identified in the general reevaluation consists of a combination of measures for groundwater protection and conservation, agricultural water supply, waterfowl management, and environmental restoration and enhancement. Plans and specifications for the major pumping station and channel items and on-farm planning is currently underway. Execution of the Project Cooperation Agreement (PCA) with the local sponsor is expected in June 2000.

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, authorized by the Flood Control Act of 1950 and deauthorized by the Water Resources Development Act (WRDA) of 1986 was conditionally reauthorized by WRDA 1996, except that the scope of the project was expanded to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Act, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto Basin. The FY 1999 and FY 2000 Appropriations Acts provided funding to continue the reevaluation.

Project Area

The Bayou Meto Basin, Arkansas Project is located in east central Arkansas and includes portions of Lonoke, Jefferson, Prairie, and Arkansas counties. The project area encompasses 765,745 acres of which 369,874 are irrigated and 22,942 are commercial fish ponds.

Study Purpose

Project planning and development for the Bayou Meto Basin will include: identification of the water resources problems and opportunities; inventory and forecast of resources; formulation, evaluation, and comparison of alternative plans; and identification of the best plan for flood control, groundwater protection and conservation, agricultural water supply, waterfowl management, and environmental restoration and enhancement.

Problems & Opportunities

The major problems in the Bayou Meto Basin project area are agricultural flooding, loss of environmental resources, and the depletion of the alluvial aquifer, which provides essentially all the water used for agricultural irrigation and baitfish farming and supports area wetlands. Problems related to fish and wildlife include: loss of instream flows during the summer months due to the lack of rainfall and withdrawals for crop irrigation; loss of timber and conversion of timber stands to less desirable species from impaired drainage; water control problems in the Bayou Meto

Wildlife Management Area (WMA); and insufficient surface water for resting and feeding areas for waterfowl during migration and wintering periods. The objective of the general reevaluation is to develop a plan to protect and conserve the groundwater resources, reduce flooding and relieve drainage problems, and restore and enhance environmental resources in the area while providing a supplemental water supply for agricultural irrigation, fish farming, and fish and wildlife, specifically waterfowl management and conservation. The WMA offers significant opportunity for restoration, enhancement, conservation, and improved management of environmental resources.

Project Description

Project planning and development is underway stages. Measures to address the total spectrum of water resource problems and opportunities will be formulated and evaluated. The following is a description of potential project features based on studies to date:

Groundwater: An authorized purpose of the Bayou Meto Basin, Arkansas Project is groundwater protection and conservation. Groundwater studies conducted by the U. S. Geological Survey and the University of Arkansas in coordination with the U. S. Army Corps of Engineers and the state of Arkansas indicated that groundwater could provide approximately 280,000 acre feet annually (39% of the total need) at a safe yield.

On-Farm Conservation & Improvements: The on-farm water management component of the plan will consist of conservation measures which will improve irrigation efficiencies, provide additional on-farm storage, and retrofit existing irrigation system components into an overall irrigation system. Approximately 738 miles of new pipeline with appurtenances will be installed for efficient on-farm conveyance and management of water. These pipelines will eliminate losses from evaporation and seepage. Approximately 312 miles of tailwater recovery systems will be installed to collect, store, and transport runoff and tailwater for reuse on the farm. Water control structures to maintain water levels, divert flows, and flood cropland for waterfowl will be installed. Approximately 10,539 acres of new on-farm storage reservoirs will be constructed to meet peak demand and critical irrigation application times. The reservoirs will be filled from runoff, tailwater, and import water. Pumping stations will be required to move water through the irrigation system, divert water from the system, and fill reservoirs.

Import Water: The current and future water needs of the Bayou Meto Basin cannot be met with existing sources: groundwater, surface water, rainfall, storage, etc. An alternate source of water must be developed. The total volume of import water needed is the decreased demand after implementation of conservation measures less tailwater capture less available storage less groundwater pumpage at a sustainable level. Based on studies conducted to date, groundwater could provide 39 percent, on-farm storage reservoirs 16 percent, and natural runoff/tailwater recovery 10 percent of the total water need. The additional 35 percent would have to come from outside sources. The only source of import water in the region that could provide the need is the Arkansas River. A plan is being developed to divert flows from the Arkansas River just north of David D. Terry Lock and Dam at River Mile 109 into a network of new canals (81 miles), existing streams (383 miles), and pipelines (270 miles) with associated structures to the water depleted areas. The proposed improvement project area for water supply includes an area encompassing 433,208 areas within the boundaries of the Bayou Meto Regional Irrigation Water Distribution District (See Plate 1). This area includes 301,483 acres of irrigated cropland, 22,942 acres of commercial fish ponds, and 33,700 acres in the Bayou Meto Basin Wildlife Management Area.

Flood Control: Flooding problems occur frequently on the many streams throughout the Bayou Meto Basin. One of the area's greatest needs today is relief from flooding and improved drainage in the lower portion of the basin which includes the Wildlife Management Area and along upper Bayou Meto. Features being evaluated to reduce flooding, improve drainage, and enhance water management include channel improvements, water control structures, and pumping station(s).

Environmental Features: Every opportunity to protect, restore, and enhance environmental resources in the project area are being pursued. The Bayou Meto area contains nationally significant environmental resources. The Bayou Meto Basin is a major wintering area for waterfowl. Measures to relieve flooding and drainage problems, provide for water level control and management, and restore bottomland hardwoods will be evaluated. Import water will provide continuous flows in existing streams sufficient to support year round fisheries and provide a source of water for additional flooding of fields for waterfowl conservation and management. Preservation of the alluvial aquifer, a significant environmental resource, will protect and preserve area wetlands which are interrelated to and are supported by the aquifer.

Study Outputs and Schedule

The Bayou Meto Basin, Arkansas general reevaluation is being conducted to evaluate a range of alternative measures to provide a plan for flood control, groundwater protection and conservation, agricultural water supply, waterfowl management and other environmental restoration and enhancement measures. Alternative plans are being developed and analyzed to the extent necessary to identify the plan which best meets the needs of the area. Detailed planning, engineering, and design studies will be completed for preparation of a baseline cost estimate and schedule for implementation.

The major product of the work effort will be a planning and engineering document which will present study results and describe the detailed plan of improvement for the Bayou Meto Basin study area. This document will be of sufficient detail and content to serve as the basis for proceeding to design memoranda, as needed, and the plans and specifications for project construction. The general reevaluation was initiated in July 1998 and is currently scheduled for completion in September 2002.

Study Execution

To accelerate study completion, an interdisciplinary team utilizing the combined resources of the Memphis and Vicksburg Districts of the Corps of Engineers and the Natural Resources

Conservation Service (NRCS) has been established. An environmental planning team consisting of Federal, state, and local resource agencies has been organized to identify fish and wildlife opportunities, develop and evaluate features for plan formulation, and identify the optimum plan for environmental restoration and enhancement. Agencies involved in this effort include: U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFWS), Environmental Protection Agency (EPA), Natural Resources Conservation Service (NRCS), Arkansas Soil and Water Conservation Commission (ASWCC), Arkansas Game and Fish Commission (AG&FC), Arkansas Natural Heritage Commission (ANHC), Arkansas Department of Environmental Quality (ADEQ), and Ducks Unlimited (DU).

Study Coordination and Public Involvement

Study coordination with all appropriate Federal and state agencies, cooperating agencies, and other members of the public follows the requirements of existing laws and regulations including the National Environmental Policy Act. Opportunities for participation in the study will continue to be provided throughout the public involvement and coordination process.

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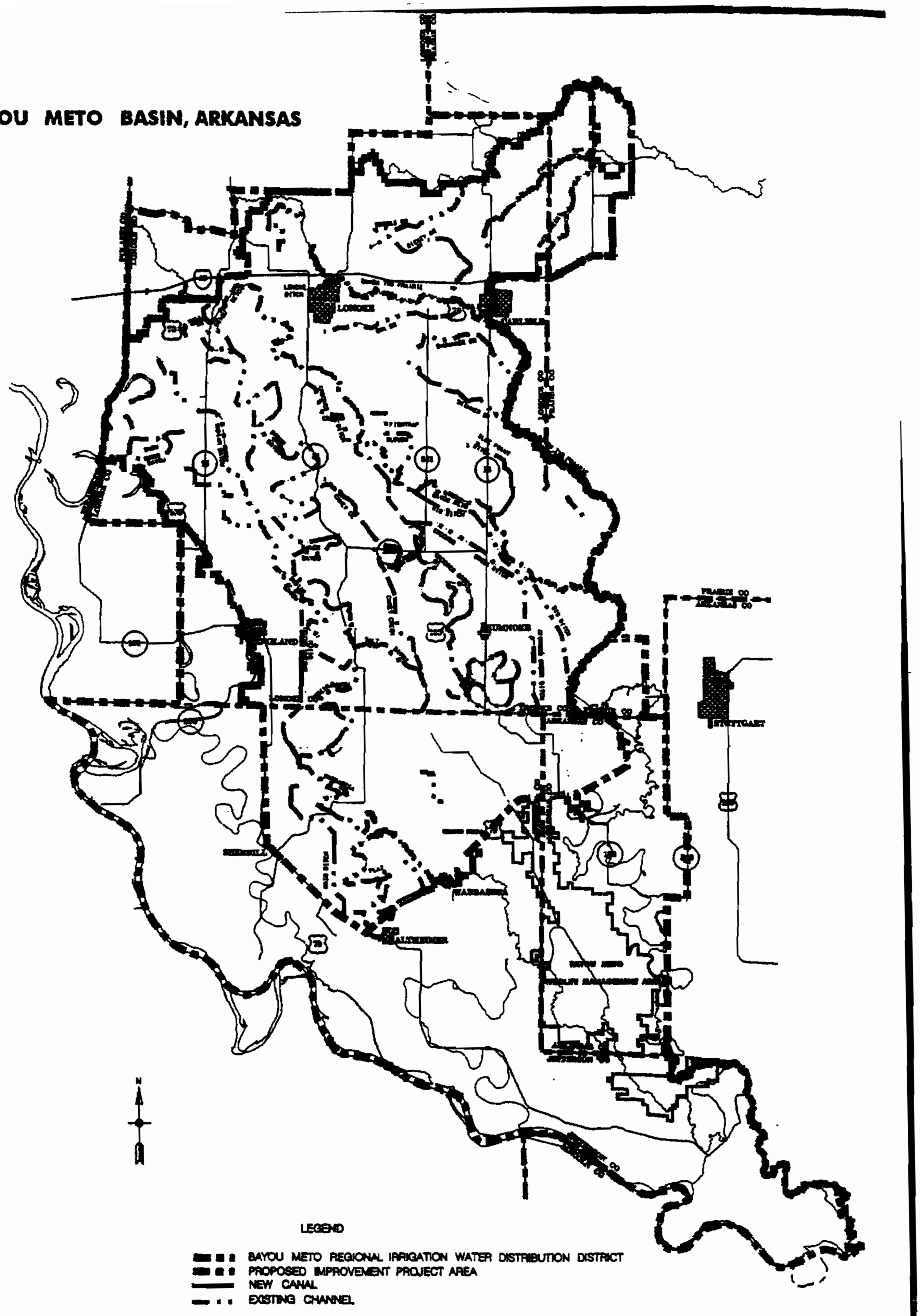
BAYOU METO BASIN, ARKANSAS



SECTION I

PUBLIC INVOLVEMENT

Part B. Draft EIS and GRR Meeting, Lonoke, AR

PUBLIC HEARING ATTENDEE LIST
LONOKE, ARKANSAS

Bayou Meto Basin Project
January 25, 2006

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IN RE: BAYOU METO PROJECT

TAPE TRANSCRIPTION
OF
PUBLIC HEARING

ALPHA REPORTING CORPORATION
100 North Main - The Lobby
Memphis, TN 38103 - 901-523-8974
www.alphareporting.com

PROCEEDINGS

* * * * * *

UNIDENTIFIED SPEAKER: June 7th contacted me and let me know his position and his involvement.

You know, a lot of times we get involved to attend public hearings. And sometimes when we're called upon, we preferably would rather sit in our chair and not say anything. But this is one project that I don't hesitate for one moment in expressing my support for it.

I represent part of Pulaski County. I represent all of Lonoke County. I represent Prairie

County, and I represent a large part of Arkansas County.

So consequently, the two projects that you have talked about here tonight as far as on your screen, both of these irrigation projects are in my district, which I realize tonight, it's my understanding that we're to focus our attention on the Bayou Meto project.

And the reason I'm coming before you is to illustrate to you of our strong support for this project. For instance, Representative Evans and

myself, we -- we get general improvement funds. And my only regret is that we don't get twice as much as what we get. Because so often, these are the only tax dollars that a lot of people -- our people see that we bring back home except for maybe highway improvements or for education.

But of our improvement funds, that we presented the board with a check, two checks, fact of business, for $113,000 to use for administrative costs.

And then the legislative council, which I'm on, we supported the bond indebtedness that would be necessary for the state of Arkansas to fund this project. The legislative council, you have to have 27 affirmative votes. And so when you go before them and ask for a roll call, you never know exactly how it's going to come out. But I can tell you because of the outstanding support that -- and the need that the people of Arkansas special legislators recognize, we have no problem in getting this passed. Because they realize that Grand Prairie is so important as far as the economics for this state is concerned. They don't want to see it without drain as such.

We realize that in addition to this

that certainly, the users will have to come up with an assessment as such. But the big dollars are going to have to come from our congression delegation in Washington. And I'm sure that's who you're representing here tonight, because this is so vital.

And the fact is that water is the life blood of agriculture. We've just got have it.

And I went to the legislature in 1973 and soon thereafter, I've been on the agriculture committee. One of the big things that came up was development of water code for the state of Arkansas. And I can assure you that that wasn't an easy chore as such. Because we realize that first and foremost, human -- human consumption must be number one.

And so as a result of that, we've got to provide an alternative source, and that's what the purpose of this project is.

As I was driving over here tonight, and I know there's one thing that you don't have anything to do with, and fact of business, we have to hit upon our congress delegation and those that serve in U.S. Congress. But the two most important things that's facing this area is a farm bill that we can live with so that our farmers can stay in business

and also irrigation. We've just got to have it.

So as far as the priority here tonight is concerned, this is our number one priority. And I just want you to know as far as the state of Arkansas, representing the state of Arkansas, that we are 110 percent behind this project because we know the importance of it. Thank you very much.

THE CHAIR: Thank you for your comments, sir. Next, we'll have Mr. Charlie Cummings, University of Arkansas Pine Bluff.

MR. CUMMINGS: Thank you. I have submitted a letter for the record. I'm not going to read the entire record, but I will paraphrase from it.

First of all, let me say that I bring you greetings from Dr. Lawrence L. Davis, Chancellor of the University of Arkansas Pine Bluff; Dr. Robert L. Cole, program administrator of UAPB Small Farm (inaudible) Equipment and Water Management Center, which is an 871 acre research and demonstration farm a couple of miles north of -- north of the city.

I'm here tonight to on behalf of the chancellor demonstrate in the strongest sense of the word our total support for this project. We have had

an academic group from the university review the draft, general re-eval -- re-evaluation report, and we wholeheartedly concur in the findings in that report.

This report more than adequately addresses the three most critical water resource problems in the basin, which as you know are ground water depletion, agriculture putting and restoring and managing the waterfowl habitat.

Out on our farm, we are currently performing research and demonstration projects on about 25 wetlands and water management projects. Our water table is dropping significantly on that farm, at a point so much it's placing some of these research projects which we're doing for NRCS and the Corps at risk of not being able to accurately do those research projects.

This makes us keenly aware and recognizes a need for the Bayou Mason -- Bayou Meto basin project. It's important to the economy, not only Arkansas but the entire nation. It goes without saying that without a portable water supply, there's no economic development, there's no industrial development, and there's no community development.

This project not only affects agriculture, but it affects our entire system. So we believe this report more than adequately fulfills any type of requirements and the goals and objectives therein.

The data developed in this report received some overwhelming support from our academic people at UAPB because they believe that the research that's in that report is going to be beneficial to them from an educational standpoint, particularly the students in the department of agriculture, and to other states and colleges and even 1890 institutions across the United States.

So on behalf of UAPB, we strongly endorse what you're trying to do. We accept this report. And we strongly encourage that you begin project construction in a timely manner. Thank you.

THE CHAIR: Thank you, sir. Next we have Annetta Tablin Beauchamp from Raydale Farms.

MS. BEAUCHAMP: I'm Annetta Beauchamp. I'm representing Raydale Farms. This is my brother, Bo Tablin. And I have more questions. Seems we've only heard from people who are really in favor of this, but we need to speak for the ones who are going

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to be seriously harmed by this.

The channel that they're talking about building -- digging is right through our farm, and we'll lose considerable acreage. And also, I have a question. I tried to file through that 400-page book I got. And it mentioned the canal, that it was 30 feet across at face. But I couldn't find any record of how much acreage will be taken in by the banks and the levies. Obviously, there would be levies on either side. And I'd like to know how much that covered.

And also, this could very easily involve a lot of homes along Little Bayou Meto, because some of the homes are right on the bayou, our family home, which we recently sold but to a friend. But still, we're concerned about it. And it involves other homes, too.

And also, I have another question I would like to ask, is who -- there's the federal shares. But who are the non-federal ones who are taking the share of this? Are they floating bonds, and if so, are they collecting interest on it? Is this -- does this have anything to do with financial thing that way where people would profit from it,

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from our loss? I would like to know -- excuse me -- to know that.

And then my brother wants to talk to you about -- we've invested quite a lot of time and labor in -- in the wetlands program. Little Bayou Meto and Crosby both run through our farm. And we have gone -- and I'll let my brother talk about that, Bo Tablin.

MR. TABLIN: Of course, we've been under federal -- federal and state funding to plant several hundred acres and trees. But actually, this may be helping some people. We're having no problem.

And if you send water -- we are on the low end of Little Bayou Meto just prior to going -- at Raydale just before it goes into the Arkansas

River.

MS. BEAUCHAMP: One mile. One mile.

MR. TABLIN: Well -- and if you send water down on us too fast, I don't trust -- I don't trust the pumps. You'll flood -- you may help somebody, but you'll flood us. And I would hate like the dickens to see little Bayou Meto turned into a sterile looking canal. It's a beautiful setting for wildlife.

And as far as I prefer, we have four wells on that farm. And as long as the Arkansas river doesn't run dry, we're in good shape.

And if y'all are planning on -- we object strenuously to the canal system of opening -- of clearing out Little Bayou Meto on the lower end, anyway. Cutting across to Big Bayou Meto through the double ditches or waste ways, that's all right, but not dump it down on us.

And the other question is, when we do object to the channelization of Little Bayou Meto on the lower end, what alternative do we have to get an unbiased hearing as to whether it should be done or not?

MS. BEAUCHAMP: Thank you.

THE CHAIR: Thank you. Mr. Neal Anderson, Value Mill Water Management District.

MR. ANDERSON: As you all probably figured out, Gary Canada is sick tonight. And I found out after I walked in the door that I was doing this. So please bear with me.

First all, I welcome all of you here tonight. This is the first meeting of this type I've been to. And it's your opportunity to tell not only

the Corps but the board of Bayou Meto irrigation district your concerns and any problems that you might have with it.

I'd like to answer these people's question, but you're going to have to get the engineers to do that. I'm not the engineer. But they'll be glad to do so.

And again, I'd like to -- I've just been involved with the project since 1981, believe it or not. During Senator Glover's speech, he was talking about the water code bill. And I got involved at that time and then have been on the Arkansas Water Soil and Water Commission or the -- the name has changed today, but for 22 years. Because I saw water as our greatest problem in this area with all the great farm land that we had.

I want to thank all of the Corps people here tonight and several other agencies. This project has taken a long time, because there was a lot of concerns to be addressed. Actually, there have been some retirements, and new people have come on board since it started. So -- but we have got a great group here from the Corps tonight.

Tracy James has just spearheaded this

thing for us and has done a wonderful job. I want to thank all the Corps people, because I know it hadn't been a single man's chore. It's been definitely a group effort.

Also, I'd like to thank all the Bayou Meto irrigation board members. We have probably spent 2000 man hours a piece on this project at no pay, of course. But it's all been devotion. And to my knowledge, we haven't had a soul get off the board other than since the project started. There may have been one or two out of the 25 or so members that are on it.

These people are dedicated, and they work very hard for the best interest of everyone in the community and the future of this community. And you know, they don't get many thanks. They get a lot of griping and a lot of complaints. But when you see them, tell them you appreciate it, because they deserve it.

This is a local project with federal assistance. And we can't ever forget that fact. Yes, it's going to take some money out of our pockets to do it. But with the -- with the improvements and the value of your land and being able to farm

hopefully for eternity, we don't know how long that is. But I can tell you one thing. Without it, whether you're a landowner that's farming his own land or a landlord, you're going to be out of business in not many years.

It doesn't take a rocket scientist to look at how fast this is strata is dropping to know this. And I hope all of you will keep that main purpose in mind.

And on all three of these components, to me, when I -- when we designed the plan, it was a win-win proposition, such as the irrigation portion of it, which has been sorely needed. I don't know how many of you have gone to the bank to get a bank loan, but if you can't irrigate it, you're not getting one.

The flood control, twice in my family's history, we've lost crop to floods. The thing I'm proudest of is our waterfowl management program. I found out today -- I'd like to introduce Alan Mueller. Where are you Alan? Alan is with the fish and wildlife service and has been -- this has kind of been his project for how many years?

MR. MUELLER: Ten years.

MR. ANDERSON: For ten years. And Alan has been wonderful in steering us through the hurdles of all the environmental concerns that were to be addressed. Alan announced his retirement today. So man, we're losing everybody. We've got to get this project going. But Alan, we appreciate you and all you've done.

Mike Freeze, Craig Uata with the Arkansas Game & Fish Commission. We've got one of the finest waterfowl facilities in Bayou Meto refuge -- national refuge or state refuge, I forgot, but in the world. People come from all over the world to hunt it.

The timber's dying because they can't get the water off, and half the time you can't hunt it because there's not any water in it. It's totally mismanaged since the lots and dams were put on the Arkansas river. You can't get the water on; you can't get it off.

And I want to give my thanks and the board's thanks to game & fish and Mike and Craig for all of their assistance in making this project work.

I can't tell you how urgent it is.

With the rate of decline in the strata today, we'll

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be lucky if they started building it as soon as it could be funded in the next congress. I can't tell you whether you have enough water before. This is a massive project.

The other thing that is so enthusing about it is the economic studies that have been done and what it means for state of Arkansas, the counties involved. The mass of federal funds coming in here to do this work is going to pay us all back in a matter of -- a short matter of time for our efforts and our problems that we face.

So you representatives from the congressional delegation, it's in your hands. We've done practically all we can do. And it's up to congress to fund this project. And the longer we wait, the more it's going to cost.

So I beg you folks to go back to your -- to our congressmen. I beg all of you to call your congressmen and encourage them to fund this project as soon as it can be funded. Because there's just -- like I say, ten years completion probably. I don't know how they could do it any faster. They do a lot of things when they have to, don't they? But we're looking at a long time yet.

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And I appreciate all of you coming out tonight. Those of you with concerns, we will address those concerns. And I hope you will -- if you'll get with our staff, they will guide you to the right people in the Corps to answer your questions. And I appreciate all of you coming out tonight. Thank you.

THE CHAIR: Thank you, sir. Next, we have Mr. Mike Freeze, Arkansas Fish & Game Commission.

MR. FREEZE: If it's permissible, I'd like Craig Uata to come up first. He's our chief of river basins. And then I'd like to follow Craig.

THE CHAIR: Yes, sir.

MR. UATA: Good evening. I'm Craig Uata, and I'm with the Arkansas Game & Fish Commission. I'm chief of the river basins and governmental relations division.

The Arkansas Game & Fish Commission is a very active member of the Bayou Meto basin interagency environmental planning team, and our agency is aware of the tremendous potential for the Bayou Meto basin project to help us meet our goals of restoring and enhancing prime (inaudible) and

waterfowl habitat and other fish and wildlife resources, particularly, on our world-renown Bayou Meto wildlife management area as well as the Bayou Meto basin.

I just want to say that last week at our January commission meeting, the commission unanimously approved sending a letter of intent committing up to 8 million dollars over a period of years to help the project sponsor to fund the $101,000,000 waterfowl management component of this Corps of Engineers project. I might add that this is contingent upon the project receiving federal dollars and other needed non-federal dollars. And we thank you.

I have a letter of -- a letter of intent I would like to just submit for the record.

MR. FREEZE: My name's Mike Freeze, and I am chairman of the Arkansas Game & Fish Commission. I wanted Craig to go first, because I've known Craig since high school. And Craig -- one thing you can say about him is that Craig deals in facts, and he deals in facts only. If Craig tells you something, you can take it to the bank. And Craig has been -- I've relied upon Craig to educate

not only myself but the other commissioners about this project.

I've been a commissioner for almost seven years now. When I first got on the -- on the commission, I talked to some other commissioners about this. And a former commissioner by the name of Bill Bridgeforth told me that he had never seen Bayou Meto dry during duck season. Well, unfortunately, Bill went off the commission, and in the last three years, I've seen the Bayou Meto Wildlife Management area dry twice out of three years.

And if I've had one duck hunter call me this year, I've had a thousand call me. And I've tried to explain to them that the game and fish is very powerful. I know that's what you believe. But we just simply cannot make it rain.

And then I usually start talking to them about the Bayou Meto irrigation project and how important it is to the -- not only to Arkansas Game & Fish Commission, the state of Arkansas, but our nation.

And a lot of our hunters, when you talk to them about it, they -- you know, especially if it's a dry year like this, they think that the most

important thing is going to be the ability to put water on that area. And that is important. It gives all of -- a large number of the ducks in the Mississippi flyway a place for winter.

But if I can keep them on the phone long enough, usually I'll go and tell them as important it is for us to have a source of water to flood that area in the years when we don't have rain fall, what's even more important is going to be those pumps on the lower end.

As you've already heard, this 32,000 acre of Bayou Meto wildlife area is called the crown jewel of wildlife management areas in the nation for waterfowl. We have a real problem. Our timber is dying on that area. We've had non biased, independent studies done time and time again. We need to be able to get that water off.

Bayou Meto Wildlife Management area as of today is full. It became full because it finally rained this weekend. Well, we've got one week of duck season left, and we want to get that water off. And if the Arkansas river's high, we can't do that. And that means our trees are going to be stressed. And if they don't die, they're not going to produce

acres, and we're not going to have, you know, food for the ducks.

But as you heard Craig said, Arkansas Game & Fish Commission has committed up to 8 million dollars to this project. We're -- it's not just --

sometimes I feel like instead of having an Arkansas Game & Fish Commission emblem on, I ought to have one that says Bayou Meto Irrigation Project cheerleader.

But I'm not the only commissioner that sees it that way. We've got several commissioners that either live in this area, are very familiar with it, and they're all quite high on this project.

I'm going to take off my game & fish commission hat for a second, because I'm also a landowner. I happen to be a fish farmer. And the game & fish commission has the largest state-owned fish (inaudible) right here in Lonoke. So they're going -- they've got the same problem.

But I happen to be a private landowner and own a large fish farm. And Neal was talking to you about no matter if we get this project started immediately, we're still going to have a our problem because of our osprey dropping.

Well, I can tell you. I've talked to a

lot of farmers, and they can raise dry land rice, and they can raise dry land cotton, but it's kind of hard to raise dry land fish. And I don't know what I'm going to do with all those ponds if this osprey keep dropping. And yet, we're closer to the Arkansas river than Neal is, and our osprey is not dropping quite as fast.

But since we've been on our farm since 1986, we have had to drop every single well. And you can only drop them so far. Pretty soon you're going to hit this natural gas everybody keeps talking about.

I just say this is an extremely important project for this area. And the people all have their fingers crossed, and they're hoping and praying that it will go forward. Thank you.

THE CHAIR: Thank you, sir. Next, Mr. Michael Crum.

MR. CRUM: I'm Mike Crum. I'm a board member for Arkansas County. And I live down close to the Bayou Meto management area. And I'll echo Mike Freeze's comments that there is a definite problem down there.

And this -- this is a crown jewel of

the -- of the wildlife management of this part of the country. And if it continues like it is, we're going to lose it.

It's like you're driving by a restaurant that doesn't have any cars parked in front of it. That's what a duck looks at. That's what the wildlife looks at. They look and say, well, I'm not stopping there. I'll get my wings dusty.

We found out that ducks don't need near as much water as they did before this year or the last -- out of the last three years. But it's definitely a problem.

And I fly over this land. I fly over this thing. Just look and you can see -- you can see dead timber, and you can see silt coming down. And we've got to have a way to get this water off. It affects the farmers down in that area.

And so this is -- this is a real, real good project. It's not just a fly by night. I've worked on this project close as long as Neal has.

And my father talked about a project similar to this 40 years ago. And so it's something that's not just layed around.

And I really, really appreciate all the

work that the Corps has done. The Corps and the fish & wildlife, game & fish, all these people have done a wonderful job.

The people in the northern end definitely need that. I mean, this is just -- I mean, they'll be out of business if they don't get water. The table -- water table is dropping.

I've been in the farming business, oh, probably ever since 1963. And I've had friends that, you know, their water table wells are dropping, wells drop out on Grand Prairie, in Stuttgard, they drop up, and they're really dropping up in this end up here. That cost these people, if they have a deep well, $50,000 to change it.

And so it's a definite, definite problem on both ends. And these people are just asking for your help. And this congressional delegation up here, this is what they need. And I appreciate everything. Thank you.

THE CHAIR: Thank you, sir. Next, Mr. Jason Phillips, U.S. Fish & Wildlife service.

MR. PHILLIPS: Good evening. My name is Jason Phillips. I'm a biologist with the Arkansas field office, the U.S Fish & Wildlife Service. These

comments are submitted with the approval of the soon-to-be retired Alan Mueller.

We along with several other state agencies have been involved with development of this project for several years, as you've heard before. Three aspects of the project, flood control, irrigation and waterfowl management have been integrated to form a project that could benefit many interests.

Our comments regarding potential impacts of fish & wildlife resources and recommended measures to avoid the minimize or necessarily compensate for impacts are detailed in the waterfowl appendix in the draft coordination act report in Volume 10 of the general re-evaluation report.

A summary of our recommendations includes instituting of water withdrawal protocol that insures diversions from the Arkansas river do not violate minimum (inaudible) established by the Arkansas National Resources Commission; to acquire and (inaudible) and restore land forest 4,093 acres of farm wetlands or other frequently flooded farmland to compensate for direct and indirect loss of habitat values due to the flood control and water delivery

components of the project; to locate the on from features away from wetlands, upland forest and remedy tall grass prairie sites; to establish a binding agreement that details the operations protocols and responsible parties regarding operation of the 1,000 CSF capacity pump station at the mouth of Little Bayou Meto; development operation and maintenance manual for the Bayou Meto wildlife management area features in accordance with, one, the Bayou Meto wildlife management area wetland management plan; and two, with the recommendations and approvals of the interagency environmental planning team.

Additionally, the parties responsible

for completing the proposed waterfowl management features should be clearly identified and a completion schedule developed to insure that this project component is completed concurrently with the water delivery and flood control components; and finally, monitoring requirements for waterfowl management features should be developed by an interagency team in order to determine if the projected benefits are actually realized.

In addition to providing comments regarding impact avoidance and compensation for the

irrigation and flood control portions of the project, we also participated in a multi agency team formed to identify waterfowl management needs within the project area.

The features identified include restoration for basis wetland complexes, three quarter station of historic Bayou Meto hardwood sites, and improvement of water management capabilities of Bayou Meto WMA.

The inclusions -- the inclusion of these waterfowl management features makes this a true multipuropse project. The service enthusiastically supports the waterfowl management features, and we have no opposition to any of the other features of the project.

Because waterfowl management is a co-equal project objective along with the irrigation and flood control components, it's very important that these features are funded and constructed concurrently with the other features. This is truly a water management project with water being regulated for flood control, irrigation and wildlife management. Three important elements of this water management are, one, the operation of the irrigation

pump which takes water out of the Arkansas river; two, the operation of the flood control pump which puts water back into the Arkansas river; and three, the control of flooding of Bayou Meto WMA.

All of these detailed operation plans should be prepared in close consultation with the service and other interested natural resource interests.

A positive relationship between the local sponsors, state agencies and federal agencies are contributing greatly to the design of the project that can be widely supported. We look forward to continued cooperation of the planning and implementation of this project.

I have a written copy of these comments if anybody's interested. Thank you.

THE CHAIR: Thank you, sir. Next, Ms. Mary Ann Dumond.

MS. DUMOND: I'd like to ask all the landowners that are here from Raydale, which is in the lower basin in Little Bayou Meto, to please just stand. Thank you.

I'm Mary Ann Dumond, and I'm with Raydale. Along with these landowners, we represent

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our farm land, our homes, our church, our post office, many of the buildings that will be affected by this project.

We are wondering how we're going to handle the moving and replacement of all these buildings. And I've noticed on a copy here that I have of the map that you have below Raydale where my family's farm is, in the book that you have, it does not have a picture of the cemetery that's on the bayou bank that is on my family's farm. There are between 75 and a hundred graves there.

There is a tiny little picture of it on the colored map over there. I did notice. But I do not know how you are going to address this. I did not see that anywhere in this book.

And since we have not had any flooding on our property in recent years, we're concerned and, you know, in question about why we need this to clean out this lower part of our basin. We're not on the Grand Prairie. We're in the delta. We're right next to the Arkansas river.

The pumping station will be right adjacent to my family farm, the Luckies, Sam Lucky, Juanita Lucky, my cousin, Barbara Lucky Coppala. And

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so we're concerned about this.

Since the individual landowners that are here did not receive notification of this meeting, we're hoping that you will notify us of any further actions or plans or changes. And we're hoping that we can see some end to this so that it will be satisfactory for everyone. Thank you.

THE CHAIR: Thank you, ma'am. Next, Mr. Bo Tablin.

MR. TABLIN: I've already spoken.

THE CHAIR: Thank you, sir. Mr. Ralph Mashburn.

MR. MASHBURN: Thank you for the opportunity to speak. I represent landowners, farmers and myself and two other landowners out in the area with cotton, rice, soybean, base fish.

I want to add an amen to all of the positive things that have been said. We need this project very badly, immediately.

Secondly, I speak uniquely, I think, as a retired U.S. Department of Agriculture employee. And I was a water resource specialist and engineer.

And I remember in 1974, I was in our headquarters of the natural resource conservation

service, soil conservation service. And I was asked to head up the review for the U.S. Department of Agriculture of a plan for the Bayou Meto area. And I said since I was raised on the farm there, I think I can help the review of that.

And so we and an interagency review, Corps of Engineers, Department of a Agriculture, Fish & Wildlife Service and a number of other agencies, we all concurred in 1974 that there was an urgent need to improve the ground water situation in the Bayou Meto area, also to control flooding and also to improve waterfowl habitat.

We passed unanimously our comments on that this was a valid and a good plan, and we would support moving ahead with action.

Now, that was over 30 years ago. And we're in a lot worse shape now than we were then. So all we can do is say, number one, thank you, thank you, thank you for coming up with a plan.

In my experience as a water resource planner throughout the country working with the Corps of Engineers, Fish & Wildlife Service, state water resource and wildlife agencies, I've never seen better cooperation. I've never seen more solid

support. And I'm grateful as all of us farmers are.

And we just urge you to move ahead and with the understanding you have our full support. And we're thankful for you doing anything, but please do it quickly.

THE CHAIR: Thank you, sir. Next, we have Mr. Lucian Walls.

MR. WALLS: Thank y'all. I'm Lucian Walls from England. I'm chairman of Humbower irrigation district. This is one project -- if we had had this project, my land would go back to being here. We would not be farming it.

I had three irrigation wells on this farm. I couldn't pump enough water to raise 80 acres of rice. They was supposed to put this project in. I got one relift. I can water 300 acres now, one relift where I couldn't water 80 acres with three wells.

The water around us now is all ready to recharge in the wells. Several people have told me that their wells is pumping better now than it was before we put this project in.

Our fish & game at these Humbower irrigation district is a lot better. The fair lake,

we keep it pumped up all the time. It's good fish in there. Wildlife, it's coming back in.

And I urge you, tomorrow is too late. We need it now, not tomorrow. We need this project right now.

THE CHAIR: Thank you, sir. Next we have Mr. Bob Bedis.

MR. BEDIS: I'm a local farmer from Scotts and a Bayou Meto irrigation district board member. I happen to be in the area of one of the first to be running out of ground water, and we thought the answer was to build reservoirs. And we spent a lot of money and put reservoirs in.

But in a year like is this and the winter when we pump the reservoirs up, the dry winter, you don't get the opportunity to pump them up. We pumped three days in our reservoirs this year, and that was just from the rain we got this past weekend.

And we're depending on the surface run off to fill them up. As more reservoirs are being built and more people competing for that same run off, it's even going be worse. We have to have this diversion for the reservoirs to work. Just building

reservoirs is not the solution, water recovery systems that people talk about.

There's just so much water that runs off from these areas. And without the diversion system, all these other things won't work. So I just want to voice my support for the project.

THE CHAIR: Thank you, sir. Before we move to the next card, I just wanted to recognize Ms. Kim Muelen from Senator Blanch Lincoln's office who's joined us. Do you have any comments?

UNIDENTIFIED SPEAKER: Do you have any money?

THE CHAIR: The last card that I have is Mr. Gene Sullivan. But after he has finished, if there are any other comments that need to be made, I'll open the floor up again.

MR. SULLIVAN: I am Gene Sullivan. I'm executive director of the Bayou Meto Water Management District (inaudible). We appreciate you coming to Lonoke to have this hearing.

A couple of things that I want to mention. First, I've been involved in water resource planning in a lot of different locations for 40 something years. And this project is the best

project that I've ever worked on.

And the reason I think it is is that the Corps has provided the leadership and involved all of the people that have an interest and need in this project. It has never been an adversarial project. We've looked at the things that are needed for the people and for the animals and the fish. And I think you've done an excellent job bringing it all together. I think we've got an excellent plan.

We've reached the point now where some of our board members think it's taken quite a few years longer than it should have, and that, it has. But we've reached the point now where it is really time to move ahead.

And I guess we're moving from a development stage and the review stage into the funding and construction stage, and hopefully that will be starting next year.

We feel that we've got the right plan. We know that all of our national legislators support our project, as evidenced by the folks that are here. And we know that it is a big project, very expensive. But it's necessary for this area. And we just want to -- want to move on out on it.

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I also know the way that you handle these meetings and you follow up and that you do follow up with all the commenters, especially those that have -- that have questions. But as far as the questions that are raised on Little Bayou Meto on the lower end of the project, I want to offer -- I want to offer from the -- from our district, the opportunity to meet with the folks that are concerned at the lower end, of course, with your staff and address the problems that are down there.

We've been very fortunate in that we have been able to deal with the problems in a manner that's a win-win situation. I heard the comments, and they're real comments, things we need to address.

I think we have some information already that will be helpful to the folks that have a question. And if not, we'll look at those problems and try to find a way to resolve the issues.

So we'll be talking to them after the meeting and then working with your folks in trying to resolve any issues that we have down in that area.

One other person that I want to mention, Eddie Belt, who's your right-hand man. Eddie's here

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tonight with us. And Eddie not only has been around in directing the activities of the folks that have been really working closely with us. But he's recently back from Iraq, and I think we ought to give him and the rest of your people that have been in Iraq recently a hand.

THE CHAIR: Thank you, sir. Are there any other comments that anyone would like to make?

UNIDENTIFIED SPEAKER: I just would like to make one more comment.

THE CHAIR: Yes, ma'am.

UNIDENTIFIED SPEAKER: I realize this is probably going to go through. There's no question about that.

And when we questioned this, the answer was, well, sometimes you have to sacrifice for the good of other people. And that's okay when you're on one end. But when you're losing your acreage and your land and your home, it makes a big difference on how you look at it. Thank you.

THE CHAIR: Yes, sir.

MR. COSWELL: I'm Guy Coswell. I farm in Raydale. Little Bayou Meto runs right through the midland. And I'm a little disturbed that most of us

from Raydale, we were not even notified that this was going on. We got a letter from someone else. And it affects us tremendously.

I have a farm that it goes right through the middle. They've got a farm. They've got a farm that it goes through the middle of it. I have a house that's 30 feet away from the bayou.

I'm a little concerned about all this. The reason I didn't mark I wanted to talk up there was because we didn't know enough about this situation until tonight to even be able to speak.

And I finally got a map about Wednesday of last week to see what was going on. And I find out I'm going to have to (inaudible) in my backyard. And this disturbs me a little bit.

And I'd like to be notified about what's going on. It looks like it's a done deal, and I don't like done deals unless landowners are involved. I don't know who the board is. I would doubt that any of them are from the Raydale area, but they should be.

THE CHAIR: Thank you, sir. Are there any others? Yes, sir.

MR. HOLLINGER: I'm Don Hollinger. I'm

a farmer in (inaudible) area. I had a regret that I don't guess I received your pamphlet. I'm kind of like Mr. Coswell. I didn't know anything about this and haven't really heard any of the specifics on this project.

My only question is -- and the idea of this project sounds like a good, sound idea. I think most of the general ideas that y'all brought up and things you said about this project sound like have been planned out and thoroughly investigated.

I'm just asking or wanting to know, the money that is put into the -- from the federal end of it to pay for the majority of the project. The people that receive the water, a young farmer like myself, as we see this year, you know, there's a struggling cost of their grain and trying to stay in the farming business, it's tough to make ends meet.

Is there an answer on how much it will cost us once this water is brought down, and what will it -- how will it be paid for, or is there a tax going to be put on our land, you know, for me and my generation -- you know, my children and generations going to pay on? How is that going to be -- you know, what are the landowners' costs going to be

involved in this when we try to continue to farm this land that's in the area?

THE CHAIR: Thank you, sir. Anyone? All right. Well, I appreciate all of the comments. We have recorded those comments. And I mentioned earlier that people on the mailing list, we will submit responses back to those who have put their addresses down and filled out their cards properly.

Those last few comments that we've just heard, I'm not quite sure whether you have done that. I would ask that you would do it before we depart for the day.

If there are no more statements, I'll remind you that the comment period will remain open through March the 3rd, 2006. If you didn't provide a statement tonight or have additional comments, please send your written comments to us at the address provided on the information sheets that are located here at the front desk.

This concludes our meeting. I thank you for all of the feedback we received. Thank you for your hospitality, and thank you for everything that you bring to this project. Have a pleasant and safe evening.

CERTIFICATE

STATE OF TENNESSEE:

COUNTY OF SHELBY:

I, KORIAN NEAL, RPR, CCR, and Notary Public, Shelby County, Tennessee, CERTIFY:

The foregoing proceedings were transcribed from audio cassette tape.

The foregoing pages contain a true and correct transcript of said audio cassette tape to the best of my ability.

I am not in the employ of an am not related to any of the parties or their counsel, and I have no interest in the matter involved.

I further certify that in order for this document to be considered a true and correct copy, it must bear my signature seal, and that any reproduction in whole or in part of this document is not authorized and not to be considered authentic.

Witness my signature this the 13th day of February, 2006.

____

KORIAN NEAL, RPR, CCR

Notary Public at Large
For the State of Tennessee

My Commission Expires:
June 7, 2006

SECTION I

PUBLIC INVOLVEMENT

Part C. Public Meeting, Reydell, AR

	NAME	MAILING ADDRESS
HURCH *	Betty Freeman	9410 E. Swan Lake Rec. Rd. Altheimer, Ar 72004 (Reydell)
*	Lester Ray DuMond	16801 Nathan Rd. Stuttgart 72160
	Rodney Kauppila	10707 W. M-48, Rudyard, MI 49780
mail xerox	Sam Luckie	16909 Nathan Rd, Stuttgart, AR 72160
	Barbara Kauppila	
	Beau Talbot	P.O Box 2635 Pine Bluff ark 71613
	Erika Kremmerich	116 N First Cons. Berry
	Jane Yahoda	120 Riverview Way, Hot Springs, AR 71901
*	[illegible] Johnson	P O Box 68 Reydell 72133
	[illegible]	
	Mark Sheppard	P.O. Box 52 Reydell, AR 72133
	Buddy DyKE	9106 East Swan Lake Rec Rd Altheimer Ar 72004
Sam Cocchi in Grandson ←	Jacob Schimmel	10 Yazoo Cove, Maumelle AR 72113
	John Kauppila	1518 Donald Ave, Royal Oak, MI 48073
*	Gregg Sheppard	P.O. Box 101 Reydell AR, 72133
	Joel Kauppila	6101 Palm Trace Landing Apt. #304, Davie, FL 33314
	CF Scott	PO Box 431 DeWitt AR 72042
	Billie Gibson	P.O Box 65 Reydell, Ar 72133.
*	Jeff Sheppard	P.O. Box 61 Reydell, AR 72133
*	Jesse Briggs	14700 Big Mo Road Stuttgart 72160
*	John H Briggs Jr	13105 Hannaberry Lake Rd. Stuttgart 7216
*	Randy Briggs	13401 Hannaberry LK Rd. Stuttgart Ar. 72160
	[illegible]	1595 Hwy 276 De Witt, AR 72042
*	Guy Kochel	2217 Masters Drive Jonesboro, Ar 72404
	Charles [illegible]	
Home Grain Bins Bridge *	C. Stacey Gillison	1427 S. Main, Ste. 153 Greenville, MS 38701

NAME	MAILING ADDRESS
Linda Jones	PO Box 45 Reydell AR 72133
Bernice Hardister	P.O. Box 33 Reydell AR 72133
Annetta Beauchamp	804 Columbia St. - Helena, Ar. 72342
Mary Ann DuMond	16881 Nathan Rd, Stuttgart, AR 72160

Requested Public Meeting Reydell Arkansas Feb 2006

Public Meeting in Reydell Arkansas 16 February 2006 4pm.:

A. Jim Lloyd (Overall Project Manager Corps of Engineers Memphis) started the meeting and introductions were made of all Corps team members, media reporters and a representative of Congressman Barry's office.

B. Gene Sullivan (Potential Project Sponsor- Bayou Meto Water Management District Executive Director) gave a brief history of the project.

C. Paul Eagles (Flood Control Component Project Manager, Corps of Engineers, Vicksburg) gave a brief overview of the flood control component of the project.

D. Barry Sullivan (Flood Control Hydraulic Engineer, Corps of Engineers Vicksburg) gave a detailed description of the flood control components of the project and handed out a map and proposed cross sections of Little Bayou Meto in the vicinity of Reydell.

E. Jim Wojtala (MVK archeologist) explained the process of cultural resource protection, The National Historic Preservation Act, etc. and how it would be part of the project.

F. There was a question and answer session as follows:

1. Statement from Lester DuMond, 16801 Nathan Rd. Stuttgart, AR : a. Did the study indicate early flooding of the bottomland hardwoods in the WMA? b. Will this project address beaver dams since they can cause flooding? c. What will happen with the trees and dredge material from the excavation of Little Bayou Meto?
d. How do you actually dredge the bayou?
e. Will you put a levee up?
f. How far could spoil be hauled for landowners?

Response: a. Yes, the study did indicate early flooding of bottomland hardwoods.

b. No, the project does not address beaver dams.

c. Trees will be removed, and dredge material will be spread out along the right away.

d. Work will typically be performed from one bank.

e. No levees will be built, but we will have spoil deposits.

f. Spoil can be hauled from 0.5 to 0.75 miles, no more than 1.0 mile.

2. *Statement from Annetta Talbot Beauchamp, 804 Columbia St., Helena AR., 72342, Tel: (870) 338-3607 (land owner):* a. What will happen to the trees during the work on Little Bayou Meto? b. What will be the status of the existing CRP ground and trees that have been planted that will be affected by the widening of Little Bayou Meto? c. Why should the people of Reydell give up anything to benefit people to the north? d. What if you don't want dirt and trees piled up on your land?

Response: a. The trees along the one bank where work is to be performed will require removal.

b. Landowners that have lands with a CRP contract with the USDA NRCS will be compensated for any damages or loss of income as a result of project construction.

c. The work in Reydell is required for flood control features to reduce agricultural and bottomland hardwood flooding in the project area.

d. All land required for construction and disposal areas will have easements.

3. Statement from Mark Shepperd, P.O. Box 52 Reydell, AR 72133: a. What is the planned project top width of Little Bayou Meto in the Reydell area?

Response: a. It will have a typical cross section of 30 foot bottom width (from original width typically 15 ft), a 20-foot depth, and 1 vertical to 3 horizontal side slopes that would be approximately 150 feet across at the top. One on two slopes are typical and may be used in some sections. This varies along the ditch. To achieve the width we will excavate on the inside of the bayou bends, and opposite buildings, cemeteries, etc.

4. Statement from Guy Kochel, 2217 Masters Drive, Jonesboro, AR 72404: a. How many farmers will this project benefit? b. Do the Double Ditches structures cause flooding and bring water to this area?

Response: a. There are approximately 1100 distinct land ownerships in the improvement project area that would benefit.

b. No, The Double Ditches Structures are also known as the Cannon Brake Structures that are planned to be modified as part of this project. The modification will allow more flow down Little Bayou Meto, but there will be less flooding due to the addition of the pump station in the Reydell area as part of the project.

5. Statement from Jessie Briggs, 14700 Bigmo Road, Stuttgart, AR 72160: a. I have a farm with a tail water recovery system with 5 foot high weirs. Will my tail water recovery system be affected by the project, and if it is how will it be built back?

Response: a. If this tail water recovery system is affected it will be rebuilt, (replaced) or the Corps would compensate you for it. Cross sections would change but plans and specifications would seek to prevent such effects.

6. *Statement from Annetta Talbot Beauchamp, 804 Columbia St., Helena AR., 72342, Tel: (870) 338-3607 (land owner):* a. Is this project all about ducks and trees?

Response: a. No, There are agricultural benefits from flood control and agricultural water supply.

7. Statement from Linda Jones, PO Box 45, Reydell, AR 72133: a. Will I have to buy water?

Response: a. No, there is no agreement with the water management district for the Reydell area.

8. Statement from Guy Kochel, 2217 Masters Drive, Jonesboro, AR 72404: a. Will the project impact endangered woodpeckers?

Response: a. No, It is not anticipated that any habitat suited for that species will be impacted.

9. Statement from Mary Ann Dumont, 16881 Nathan Road, Stuttgart, AR 72160: a. "What is the timeline" and when will construction start on the project? B. "Why does The [GRR] report only have two paragraphs for the Reydell area. "

Response: a. Once Congress authorizes construction funds and funds are appropriated. Construction is planned to start in CY07 if funds are made available.

b. There will be more information in the plans and specifications for the Reydell area that would follow.

10. Statement from an unidentified woman. a. "For those of us who missed the Lonoke Public Meeting, how were we to be advised?"

Response: a. The Corps and the project sponsor will be contacting each landowner after plans and specifications. Landowners were asked to identify themselves on the sign in sheet with contact information.

11. Statement from Guy Kochel, 2217 Masters Drive, Jonesboro, AR 72404: a. What will happen to the existing bridges crossing Little Bayou Meto? He knows of two.

Response: a. 3 bridges are planned to be replaced. Access will be maintained, and the Corps will reimburse cost of re-building .

12. Statement from unidentified man: a. What will happen if the project is not constructed?

Response: a. A failed aquifer, no reduction in flooding, and no waterfowl benefits as listed in the current project report.

13. Statement from Guy Kochel, 2217 Masters Drive, Jonesboro, AR 72404: a. "Who will keep beavers from plugging the new work?" [Who monitors beavers and the water?] b. How will the operation of the structure be handled?

Response: a. & b. The project sponsor is responsible for operation and maintenance based on a detailed Operations and Maintenance manual developed by the COE.

14. Statement from W. Stacy Gillison, 1427 S. Main, Ste 153 Greenville, MS: a. Will the bridge at the existing drainage structure need to be replaced?

Response: a. No

15. Statement from an Un-identified woman: a. Will residents be advised of the final plans and specs? She recommended that project information be sent to anyone affected by the project.

Response: a. Yes, The Corps of Engineers and the project sponsor will keep residents advised of plans.

16. Statement from Jake Schimmel, 10 Yazoo Cove, Maumelle, AR: a. How do the project pumps operate- are they automatic? b. Will the existing levee be breeched? c. What is the routing of the pump discharge piping through the levee? d. Will the existing bridges in the area of Reydell be affected?

Response: a. They are manual and will be started by an individual based on water levels in Little Bayo Meto and the Arkansas River.

b. No

c. The pump discharge goes through the levee just under the top surface with sufficient earth cover and ramps on each side.

d. Yes, The bridges will be replaced.

17. Statement from an Un-identified Woman: a. Will landowners be compensated for any crops that are lost due to the construction of the project? b. What will be the final easement size along little Bayou Meto?

Response: a. Yes. Damage to crops as a result of project construction or on lands outside the project easement areas as a result of project operation will be appraised and compensation paid the farmer.

b. Approximately 100 to 150 feet on one side back from top bank for channel enlargement. Other easements acquired for material disposal will be identified during project design.

18. Statement from an Unidentified Man: a. How much affect do the wells associated with the existing pulp well in Pine Bluff mill have on the aquifer?

Response: a. The wells in this location tap the Sparta aquifer. These wells contribute to the drawdown of this aquifer.

19. Statement from Beau Talbot, PO Box 2635 Pine Bluff, AR: a. Is there going to be channelization of Big Bayou Meto?

Response: a. No, channelization is not planned for Big Bayou Meto.

20. Statement from an Unidentified Man: a. Will the existing flood gate be used? b. Will only one side of the Little Bayou Meto be affected by the project?

Response: a. Yes. When the pump is not needed, the existing flood gate will be used.

b. Yes. Excavation and work will be done from one side, but which side will be used depends on actual conditions and work may alternate from left to the right descending bank.

21. Statement from an Unidentified womant: a. What if two houses are directly across from each other on Little Bayou Meto? An example would be the post office and the house across from the post office.

Response: a. The COE does not think this is a problem, but further surveys will indicate any problems. The plan is to avoid any building structures.

22. Statement from an Unidentified Man: a. Will the bridge in Reydell be replaced?

Response: a. Yes, the bridge in Reydell will be replaced.

23. Statement from Erika Krennerich Projects Coordinator for Marion Berry, Member of Congress, 116 North First, Suite C-1, Cabot, AR 72023 (501) 843-3043: Stated that she is available and invited the residents to contact her about any issues on the project and offered her business cards for contact information. She said Mr. Berry wants this project to have as few impacts as possible. She urged the participants to make their issues known so that everyone understood their problems, and to respond during the public comment period. She said that she would work with the residents on their issues even though this geographic area is outside Cong. Berry's formal area of service, and thanked them for their participation.

Response: No response required

24. Statement from an unidentified man: a. If there is crop loss due to a flood after the project is in place is the Corps of Engineers responsible for compensating for these losses? b. For Farmers that are not being charged for water, "how can citizens be assured they will not be charged money later?" will there be any written contract to that effect?

Response: a. No, compensation will not be paid by the Corps of Engineers for crop losses.

b. No. There is no plan for a written contract that farmers will not pay for water. Unless a legal entity was organized here (Reydell area), no assessment would be possible.

25. Statement from an unidentified woman: a. Who is responsible for operation of the pumps and structures? b. How will those responsible for operation communicate? c. Will the operation of the system be communicated to the public?

Response: a. The sponsor is responsible for operation.

b. An Operations and Maintenance plan will be developed for the project by the Corps of Engineers that should address communication.

c. Yes. This will be part of the O&M plan.

26. Statement from Guy Kochel, 2217 Masters Drive, Jonesboro AR 72404: a. Who is responsible for future maintenance? b. If there is future flooding after the project will the Corps of Engineers address any problems?

Response: a. The sponsor is responsible for the operation and maintenance.

b. The Corps would probably be asked to investigate any substantial flooding.

27. Statement from an Unidentified Mant: There was a hole in the existing floodgate that took two years to repair and caused flooding of his crops. a. Will the Corps of engineers be responsible for crop damages due to a lack of maintenance of the project in the future? b. I have flooding problems with my property in the Reydell area. When the Arkansas River is up there are flood damages in the Reydell area. Will this be a problem after the project?

Response: a. No, the Corps of Engineers is not responsible for crop damages due to a lack of maintenance.

b. No, flooding will be reduced in the Reydell area, however the nature of flooding would have to be evaluated to determine whether the project would benefit a specific location.

28. Statement from Beau Talbot PO box 2635 Pine Bluff, AR 71613: a. Can water be diverted from Big Bayou Meto into Little Bayou Meto so that Reydell Farms could irrigate crops from Little Bayou Meto?

Response: a. Water can be diverted from Big Bayou Meto to Little Bayou Meto, but it is not done for irrigation.

29. Statement from Lester DuMond: Where is the location of the pump station?

Response: a. Close to the levee on the west side.

G. Jim Lloyd with the Corps of Engineers asked if there were any more questions, there were none.

H. Gene Sullivan gave the closing remarks.

List of attendees on sign in sheet. "*" indicates landowner.

1. *Lester DuMond, 16801 Nathan Rd. Stuttgart, AR 72160
2. Annetta Talbot Beauchamp, 804 Columbia St., Helena, AR. 72342
3. Mark Shepperd, P.O. Box 52 Reydell, AR 72133
4. * Guy Kochel, 2217 Masters Drive, Jonesboro, AR 72404
5. Erika Krennerich, Projects Coordinator for Marion Barry, Member of Congress, 116 North First, Suite C-1, Cabot, AR 72023
6. Beau Talbot, PO Box 2635 Pine Bluff, AR 71613
7. Jacob Schimmel, 10 Yazoo Cove, Maumelle, AR 72113
8. * W. Stacy Gillison, 1427 S. Main, Ste 153 Greenville, MS 38701
9. * Jessie Briggs, 14700 Bigmo Road Stuttgart, AR 72160
10. Lester Ray DuMond, 16801 Nathan Rd. Stuttgart, AR 72160
11. Barbara Kauppila_(No address_given)
12. *Betty Freeman, 9410 E. Swan Lake Rec. Rd. Altheimer, AR 72004
13. Rodney Kauppila, 107 W. M-48, Rudyard, MI 49780
14. Sam Luckie, 16909 Nathan Rd. Stuttgart, AR 72160
15. Jane Yahoda, 120 River view Way, Hot Springs, AR 71901
16. *G. P. Johnson, P.O. Box 68 Reydell, AR 72133
17. Buddy Dyke, 9106 East Swan Lake Rec. Rd. Althiemer, AR 72004

18 Michael R. Crum (No Address given) [wasn't this guy a state senator or levee board rep. or something like that; he was some kind of well known "VIP" ask Gene Sullivan]

19. John Kauppila, 1518 Donald Ave, Royal Oak, MI 48073
20. C. F. Scott, P.O. Box 431 DeWitt, AR 72042
21. Billie Gipson, P.O. Box 65 Reydell, AR 72113
22. * Jeff Sheppard, P.O. Box 61 Reydell, AR 72113
23. * John H. Briggs Jr., 13105 Hannaberry Lake Rd. Stuttgart, AR 72160
24. * Randy Briggs, 13401 Hannaberry Lake Rd. Stuttgart, AR 72160
25. T. J. Sallan, 1595 Hwy 276 DeWitt, AR 72042

26. Charles Revils (No Address given)
27. Linda Jones, P.O. Box 45 Reydell, AR
28. Bernice Hardistec, P.O. Box 33 Reydell, AR
29. Mary Ann DuMond, 16881 Nathan Rd. Stuttgart, AR 72160
30. * Gregg Sheppard, PO Box 101, Reydell, AR 72133
31. Joel Kauppila, 6101 Palm Trace Landing, Apt. 304, Davie, FL 33314

SECTION II

COORDINATION

Part A. Fish and Wildlife
  1. Planning Aid Report
  2. Coordination Act Report
Part B. Prime and Unique Farmland
Part C. Pertinent Correspondence

SECTION II

COORDINATION

Part A. Fish and Wildlife
1. Planning Aid Report

IN REPLY REFER TO:

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1500 Museum Road, Suite 105
Conway, Arkansas 72032

June 9, 2000

Colonel Daniel W. Krueger
U.S. Army Corps of Engineers
167 North Main Street, Room B-202
Memphis, Tennessee 38103-1894

Dear Colonel Krueger:

Attached is our planning aid report relative to the Memphis and Vicksburg Districts' Eastern Arkansas Region Comprehensive Study, Bayou Meto General Reevaluation (Bayou Meto Basin subarea). This report assesses the impacts of the proposed project on fish and wildlife resources, identifies possible environmental enhancement features, and environmental project concerns. Our report has been prepared in accordance with the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 40, as amended; 16 U.S.C. 661 et seq.), but does not constitute our final report as required by Section 2(b) of the Act. In keeping with the requirements of the FWCA, this report should be attached to and made an integral part of your General Reevaluation Report.

We appreciate the opportunity to provide these preliminary comments and recommendations. We look forward to working with you and your staff as the study progresses.

Sincerely,

Allan J. Mueller
Field Supervisor

attachment

cc:

Vicksburg District, Vicksburg
Attn: Paul Eagles
Wildlife Management Institute, Ward, Arkansas
Attn: Donald McKenzie
Natural Resources Conservation Service, Lonoke, Arkansas
Attn: Tom Fortner
US Fish and Wildlife Service, Atlanta, GA
Arkansas Game and Fish Commission, Little Rock, Arkansas
Attn: Robert Leonard
Arkansas Soil and Water Commission, Little Rock, Arkansas
Attn: Kenneth Colbert
Arkansas Department of Environmental Quality, Little Rock, Arkansas
Attn: Greg Patterson
Environmental Protection Agency, Dallas, Texas
Attn: Laura Talbot
Arkansas Natural Heritage Commission, Little Rock, Arkansas
Attn: Cindy Osborne
Gaylord Memorial Laboratory, University of Missouri-Columbia, MO
Attn: Mickey Heitmeyer, PhD
Bayou Meto Irrigation District, Lonoke, Arkansas
Attn: Gene Sullivan

A Planning Aid Report

on the

Eastern Arkansas Region Comprehensive Reevaluation Study

Bayou Meto Subarea, Arkansas

Prepared by:
Debbie Ryckeley

Ecological Services, Arkansas Field Office
Conway, Arkansas

United States Fish and Wildlife Services
Southeast Region
Atlanta, Georgia
June, 2000

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INTRODUCTION

This is the Fish and Wildlife Service's (Service) Planning Aid Report (PAR) on activities relative to the Eastern Arkansas Region Comprehensive Reevaluation Study, Bayou Meto, Arkansas. The comprehensive study area has been divided into five subareas, which encompass parts of 13 counties and include: the Grand Prairie, White River, the Little Red River, Bayou Meto, and the Black River subareas. This PAR covers only the Bayou Meto subarea which encompasses portions of Arkansas, Jefferson, Lonoke, Pulaski, and Prairie Counties. The purposes of the study are to identify measures to reduce flooding, to alleviate anticipated agricultural water supply shortages, and identify environmental features in the Bayou Meto Basin general reevaluation study area. This report describes fish and wildlife resources, identifies possible project problems, identifies planning objectives, and discusses potential conservation measures. It has been prepared, in cooperation with the Arkansas State Game and Fish Commission, for fulfillment of the fiscal year 2000 scope of work for the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661et seq.) and the Endangered Species Act (87 Stat. 884, as amended U.S.C. 1531 et seq.). However this report does not constitute the final report of the Department of the Interior as required by Section 2(b) of the Act.

The Bayou Meto Basin, Arkansas general reevaluation (BMBGR) section of the study is being conducted jointly by the Memphis and Vicksburg Districts of the Army Corps of Engineers. The Memphis District has overall responsibility for project administration, study management, and for the general reevaluation effort. The Vicksburg District and the Natural Resources Conservation Service (NRCS) also have roles in the planning, engineering, and design of the project. The NRCS will assist in the planning process as it relates to the inventory and projection of resource needs, project measures, and design of the on-farm portion of the project, including, but not restricted to, reservoirs and tailwater recovery systems.

Some of major problems identified by the Corps in the BMBGR are agricultural flooding and the depletion of the basin's shallow alluvial aquifer. The aquifer provides essentially all the water used for the area's terrestrial and aquatic farming. The agricultural areas of eastern Arkansas have experienced moderate to severe ground water level decides over the past 30 years.

PURPOSE, SCOPE, AND AUTHORITY

The purposes of the BMBGR study are groundwater protection, flood control, environmental enhancement, and agricultural water supply. It is projected that if the present agricultural usage remains constant, the current and future water needs of the basin cannot be met using present groundwater, surface water, rainfall, and storage systems. Water resource issues have been identified as critical for both agriculture and outdoor recreation within the Bayou Meto watershed. Project planning for the basin includes the identification of water resource problems, plans for groundwater protection and conservation, agricultural water supply, waterfowl management, environmental restoration and enhancement, and flood control in the lower portion of the basin.

Section 204 of the Flood Control Act of 1950 (64 Stat 174) authorized a project for flood control in the Grand Prairie Region and Bayou Meto Basin in eastern Arkansas. Due to lack of local sponsorship, the project was never funded and was subsequently deauthorized by Section 1001 (B) of the Water Resources Development Act (WRDA) of 1986 (33 U.S.C. 579A(B)). The project was conditionally reauthorized by WRDA 1996 and the scope of the project expanded to include ground water protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Act 1998, directed the Army Corps of Engineers (Corps) to initiate a reevaluation of the Bayou Meto Basin, and the FY 1999 and FY 2000 Appropriations Acts provided the necessary funding.

PRIOR STUDIES AND REPORTS

In September 1982 the U.S. House of Representatives Committee on Public Works and Transportation authorized the Corps to investigate the feasibility of water conservation and water supply improvements in the alluvial valley of eastern Arkansas. As a result, the Corps conducted the Eastern Arkansas Region Comprehensive Study (EARCS). The EARCS study area included all or part of the 24 counties in eastern Arkansas.

The Service has written three reports on the Bayou Meto Basin segment of the EARCS. In September 1959, the Service wrote a Fish and Wildlife Coordination Act Report providing comments to the Corps regarding the enlargement, realignment, and clean out of 188 miles of stream channel in the basin. The Bayou Meto Project met with strong opposition from a variety of groups and is not currently being considered.

In 1981 the Service sent a letter to the Governor of Arkansas which provided our views on the Corps' proposal to divert water from the Arkansas River to Bayou Meto. The letter stated that the diversion of water could be beneficial to fish and wildlife if minimum flows were guaranteed during low flow periods.

In 1989 the Service reviewed the preliminary project scope of work for the Eastern Arkansas Region Study, Bayou Meto section of the EARCS. In response, we wrote a planning aid report in March of the same year discussing possible project impacts and benefits to the study area and basin.

DESCRIPTION OF THE STUDY AREA

Located primarily in Arkansas and Jefferson Counties, the drainage area of Bayou Meto and its tributaries encompasses over 700,000 square miles in the central part of Arkansas. The BMBGR encompasses 779,109 acres between the Arkansas and White Rivers in east central Arkansas (Figure 1). Of this, 369,874 acres are irrigated and 22,942 are used for commercial fish ponds (Table 1). The major crops grown within the study area include rice (102,850 acres), soybeans (206,699 acres), and cotton (55,964 acres). About 49,513 acres of late soybeans are double

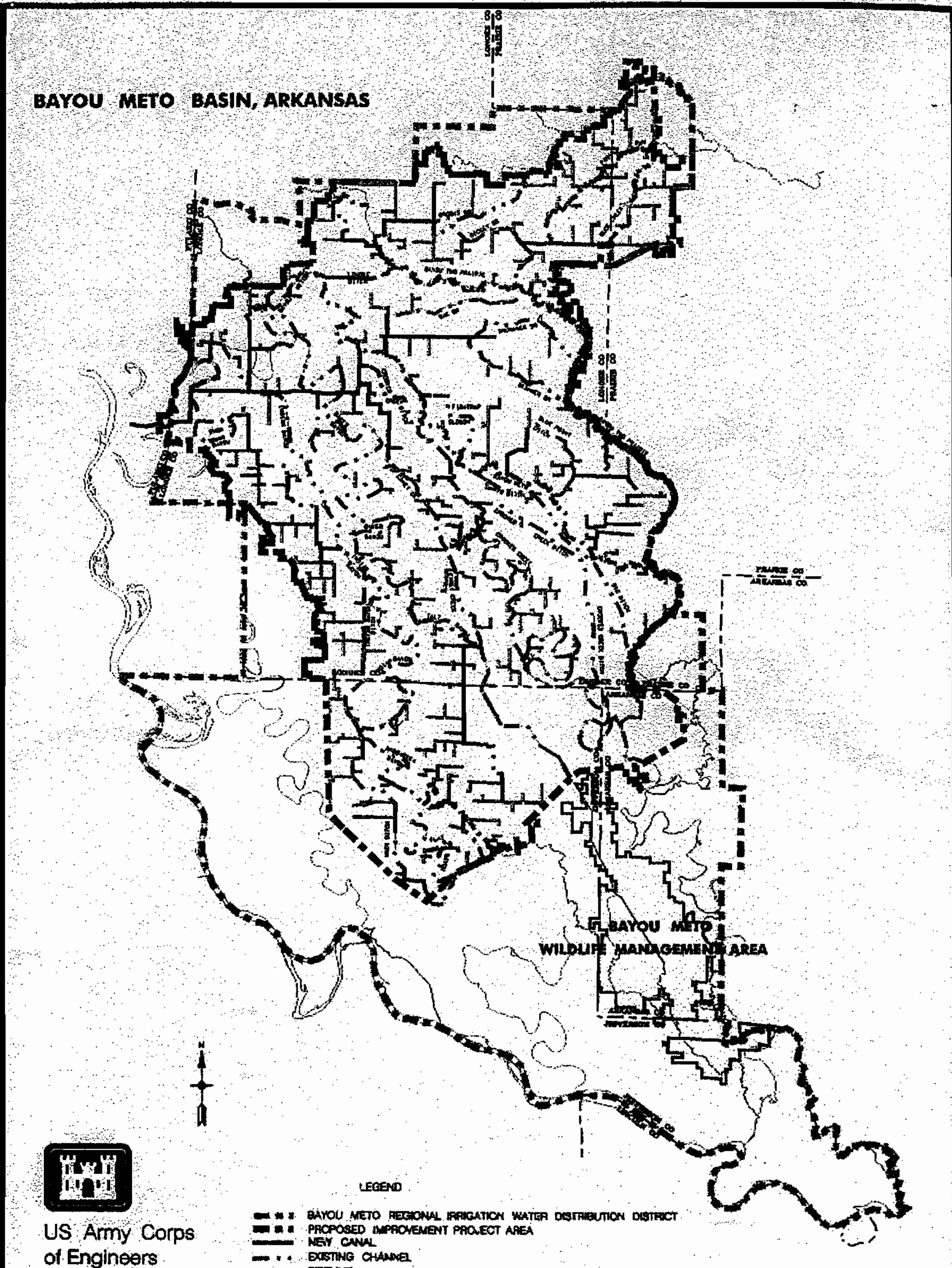

BAYOU METO BASIN, ARKANSAS
BAYOU METO
WILDLIFE MANAGEMENT AREA
N
US Army Corps
of Engineers
Memphis District
LEGEND
BAYOU METO REGIONAL IRRIGATION WATER DISTRIBUTION DISTRICT
PROPOSED IMPROVEMENT PROJECT AREA
NEW CANAL
EXISTING CHANNEL
PIPELINE

Figure 1

cropped with wheat. Pasture, hay, and Conservation Reserve Program (CRP) lands account for approximately 50,060 acres.

TABLE 1
CURRENT LAND USAGE IN STUDY AREA (NRCS 2000)

Land Use	Acres	Percent
Cropland	369,874	47
CRP	8,071	1
Pasture & Hay	41,989	5
Woodland	117,604	15
Reservoirs	7,350	1
Fish Ponds	22,942	3
Lakes, Streams, Other Waters	12,566	2
Other *	199,713	26
Total	**779,109**	**100**

* *This category includes roads, commercial/industrial, community services, and other uses.*

Most of the original vegetation in the study area has been removed or altered since the early 1900's. Historically, extensive, diverse forested wetlands and meandering waterways covered much of the basin. Since then, the majority of the Bayou Meto basin has been altered or converted to some form of agriculture or urban development (Table 2).

Approximately 166,000 acres of wetlands still remain within the Bayou Meto watershed. About 15 percent of these wetlands are concentrated in the lower section of the project area within the 33,800 acre Bayou Meto Wildlife Management Area (WMA), the 455 acre Smoke Hole Natural Area, and independent hunting clubs. A large corridor of wetlands in the study area also occurs along Bayou Two Prairie. Currently, data for the precise locations, size, and types of remaining wetland within the study area are still being gathered and analyzed. However, riparian corridors along most of the other streams and bayous within the watershed have become increasingly restricted and extremely fragmented. Many of the existing waterways in the project area have little or no wooded riparian area left, and in some areas the channels are so degraded and ill defined that they are almost non-existent.

TABLE 2

FARM DEMOGRAPHICS*
(U.S. Department of Commerce 1994)

	Arkansas Co.	**Jefferson Co.**	**Lonoke Co.**	**Prairie Co.**
No. Farms	490	351	836	401
Land in Farms (acres)	411,473	281,864	382,714	313,232
Avg. Size of Farm (acres)	840	803	458	781
Percent of Land Area in Farms	65	49.8	78.1	75.8
Total Cropland (acres)	357,491	256,926	326,004	268,327
Irrigated Land (acres)	272,596	79,624	169,789	157,005
Harvested Cropland (acres)	335,860	228,802	271,511	242,007
Woodland (non-pasture) (acres)	30,465	7,804	15,746	18,865
Pastureland (all type) (acres)	8,834	14,000	39,330	27,380

**Note*: Data are for entire counties. The study area encompasses only a portion of each county.*

Drainage within the project area is maintained by tributaries of the Arkansas River along with the numerous of streams, ditches, and bayous found throughout the area (Table 3). Most of the larger waterways within the BMBGR area are projected to be used as part of the project's irrigation system, transporting water to small diversion canals that will be created to convey water to adjacent farms.

TABLE 3
Some of the Major and Minor Waterways Located in the BMBGR Study Area

Major Streams	Lesser Streams	Ditches
Arkansas River*	Flat Bayou	Blue Point Ditch
Bayou Two Prairie	Shumaker Branch	Big Ditch
Bayou Meto	White Oak Branch	Main Ditch
Bakers Bayou	Caney Creek	Crooked Creek Ditch
Wabbaseka Bayou	Salt Bayou	Lonoke Ditch
Indian Bayou	Snow Bayou	Indian Bayou Ditch
Little Bayou Meto	Brooks Branch	Caney Creek Ditch
	Fish Trap Slough	Salt Bayou Ditch
	Ricky Branch	
	Buck Creek	
	Faras Run	

**Although the Arkansas River is outside the study area, it is included in the table as it will be used as the primary source of water for the irrigation project.*

The hydrology of the Bayou Meto Basin has been altered significantly since the turn of the century. Flood control, drainage projects, artificial flooding, waterfowl and wildlife habitat improvements, such as moist soil units and greentree reservoirs, have all impacted the area's natural hydrology. As a result of these modifications, the annual and seasonal patterns of water distribution, streamflow, water elevations, and flooding within the watershed are highly variable and often unpredictable (Gandy *et al.* 2000).

DESCRIPTION OF FISH AND WILDLIFE RESOURCES

The Bayou Meto basin area contains important fish and wildlife resources. Migratory waterfowl use the basin extensively during the winter months for feeding and resting. In addition, the scattered bottomland hardwood tracts located in the basin provide habitat for many game and nongame species.

Though approximately 166,000 acres of wetlands still remain within the Bayou Meto watershed (Gandy *et al.* 2000) most of the large contiguous forests no longer exist, though some fragments remain. Bayou Meto Wildlife Management Area (WMA), Smoke Hole Natural Area, hunting clubs, and Bayou Two Prairie contain the largest remaining tracts of bottomland hardwoods in the study area. However, even small narrow strips of hardwoods remaining along channels, bayous, and ditches are valuable and should be protected. They provide important travel corridors for wildlife in this predominately agricultural area.

Vegetation

Typically, the remaining native vegetative community types found within the Bayou Meto watershed include mixed oak-hickory upland deciduous forest, shortleaf pine-cedar forest, isolated tall grass and moist soil prairie remnants, bottomland hardwood forest, and cypress-tupelo swamps. Oak-hickory upland forest communities are found predominantly along the hills, ridges, and higher terrain in the upper section of the watershed. Representative species in these upland forests include various oak species, hickories, black walnut, sycamore, black locust, honey locust, persimmon, and elms (Gandy *et al.* 2000).

Some small remnants of prairie can still be found in the portion of the Bayou Meto watershed where it intersects with the Grand Prairie. There is evidence that indicates some viable prairie areas could still exist within the study area and a survey/data search should be made to locate any remaining prairie. Dominant native species of the prairie include three major grasses: big blue stem, switchgrass and Indian grass. Even though there are not any known large unimpacted prairie remnants within the study area, there is a potential for prairie restoration work within the basin and project area (Foti 2000).

Wildlife Resources

The majority of the remaining bottomland hardwood forests are found in and along the lower reaches of the study area. The bottomland hardwood forest communities vary with topography and the duration, frequency, and depth of inundation. The topography of the bottomlands include flat broad terraces, backwater swamps, oxbow/abandoned river channels, and ridges and swales. Depending on the hydrology and topography, the remaining bottomland forest ranges from cypress-tupelo oxbow swamps to mixed deciduous oak hardwood forests. Typically, these forested wetlands are dominated by a combination of oak species, hickory, persimmon, sweet gum, black willow, and bald cypress. Though fragmented, they are still among the most productive wildlife habits found within the Bayou Meto basin. Seasonally flooded forested wetlands provide habitat for white-tailed deer, fox and gray squirrel, mink, beaver, raccoon, red and gray fox, opossum, cottontail and swamp rabbit, eastern wild turkey, wood duck, mallard, song birds, reptiles, and amphibians.

Tupelo gum and bald cypress, which experience prolonged or permanent flooding, are used extensively by migrating waterfowl for feeding, resting and, in the case of wood ducks and hooded mergansers, nesting and roosting. Also, such diverse wetlands as these support mink, beaver, herons, egrets, and numerous reptiles and amphibians (Gandy *et al.* 2000).

Fishery Resources

Significant fishery resources in the BMBGR include four main aquatic habitat types: streams/bayous, oxbow lakes, multipurpose reservoirs, and the lower reach of the Arkansas River (Table 4). The diversity of fish species found in the Bayou Meto watershed has changed noticeably over the past several decades. Surveys conducted by state and federal agencies in the past recorded a total of 79 species of fish within the watershed. However, surveys taken between May 1991 and September 1992 found only 64 species present (Long 2000).

Aquatic species have shown a significant decrease in productivity that can be traced back to the highly turbid water of the area. In the past, the fisheries in the study area streams varied from poor to good. Losses of instream and riparian habitat along the basin's waterways have resulted in increases in siltation and turbidity and elevated water temperatures. In addition, lack of buffers on waterways, channelization, industrial pollution, loss of instream flows during summer months due to crop irrigation, lack of rainfall, and agricultural runoff from thousands of acres of agricultural lands have contributed to a decrease in stream productivity.

In spite of habitat degradation, the BMBGR provides habitat for a number of recreational and commercially important fish species. Carp, buffalo, white crappie, and largemouth bass are found in the oxbows, lakes, and streams. The predominant forage species in the area is the gizzard shad, while the primary predator species are gar and bowfin (Gandy *et al.* 2000).

The fisheries of the Arkansas River can vary from fair to good depending on river conditions. Variations result largely from the sediment deposition and elevated turbidity levels that accompany seasonal flooding. Principal game and commercial species of the river include, largemouth bass, crappie, bluegill, catfish, striped bass, paddlefish, buffalo, carp, and gar.

Endangered Species and Species of State Concern

The Endangered Species Act (ESA) (87 Stat. 884, as amended 16 U.S.C. 1531 et seq.) requires consultation with the Service regarding any federal action that may effect any endangered or threatened species. The threatened American bald eagle (*Haliaeetus leucocephalus*) and the endangered interior least tern (*Sterna antillarum athalassos*) are migratory birds found along the Arkansas River and its tributaries in the study area.

Several plant and animal species are rare or endemic to Arkansas. Some examples of species of state concern recorded in the proposed project area include birds such as Swainson's warbler and the yellow-crowned night-heron. Plant species of concern include prairie evening primrose, Arkansas sneezeweed, and corkwood (Osborne 2000).

DESCRIPTION OF PROPOSED PROJECT

Some of the major problems to be addressed in the BMBGR include agricultural flooding, loss of environmental resources, irrigation, water storage, and the depletion of the alluvial aquifer. The

TABLE 4
LAKES, OXBOWS, AND IMPOUNDMENTS WITHIN THE PROPOSED PROJECT AREA

County	Lakes/Oxbows (Natural)	Impoundments (large)	Impoundments (small)
Arkansas	1* Hufford Brake	9*	30*
Jefferson	2* Patton Lake	20*	20*
Lonoke	18* Carlee Brake Nelon Brake Anthony Brake Cash Brake McGregor Brake Jordan Brake Piney Brake Coburn Brake Bearskin Lake Snow Brake Bullneck Brake North Bayou	209* Peterson Lake Parker Lake Youny's Pond	396* Big Pond Little Pond Burlesons Pond Reservoir Number 1
Prairie	1* Horseshoe Lake	32* Vaught's Reservoir Lake Treadway	130* Omni Pond

**Unnamed water bodies and/or fish ponds.*

project objective is to develop a plan/project to protect and conserve groundwater resources, reduce flooding and relieve drainage problems, and restore and enhance the environmental resources in the area (Corps 1998). Studies to address the total spectrum of the project's resource problems and opportunities are still being formulated and developed. The following are descriptions of potential project features based on data and information obtained to date.

Groundwater

The authorized purpose of the proposed project is groundwater protection and conservation. Groundwater studies were conducted by the U. S. Geological Survey and the University of Arkansas, in coordination with the Corps and the state of Arkansas. Approximately 88 percent of the basin's irrigation water is currently pumped from the alluvial aquifer. This rate of pumping is depleting the aquifer. To provide adequate groundwater recharge, pumping would have to be reduced to a level that would provide only 39 percent of current use (Corps 2000).

On-Farm Conservation and Improvements

The on-farm water management element of the project plan will consist of conservation measures. The conservation measures would use a combination of improved irrigation techniques, additional on-farm water storage systems, and the retrofit of existing irrigation system components into the project's irrigation plan.

Approximately 738 miles of new pipeline will be designed and installed for the most efficient on-farm conveyance and management of water. Nearly 312 miles of tailwater recovery systems will be created to collect, store, and transport runoff and tailwater for reuse on the farms. Water control structures will be installed in streams and ditches to help maintain water levels, divert flows, and flood crop land for winter waterfowl. It is projected that 10,539 acres of new on-farm storage reservoirs will be constructed to handle water needs during critical irrigation months. The reservoirs would be filled using runoff, rain water, tail water, and imported water. Pumping stations would be required to move water through the irrigation system, divert water from the system, and fill reservoirs.

Import of Water

At present, approximately 88 percent of the agricultural water supply comes from ground water. If farming practices and crop production remain unchanged, it is projected that the current and future water needs of the Bayou Meto basin cannot be met using the existing sources of groundwater, surface water, rainfall, and current storage systems (Corps 1998). An alternative would be to supplement current water sources with imported water. Based on studies to date, ground water could provide 39 percent of irrigation needs, on-farm storage 16 percent, with natural runoff/tailwater recovery accounting for 10 percent of the water needed. An additional 35 percent would be needed to make up the projected water deficient. The project proposes to provide the additional water by importing it from an outside source. The Arkansas River is the only nearby source of permanent water with the quantity necessary to offset the projected deficit.

A plan is being developed to divert flows from the Arkansas River just north of David D. Terry Lock and Dam at River Mile 109. Water would then be transported to farms along 81 miles of new canals, 383 miles of existing waterways, and 270 miles of pipelines. Water control structures would also be developed along the route to help control runoff rate and trap sediment (Corps 2000).

Flood Control

Frequent flooding occurs for various reasons throughout the Bayou Meto basin. Though the basin is naturally prone to flooding, flood control along with channelization, forest removal, and farming and development in floodplains have combined to exacerbate the problem. The lower portion of the study area along Bayou Meto and within the Bayou Meto WMA are the areas most impacted by excess water. Features being evaluated to reduce flooding in these areas include improved drainage and water management through channel improvements, water control structures, and pumping stations.

In the past the Bayou Meto WMA has had problems with prolonged flooding during the growing season. This prolong flooding has damaged or destroyed hundreds of acres of wooded wetlands. The Corps is coordinating closely with the Bayou Meto WMA on the development of design elements that will help elevate this flooding problem (Corps 2000).

Environmental Features

A major emphasis will be placed on the formulation of environmental project features. Measures will be designed into the proposed project for the creation/restoration of wetlands and the enhancement/restoration of fish and wildlife habitat. Moreover, all alternative plans will also include project designs for increasing waterfowl feeding and resting habitat, improvement of water quality, and the protection of existing surface and groundwater resources (Corps 1998).

Properly designed, many of the proposed on-farm reservoirs would benefit shorebirds, waterfowl, and the resident wildlife in the area. Sloping bottoms would expose mudflats during reservoir drawdowns. In larger reservoirs brushy islands could be created to provide nesting habitat for many bird species; while rough bottoms and sunken trees could provide fishery habitat.

The flooding of rice and soybean fields would also provide additional feeding and resting areas for winter waterfowl. During the spring, shorebirds are most often observed on mudflats and on rice fields with little cover.

FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

Historically, this watershed was known for its high diversity of wildlife and supporting habitat. However, intensive agricultural activities and urban development in the basin have led to a decline in fish and wildlife habitat, which in turn has resulted in a basin wide decline in resident and migratory species.

Agricultural Practices

Most of the land in the study area has been converted to some form of cultivated or aquatic agriculture. One of the main project objectives is to maintain irrigated agriculture and aquiculture at their current levels, while sustaining the basin's aquifer. However, if this project goes forward, the readily available irrigation water should not be allowed to be used as a reason to convert more land to agriculture.

The majority of the farmland has been converted primarily to the high water usage soybean and rice crops. In many instances the land has been cleared and is farmed right up to the streambanks. Loss of stream buffers and riparian habitat have led to bank erosion and heavy siltation in some channels, severely limiting their carrying capacity. In addition, the removal of bottomland forest, riparian areas, and lack of buffers along water systems have combined to create many short and long term problems throughout the basin. Serious sediment deposition problems exist throughout the project area. Soil conservation practices such as fall plowing, clean tillage farming, and the growing of a single crop with no fall cover crop are common in the basin area. These types of soil conservation practices has resulted directly and indirectly to sheet erosion, sediment deposition, elevated turbidity levels, and agricultural chemical runoff throughout the project area (Inmon 1989). In recent years, techniques such as no till farming have been developed, and proved successful, in decreasing both soil erosion and the amount of fertilizer need for crop production.

In addition, in stream flows are greatly reduced during the summer months due to lack of rainfall and excessive withdrawals for high water consumption crop irrigation. Heavy use of ground and surface water for the irrigation of rice and soybeans, and urban development have seriously impacted the basin's water system, the diverse fish and wildlife habitats which depend on it, and its aquifer.

Flooding

Within the BMBGR study area, both flooding and drought conditions can occur annually. Stream flows in the area are generally highest from December through May, due to increased precipitation. Streams often have insufficient flow to support a healthy fisheries population from June through November because of low rainfall and high demands for irrigation water.

Stream gradients change little throughout the lower section of the study area. Streams and bayous are meandering, often multichanneled and braided. In addition, heavy soils and improved drainage in the upper portion of the project area contribute to drainage problems and late season flooding of agricultural and forest land in the lower part of the study area. Prolonged innundation has resulted in the loss of timber, the conversion of some stands to less wildlife desirable species, and water control problems within Bayou Meto WMA. Flood control alternatives will be developed at the outlet of Bayou Meto to help alleviate this problem.

Many of the basin's flood problems can be traced back to the widespread clearing of woodlands, development of farm drainage systems, landleveling, and channelization of waterways. With the clearing of forest and filling of natural topographic features, such as ridge and swale areas, the channel capacity of some streams is overloaded by unchecked water runoff during storm events. Channelization typically shortens channel length, actually lessening the carrying capacity of some streams. In other cases, though it may provide a degree of flood relief in the immediate area, the peak flows surge downstream increasing flooding. Problems are further compounded by the destruction of riparian areas and farming along the edges of the streams. Such practices often result in bank destabilization and increased sedimentation, further reducing the system's carry capacity (Neves *et al.* 1997).

Contaminate Issues

Bayou Meto is one of the primary waterways that flow though the study area and is slated to carry a large portion of the project's irrigation water. The bayou is a low gradient, highly turbid, warm water stream originating near Jacksonville, Arkansas. In the 1970's, the bayou was contaminated with dioxin from Vertac Chemical, Inc. after metal drums buried on site began to leak. Dioxin is a generic term for a group of extremely toxic polychlorinated compounds, with TCDD (2, 3, 7, 8-tetrachlorodibenzo-*p*-dioxin) being the most toxic synthetic compound ever tested.

Rocky Branch, a tributary of Bayou Meto, traverses the Vertac site and received effluent containing dioxin from the contaminated site. Dioxin contaminated effluent then entered Bayou Meto from both the Jacksonville Sewage Treatment Plant and Rocky Branch. Elevated levels of dioxin resulted in the Vertac site being designated as a Superfund Site, the Arkansas Game and Fish Commission closing the entire length of Bayou Meto to commercial fishing, and the Arkansas Department of Health and Human Services closing it to all fishing between Rocky Branch and the highway I-40 bridge in 1980. Vertac Chemical ceased operation in 1986, but sampling in the early 1990's revealed elevated TCDD levels in the soils, duck eggs, and fishes in and around Bayou Meto, downstream of Jacksonville.

More than 12 years after the dioxin was discovered, the fishes and sediment from Bayou Meto still showed elevated levels of TCDD, though the levels have declined since the initial tests were conducted. Current data indicates that concentrations of TCDD lessen the farther they get from the point source (Johnson *et al.* 1996). There is reason to believe that the level of TCDD will continue to decline over time if conditions remain stable. However, the possibility of releasing dangerous amounts of sediment suspended TCDD into the water system during any channel work should be taken into account and studied during the initial planning phase of the project. Also, the method of disposal of contaminated sediment should be addressed in future project development.

The Spread of Non-Native Zebra Mussels *(Dreissena polymorpha)*

The zebra mussel has spread through many freshwater systems in the United States since being introduced into Lake St. Clair, Michigan in 1986. An aggressive species, by 1994 the mussel had been documented as far south as New Orleans. The zebra mussel is a prolific breeder and establishes dense populations once it enters a water system. Unlike native mussels which burrow in the sand and mud, the exotic invader spends its adult life attached to hard substratum. Because of this, native freshwater mussels are sometimes heavily impacted by zebra mussel colonization. The impacts from these mussels can be so devastating that it can cause the decline or extirpation of native mussels.

Other impacts caused by these mussels include clogging of water intake pipes, fouling of boat hulls, and diminished fish yields in areas supporting dense populations (Greg 1998). This issue should be addressed in all planning alternatives since the proposed water source for the project, the Arkansas River, is heavily infested with zebra mussels.

Availability of Bird Habitat

Wetlands within the study area are a critical part of the ecosystem for migrating and wintering waterfowl. Located between the White and Arkansas Rivers, the flooded wetlands within the project area provide optimal habitat for waterfowl. Flooded habitat in the bottomlands and flats within the lower basin combine with the wooded wetlands in Bayou Meto WMA to support over 60,000 ducks and 15,000 geese during peak winter periods (Gandy *et al.* 2000). Some of the primary species the study area provides food and cover for are the northern pintail (*Anas acuta*), blue- and green-winged teal (*Anas discors* and *Anas crecca*), gadwall (*Anas strepra*), American wigeon (*Anas americana*), canvasback (*Aythya valisineria*), ring-necked duck (*Aythya collaris*), and snow and Canada geese (*Chen caerulescens* and *Branta canadensis*). The forested wetlands provide important waterfowl wintering and resting areas, and breeding habitat for the wood duck (*Aix sponsa*) and hooded merganser (*Lophodytes cucullatus*).

A portion of the study includes developing and analyzing project features for the creation and enhancement of waterfowl habitat. The Bayou Meto Basin, and thus the project area, is one of the high priority habitat areas for waterfowl habitat protection and enhancement. Specific conservation strategies for these critical areas along the Mississippi Flyway should include the development of waterfowl habitat on private lands, increasing the waterfowl carrying capacity on public lands, and incorporating waterfowl conservation into the planning, construction, and operation of water resource development projects (Gregg 1993). Although hunting clubs and the Bayou Meto WMA have constructed greentree reservoirs (GTR's) and installed water control structures to increase winter habitat for migrating waterfowl, there is still an overall scarcity of resting and feeding areas in this part of the flyway. The flooding of additional lands for migratory waterfowl could help to reverse or modify some of the activities that have destroyed or degraded the basin's habitats. However, if mismanaged GTR's can cause degradation and loss of bottomland hardwood habitat. Flooding GTR's too early or dewatering them too late could lead to forest degradation from the timber mortality and a shift toward less desirable vegetation characteristic of wetter habitats. There is a growing concern that if more water is readily available during the fall, as would be provided by this project, hunting clubs and management areas would flood GTR's before trees become dormant.

The development of a plan to provide habitat for other birds such as neotropical migrants and marsh breeding birds (e.g., bittens, rails, and herons) should also be considered. Special effort should be placed on the reestablishment or enlargement of forested areas within the project area as designated by the Mississippi Alluvial Valley Migratory Bird Initiative (Mueller *et al.* 1999). The Bayou Meto and Big Ditch Bird Conservation Areas are in the proposed BMBGR project area (Figure 2). Reforestation of these bird conservation areas would greatly benefit breeding songbirds.

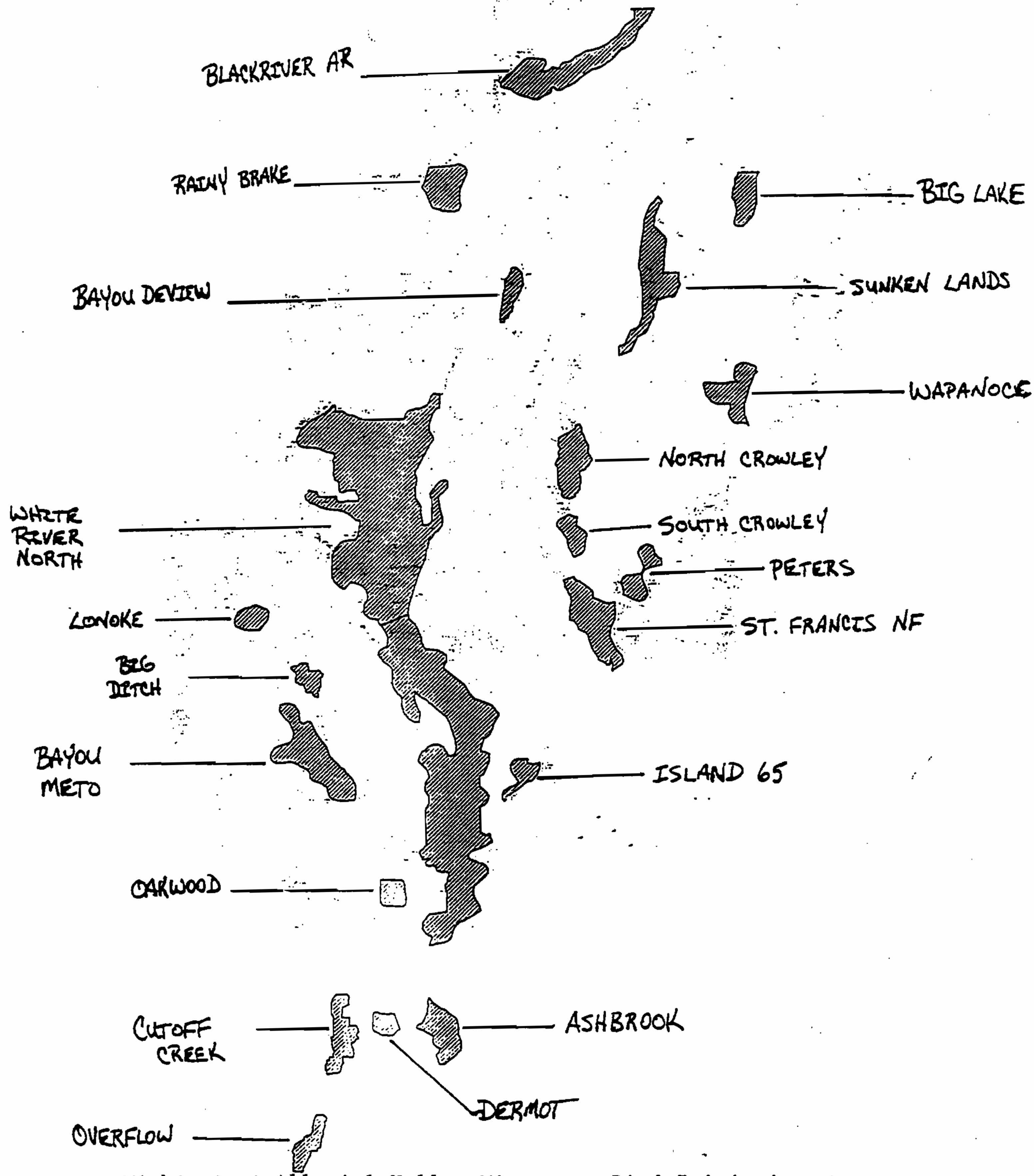
Additional features for songbirds and waterfowl could include the widening of buffer areas along all water systems in the project area, and the restoration of prairie areas, marsh, and riparian/flood plain habitat. The creation of informational parks in combination with wildlife enhancement and viewing areas should also be considered as part of the project.

Water held on rice fields during the breeding season (May–July) could provide important feeding areas for species of birds dependent on these vanishing habitats. In fact, a possible environmental feature for the BMBGR could be the creation of permanent marsh type wetlands in the study area. Plans to increase marsh and shorebird foraging habitat should also be considered when designing irrigation reservoirs as over thirty-one species of shorebirds migrate through Arkansas annually.

Planning Objectives

The Service recommends that the following planning objectives be incorporated into any future planning studies, in order to protect and improve the fish and wildlife resources in the proposed project area.

1. Protect and improve water quality and fishery resources in the project area.
2. Increase the number, width, and length of wildlife corridors in the project area.
3. Implement Best Management Practices (BMPs) on all agricultural lands.
4. Protect and increase the amount of forested and herbaceous wetlands within the project area, especially in the areas identified by the Mississippi Alluvial Valley Migratory Bird Initiative.
5. Increase all types of wintering waterfowl (resting and feeding) habitat in the project area.
6. Prevent increased contamination in the project area.
7. Increase the size and quality of any remaining pockets of relic prairie areas.
8. Restore natural channels in the project area, their riparian areas, hydrologic flows, and fisheries.



Mississippi Alluvial Valley Migratory Bird Initiative Map

Figure

POTENTIAL IMPACTS

Due to the preliminary nature of the BMBGR most of the potential project impacts cannot be quantified at this time. However, possible project impacts to the area's fisheries, wildlife, terrestrial, and aquatic habitats are discussed in this section in qualitative terms.

Stream and Fishery Impacts

Implementation of this project would result in the creation of new channels, excavation and/or restoration of existing channels, and the importation of water from the Arkansas River. Potential impacts from these actions include, but are not limited to, the following.

1. Removal of riparian vegetation/wildlife corridors during channel work and possible resulting increased streambank instability.
2. Removal of instream fisheries habitat and cover, channel roughness, and modification of channel morphology.
3. A reduction in stage, frequency, and the duration of overbank flooding.
4. An increase in stages during May through October.
5. The importation of zebra mussels into the Bayou Meto basin system from the Arkansas River.
6. An increase in the dioxin, pesticides, and contaminates suspended within the water systems resulting from channel modification.
7. Wetland losses from channel modification and/or the location of on-farm storage features.
8. Impacts to the Arkansas River, and its fisheries as well as the tributaries and lakes it supports.

Removal of streamside vegetation during channel work would result in increased bank instability and a loss of runoff filtering vegetation. The removal of shade producing vegetation along the banks and over the stream can cause a rise in water temperature and decreased dissolved oxygen levels. Riparian vegetation removal, the subsequent loss of its filtering capability, and an increase in sediment entering the system from farm run-off could result in increased amounts of pesticides, trace metals, and excess nutrients entering the water systems.

Though generally for a short duration, channel work increases the suspended sediments in the water system. Turbidity also increases with the increases in velocity, erosion, and sediment transport associated with dredging and other channel work and the initial erosional post construction phase. Increased turbidity would smother and kill benthic organisms, which larger animals depend on for food. Further, increased turbidity levels result in decreased levels of light penetration and reduced levels of photosynthesis, which are necessary for a healthy aquatic ecosystem.

Removal of stream sediment could also temporally increase the amount of pesticides and trace metals in the water column, making the substances more biologically available. Contaminates such as persistent organochlorine pesticides (DDT, toxaphene), TCDD (Bayou Meto), polychorinated biphenyls, and trace metals could be resuspended in the water column during sediment removal making them available for ingestion by fish, mussels, crayfish, and other aquatic organisms.

Increasing the flow capacity of streams and bayous could prevent them from seasonally flooding the bottomland hardwoods within their floodplains, an important part of this wetland's seasonal cycle. The reduction in overbank flooding would reduce the inflow of organic material into the water systems. Detritus is one of the base links in the aquatic and terrestrial food chains. Reduction in overbank flooding would also reduce spawning and nursery habitat for fish and their fry. In addition, the increased velocity associated with channel clean outs would reduce resting and feeding habitat for many of the fish species. Some new fishery habitat would likely be created through the construction of diversion canals. However, these habitats would be of low quality due to the uniform channel design, agricultural pollution, sediment deposition, high turbidity levels, and bankfull stages during the summer and fall.

The Arkansas River is the proposed water source for the irrigation portion of the project. If done improperly pumping water from the Arkansas River could lower levels enough to adversely affect the river's fisheries and its supporting habitat. Studies should be done to determine the amount of water that can be removed from the river at any given time and still maintain adequate flows to protect the river, its oxbow lakes, and the tributaries it supports.

The Arkansas River is heavily infested with the exotic zebra mussel. The zebra mussel has spread throughout several of the freshwater systems in the United States since its introduction. Excellent filter feeders, an adult zebra mussel is able to filter up to one liter of water per day, potentially resulting in food competition with other native aquatic organisms. Removal of a large proportion of plankton at the base of the food chain could diminish the energy available for fish production. In addition, native freshwater mussels are extremely susceptible to zebra mussel colonization, which may lead to the mortality of the host mussel.

Possible improvements/enhancements to the aquatic resources of the project area from the implementation of the Bayou Meto project include, but are not limited to the following.

1. Re-open/restore natural waterways within the study area, such as Indian Bayou, that have been bypassed, channelized, or degraded.
2. Add water to systems normally heavily impacted by irrigation water withdrawals.
3. Re-establish and expand riparian areas to improve water quality and to help regulate water temperatures.

<u>Terrestrial Impacts</u>

Though most of the Bayou Meto basin has been cleared for some form of agriculture, aquiculture, or urban development, there still remains the potential for significant wetland impacts. Even small or narrow areas of wooded wetlands are valuable, offering food, shelter, and resting areas for small mammals, songbirds, and other wildlife species. Poorly designed or located reservoirs and canals could cause further fragmentation of these wetland habitats. Care should be taken to locate and design channels through agricultural land to reduce possible impacts to wildlife and wetland habitat. In addition, the augmentation of project supplied irrigation water should not be used as a justification to convert more wetlands to agriculture.

Possible improvement to terrestrial resources of the Bayou Meto project area from the implementation of the proposed project include, but are not limited to, the following.

1. The design and enhancement of on-farm reservoirs to benefit shorebirds and other wildlife.
2. The Installation of Best Management Practices (BMP) on all agricultural land.
3. An increase winter waterfowl resting and feeding habitat by the timely flooding of agricultural fields.
4. The re-establishment or expansion of wildlife corridors.

RECOMMENDATIONS

The National Environmental Policy Act (NEPA) and the Service Mitigation Policy both state that projects should be sequentially planned to first avoid adverse impacts, then to minimize impacts, rectify the impacts, reduce or eliminate the impacts over time, and finally to compensate for unavoidable impacts to fish and wildlife habitat. To comply with the mitigation policy and to achieve the aforementioned planning objectives, the Service has formulated the following potential conservation measures and recommendations:

1. Locate on-farm irrigation reservoirs, tailwater recovery systems, and canals away from any wetlands and natural heritage sites.

Although a high percentage of the bottomland hardwoods has been cleared in the BMBGR, some corridors and isolated areas remain. Even small or narrow areas of wooded wetlands are valuable, offering food, shelter, and resting areas for small mammals, songbirds, and other wildlife species. In addition, bottomland hardwoods and riparian forest provide beneficial nutrient input into the aquatic ecosystem and help control erosion. Trees also provide shade and are an important source of detrital material. They provide an important source of food and nutrients to stream ecosystem as well as helping to control extreme water temperatures and the interrelated dissolved oxygen fluctuations. In order to protect these areas all new canals should be routed through cleared agricultural lands. It cannot be emphasized too strongly that all on farm reservoirs and tail water recovery systems should be located away from wetlands.

2. Design on farm reservoirs with wildlife enhancement features.

If properly designed and operated, on farm reservoirs could benefit shorebirds, waterfowl, fisheries, wildlife, and help conserve the alluvial aquifer. Whenever possible, maintain and enhance shorebird habitat by designing multipurpose on farm storage. Sloping bottoms would expose mudflats during water withdrawal. On the deeper reservoirs, rough bottoms and submerged structures would provide fisheries habitat and leave pools of water for wildlife during water drawdown. Vegetated islands within the reservoir would create feeding and nesting habitat for birds.

3. Establish minimum flows on the Arkansas River to protect its fisheries and other aquatic resources, as well as the tributaries and lakes it supports.

It is possible that pumping water from the Arkansas River could lower levels enough to adversely affect the river's fisheries and its supporting habitat. Though the Arkansas Soil and Water Conservation Commission has established minimum flows for the Arkansas River, these studies should be reviewed to determine if the minimum flows they have established will be adequate to protect the river's various resources. Also, a water management plan with minimum flow determinations for the river and the project area's waterways should be developed and in place before the start of the proposed project.

4. Investigate alternatives to stream cleanout and allow some overbank flooding in selective areas.

As project planning progresses problem channel reaches will be identified and studied. Channel areas will then be categorized as no work reaches, stream obstruction removal sections, clean-out (sediment) reaches, and restoration segments (Corps 1998). These activities could alter channel geomorphology, fisheries, and remove important riparian habitat. Although stream alteration is sometimes deemed necessary for land protection, other alternatives should be explored as well. Instead of channelization or other flood control techniques, it may be more advantageous to restore the natural channel contours and riparian areas and allow some natural out of bank flow. Without flooding, fish are denied access to feeding and breeding areas, fish reproductive success is reduced, production of instream fish food organisms declines, and the stream fishery suffers. In addition, shallow aquifers are not given a chance to recharge, thereby reducing the amount of water available for consumption (Hubbard *et al.* 1993).

Nonstructural flood damage reduction should be investigated. A voluntary program to purchase or obtain easements of floodplain areas should be designed and established. These areas could then be reforested and allowed to flood naturally, helping to reestablish the natural flood and draw down pattern historically followed throughout the Bayou Meto basin.

If stream cleanout is deemed necessary, the least environmentally damaging techniques should be developed and employed. Such methods could include working from one side and the use of standard stream obstruction removal guidelines.

5. Make farm Best Management Practices (BMP's) an intimate part of the project design.

Nonpoint source pollution is a severe problem in the basin. Inadequate soil management, urban, agriculture, and livestock runoff have all combined to degrade the water systems throughout the

Bayou Meto basin. In addition to the loss of instream and riparian habitat, decreased out of bank flooding, increased turbidity, chemical runoff, and siltation have combined to degrade the basin's valuable aquatic habitats. To help alleviate these impacts agricultural BMP's should be made part of any project alternative. BMP's such as minimum tillage, vegetated filter strips, and strip cropping would reduce the amount of sediment transport, and improve water quality, ultimately reducing the need for channel maintenance. Also, technical assistance of the Natural Resource Conservation Service should be sought to assist in the development and implementation of additional on farm BMP's.

6. <u>Avoid channel work in Bayou Meto.</u>

We recommend that channel work and sediment disturbance be avoided if at all possible on the upper reaches of Bayou Meto. All possible results should be carefully considered before any work is done within the bayou. Samples of fish, sediment, and water should be taken before, during, and after any work is done in Bayou Meto. Contaminant surveys conducted before project implementation would supply a baseline for future data analysis. The possible impacts of releasing dangerous amounts TCDD into the water system during any channel work should be taken into account and studied during the initial planning phase of the project. If proper precautions are not taken, the project could result in unacceptable contaminate levels. Also, the method of disposal of contaminated sediment should be addressed in future project development.

7. <u>Increase riparian areas and buffer strips to help protect and improve water quality and fishery resources in the project area</u>.

As part of the on farm channel project design, vegetated buffer strips should be placed along all new channels to help filter farm runoff and improve water quality. The reestablishment of wide riparian buffers along heavily impacted waterways would improve water quality, help regulate water temperature, improve fisheries, and create or expand wildlife corridors within the study area.

8. <u>Protect and increase the amount of forested and herbaceous wetlands in the project area.</u>.

Special effort should be place on the reforestation of the Big Ditch and Bayou Meto Bird Conservation Areas, as designated by the Mississippi Alluvial Valley Migratory Bird Initiative (Mueller *et al.* 1999).

9. <u>Increase all types of wintering waterfowl (resting and feeding) and other migratory bird habitat in the study area</u>.

One of the environmental features that should be built into the proposed project design is the development or enhancement of habitat for waterfowl and other migratory birds that use this part of the Mississippi Flyway.

Many species of shorebirds and waterfowl migrate from Arctic breeding grounds to Central and South American wintering grounds. The project area falls within this major migration corridor. To migrate successfully these birds require highly productive feeding areas along the route where they can rest and forage efficiently to replenish their fat reserves. During the fall and winter, flooded rice fields and fallow fields provide high quality habitat for migratory waterfowl.

10. Investigate ways to control the introduction of zebra mussels into the Bayou Meto basin and conduct mussel surveys where channel work is anticipated.

As previously mentioned, the exotic zebra mussel can have adverse impacts on species in the water system it invades. Studies should be conducted to address the issue of the importation of this species from the Arkansas River into the Bayou Meto Basin. Also, impact assessment mussel surveys should be made if any channel or bank work is anticipated

11. Develop recreation, marshes, and wildlife interpretive areas as part of the project.

A major emphasis in the BMBGR study will be placed on the formulation of environmental design features. The creation of informational parks and interpretive centers in combination with wildlife enhancement and viewing areas in marshes and other wetlands should be developed as one of the main environmental features of the project.

12. Restore old, by passed natural bayous and streams.

In the past some of the basin's natural channels and creeks were cutoff and man made ditches were created to convey their water. Future studies should address the possibility of restoring these natural channels, their riparian areas, hydrologic flows, and fisheries.

FISH AND WILDLIFE COORDINATION ACT ACTIVITIES FOR THE FEASIBILITY PHASE

During the feasibility phase of the study, the Service will be involved in the terrestrial and aquatic HEP studies. The Service will be responsible for preparing a Fish and Wildlife Coordination Act (FWCA) report as required by Section 2(b) of the Act. The report will evaluate alternative plans in detail and recommend measures to conserve fish and wildlife resources. In addition, we will prepare a waterfowl impact analysis for the proposed study area.

The Service will participate in interdisciplinary planning team meetings as well as coordinate with the Arkansas Game and Fish Commission and other state agencies to incorporate their concerns in to the FWCA. We will also attend public meeting pertaining to the BMBGR study.

To fulfill Service obligations under the FWCA and to fully evaluate each alternative developed, the following information should be developed and supplied to us during the feasibility phase.

1. The total amount of forested wetlands in the project area.
2. Specific descriptions of project features such as pumps, weirs, and dams, as well as the waterways to be used and projected modification that may be made to them. This information should include everything from clearing and snagging to channel cleanout.
3. Average annual seasonal acres flooded, with and without the project, by crop and land use type, during the period November through March.
4. The estimated amount of riparian habitat that would be removed during any channel work and its location.
5. The results of the fishery and terrestrial HEP's, as well as any aquatic and contaminant studies.
6. The Service will need transfer funding to cover all Fish and Wildlife Coordination Act activities.

DESCRIPTION OF EVALUATION METHODS

Wetland Data Collection Methods

Field investigations will be conducted throughout the project area to determine existing project area conditions, evaluate significant environmental features, and potential changes to the resource from project development and implementation. Wetlands and other important environmental features will be identified using satellite imagery and geographical information system techniques (GIS) and verified through field investigations. GIS technology will be used to help assess direct construction impacts to wetlands and other impacts associated with project induced hydrologic changes. In addition, topographic, vegetative, and hydrologic data will be developed to further analyze possible project impacts on wetland functions.

Terrestrial Data Collection Methods

Habitat Evaluation Procedures (HEP) will be used to help determine the quality of terrestrial habitat. An inter-agency team of biologists will be created to select appropriate evaluation species and to develop sampling criteria. HEP along with GIS information will be used to determine the magnitude and duration of possible project impacts, along with the project's potential aquatic and terrestrial restoration benefits.

Aquatic Data Collection Methods

The Service will review and evaluate data generated by steady flow hydrologic models which will be developed for each of the streams used in the irrigation delivery system and in the areas where flooding is considered problematical.

Potential losses of fish in the Arkansas River during water diversion to the Bayou Meto basin will be evaluated. Determinations of the effects of diversion canal construction on adjacent habitats (e.g. wetlands, oxbow lakes) will be made during the study. In addition, the possible benefits to fish resulting from increased water levels and the impacts of flood control activities on the fishes in the lower Bayou Meto basin will be quantified using HEP. HEP methodology will also be used to calculate benefits to fisheries associated with the enlargement of canals. The Service will assist in cover surveys to estimate the amount of riparian habitat that will be removed during channel modification.

Fisheries Data Collection Methods

The Corps' fishery evaluation scope of work (Kilgore 1999) for the proposed project lists the following as studies to be incorporated into the project:

1. The evaluation of potential loss of fishes from the Arkansas River during water diversion into the Bayou Meto basin.
2. The evaluation of diversion canal construction impacts on adjacent habitats including, but not limited to, oxbow lakes and bottomland hardwoods.
3. An estimation of the possible benefits of increased water levels in receiving streams and canals on habitat and fisheries.
4. The collection of data to quantify impacts of flood control activities on the channel and floodplain fishes in lower section of Bayou Meto.

Field collections will be used to determine the distribution of fish, including ichthyoplankton (eggs and larvae), at the diversion site during the irrigation season. Potential losses from the Arkansas River into the basin will evaluated during the irrigation season (April-September) near the site of the diversion canal.

Field data from proposed water diversion receiving streams and canals will be collected during the summer when effects of water diversion would be most pronounced. Fish diversity will be calculated for each sample and used as the dependent variable in Habitat Suitability Index (HSI) models, which will be used as part of the aquatic HEP. The benefits or adverse impacts of water diversion from the Arkansas River to the streams and canals in the BMBGR will be quantified using HEP. HSI models will be developed from the field data obtained from the sampling sites and used to calculate the Habitat Units (HU) for the 640 miles of streams that will be influenced by the project. In addition, HU's will be calculated for any of the proposed channels that are deemed large enough to support viable fish populations (Corps 1998).

Although changes in water surface elevation in the navigation pool is not anticipated at this point, construction activities at the diversion facility may alter the hydrology of some of the oxbow lakes. Baseline field data will be used to determine potential effects on fish communities, including species of special interest, such as the paddlefish. HEP will be used to quantify the impacts of the flood control portion of the project on river and floodplain habitats (Kilgore 1999).

SUMMARY OF FINDINGS AND SERVICE POSITION

Due to the preliminary nature of the BMBGR study, the Service has not been able to analyze the full scope of the proposal, and therefore has developed no position on the project at this time. The concerns, conservation methods, objectives and recommendations identified in this report should be considered in future project planning.

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SECTION II

COORDINATION

Part A. Fish and Wildlife
2. Coordination Act Report

IN REPLY REFER TO:

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1500 Museum Road, Suite 105
Conway, Arkansas 72032
Tel.: 501/513-4470 Fax: 501/513-4480

November 21, 2006

Colonel Charles O. Smithers
U.S. Army Corps of Engineers
167 North Main Street, Room B-202
Memphis, TN 38103-1894

Dear Colonel Smithers:

Attached is the final Coordination Act Report relative to the Bayou Meto Basin, Arkansas, General Reevaluation. The information and recommendations contained in this report are submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. et seq.) and in coordination with the Arkansas Game and Fish Commission (AGFC). A letter from the AGFC is provided as an attachment to this report. This constitutes the final report of the Department of Interior, Fish and Wildlife Service, as required by Section 2(b) of the Act. A Waterfowl Appendix to this report detailing project effects upon waterfowl carrying capacity and a Shorebird Appendix regarding the habitat needs of shorebirds are attached.

We appreciate the opportunity to provide these comments and commend the aid provided by your staff throughout the planning stage of this project. We hope to continue working closely with the Corps and other involved agencies if this project is funded. Should you or your staff have questions about this report, please do not hesitate to call me.

Sincerely,

Margaret Harney

Margaret Harney
Acting Field Supervisor

cc: Arkansas Game and Fish Commission, Little Rock, AR
Arkansas Natural Heritage Commission, Little Rock, AR
Natural Resources Conservation Service, Little Rock, AR
FWS, Regional Office, Atlanta, GA
Environmental Protection Agency, Dallas, TX
Arkansas Soil and Water Conservation Commision, Little Rock, AR
Arkansas Department of Environmental Quality, Little Rock, AR
Ducks Unlimited, Little Rock, AR
Bayou Meto Irrigation District, Lonoke, AR

Final Fish and Wildlife Coordination Act Report

on the

Bayou Meto Basin, Arkansas, General Reevaluation

Prepared by

Jason W. Phillips
U.S. Fish and Wildlife Service
Arkansas Field Office
Arkansas Delta Suboffice
Augusta, Arkansas

November 2006

Executive Summary

This final Fish and Wildlife Coordination Act (FWCA) report contains the findings and recommendations of the U.S. Fish and Wildlife Service (Service) pertaining to the Memphis District (in conjunction with the Vicksburg District), U.S. Army, Corps of Engineers' (Corps) Bayou Meto Basin, Arkansas, General Reevaluation. It has been prepared and is submitted in accordance with the FWCA (48 Stat. 401, as amended; 16 U.S.C. et seq.). This report discusses the impacts of the authorized project on the fish and wildlife resources, outlines conservation measures to address fish and wildlife resource concerns, and recommends mitigation measures to offset unavoidable fish and wildlife resource losses. This document constitutes the report of the Service as required by Section 2(b) of the Act.

The study area is located in portions of Arkansas, Jefferson, Lonoke, Pulaski, and Prairie Counties within the Arkansas and White River basins. The vast majority of the project area is located within the Arkansas River basin and encompasses numerous streams including Bayou Meto, Little Bayou Meto, Wabbaseka Bayou, Indian Bayou, Bayou Two Prairie, Salt Bayou, Boggy Slough, Crooked Creek, and their tributaries. The extreme northeastern portion of the project area contains streams draining into Wattensaw Bayou, a tributary of the White River. The Arkansas River, despite significant modifications to facilitate barge navigation, remains an important recreational fishery.

Important wildlife habitats within the 779,109 acre project area include the Bayou Meto Wildlife Management Area (WMA) and Forest Bird Conservation Area (FBCA) and the

Big Ditch FBCA. These two areas provide the largest core acreages of bottomland hardwood habitats in the project area with 15,618 acres and 2,216 acres, respectively, of unfragmented forest. The total amount of forested habitat in these areas is 52,384 acres and 10,732 acres, respectively. These areas, along with the surrounding agricultural land, provide important habitat for both migratory and resident waterfowl including Mallard, Northern Pintail, Blue-wing Teal, Green-wing Teal, Gadwall, American Wigeon, Black Duck, Canvasback, Ring-necked Duck, Wood Duck, Hooded Merganser, Snow Goose, and Canada Goose. Many species of neotropical migratory songbirds are especially dependant upon large forested areas for successful reproduction. Other game, non-game, and furbearing species that inhabit the project area include Eastern Wild Turkey, white-tailed deer, gray squirrel, fox squirrel, swamp rabbit, cottontail rabbit, Mourning Dove, numerous raptor species, raccoon, opossum, beaver, mink, muskrat, and river otter.

A project for flood control in the Bayou Meto basin in eastern Arkansas was originally authorized by Section 204 of the Flood Control Act of 1950 (64 Stat 174). The original project was deauthorized in 1986 by Section 1001 of the Water Resources Development Act (WRDA) (33 U.S.C. 579A(B)). The Eastern Arkansas Region Comprehensive Study was conducted jointly by the Corps of Engineers' Memphis District and the Natural Resources Conservation Service in 1990. The reconnaissance phase report and the feasibility report indicated that several agricultural water supply and conservation plans were feasible, including within the Bayou Meto area. This study was eventually terminated because Corps policy does not consider agricultural water supply a high priority mission. The Corps was directed by Congress to select and develop implementation plans for one area to serve as an agricultural water supply demonstration project. The Grand Prairie subarea directly adjacent to the Bayou Meto project area was selected due to the severity of aquifer depletion. This demonstration project is currently in the construction phase. The Bayou Meto project was conditionally reauthorized by WRDA 1996 and the scope of the project was expanded to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Act 1998 directed the Corps to initiate a reevaluation of the Bayou Meto Basin.

Four water delivery alternatives, six flood control alternatives, and several waterfowl management alternatives were investigated in detail. The final preferred alternative incorporates aspects of all these including:

Water Delivery

1. Construction of tailwater recovery systems and conversion from open ditches to pipelines (552 miles) for on-farm water distribution to increase water use efficiency from 60 to 70 percent.
2. Construction of on-farm water storage reservoirs (8,832 acres).
3. Construction of a 1,750 cfs capacity pumping station on the Arkansas River.
4. Construction of pumping stations (4), regulation reservoirs (3), new canals (105 miles), modifications to existing ditches (116 miles), siphons (74), weirs (56), pipelines (472 miles), and smaller pumps (183) to distribute and regulate irrigation water throughout the project area.

Flood Control

1. Construction of a 1,000 cfs capacity pump station at the mouth of Little Bayou Meto to pass flood flows over the existing gate/levee system into the Arkansas River. This is both a flood control and waterfowl management feature.
2. Channel silt cleanouts and selective debris jam removals on several streams in the lower basin including Little Bayou Meto, Boggy Slough, Wabbaseka Bayou, Indian Bayou Ditch, Indian Bayou, Salt Bayou, Crooked Creek Ditch, and Crooked Creek.
3. Five mile diversion of Big Bayou Meto with a levee along the right descending bank.
4. Establishment of 100 ft. wide riparian corridors on 2,643 acres of land to provide non-structural flood damage control.

Waterfowl Management and Restoration

1. Construction of a 1,000 cfs capacity pump station at the mouth of Little Bayou Meto to pass flood flows over the existing gate/levee system into the Arkansas River. This is both a flood control and waterfowl management feature. The ability to pass water over the levee system will reduce prolonged spring and summer flooding that has contributed to timber death and stress in the Bayou Meto WMA.
2. Completion of silt cleanouts from selected streams and ditches within the Bayou Meto WMA, construction of control structures, and removal of selected levees to

facilitate water management and aid in restoration of the natural hydrologic regime in the area.

3. Restoration of habitats in the Grand Prairie region to benefit resident and migratory King Rail and other waterfowl populations. Specific habitat restorations will include construction of herbaceous wetlands (2,000 acres) to provide nesting habitat for King Rails and planting of upland buffers (8,000 acres) to preserve wetland functions and reduce nest predation. These features will have numerous ancillary benefits to other prairie species including migratory waterfowl such as Northern Pintail and obligate grassland birds such as Smith's Longspur and the extirpated Greater Prairie-Chicken.
4. Restoration of 23,000 acres of bottomland hardwood habitats to benefit migratory waterfowl, especially Mallards and Wood Ducks. Planting of frequently flooded agricultural land to hardwoods will provide multiple primary and ancillary benefits including providing diverse and nutritious forage for waterfowl; providing habitat for waterfowl pair bonding and predator evasion; enlarging and connecting existing forest patches to benefit obligate interior forest nesting neotropical migrant birds; and providing habitat for a myriad of other common and rare birds, mammals, reptiles, and amphibians.
5. Establishment of 100 ft. wide riparian corridors on 2,643 acres of land to help reduce sedimentation and provide minimal wildlife habitat.
6. Establishment of 240 acres of managed moist soil habitat to benefit migratory waterfowl and fulfill regional habitat goals.

Direct and indirect impacts of the preferred alternative would require 2,313 acres and 1,780 acres of mitigation, respectively, to compensate for losses of terrestrial habitat functions and wetland functions. These figures were derived using the terrestrial Habitat Evaluation Procedures (HEP) and a hydrogeomorphic (HGM) wetlands impact assessment to determine compensatory mitigation requirements due to direct habitat impacts such as the footprints of spoil piles, canals, or other infrastructure, and indirect impacts such as alteration of hydrological regimes (Corps, unpublished data 2005; Klimas and Blake 2005). The other analyses, including a waterfowl carrying capacity analysis and an aquatic HEP, all resulted in lower compensation requirements, therefore the results of the terrestrial HEP and HGM analysis were used to determine the minimum compensation acreage. Specific mitigation locations will be coordinated with the Service and the Arkansas Game and Fish Commission (AGFC).

We have identified several serious existing fish and wildlife resource concerns in the project area. These include: 1) conversion of bottomland hardwood forests and other presettlement habitats; 2) alteration of groundwater and surface water hydrology; 3) agricultural practices/non-point source sediment pollution; 4) contaminant issues; 5) introduction of non-native zebra mussels; 6) reduced migratory bird habitat; and 7) loss of grassland habitat and grassland wildlife.

To protect and conserve the fish and wildlife resource values of the project area, reduce and minimize project impacts, and insure realization of project benefits, the Service recommends the following measures:

1. Institute a water withdrawal protocol that ensures the diversions from the Arkansas River do not violate minimum flows established by the ASWCC.

2. Avoid or relocate significant freshwater mussel concentrations.

3. Removal of stream blockages should be done conservatively and with established methods acceptable to the Service (Stream Obstruction Removal Guidelines, AFS/TWS 1983).

4. Acquire in fee title and restore/reforest 4,093 acres of farmed wetlands or other frequently flooded farmland to compensate for direct and indirect loss of habitat values due to the flood control and water delivery components.

5. Locate on-farm features away from wetlands, upland forests, and remnant tallgrass prairie sites. Any impacts to these habitats should limited by and compensated for according to the terms of an inter-agency developed general permit and/or other agreements.

6. Design on-farm reservoirs to benefit migratory birds.

7. Use BMPs on agricultural land to improve water quality and reduce channel maintenance requirements.

8. Install weirs and grade control structures in canals and ditches.

9. Revegetate channel rights-of-way.

10. Establish a binding agreement that details the operation protocols and responsible parties regarding operation of the 1,000 cfs capacity pump station at the mouth of Little Bayou Meto.

11. Develop an operation and maintenance manual for the Bayou Meto WMA features in accordance with (a) the Bayou Meto Wildlife Management Area Wetland Management Plan (Heitmeyer *et al.* 2004) and (b) the recommendations and approvals of the interagency environmental planning team.

12. The parties responsible for completing the proposed waterfowl management features should be clearly identified and a completion schedule developed to ensure that this project component is completed concurrently with the water delivery and flood control components.

13. Monitoring requirements for waterfowl management features should be developed by an interagency team in order to determine if projected benefits are realized.

The Service supports the continuation of the Bayou Meto General Reevaluation provided that the previously discussed mitigation and compensation measures and recommendations are incorporated into project planning. Inclusion of our planning objectives and incorporation of our specific conservation measures and recommendations are essential for addressing serious fish and wildlife resource concerns and ensuring that projected benefits from the waterfowl management features are realized.

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INTRODUCTION

This is the U.S. Fish and Wildlife Service's (Service) final Fish and Wildlife Coordination Act (FWCA) report on the Bayou Meto Basin, Arkansas, General Reevaluation. This report describes the fish and wildlife resources, concerns, and planning objectives in the study area; evaluates alternative plans; discusses adequate mitigation measures; and discusses potential fish and wildlife conservation measures. It was prepared in coordination with the Arkansas Game and Fish Commission (AGFC) and is submitted in accordance with the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e) and the Endangered Species Act (87 Stat. 884, as amended U.S.C. 1531 et seq.).

The Bayou Meto Basin, Arkansas, General Reevaluation was conducted jointly by the Memphis and Vicksburg Districts of the U.S. Army Corps of Engineers (Corps) and the Natural Resources Conservation Service (NRCS). A project for flood control in the Grand Prairie region and Bayou Meto basin in eastern Arkansas was originally authorized by Section 204 of the Flood Control Act of 1950 (64 Stat 174). The original project was deauthorized in 1986 by Section 1001 of the Water Resources Development Act (WRDA) (33 U.S.C. 579A(B)). The project was conditionally reauthorized by WRDA 1996 and the scope of the project was expanded to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Act 1998 directed the Corps to initiate a reevaluation of the Bayou Meto Basin.

PRIOR REPORTS

Several reports have been written by the Service on the Bayou Meto Basin General Reevaluation (BMBGR) and previous studies in the basin. The findings of the most pertinent reports are summarized below.

1959 – Coordination Act Report

The Service provided comments regarding the enlargement, realignment, and cleanout of 188 miles of stream channel in the basin.

1981 – Letter to Arkansas Governor

The Service sent a letter to the Governor of Arkansas which provided our views on the Corps' proposal to divert water from the Arkansas River to Bayou Meto. The letter stated that the diversion of water could be beneficial to fish and wildlife if minimum flows were guaranteed during low flow periods.

1984 – FWCA Planning Aid Letter

The Service provided the Corps current and projected bottomland hardwood acreage for the counties in the Eastern Arkansas Region Comprehensive Study.

January 1985 – FWCA Planning Aid Letter

The Service submitted to the Corps the current acreage in national wildlife refuges and state wildlife management areas as well as projected federal and state land acquisition in the Eastern Arkansas Region Comprehensive Study area.

May 1985 – FWCA Planning Aid Report

The Service identified data gaps relative to instream flows, water quality, and winter water. The letter recommended instream flow studies, a study to determine the feasibility of implementing best management practices to improve water quality, and a study to determine winter water needs for waterfowl.

January 1989 – FWCA Planning Aid Report

The Service identified fish and wildlife problems and needs for the Eastern Arkansas Region Reevaluation Study and discussed potential conservation measures.

March 1989 – FWCA Planning Aid Report

The Service identified fish and wildlife problems and needs for the Bayou Meto subarea and discussed potential conservation measures.

September 1990 – Coordination Act Report

The Service identified fish and wildlife problems and needs for the Eastern Arkansas Region Study and discussed potential conservation measures.

June 2000 – FWCA Planning Aid Report

The Service identified fish and wildlife problems and needs for the Eastern Arkansas Region Comprehensive Study, Bayou Meto General Reevaluation.

May 2002 – FWCA Planning Aid Report

The Service commented on the draft report for the freshwater mussel survey conducted as part of the Bayou Meto General Reevaluation.

June 2002 – FWCA Planning Aid Report

The Service submitted recommendations for surveys of marsh birds and colonial nesting water birds in conjunction with the Bayou Meto General Reevaluation.

September 2002 – FWCA Planning Aid Report

The Service recommended that the Corps include as one of their final flood control alternatives a non-structural option, specifically reforestation of frequently flooded areas.

October 2002 – Migratory Bird Management Plan

The Service provided a report to the Corps detailing habitat goals for waterfowl, shorebirds, and neotropical migrant songbirds in the Bayou Meto General Reevaluation project area.

March 2003 – FWCA Planning Aid Report

The Service expressed concerns about the possible transfer of zebra mussels from the Arkansas River to the Bayou Meto basin.

April 2003 – Habitat Restoration Recommendations Report

The Service presented the Corps with recommendations for bottomland hardwood restoration priorities.

November 2003 – Waterfowl Appendix

The Service provide the Corps with a report detailing the losses of waterfowl forage (measured in Duck-Use-Days) and potential mitigation strategies for the flood control portion of the Bayou Meto General Reevaluation.

February 2004 – Waterfowl Appendix (amended)

The Service provided the Corps with an updated waterfowl appendix based on modified project features.

STUDY AREA DESCRIPTION

Located primarily in Lonoke, Arkansas, and Jefferson Counties, the drainage area of Bayou Meto and its tributaries encompasses over 1,500 square miles in the central part of Arkansas. The BMBGR study area contains 779,109 acres between the Arkansas and White Rivers in east central Arkansas (Figure 1). Within this larger area, 433,166 acres are under consideration for development of a supplemental surface water delivery system. Of this, 276,814 acres are irrigated cropland and 22,079 are used for commercial fish ponds (Table 1, NRCS 2002). The major crops grown within the irrigation study area include rice (81,675 acres), soybeans (154,580 acres), and cotton (38,418 acres). About 49,513 acres of late soybeans are double cropped with wheat. Pasture, hay, and Conservation Reserve Program (CRP) lands account for approximately 38,170 acres.

Most of the original vegetation in the study area has been removed or altered since the early 1900's. Historically, extensive and diverse forested wetlands and meandering waterways covered much of the basin. Since then the majority of the Bayou Meto basin has been altered or converted to some form of agriculture or urban development (Table 2).

Approximately 122,500 acres of wetlands still remain within the Bayou Meto BMBGR study area. Over 64,000 acres of these wetlands are forested while the remaining 58,462 acres are in cleared areas. The majority of the forested wetlands are concentrated in the lower section of the project area within the 32,000 acre Bayou Meto Wildlife Management Area (WMA), the 455 acre Smoke Hole Natural Area, and nearby private hunting clubs. A large corridor of wetlands in the study area also occurs along Bayou Two Prairie. Wooded riparian corridors along many of the streams and bayous within the project area have been greatly reduced or eliminated. Some of these waterways are so degraded by sedimentation that the channels are ill defined or practically non-existent. The drainage in the area is generally in a southerly direction towards the Arkansas River, although a small northeastern portion of the project area drains into the White River basin. Most streams in the basin have been impacted to various degrees by modifications including channel cleanouts and enlargements, bend cutoffs, channel diversions, and surface water diversions. Major streams in the study area include Bayou Meto, Bayou Two Prairie, Wabbaseka Bayou, and Indian Bayou. There are numerous smaller streams and constructed ditches (Table 3). Existing waterways and ditches within the BMBGR area are

FIGURE 1. BAYOU METO GENERAL REEVALUATION TOTAL PROJECT AREA (COMBINED IRRIGATION AND FLOOD CONTROL)

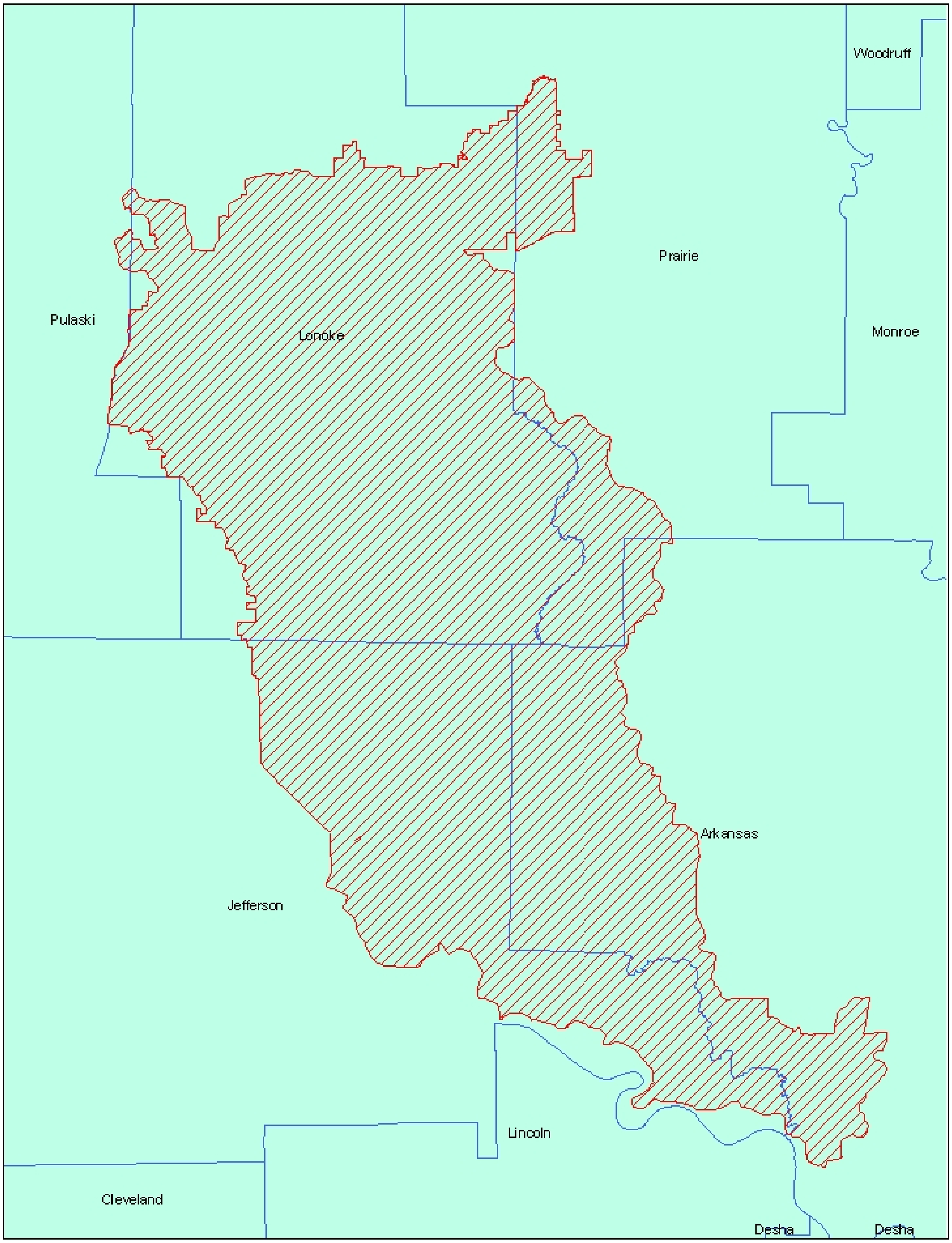

TABLE 1
CURRENT LAND USE IN WATER SUPPLY STUDY AREA (NRCS 2002)

Land Use	Acres	Percent
Cropland	276,814	64
CRP	4,453	1
Pasture and Hay	33,717	8
Woodland	41,350	10
Reservoirs	4,893	1
Fish Ponds	22,079	5
Lakes, Streams, Other Water	10,650	2
Other *	39,210	9
Total	**433,166**	**100**

** This category includes roads, commercial/industrial, community services, and other uses.*

TABLE 2
FARM DEMOGRAPHICS *
(U.S. Department of Agriculture 1999)

	Arkansas Co.	Jefferson Co.	Lonoke Co.	Prairie Co.
No. Farms	518	362	869	420
Land in Farms (acres)	426,363	288,655	390,705	301,851
Avg. Size of Farm (acres)	823	797	450	719
Percent of Land Area in Farms	67.4	51	79.7	73
Total Cropland (acres)	375,526	258,344	327,025	257,472
Irrigated Land (acres)	308,540	146,774	209,562	178,631
Harvested Cropland (acres)	359,150	238,625	280,525	239,175
Woodland (non-pasture) (acres)	21,924	10,406	20,677	20,841
Pastureland (all types) (acres)	10,229	16,370	34,526	11,681

** Note: Data are for entire counties. The study area encompasses only a portion of each county.*

projected to be used as part of the project's irrigation water delivery system. Additional canals, ditches, and pipelines will be built in order to transport water from these to individual farms.

The hydrology of the Bayou Meto Basin has been altered significantly since the turn of the century (Heitmeyer *et al.* 2002). Flood control, drainage projects, artificial flooding, and wildlife habitat manipulation (i.e. moist soil management and greentree reservoir management) have all altered the area's natural hydrology. As a result of these modifications, the annual and seasonal patterns of water distribution, stream flow, water elevations, and flooding within the watershed are highly variable and often unpredictable (Gandy *et al.* 2000).

TABLE 3
Major and Minor Waterways Located in the BMBGR Study Area

Major Streams	Lesser Streams	Ditches
Arkansas River *	Flat Bayou	Blue Point Ditch
Bayou Two Prairie	Shumaker Branch	Big Ditch
Bayou Meto	White Oak Branch	Main Ditch
Bakers Bayou	Caney Creek	Crooked Creek Ditch
Wabbaseka Bayou	Salt Bayou	Lonoke Ditch
Indian Bayou	Snow Bayou	Indian Bayou Ditch
Little Bayou Meto	Brooks Branch	Caney Creek Ditch
	Fish Trap Slough	Salt Bayou Ditch
	Ricky Branch	
	Buck Creek	
	Faras Run	

** Although the Arkansas River is outside the study area, it is included in the table as it will be used as the primary source of water for the irrigation project.*

FISH AND WILDLIFE RESOURCES

Fisheries and Other Aquatic Resources

Significant fishery resources in the BMBGR include four main aquatic habitat types: streams/bayous, oxbow lakes, multipurpose reservoirs, and the Arkansas River (Table 4). The diversity of fish species found in the Bayou Meto watershed has changed noticeably over the past several decades. Surveys conducted by state and federal agencies in the past recorded a total of 79 species of fish within the watershed. However, surveys taken between May 1991 and September 1992 found only 64 species present (Long 2000). Sampling during the summers of 1999 and 2000 revealed a total of 43 species within the project area (Killgore *et al*. 2003). The sampling in 1991-1992 incorporated a variety of collection techniques while that in 1999-2000 was limited to seines and gill nets. This may account for the reduction in species richness over this nine year period.

The reduction from historic fish species richness is likely due to the effects of habitat modifications and degradation. The likely causes of this decline include: 1) conversion to more homogonous habitats, 2) increased sedimentation, and 3) reduction in water quantity/quality during critical late summer/fall periods. Natural aquatic systems usually contain more diverse faunal assemblages than those altered for flood control. Natural systems are characterized by a diversity of water depths and velocities, exhibit moderated water temperatures in the summer due to shading from riparian vegetation, and contain a large amount of small and large woody debris. The diversity of conditions available in these streams allow for the development of a diverse

TABLE 4
LAKES, OXBOWS, AND IMPOUNDMENTS WITHIN THE PROJECT AREA

County	Lakes/Oxbows (natural)	Impoundments (large)	Impoundments (small)
Arkansas	1* Hufford Brake	9*	30*
Jefferson	2* Patton Lake	20*	20*
Lonoke	18* Carlee Brake Nelon Brake Anthony Brake Cash Brake McGregor Brake Jordan Brake Piney Brake Coburn Brake Bearskin Lake Snow Brake Bullneck Brake North Bayou	209* Peterson Lake Parker Lake Youny's Pond	396* Big Pond Little Pond Burleson's Pond Reservoir Number 1
Prairie	1* Horseshoe Lake	32* Vaught's Reservoir Lake Treadway	130* Omni Pond

** Unnamed water bodies and/or fish ponds.*

aquatic faunal assemblage. Streams modified for flood control often exhibit more uniform depths and velocities, warmer water temperatures due to increased sun exposure, and a general reduction of large woody debris. These factors combine to exclude many habitat specific organisms ranging from aquatic macroinvertebrates to large fishes. In the Bayou Meto basin 75 percent of the total numbers of fish collected in 1999-2000 belonged to tolerant, widespread taxa (Killgore *et al*. 2003).

Increased siltation, which is the result of stream channel instability and sediment laden runoff from adjacent croplands, is also a perturbation that excludes many aquatic species. Many species of fish require relatively stable substrates for spawning. Other aquatic species such as freshwater mussels and many aquatic macroinvertebrates also require relatively stable substrates for survival. Increased sedimentation is also linked with increases in turbidity. Many species of fish are intolerant to extended increases in turbidity.

The last major factor limiting fish diversity and species richness in the BMBGR project area is reduced instream water quantity during critical low rainfall/high temperature periods in the late summer and early fall. This is primarily the result of surface water diversions for crop irrigation. The problem of reduced water quantity is exacerbated during drought years, resulting in high water temperatures and low dissolved oxygen levels. Another factor that may limit the distribution of sensitive fishes in the project area is the presence of industrial and agricultural chemical pollution.

Despite the problems discussed above, the BMBGR project area provides habitat for a number of recreational and commercially important fish species. Buffaloes (*Ictiobus spp.*), white crappie (*Pomoxis annularis*), bluegill (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*) are found in the oxbows, lakes, and streams. The predominant forage species in the area is the gizzard shad (*Dorosoma cepedianum*), while the primary predator species are gars (*Lepisosteus spp.*) and bowfin (*Amia calva*) (Gandy *et al*. 2000).

Multipurpose reservoirs are one existing aquatic habitat that will likely be expanded as a result of this project. The vast majority of these will be of little or no fishery value due to extreme drawdowns during the peak irrigation season. Even those reservoirs with water level management aimed at maintaining fisheries will contribute little towards maintaining a natural, diverse fish assemblage. These reservoirs will likely be stocked with and managed for common sport fishes such as bluegill, largemouth bass, and channel catfish (*Ictalurus punctatus*).

The Arkansas River, the proposed source of supplemental water for this project, is well known for its sport fishery. The largemouth bass is the most sought after species, but others include bluegill, crappie, channel catfish, blue catfish (*Ictalurus furcatus*), flathead catfish (*Pylodictis olivaris*), and striped bass (*Morone saxatilis*). Several commercially important species, in addition to the catfish listed above, include buffaloes, paddlefish (*Polyodon spathula*), river carpsucker (*Carpiodes carpio*), and gars. Many of the once common riverine fishes such as shovelnose sturgeon (*Scaphirhynchus platorynchus*), blue sucker (*Cycleptus elongatus*), and chubs (*Macrhybopsis spp*.) are now rare or absent in this impounded section of the Arkansas River.

A 2001 survey of freshwater mussels in the project area revealed a total of 18 species concentrated primarily in Indian Bayou and Salt Bayou Ditch (Miller and Payne 2002). In the remaining streams, including Bayou Meto, mussel populations were extremely limited or nonexistent due primarily to the presence of deep, unstable substrates and stressful water quality/quantity conditions. The threeridge (*Amblema plicata*) and mapleleaf (*Quadrula quadrula*), two very common species, comprised over 80 percent of the individuals sampled. One species of state concern, the black sandshell (*Ligumia recta*), was found in Indian Bayou Ditch. Overall, the mussel resources within the project area are highly degraded. This is reinforced by the fact that 86 percent of the mussels found during the 2001 survey were at 2 sites in Indian Bayou (over 45 sites were sampled throughout the basin).

Vegetation

Historically the Bayou Meto basin was characterized by expansive bottomland hardwood forests; semi-permanently flooded cypress/tupelo swamps; seasonal herbaceous wetlands; riparian forests; riverfront forests; natural levee forests; and higher elevation sites composed of herbaceous wetland, savannah, slash, or tallgrass prairie (Heitmeyer *et al*. 2002). Bottomland hardwood forests dominated the basin and were composed of six types distinguished by elevation and flooding frequency, depth, and duration. Cypress/tupelo communities were present in the lowest elevations in areas characterized by extended flooding and almost constant soil saturation. Low bottomland hardwoods, supporting trees such as green ash (*Fraxinus pennsylvanica*), cedar elm (*Ulmus crassifolia*), water hickory (*Carya aquatica*), overcup oak (*Quercus lyrata*), were located in areas that flooded 1-3 months of the year and experience extended soil saturation. Intermediate bottomland hardwoods were found in places that flooded for a few weeks to two months a year and experienced soil saturation for up to three months. They were characterized by trees such as sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), Nuttall oak (*Quercus nuttallii*), willow oak (*Quercus phellos*), and sweetgum (*Liquidambar styraciflua*). High bottomland hardwoods were located at higher elevations that were flooded up to a few weeks in some years with soils that were usually saturated for a short period each year. Characteristic trees included water oak (*Quercus nigra*), willow oak, cherrybark oak (*Quercus falcata*), shagbark hickory (*Carya ovata*), and sweetgum. Riparian forests are located along the margins of small streams in the immediate floodplain. They are within the five year floodplain; experience deep, high velocity flooding; and usually contain a mixture of the tree species found in cypress/tupelo and low bottomland hardwood communities. Natural levee plant communities occur on the high ground immediately adjacent to existing or former drainages. These small, infrequently flooded strips of land are often up to five feet higher in elevation than the surrounding floodplain and support trees such as cottonwood (*Populus deltoides*), box elder (*Acer negundo*), cow oak (*Quercus michauxii*), cherrybark oak, and delta post oak (*Quercus stellata* spp.).

About 85 percent of the native vegetative communities in the BMBGR project area were converted to agriculture, urban, and residential or industrial uses during the last 150 years (Heitmeyer *et al*. 2002). The communities with the highest percentage of loss are prairie grassland, seasonal herbaceous wetland, savanna, and high bottomland hardwoods. Even the vegetation types found at the lowest, most frequently flooded elevations (i.e. cypress/tupelo and riparian habitats) have been reduced by at least 50 percent. The remaining forested habitat consists mainly of intermediate and low bottomland hardwoods with scattered tracts of cypress/tupelo communities. The largest acreage of forested habitat remaining is concentrated in and around the Bayou Meto WMA and in several private hunting clubs adjacent to Bayou Meto north of the management area. Historically prairie, herbaceous wetland, slash, and savannah habitats were present along the border of the Grand Prairie region in the northeastern part of the project area. Today these habitats are quite scarce and exist primarily as small periodically farmed depressions in unleveled cropland and pastures (Heitmeyer *et al*. 2000).

Many of the historic vegetation communities that were not directly converted to agriculture or other uses have been altered due to extensive hydrologic modifications in the project area. Examples of modifications that have occurred since the early 1900's include: forest clearing; land leveling; construction of roads, ditches, railroad beds; construction of reservoirs, fish ponds, and greentree reservoirs (GTR); diversion of surface water from streams for irrigation; on-farm tailwater recovery; placement of weirs in streams; and widespread stream channel alterations (channel deepening/widening, bend cutoffs, and channel diversions) (Heitmeyer *et al*. 2002). These alterations, depending on the location within the project area, have resulted in lower frequency and shorter duration floods or more frequent and extended flooding and interruption of sheetwater flow. Because the hydrologic regime is one of the primary factors that determines plant community distribution in the Mississippi alluvial valley (MAV), these alterations have resulted in significant changes from the pre-settlement landscape. Alterations that resulted in less frequent flooding also provided easier access for conversion of forested areas to agriculture. Some of the forests in the lower part of the basin now experience flooding of an artificially extended nature due to upstream and downstream flood control efforts, changes in land use, excess instream sediment, and water level manipulation for waterfowl management. Due to this extended flood regime, many areas that were historically composed of intermediate bottomland hardwoods are slowly converting to low bottomland hardwood or cypress/tupelo communities.

Wildlife Resources

Prior to European and African settlement, the Mississippi River floodplain was characterized by large expanses of bottomland hardwood forests interspersed with meandering rivers, bayous, and swamps. One exception to this was the Grand Prairie region, which is located at higher elevations on the Prairie and Deweyville terraces. Historically this area, encompassing approximately 900,000 acres, contained tallgrass prairie, slash, savannah, and herbaceous wetland habitats (Heitmeyer *et al*. 2000). These habitats represented a marked difference from the surrounding bottomland hardwood habitats and supported flora and fauna unique to the region. While most of the Bayou Meto project area was characterized by low to intermediate bottomland hardwoods, some of the eastern and northeastern portions of the area consisted of tallgrass prairie and associated habitat types (slash, savannah, herbaceous wetland).

Accurate estimates of wildlife abundance and diversity in and near the project area prior to modern settlement are not available (AGFC 1998). Prior to modern settlement it is a safe assumption that healthy populations of most endemic species were present in the prairies, upland forests, and bottomland hardwood forests. Anecdotal accounts suggest that Wild Turkey (*Meleagris gallopavo*), Northern Bobwhite (*Colinus virginianus*), Greater Prairie-Chicken (*Tympanuchus cupido*), waterfowl, Carolina Parakeet (*Conuropsis carolinensis*), Passenger Pigeon (*Ectopistes migratorius*), and large predators such as black bear (*Ursus americanus*), mountain lion (*Felis concolor*), and red wolf (*Canis rufus*) were plentiful (Heitmeyer *et al*. 2002). Today, most of these species have become extinct, been extirpated, or have very limited populations in the project area. Turkey, quail, and black bear occur in remnants of suitable habitat that are found largely on public land. Highly adaptable and generalist species such as white-tailed deer (*Odocoileus virginianus*), fox and gray squirrel (*Sciurus niger* and *S. carolinensis*), mink (*Mustela vison*), beaver (*Castor canadensis*), raccoon (*Procyon lotor*), coyote (*Canis latrans*), opossum (*Didelphus virginiana*), cottontail and swamp rabbit (*Sylvilagus floridanus* and *S. aquaticus*), red and gray fox (*Vulpes vulpes* and *Urocyon cinereoargenteus*), and some reptiles and amphibians are still locally common in the remaining forests, riparian strips, and the margins of agricultural areas. Some species, such as white-tailed deer and raccoon, are extremely tolerant of habitat disturbances and readily exploit the food resources available in agricultural fields.

Waterfowl populations in the Bayou Meto basin are lower than those present in pre-settlement times. Due to their migratory nature this trend is the result of nesting habitat conversion in the northern United States and Canada and loss of wintering habitat in the southern United States. Despite this, waterfowl still inhabit significant portions of the project area in large numbers. This is due in large part to the fact that many species of waterfowl quickly adapted to exploit the food resources found in flooded and dry agricultural fields. Historically, waterfowl fed on the acorns, plant seeds, and invertebrates found in flooded forests, flooded areas containing moist soil plants, and herbaceous wetlands. Because of landscape level conversions of forests to cropland, waterfowl are now more dependant upon waste grain such as rice, corn, soybeans, and grain sorghum to fulfill a portion of their energetic requirements. Examples of waterfowl species that readily use agricultural fields include Mallard (*Anas platyrhynchos*), Northern Pintail (*Anas acuta*), Blue and Green-winged Teal (*Anas discors* and *Anas crecca*), Gadwall (*Anas strepra*), American Wigeon (*Anas americana*), Northern Shoveler (*Anas clypeata*), Black Duck (*Anas rubripes*), Snow Goose (*Chen caerulescens*), and Canada Goose (*Branta canadensis*). Diving ducks, including Ring-necked Duck (*Aythya collaris*), Lesser Scaup (*Aythya affinis*), Redhead (*Aythya americana*), and Canvasback (*Aythya valisineria*), use agricultural habitats to a lesser extent.

Despite their use of converted habitats, many species, specifically Mallards, also require wooded and moist soil habitats to fulfill other life cycle requirements. Although waste grains provide energy for wintering and migrating waterfowl, they do not provide a nutritionally complete diet. Many proteins and essential amino acids that waterfowl require for feather and egg production can only be found in native plant seeds and invertebrates. These food sources are much more common in naturally functioning bottomland hardwood, moist soil, and herbaceous wetland habitats. Forested wetlands also provide cover from predators and isolation for pair bonding. Wood Ducks (*Aix sponsa*) and Hooded Mergansers (*Lophodytes cucullatus*) require forested habitats for nesting. A more detailed review of the waterfowl status in the study area and wintering waterfowl biology, behavior, and habitat requirements is found in Appendix A (Phillips 2005).

Service harvest surveys show that Arkansas consistently harvests more Mallards than any other state in the nation (USFWS 2002). The state usually ranks second or third in total harvest of all duck species. Arkansas, Lonoke, Prairie, and Jefferson Counties, portions of which occupy the project area, consistently rank among the top counties for waterfowl harvests in Arkansas. These statistics highlight the recreational opportunities provided by duck hunting in this region. Waterfowl hunting attracts hunters from around the nation and makes a significant contribution to the economy of the area.

A diverse assemblage of shorebirds breeds, migrates, and winters throughout the Bayou Meto project area. They often congregate at dewatered irrigation reservoirs and fish ponds in the late summer and fall to take advantage of invertebrate food sources. Among the more common species of shorebirds are the Killdeer (*Charadrius vociferous*), Long and Short-billed Dowitchers (*Limnodromus scolopaceus* and *L. griseus*), Wilson's Snipe (*Gallinago delicata*), Least Sandpipers (*Calidris minutilla*), and Lesser and Greater Yellowlegs (*Tringa melanoleuca* and *T. flavipes*). A more detailed discussion on the biology and habitat requirements of shorebirds is found in Appendix B (USFWS 1998).

The Service has determined that the bottomland hardwood forests in the study area are Resource Category 2 habitats. Resource Category 2 habitats are of high value for evaluation species and are relatively scarce on a national basis or in the ecoregion. Large contiguous tracts of bottomland forests are among the most important, and rarest, habitats in the Mississippi alluvial valley. Many groups of animals inhabit these bottomland forests habitats. Relatively common animals such as Mallards, white-tailed deer, and grey squirrel thrive in these habitats. Some groups of animals such as interior forest nesting birds and large mammals such as black bear require large, unbroken tracts of forested habitat to survive and/or reproduce successfully. The Bayou Meto General Reevaluation study area contains one of the largest state owned parcels of bottomland hardwoods in the nation in addition to several large private forest holdings. The mitigation goal for Resource Category 2 habitats is no net loss of in-kind habitat value. The Service anticipates that with or without this project, the acreage of bottomland hardwoods should increase in the project area in the future due to programs like WRP, CRP, and CREP.

Endangered and Threatened Species

The Endangered Species Act (ESA) (87 Stat. 884, as amended 16 U.S.C. 1531 et seq.) requires consultation with the Service regarding any federal action that may effect any endangered or threatened species. The threatened Bald Eagle (*Haliaeetus leucocephalus*) and the endangered Interior Least Tern (*Sterna antillarum athalassos*) are migratory birds found along the Arkansas River and its tributaries in the study area.

Several plant and animal species that are rare or endemic to Arkansas also occur in the project area. Examples of state species of concern include Swainson's Warbler (*Limnothlypis swainsonii*) and the Yellow-crowned Night-Heron (*Nyctanassa violacea*). Plant species of concern include prairie evening primrose (*Oenothera pilosella*), Arkansas sneezeweed (*Helenium campestre*), and corkwood (*Leitneria floridana*) (Arkansas Natural Heritage Commission 2004).

FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

Conversion of Bottomland Hardwood Forests and Other Presettlement Habitats

Over 85 percent of the historic vegetation types in the project area have been converted to agricultural, urban, or residential uses (Heitmeyer *et al*. 2002). The vast majority of these converted communities were formally bottomland hardwoods. Bottomland hardwood habitats ranging from cypress/tupelo to natural levee communities characterized over 750,000 acres of the presettlement vegetation (Klimas *et al*. 2002). The low, intermediate, and high bottomland hardwood communities each comprised over 200,000 acres of this total. The higher communities such as natural levees and intermediate/high bottomland hardwoods were the first and most extensively converted due to the relative infrequency of flooding that occurred at those sites. Even the lower, frequently flooded cypress/tupelo and riparian communities have been reduced by at least 50 percent over the last 150 years. Almost 420,000 acres of native habitats have been converted to mechanized agriculture, with an additional 200,000 acres converted to urban and commercial areas or roads (Heitmeyer *et al*. 2002). About 30,000 acres were converted to ponds or reservoirs. Currently, the largest remaining tract of bottomland forest is within and directly adjacent to the approximately 32,000 acre Bayou Meto WMA. The management area contains nearly equal amounts of low and intermediate bottomland hardwoods with cypress/tupelo inclusions.

Although bottomland hardwood forest habitats have experienced high levels of conversion to other uses, higher elevation communities such as slash, savannah, tallgrass prairie, and seasonal herbaceous wetlands were the first and most extensively converted habitats in the project area (Heitmeyer *et al*. 2002). Only narrow strips of slash habitat remain in drainages that cut into the Prairie and Deweyville Terrace deposits. Some remnant savannah habitat with altered understory composition can still be found near small towns, rural churches and cemeteries, and pastures. Tallgrass prairie is now relegated to very small patches in or near the former sites of the Grand and Long Prairies. Seasonal herbaceous wetlands are now restricted to small farmed depressions in pasture or unleveled croplands.

Alteration of Groundwater and Surface Water Hydrology

The project area is located over the Mississippi River Valley alluvial aquifer (hereafter referred to as the alluvial aquifer) that extends from Missouri and Kentucky south to Mississippi and Louisiana. In Arkansas this aquifer is found from the fall line at the border of the Mississippi

Alluvial Plain and the Ozark Plateau/West Gulf Coastal Plain east to the Mississippi River. During the Pleistocene and Holocene deposits from the Mississippi and Arkansas Rivers formed a sequence of sands, silts, and clays that now constitute the alluvial aquifer and semi-confining units (Reed 2003). In eastern Arkansas these sediment deposits can be roughly divided into two units. The upper clay, silt, and fine sand units act to confine the alluvial aquifer in places and are usually collectively referred to as the "clay cap". The lower unit, which actually contains the aquifer, is comprised of course sand and gravel that gradually turns to finer sand in the upper levels. The deeper gravel levels provide the greatest water conductivity to wells.

Throughout the 20th century to present groundwater has provided the majority of the irrigation water used for agriculture in eastern Arkansas. In 2000 over 97 percent of the groundwater pumped in eastern Arkansas was from the alluvial aquifer (Czarnecki *et al.* 2003). In the presettlement period the alluvial aquifer in eastern Arkansas had a saturated thickness of over 150 feet in some areas. Currently, some portions of the aquifer exhibit cones of depression in areas of heavy use and have been reduced to a saturated thickness of less than 50 feet (Reed 2003). Prior to the development of the aquifer, most rivers in eastern Arkansas, including the Mississippi, White, and Arkansas, received a portion of their flow from groundwater. During dry summer months a substantial part of the base stream flow was composed of infiltration from the alluvial aquifer (Czarnecki *et al.* 2002). As the use of groundwater continued and aquifer levels declined, this water transfer reversed in the White and Arkansas Rivers. Major streams such as these now serve as the largest point of recharge into the alluvial aquifer.

Surface water hydrology, including both floodplain and instream dynamics, has been extensively altered throughout the Lower Mississippi Alluvial Valley. Factors that have contributed to this alteration in the Bayou Meto basin floodplain include clearing of forests; land leveling; construction of roads, ditches, and railroad beds; construction of storage reservoirs and fish ponds; construction of ditches and levees associated with greentree reservoirs; construction of on-farm tailwater recovery systems; and construction of levees along the margins of the Arkansas River (Heitmeyer *et al.* 2002). These modifications have altered the patterns and timing of drainage and sheetflow within the floodplain of the project area. Sheetflow across the floodplain is virtually non-existent now due to the interception of flows by ditches, levees, and reservoirs. The normal flood pulse of the streams has also been altered due to the storing or diverting effects of these modifications.

Significant modification of the streams in the project area also took place beginning early in the 20th century and continued until present. Instream alterations include pumping of surface water for irrigation, placement of weirs (low dams) to pool water for irrigation, channelization (straightening) or enlargement of some stream channels to convey floodwaters more quickly, silting in of some stream channels due to excessive non-point source sediment contributions and channel instability, construction of canals or ditches that bypass a portion of stream flow, severing of historic “cross bayou” connections between stream basins, and construction of gated structures at the mouths of Bayou Meto and Little Bayou Meto. Channel modifications, high sediment loads, and the removal of surface water for irrigation in the summer have resulted in high turbidity, unstable substrates, low dissolved oxygen, and high water temperatures in many of the streams in the project area. Much of the upper 2/3 of the basin has been heavily channelized for flood control. This has the effect of sending large volumes of water from the upper basin downstream much faster than it can drain, creating a pooling effect in the lower 1/3 of the basin (Heitmeyer *et al.* 2002). This problem is exacerbated by the closure of the structures at the mouths of Bayou Meto and Little Bayou Meto during high flow events on the Arkansas River to prevent water from backing up into the Bayou Meto basin. If the gate closure coincides with high flows in the Bayou Meto basin, the pooling effect at the downstream end is magnified. The basin-wide results of these modifications are faster drainage and less frequent, shorter duration floods in the upper portion and more frequent, longer duration floods in the lower portion.

Partially as a result of increased flooding frequency and duration in the lower 1/3 of the Bayou Meto basin, many of the bottomland hardwoods in the Bayou Meto WMA are showing signs of stress, mortality, lack of regeneration, or conversion to more water tolerant vegetation communities. A study of water management options for Bayou Meto WMA by Heitmeyer *et al*. (2004) recommended that water should be removed at an earlier date on many of the managed greentree reservoirs on the management area in order to prevent further degradation and allow recovery of the natural vegetation composition. They stated that during certain years the operation of a pump downstream of the management area would aid in removing this late winter/spring water in a timely manner. They also noted that such a pump would only be beneficial to the management area and surrounding lands if it did not compromise the intentional flooding schedules of the WMA or regional water conditions adjacent to the WMA that are desirable in late fall and winter.

Some of the GTR units within the management area have also been damaged due to flooding too early in the fall or because of lack intra and inter year variance in water levels (Heitmeyer *et al*. 2004). Degraded GTR units on the area generally suffered from a combination of improper management (first flooding date and lack of variance) and the inability to remove water in the spring due to the previously mentioned reasons. The successful rehabilitation of the vegetative communities on Bayou Meto WMA will require a solution to both problems. Pumps at the mouth of Little Bayou Meto would aid with the water removal difficulties in the spring and summer, but they would have to be operated under a protocol that restricts their use during other seasonal periods in order to realize basin-wide benefits to fish and wildlife and vegetation communities. Widespread wetland impacts would result from the use of the pumps prior to the late winter/spring period and may negate the potential benefits to Bayou Meto WMA. Alteration of the existing water management scheme at Bayou Meto WMA is also essential for the remediation of bottomland hardwood degradation. The adoption of a new water management plan based on the recommendations of Heitmeyer *et al.* (2004) would address the unnatural fall and winter hydrology that is currently in place.

Agricultural Practices/Non-Point Source Sediment Pollution

A large percentage of the land in the study area has been converted to some form of cultivated agriculture, pastureland, or aquaculture. In many instances land has been cleared and is farmed directly adjacent to streams or their tributaries (including small ditches). Some common farming practices such as fall tillage, clean tillage, and growth of single crops with no fall cover crop, can result in sheet erosion, sediment deposition, elevated turbidity levels, and agricultural chemical runoff. Because many crops lack sufficient buffer widths to capture the soil particles associated with rainfall runoff, local streams receive large sediment loads following heavy rain events. When combined with the sediment contributed by unstable channelized streams and ditches from upstream, many streams in the lower portion of the basin exhibit reduced channel dimensions. Streams such as Little Bayou Meto now have ill-defined channels that support woody vegetation across the entire width. This reduction from natural water carrying capacity has contributed to the unnaturally frequent and prolonged flooding regime now present in the downstream portion of the project area.

Contaminant Issues

Bayou Meto is the primary waterway that flows through the study area. The bayou is a low gradient, highly turbid, warm water stream originating near Jacksonville, Arkansas. In the 1970's, the bayou was contaminated with dioxin from Vertac Chemical, Inc. after metal drums buried on site began to leak. Dioxin is a generic term for a group of extremely toxic polychlorinated compounds, with TCDD (2, 3, 7, 8-tetrachlorodibenzo-*p*-dioxin) being the most toxic synthetic compound ever tested.

Rocky Branch, a tributary of Bayou Meto, traverses the Vertac site and received effluent containing dioxin from the contaminated site. Dioxin contaminated effluent then entered Bayou Meto from both the Jacksonville Sewage Treatment Plant and Rocky Branch. Elevated levels of dioxin resulted in the Vertac site being designated as a Superfund Site, the Arkansas Game and Fish Commission closing the entire length of Bayou Meto to commercial fishing, and the Arkansas Department of Health and Human Services closing it to all fishing between Rocky Branch and the highway I-40 bridge in 1980. Vertac Chemical ceased its operation in 1986, but sampling in the early 1990's revealed elevated TCDD levels in the soils, wood duck eggs, and fishes in and around Bayou Meto downstream of Jacksonville.

More than 12 years after the dioxin was discovered, the fishes and sediment from Bayou Meto still showed elevated levels of TCDD, though the levels have declined since the initial tests were conducted. Current data indicate that the concentrations of TCDD lessen the farther they get from the point source (Johnson *et al*. 1996). There is reason to believe that the level of TCDD will continue to decline over time if conditions remain stable. However, the possibility of releasing dangerous amounts of TCDD by disturbance of sediments during any channel work should be taken into account and studied. Also, the method of disposal of contaminated sediment should be addressed in the final planning document.

Introduction of Non-Native Zebra Mussels (*Dreissena polymorpha*)

The zebra mussel has spread through many freshwater systems in the United States since being introduced into Lake St. Clair, Michigan in 1986. The species spread quickly and had been documented as far south as New Orleans, Louisiana by 1994. They were documented in the Arkansas River in the early 1990's and were well established by 1996 (Stoeckel *et al.* 1997). Zebra mussels are prolific breeders and will establish dense populations once they enter a new water system if conditions are favorable. Unlike native mussels which burrow into substrate, this exotic mussel spends its adult life attached to hard substratum such as rocks or concrete. They are also capable of limited attachment to wood and other plant materials. Zebra mussels will also readily attach to the hard valves of native mussels and heavy infestations have caused declines in the native mussel communities in some areas in the Great Lakes. They are very efficient filter feeders and may compete with larval fishes for food and diminish the energy available for fish production. Some areas in the great lakes have shown reductions in diatoms and rotifers (microscopic plants and animals) of 80 to 90 percent following establishment of zebra mussels (Holland 1993).

Unlike native mussels, which depend on a fish host to incubate their larvae (glochidia) and facilitate distribution of juveniles, zebra mussels have free floating larvae (veliger) that are generally distributed with the prevailing currents. The larvae can also be transported in live wells, bilge water, bait containers, and other activities that transfer water from infested waters to new areas. Adults can also be transported on the hulls of boats or barges.

Because the proposed water source is the Arkansas River, the irrigation component of this project will likely transport larvae from that stream into the canals, streams, and pipelines used to distribute water throughout the project area. It is likely that some of these larvae will survive to the juvenile and adult stages for a short period as was observed in the receiving waters of the Plum Bayou Irrigation Project, which also used the Arkansas River as a source for irrigation water (pers. obs., Phillips 2002). However, there is no evidence that adult mussels survived in Plum Bayou through the summer. A search of Plum Bayou during the summer of 2002 revealed the empty shells of few recently deceased adults on rip-rap adjacent to the main pump outflow. There was no evidence of zebra mussel colonization farther downstream in this stream, even on ideal attachment structures such as rip-rap and concrete pillars. However, unlike the Bayou Meto project, this project pumps water into an already impounded section of Plum Bayou. The water pumped from the Arkansas River enters a habitat more similar to an oxbow lake than a flowing stream. This may contribute to the lack of dispersion through this system.

The two factors that may limit the establishment of zebra mussels in some streams in the southern United States are high water temperatures and low dissolved oxygen levels. Laboratory testing has shown that mortality in North American zebra mussels begins when they are exposed to temperatures of 31 degrees Celsius for 52 to 292 hours, depending on their acclimation temperature (McMahon *et al.* 1995, Armistead 1995). Water temperature records show that both the Arkansas River at Murray Lock and Dam and Bayou Meto regularly reach or exceed this temperature near the surface, sometimes for extended periods, during the months of May through September (Arkansas Department of Environmental Quality 2004, U.S. Geological Survey 2004). The maximum near surface water temperatures recorded in the Arkansas River and Bayou Meto were 34 and 35 degrees Celsius, respectively. The warmest water temperatures were recorded in July and August for both water bodies. In 1997 the population of zebra mussels in Lake Dardanelle (an impoundment of the Arkansas River) exhibited 100 percent mortality in areas less than two meters deep and over 90 percent mortality in deeper portions (pers. comm., Stoeckel 2003). Since that time the population has recovered and declined several times depending on the intensity of summer water temperatures. Extended periods (one to several weeks) of daytime near surface water temperatures exceeding 31 degrees Celsius have resulted in total mortality of individuals in shallow waters.

Dissolved oxygen concentration has also been listed as a limiting factor for zebra mussel establishment and survival (Hayward and Estevez 1997). The potential for zebra mussel colonization in habitats with chronic dissolved oxygen concentrations below four mg/L is considered very low (Tippit and Miller 1993). Dissolved oxygen concentrations in the Arkansas River near David D. Terry Lock and Dam very rarely fall to 4-5 mg/L. However, records show that concentrations in Bayou Meto regularly measure in the range of 4-5 mg/L and sometimes fall to <1-3 mg/L during the months of May through October (ADEQ 2004, USGS 2004).

Another factor that may limit zebra mussel colonization in the Bayou Meto watershed is a scarcity of suitable attachment sites. Zebra mussels generally prefer hard substrates such as rocks or concrete for attachment. They are also capable of attachment in much less dense concentrations to other substrates such as large woody debris, herbaceous aquatic plants, and even small gravel. There is little hard attachment substrate currently available in the Bayou Meto watershed. Most of the natural substrate consists of fine silts and detritus. Hard substrate would be available in the form of bridge pillars and rock weirs. The shells of native freshwater mussels will also provide potential attachment sites. However, freshwater mussels are currently practically absent from much of the Bayou Meto mainstem and occur only in small, sporadic concentrations in the remainder of the streams in the basin (Miller and Payne 2002). Common species that are tolerant of extremes in dissolved oxygen/temperature and heavy siltation dominate the species assemblage.

The combinations of chronic water temperatures exceeding 31 degrees Celsius, dissolved oxygen concentrations falling below four mg/L, and relative lack of hard attachment substrates will likely preclude the successful colonization of the Bayou Meto basin by zebra mussels. It is likely that (as in Plum Bayou) some larvae will survive to the juvenile or adult stages near the pump outlets in the early spring period. However, these individuals will likely succumb to the above stressors before a significant population can become established. It is unlikely that zebra mussels will ever reach densities high enough to impact the remaining freshwater mussel resources or fishery resources of streams in the Bayou Meto basin.

Availability of Migratory Bird Habitat

Migratory birds can be divided into four groups: shorebirds, waterfowl, land birds, and other water birds. The Mississippi Alluvial Valley Migratory Bird Initiative quantified the habitat needs of shorebirds, waterfowl, and song birds in the Mississippi Alluvial Valley (Hunter *et al.* 1996, Mueller 1996, Twedt *et al.* 1999, Loesch *et al.* 2000, Mueller *et al.* 2000, Mueller *et al.* In press). Elliott and McKnight (2000) provide additional information on shorebirds, and the North American Waterbird Conservation Plan southeast working group is preparing a plan that will address the needs of wading and marsh birds. The Arkansas Game and Fish Commission's Bayou Meto Wildlife Management Area is the most important wildlife habitat in the basin and has been managed primarily to provide habitat for waterfowl. Over 60,000 ducks and 15,000 geese have been observed at the Hallowell Reservoir rest area alone during peak winter periods (Gandy *et al*. 2000). The forested wetlands, moist soil units, and seasonally flooded farm units of this area and surrounding private lands in the lower portion of the project area also provide substantial habitat for other migratory birds including song birds, shorebirds, and wading birds.

A large portion of the waterfowl management associated with this project will be in the form of bottomland hardwood forest restoration. The waterfowl habitat goals of the Lower Mississippi Valley Joint Venture (LMVJV) state that there is a deficit of 5,637 acres of publicly managed bottomland hardwoods. Specifically within Bayou Meto WMA 2,662 acres of bottomland hardwoods are needed to meet the habitat goals (pers. comm., Wilson 2002). The LMVJV also has as a goal the establishment of 112,225 acres of naturally flooding unmanaged forest habitat in the Arkansas portion of the Mississippi Alluvial Valley. Moist soil development will be an additional component of the waterfowl management portion of the project. According to the waterfowl habitat goals of the LMVJV, the delta portion of the state needs an additional 8,982 acres of publicly managed moist soil habitat. An additional 240 acres of moist soil habitat are required to meet the goals on Bayou Meto WMA. The proposed restoration and management of herbaceous wetlands in the Grand Prairie portion of the project area will also contribute towards these acreage goals.

The habitat goal for shorebirds in the Mississippi Alluvial Valley is 5,000 acres of mudflat (Twedt *et al.* 1999) available for feeding during the southward (fall) migration period (July-September). This has been further stepped down to a need for 1,300 acres in Arkansas. Currently 367 acres of fall mud flat habitat is provided on national wildlife refuges in Arkansas (Bald Knob, Oakwood, Overflow, and Wapanocca), none of which are in the Bayou Meto basin. The remainder (933 acres) of the fall Arkansas shorebird habitat goal is unmet at this time.

Fall shorebird habitat in the Bayou Meto basin is present in very limited amounts. Drying of streams and lakes creates low quality mud flats (for shorebirds) that quickly dry up or support dense growths of herbaceous vegetation. The normal management regime of fish hatcheries and aquaculture facilities creates high quality shorebird habitat when ponds are drained for cleaning or refurbishing. The ponds are high in nutrients and, consequently, have a high population of benthic invertebrates, the prime food source for shorebirds. Ponds are drained throughout the year so their occurrence during the southward shorebird migration period is accidental and not assured. Also, during the typically hot fall migration period (July-September) the drained ponds rapidly dry up, destroying their mud flat characteristics. The preferred alternative for the irrigation water conveyance portion of this project will involve over 8,000 acres of new reservoirs for on-farm water storage. The drawdown period for these reservoirs should coincide with the fall migration period for shorebirds and they could potentially provide additional shorebird foraging habitat. We have the following recommendation regarding the construction of reservoirs with fish and wildlife considerations:

- Provide multilayered woody and herbaceous vegetation down to the water's edge on one or more sides.
- Create variable bottom topography-deep holes and shallow edges.
- Create islands inside the reservoir.
- Provide gradual bottom slopes.
- Construct variable side slopes, some gradual (<20H:1V) and some steep (>4H:1V).
- Construct sinuous or irregular shorelines with peninsulas and islands.

Neotropical migratory birds breed in Canada and the United States and winter in Mexico, the Caribbean, Central America, and South America. Bottomland hardwood forests in the Mississippi Alluvial Valley (MAV) are used extensively by these migrants during the nesting and migration seasons. Reduction in the acreage of forested habitat and associated changes in the quality and distribution of vegetation have caused a reduction in neotropical migratory bird populations (Pashley and Barrow 1992). Forest acreage reduction is not the only measure of loss. Because of changes in flooding and disturbance and varying histories of management, current tree species composition and age distribution are probably very different from pre-settlement conditions. Much of the remaining forest is extremely fragmented, which increases nest predation and parasitism. An analysis of Breeding Bird Survey data for the period from 1966 to 1990 found the MAV was one of five physiographic areas in which notable declines occurred (Pashley and Barrow 1992). Seventy-seven percent of birds breeding in bottomland hardwoods of the MAV declined. Declining species include interior forest species such as the Prothonotary Warbler (*Protonotaria citrea*) and also second growth or edge species such as the Orchard Oriole (*Icterus spurious*) and Yellow-breasted Chat (*Icteria virens*).

The Mississippi Alluvial Valley Migratory Bird Initiative identified over 100 Forest Bird Conservation Areas (FBCA) throughout the Mississippi Alluvial Valley (Twedt *et al*. 1999) to meet the needs of forest breeding birds. Two FBCAs are in the Bayou Meto basin, the Big Ditch and Bayou Meto FBCAs. To the extent practical, each FBCA should be an unbroken stand of forest. This was established to reduce or eliminate the effects of forest fragmentation on forest bird breeding success. To be assured of long term, secure populations, many forest breeding birds require "core", or interior forest, which is some distance from the forest edge. The Bayou Meto FBCA currently exceeds both its forest (20,000 acres) and core forest (12,800 acres) acreage goals. The Big Ditch FBCA currently narrowly exceeds its forest acreage goal of 10,000 acres but is almost 3,000 acres short of its core forest goal of 5,200 acres. Reforestation of key tracts within or adjacent to the Big Ditch FBCA would reduce fragmentation and enable the core forest goal to be met with a relatively small amount of reforestation. The reforestation of a connector between the Big Ditch and Bayou Meto FBCAs would combine these existing large forest patches and essentially result in one larger forested patch. This would not only benefit interior forest breeding birds and waterfowl, but would also provide travel corridors for large mammals such as black bears.

The North American Waterbird Conservation Plan is in the early stages of setting wading (herons, egrets, and bitterns) and marsh bird (rails, wrens, and moorhens) population and habitat goals for the nation and the southeast. At this time they have not produced any goals that can be applied to the Bayou Meto basin. Wading and marsh bird occurrence in the project area is poorly known. At least three wading bird colony sites have been identified. Several other locations appear to be suitable to support breeding colonies, especially in the Bayou Meto WMA, yet no additional colonies are known.

Loss of Grassland Habitat and Grassland Birds

The extreme northern and eastern portions of the project area historically contained tallgrass prairie interspersed with herbaceous wetlands with slash and savannah communities along drainages. The Grand Prairie extends into the eastern border of the project area. Both the Grand Prairie and Long Prairie historically occupied northern portions of the project area. Today only tiny fragments of this original tallgrass prairie ecosystem remain in the project area or eastern Arkansas as a whole.

Historically, grasslands evolved and were maintained by frequent disturbances such as drought, grazing by native herbivores, and fire. The decline of the tallgrass prairie in eastern Arkansas (estimated loss of nearly 100 percent) exceeds that reported for any other ecosystem in North

America (Heitmeyer *et al.* 2000, Vickery *et al.* 1995). Throughout much of the area that once supported tallgrass prairies, agricultural crops have replaced grasslands. Grassland habitats are occupied by a small number of uniquely adapted bird species, selecting habitat features from a wide range of grass heights and densities. In North America, grassland birds have experienced steeper, more consistent, and more widespread population declines over the last quarter century than any other avian guild. Some grassland bird species are neotropical migrants, however, most are short distance migrants that winter primarily in the southern U.S. and northern Mexico. Thus, there are opportunities for conservation on both breeding and wintering grounds. Winter survivorship is a critically important factor in the long term decline of grassland birds.

Habitat fragmentation and degradation of grasslands have been severe. Habitat loss has been caused by human development and forest succession, and includes subtle degradations such as unnatural grazing regimes, planting of exotic grasses, and succession to shrublands. Fire suppression and the resultant woody encroachment are major tallgrass management problems that influence grassland bird distribution patterns and nesting success. Early and mid-season cutting of agricultural grasslands have catastrophic impacts on the nesting success of grassland birds.

The U.S. Fish and Wildlife Service, Arkansas Game and Fish Commission, Arkansas Natural Heritage Commission, and the city of Stuttgart, Arkansas, are currently in the early stages of a grassland restoration project on the property of the Stuttgart Municipal Airport. The long term goal of this restoration is to restore enough tallgrass prairie to support a viable population of Greater Prairie-Chickens (Krystofik 2003). This species was once so prolific that hunters traveled from as far as the east coast of the United States to hunt them. By 1938 the last documented individual was shot in Prairie County, the species essentially extirpated due to the conversion of tallgrass prairie habitat to agriculture and other uses (Foti *et al*. 2003). According to the Partners In Flight prairie grassland bird conservation area model, prairie-chickens require a minimum 10,000 acre management area centered around a 2,000 acre core of prairie surrounded by a matrix of agriculture and 2,000 additional acres of prairie (Fitzgerald *et al*. 2000). At least half of the prairie patches within the surrounding matrix it should be 100 acres or larger. This would be enough to support two small populations of Greater Prairie-Chickens based on their home range size and habitat requirements. The restoration of larger blocks of prairie/savannah/slash/herbaceous wetlands (>10,000 acres) would provide the diversity and acreage of habitat needed to support a much greater portion of the historic prairie bird community, including Greater Prairie-Chickens, Short-eared Owls (*Asio flammeus*), Grasshopper Sparrows (*Ammodramus savannarum*), Smith's Longspurs (*Calcarius pictus*), and Dickcissels (*Spiza americana*) (Sample and Mossman 1997). Restoration and management of the herbaceous wetlands/associated uplands components of this historic ecosystem would also benefit wetland oriented nesting and migratory species such as the King Rail (*Rallus elegans*) and other waterfowl

There is potential for significant wetland/prairie buffer restoration and management associated with the waterfowl management portion of this project. Long Prairie and Grand Prairie were historically located in the northern portion and Grand Prairie in the extreme eastern portion of the project area. These areas are now primarily farm land but hold great potential for restoration of herbaceous wetlands with buffers of tallgrass prairie and associated savannah and slash habitats. The portion of Grand Prairie along the eastern border of the project area is especially promising as it is close to the restoration planned for the Stuttgart Airport property. Restoration associated with the Bayou Meto project, while intended to provide habitat for King Rails and other waterfowl, could also become an integral component of the repatriation of Greater Prairie-Chickens to eastern Arkansas.

Planning Objectives

The Service advocates that the following planning objectives be incorporated into any future planning studies in order to protect fish and wildlife resources in the area.

1. Protect and improve water quality and aquatic resources in the project area.

2. Encourage implementation of erosion control measures.

3. Protect and increase forested bottomland hardwood wetlands in the project area.

4. Protect and increase other wintering waterfowl habitat in the project area.

5. Protect and increase tallgrass prairie habitat which contains rare plant communities and supports rare and sensitive species of wildlife.

6. Protect and expand vegetated corridors along natural streams and constructed ditches and canals.

7. Maintain and enhance shorebird migration habitat by incorporating recommended designs into on-farm water storage reservoirs.

8. Reduce habitat fragmentation by constructing new canals to avoid existing forest and grassland habitats.

PROJECT ALTERNATIVES

This project can be divided into three basic components: irrigation water supply, flood control, and waterfowl management. The irrigation water supply component is being studied and designed by the Memphis District of the Corps and the Natural Resources Conservation Service (NRCS). The Vicksburg District of the Corps is studying and designing the flood control portion of the project. The Memphis District is the lead on the project and has combined an irrigation water delivery alternative with a flood control alternative to form the preferred project alternative. The Corps' selected plan consists of a combination of water delivery alterative WS4B and flood control alternative FC3A, as described in the following sections. All water supply and flood control alternatives, including the preferred alternative, are considered in the National Economic Development plan (NED). The third component of this project, waterfowl management and restoration, will be studied and designed by the Memphis District.

Water Supply

Five water delivery alternatives, including the no action alternative, were considered for this project. They incorporate a combination of on-farm water conservation measures and supplemental water via a delivery system from the Arkansas River. Several alternatives have sub-alternatives that detail various on-farm surface water storage capacities. Descriptions of each alternative follow:

1. Alternative WS1: No Action - This alternative represents the conditions that will occur in the project area in the absence of the proposed project. The desired land use and demand for irrigation water will remain at current levels. Only 45 percent of the project area can be sustainably irrigated in an average year without the project.

2. Alternative WS2: Conservation with storage - This alternative would increase the amount of on-farm water storage and conservation measures in an effort to maximize the use of existing water sources. This would involve increasing the irrigation water use efficiency from 60 percent to 70 percent. An additional 4,941 acres of reservoirs would also be constructed. This is the maximum acreage that could be constructed without a supplemental delivery system. With this alternative in place approximately 60 percent of the area could remain irrigated if groundwater withdrawal was regulated at the safe yield level.

3. Alternative WS3: Conservation and storage plus a 1,650 cfs water import system - While this alternative would similarly increase water use efficiency to 70 percent and feature the construction of on-farm storage reservoirs, it would also incorporate a system for the distribution

of supplemental water. Water from the Arkansas River would be pumped throughout the project area via a system of new canals and pipelines in addition to existing streams. The addition of this water would allow the construction of additional acres of on-farm storage. The following sub-alternatives feature the above components plus three options for new reservoir construction.

Alternative WS3A: 5,954 acres of additional storage reservoirs.

Alternative WS3B: 8,832 acres of additional storage reservoirs.

Alternative WS3C: 14,544 acres of additional storage reservoirs.

4. Alternative WS4: Conservation and storage plus a 1,750 cfs water import system - This alternative is identical to alternative WS3 except for a 100 cfs increase in water import capacity. The acreage of storage reservoirs (sub-alternatives 4A-4C) remains the same.

5. Alternative WS5: Conservation and storage plus a 1,850 cfs water import system - This alternative is identical to alternative WS3 except for a 200 cfs increase in water import capacity. The acreage of storage reservoirs (sub-alternatives WS5A-WS5C) remains the same.

Flood Control

Four structural flood control alternatives in addition to no action and nonstructural alternatives were carried forward for detailed investigation. For each structural alternative, the project area was divided into 11 reaches with specific actions such as channel cleanouts, excavations, or channel enlargements designated for each reach. The details of each alternative follow:

1. Alternative FC1 - This no action alternative assumes that no work will occur and conditions will remain similar to those that currently characterize the project area.

2. Alternative FC6 - This nonstructural plan would involve reforestation of 15,140 acres of cropland in the pre-project two year floodplain.

3. Alternative FC2 - This alternative would involve an array of selective clearing, channel cleanout, weir placement, and excavation work on eight stream reaches. It would provide a reduction in flooding for the most frequently flooded reaches in the project area.

4. Alternative FC2A - This alternative is identical to alternative 2 except for some additional channel enlargement in Indian Bayou Ditch, Crooked Creek Ditch, and Crooked Creek to accommodate some of the water supply features.

5. Alternative FC3A - This alternative incorporates all of the features of alternative 2A while adding additional excavation and channel enlargement in Little Bayou Meto, Boggy Slough, and Boggy Slough diversion. More notably, this alternative also includes the installation of a 1,000 cfs pump near the mouth of Little Bayou Meto.

6. Alternative FC3B - This alternative is identical to alternative 3A except that a 3,000 cfs pump would be used in place of the 1,000 cfs pump. The increase in pump capacity would also require modification of the existing Cannon Brake water control structures to pass the extra water volume.

Waterfowl Management and Restoration

In addition to the NED features discussed above, the Corps must also develop a waterfowl management plan in order to maximize waterfowl benefits compared to costs. The Waterfowl Management and Restoration Plan is analyzed both as a separate component from the other project features and in combination with those features. The ideal final project would maximize both economic and waterfowl management gains within the project area. The following management and/or restoration actions have been proposed for inclusion in the final plan. Those features that provide significant waterfowl benefits and are within the financial capability of the local sponsors will be included in the final plan and combined with the NED plan to form the final project plan. At this time the local sponsor has indicated a willingness to provide cost sharing funds for a significant portion of the proposed actions, and other cost share partners are being solicited.

1. **Prairie Restoration** - One of the specific restoration goals stated in the Corps' Waterfowl Management and Restoration Plan is to restore enough acreage of herbaceous wetlands and associated upland buffers (tallgrass prairie, slash, and savannah) to support a population of 500 breeding pairs of King Rails. Based on the breeding habitat requirements of this species, a minimum of 2,000 acres of herbaceous wetlands in the form of potholes (generally 1-10 acres in size) or abandoned river scars (<100-450 ft. wide and up to tens of miles long) would be restored. To ensure the maintenance of this habitat type and aid in its long term management, upland buffers around these wetlands are also required. These buffers will function to filter incoming sediment, nutrients, and other chemicals; provide a forage base of invertebrates and small vertebrates for King Rails; and disperse nest predators to prevent isolated wetlands from

becoming population sinks. The size of these buffers will vary, but they will generally be around 275 ft. wide and result in a wetland/upland ratio of 4:1 when applied to a four acre pothole wetland. This effort to restore and manage King Rails will also benefit many other species of plants and animals that are currently rare in Arkansas due to the lack of tallgrass prairie ecosystem habitats. The Corps proposes to restore up to 8,000 acres of tallgrass prairie buffers around the wetland restoration sites, which would result in a total of 10,000 acres of tallgrass prairie ecosystem habitat. This restoration and management would greatly compliment the efforts of the Service, AGFC, and ANHC to restore prairie habitats at the site of the Stuttgart Municipal Airport along the borders of the Bayou Meto project area. The ancillary benefits of King Rail habitat restoration and management to other rare grassland and wetland species and to the effort to restore extirpated species such as the Greater Prairie-Chicken will be enormous.

2. **Forest Restoration** - The goal for this feature is to reforest up to 23,000 acres of privately owned property located primarily in the post-project two and five year floodplains. This would contribute significantly towards the LMVJV goals of 112,826 acres of naturally flooded forest habitat for the Arkansas portion of the Mississippi Alluvial Valley. The majority of this area would be most suitable for restoration to cypress/tupelo or low bottomland hardwood forest communities, although restoration of areas within the five year floodplain would also benefit waterfowl due to the high red oak component at this flood frequency. This restoration would benefit aquatic species that use the floodplain for spawning and nursery habitat; resident mammals, birds, amphibians, and reptiles; and migratory waterfowl and interior forest nesting migratory birds. Restoration would consist primarily of planting bottomland hardwood trees on areas that are currently under cultivation. Appropriate native tree species will be planted

according to site specific soil and hydrology characteristics. Some areas that have been precision leveled in the past may require work to restore the microtopography in order to mimic the natural hydrology. Land for these restoration activities would be acquired through conservation easements with willing landowners or fee title acquisition. Landowners entering into easement agreements would retain ownership of the property along with the right to manage access and timber (in accordance with approved plans). Once the areas are restored, the participants will also have the opportunity to lease the property to outside parties for recreational purposes (e.g. duck or deer hunting).

While these efforts will focus on areas within the two and five year flood frequency elevations, there are two areas within these zones that should receive priority for reforestation. The first area is located within a band approximately 2.5 miles wide by 10 miles long that connects the Bayou Meto WMA with the Big Ditch FBCA to the northeast. Cleared tracts adjacent to or within the existing forest block in the Big Ditch FBCA would also be high priority. This feature will lead to significant restoration of higher elevation vegetation communities such as intermediate and high bottomland forests, riparian forests, natural levee forests, and post oak flats. These areas typically contain higher concentrations of red oak species that yield acorns suitable for waterfowl consumption and are therefore important to wintering waterfowl during years when flood stages reach the five year frequency elevation. Both the Big Ditch area and the land in and around Bayou Meto WMA have been designated as Forest Bird Conservation Areas (FBCA) by the Mississippi Alluvial Valley Migratory Bird Initiative. If the resulting connector has sufficient width, this feature may actually serve to fill the gap between these existing forest blocks and result in one larger block. This is especially important for interior forest nesting birds that need large blocks to maintain self sustaining populations.

The second priority area for reforestation is in the area known as the Wabbaseka Scatters. This area is located adjacent to the southwest portion of Bayou Meto WMA. Restoration in this area will consist of reforestation of the historical vegetation communities characteristic of intermediate and high bottomlands, riparian forests, and natural levee forests. Hydrologic restoration will also be necessary to restore the high interconnectedness of the areas streams and bayous, a feature that led to the term “scatters”. Focusing on this area will have many of the same benefits as the first priority area and will result in the restoration of a unique habitat that currently bears little resemblance to its name.

3. **Riparian Buffer Restoration** - This proposed feature includes restoring riparian forests along all project affected streams in the project area. The buffers will be a minimum of 100 feet wide in order to assure that they function to reduce non-point source pollution from sediment and other pollutants. These widths will provide limited terrestrial wildlife benefits as well. Over 2,643 acres would be planted with vegetation characteristic of low, intermediate, and high bottomland forests; riparian forests; and natural levee forests, as appropriate.

4. **Moist Soil Habitat** - At least 240 acres of managed moist soil acreage would be established within the project area. The property would ideally be located near the Bayou Meto WMA to allow for easier management by existing personnel. This feature would fulfill the goals of the North American Waterfowl Management Plan as stated for this area.

5. **Bayou Meto WMA** - This feature will involve several dozen actions mostly within Bayou Meto WMA including ditch cleanouts, levee removals, and installation/renovation of water control structures. None of the proposed features will function as planned without a method for removal of excess water in the lower portion of the basin, therefore the two 500 cfs pumps at the mouth of Little Bayou Meto will be funded as both a waterfowl management and flood control feature. All of the proposed features were derived from the "Bayou Meto Wildlife Management Area Wetland Management Plan" (Heitmeyer *et al.* 2004) or consultations with AGFC management staff. The ultimate goal of these features is to facilitate easier water management on the WMA and allow removal of excess water in the spring. This will allow the management staff to more closely mimic the natural hydrology and reverse the trend of timber stress/death and conversion to more water tolerant plant communities.

PROJECT IMPACTS

The preferred alternative consists of a combination of water delivery alterative WS4B and flood control alternative FC3A, in addition to the waterfowl management and restoration features. The flood control portion will include selective snagging within streams, stream channel cleanouts, and the operation of two 500 cfs pumps at the mouth of Little Bayou Meto. The irrigation portion of the project would divert water from the Arkansas River and distribute it throughout the project area via a system of existing ditches, new canals, and pipelines. The proposed plan also includes the construction of rock weirs in canals and existing ditches to pool irrigation water. The irrigation component will also incorporate the construction of on-farm features such as tailwater recovery pits and storage reservoirs. The waterfowl management features consist largely of reforestation and restoration of herbaceous wetlands with upland buffers. Many of the waterfowl management features on the Bayou Meto WMA will involve ditch cleanouts as well as levee removals and construction/renovation of water control structures. Each proposed feature has potential negative or positive impacts to the fisheries and mussel resources in the project area and affected streams outside the project area.

Fishery and Freshwater Mussel Impacts

Flood Control

Several streams are slated to have instream woody debris and snags selectively removed in order to increase the water conveyance capacity of the channels. The removal of significant amounts of this material from stream channels will have an overall negative effect on the aquatic ecosystem. In low gradient floodplain systems a significant portion of the biological activity (i.e. macroinvertebrate production) is associated with habitat provided by instream woody debris (Benke 2001). The density and diversity of macroinvertebrates associated with floodplain habitats and instream benthic substrates is low in comparison to the communities associated with instream woody debris. Total biomass production is higher in floodplain habitats than that associated with instream snags due to the overwhelming surface area available. Although predatory fishes take advantage of this food source on the floodplain during high water periods, the high variation in the magnitude and duration of floods between and within years results in unpredictable production from the floodplain through time. This unpredictability is also the reason for the relatively low diversity and density of macroinvertebrates produced on the floodplain (Benke *et al*. 2000). The invertebrate communities associated with instream snag habitat provide a dependable source of food for organisms higher on the food chain, especially during periods when the stream is contained within the channel. Many species of fishes depend on macroinvertebrates from snags and inchannel substrates for all or part of their food requirements (Benke *et al*. 1985; Robison and Buchanan 1988).

In addition to snagging, sediment cleanouts and/or channel enlargements are proposed for several streams within the project area. Many streams, such as Little Bayou Meto, contain so much accumulated silt that they are mostly dry except during high water events. This has not only exacerbated lower basin flooding but also excluded these streams from use by most aquatic organisms. Many sensitive species of fishes are intolerant of heavy sedimentation. Killgore *et al*. (2003) considered excessive sedimentation to be one of the primary contributors to the relatively depauperate and tolerant fish community currently present in the Bayou Meto basin. Most of the streams that maintain year round flows also suffer from elevated sedimentation rates. The preferred alternative also calls for the installation of drop control structures throughout the project area to reduce the amount of sediment input from farm fields. The proposed channel enlargements are restricted to existing ditches and channelized streams, many of which are ephemeral, and should therefore have limited impacts on significant instream aquatic resources. Many of the proposed sediment cleanouts will take place in larger perennially flowing streams with naturally sinuous channels. These streams contain a greater diversity and density of fishes, mussels, and other aquatic organisms, therefore the short term risks associated with sediment removal are greater. However, if steps are taken to avoid or relocate significant resources such as mussel beds, the removal of accumulated sediments should improve the future aquatic habitat conditions. The use of drop control structures to reduce future sediment runoff into streams should reduce the need for future sediment removal activities.

The final flood control feature is the operation of two 500 cfs pumps at the mouth of Little Bayou Meto in order to evacuate water from the lower Bayou Meto basin over the levee along the Arkansas River. This feature will work in concert with the snagging and ditch cleanout/enlargements described above to reduce the frequency and duration of flooding in the current two year floodplain. Currently within the project area over 15,689 acres of functional fish spawning and/or nursery habitat is flooded at least once every two years (Killgore *et al*. 2005). The preferred flood control alternative will result in a reduction of 1,217 acres in the average daily acres flooded in the two year flood plain compared to existing conditions. This alternative will also result in the direct loss of 1,058 acres of spawning/nursery habitat due to loss of riparian habitat along streams scheduled for cleanout and loss of habitat due to construction of new canals. See Kilgore *et al.* (2005) for details on acreage/habitat unit losses for various flood control alternatives.

The impacts to fishes, mussels, and other aquatic organisms resulting from the flood control portion of this project vary by project feature. The selective snagging, channel cleanouts, and pumps will result in a net loss of spawning and nursery habitat available to fishes that use the floodplain for these purposes. The selective snagging will have a negative impact on all fishes except those that inhabit permanent wetlands (oxbows) outside of the main stream channels. Instream snags provide habitat for the greatest density and diversity of macroinvertebrates that provide a significant portion of the forage base for fishes and other aquatic organisms. Channel cleanouts will have an initial, though temporary, negative impact on fishes in the impacted reaches due to increased turbidity. Most fishes are mobile enough to retreat and avoid these temporary impacts. On the other hand, unless relocated prior to construction, freshwater mussel beds could be eliminated by this activity. However, due to the negative impacts of excessive sedimentation in this project area, the long term effects of sediment removal will be positive for fishes, mussels, and other aquatic organisms. The installation of drop control structures throughout the basin will aid with the maintenance of this condition with lessened need for future cleanouts.

Water Delivery

The preferred alternative involves the construction of several large pump stations and regulation reservoirs, 105 miles of new canals, 56 weirs, and 472 miles of buried pipelines with 183 associated smaller pumps. The water distribution system will also incorporate 116 miles of existing ditches. The source of supplemental irrigation water will be the Arkansas River at a point near David D. Terry Lock and Dam No. 6. The planned total diversion capacity is 1,750 cfs. This portion of the project will also incorporate the construction of on-farm tailwater recovery systems and over 8,000 acres of storage reservoirs. The potential negative impacts to aquatic organisms from this project component include reductions in Arkansas River flows; entrainment of larval fishes from the Arkansas River; import of zebra mussels into the Bayou Meto watershed; and direct impacts to instream and floodplain habitats due to construction of infrastructure such as canals, weirs, and pump stations. The import of supplemental water into the Bayou Meto basin will have a positive impact towards populations of fishes, mussels, and other aquatic organisms in some existing streams/ditches that currently become dry or hypoxic during the peak irrigation season.

The Arkansas River will be the source of supplemental irrigation water for this project. Already on this river two diversions for irrigation and wetland management (Plum Bayou in Jefferson County and Point Remove in Conway County) are complete or nearing completion and another project to divert irrigation water throughout a project area of over one million acres in southeast Arkansas (Boeuf-Tensas project) is in the planning stages. The Arkansas Soil and Water Conservation Commission (ASWCC) established minimum flows of 3,000 cfs required to maintain navigation during the period from July through October. The November through March and April through June periods require flows of 4,361 cfs and 6,778 cfs, respectively, for maintenance of fish and wildlife resources. The 1,750 cfs diversion for the Bayou Meto project was planned with these levels in mind. The provisions to cease pumping once the limits established by the ASWCC are reached should be clear and the parties responsible for monitoring identified. Projects that are proposed or in the planning stages were not taken into account, therefore the analysis of impacts to Arkansas River flows resulting from future diversions will be very important.

The potential for entrainment of larval fishes from the Arkansas River in the diversion pumps was studied by Killgore *et al.* (2003). They indicated the risk of entrainment for larval fishes will be low (less than three percent) based on ichthyoplankton surveys conducted near the proposed diversion site in 1999 and 2000. Before entering the main pumps, water will be moved from the river via a gravity fed structure through a canal to a regulating reservoir. Most of the larval fishes that would be susceptible to entrainment from the gravity feed structure and canal leading to the primary diversion pumps belong to widespread and tolerant taxa such as suckers (*Catostomidae*), drum (*Sciaenidae*), and shad (*Clupeidae*).

A potential point of concern with water diversions from the Arkansas River is the transfer of zebra mussels into the Bayou Meto basin. The risk associated with this was discussed in detail earlier in the "Fish and Wildlife Resource Concerns and Planning Objectives" section of this report. In summary, the risk for a successful transfer of zebra mussels and establishment of a population in the Bayou Meto basin is very low. The reasons for this include lethally high water temperatures, low dissolved oxygen concentrations, and relative lack suitable attachment substrates in the ditches and canals that will receive the water.

The water import component of this project will also have direct impacts to fish spawning and nursery habitats on the floodplain due to construction of on-farm reservoirs, regulating reservoirs, and canals. The construction of regulation reservoirs is projected to result in the conversion of 108 forested acres and 92 cleared acres. The location of over 8,000 acres of on-farm reservoirs will be determined on a case-by-case basis. They will be located primarily on existing cleared areas, although some forested areas will be impacted as well. Many of these will fall within the floodplain and portions of some may fall within farmed or forested wetlands. Approximately 250 acres of cleared and forested habitat will be converted via the construction of 105 miles of new canals for water distribution. Some of this will result in the conversion of seasonally flooded habitats to permanently flooded lotic habitats.

The water supply component will also have some positive benefits to the instream aquatic ecosystem in the Bayou Meto basin. Currently many streams and ditches are used as sources of surface water for crop irrigation. During the peak of the irrigation season many of these streams become stagnant and hypoxic or dry. The addition of supplemental irrigation water and construction of weirs and the resultant permanent water will result in a positive impact towards aquatic organisms that inhabit these waterbodies. The construction of on-farm storage reservoirs will provide limited habitat for some fishes, although the majority of these will be managed to provide maximum irrigation water and will be drawn down fully on an annual basis. Even those reservoirs that are managed to maintain a fishery will be stocked with common species such as largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*). These impoundments will contribute little towards maintaining a diverse assemblage of native fishes, although they will provide additional recreational opportunities.

Waterfowl Management and Restoration

This project component will consist largely of restoring and managing bottomland hardwood forests in the two and five year floodplains and restoring herbaceous wetlands in the Grand Prairie region. Some of the features on Bayou Meto WMA will involve channel cleanouts. All of the proposed features should provide a net benefit to aquatic resources. Reforestation will reduce sedimentation from farmed areas and increase the density and complexity of vegetation on the floodplain, therefore increasing its value to fishes as spawning and nursery habitat. The restoration of herbaceous wetlands and associated upland buffers in the Grand Prairie region will reduce the movement of sediment from farmed areas into local ditches and streams. The ditch and stream cleanouts proposed for Bayou Meto WMA will have effects similar to those actions proposed for the flood control component of the project. Known concentrations of relatively immobile organisms such as freshwater mussels should be avoided or relocated prior to channel clearing. Because waterways in the Bayou Meto basin and the WMA are currently dominated by species that are tolerant to heavy sedimentation, the long term consequence of sediment removal from ditches and selected streams in the WMA should be an increase in the diversity of fishes, freshwater mussels, and other aquatic organisms.

Wildlife Impacts

Flood Control

The primary impact to terrestrial organisms resulting from the flood control component will be a reduction in the amount of natural and agricultural forage available to waterfowl on the floodplain. Most of this loss will result from a reduction in access to food items due to lowered flood frequencies and durations. The amount and availability of forage to waterfowl is expressed as a Duck-Use-Day (DUD), which refers to the capacity of available forage to meet the energy needs of one duck for one day. The proposed flood control plan would result in a loss of 482,948 DUD verses current conditions due to reduced hydrology (see Appendix A for details).

Flood control features that result in the loss of forested acres within existing large tracts of forest will negatively impact regional efforts to increase the number and acreage of large forest blocks. These large areas of continuous forest are especially important to interior forest nesting species of migratory neotropical birds. Fragmentation of large forest patches leads to higher rates of nest parasitism and predation in many of these species.

Water Delivery

This project component will also impact food availability to waterfowl foraging on the floodplain due to direct conversion of forested and agricultural wetlands to project features such as regulation reservoirs, pump stations, new canals, on-farm reservoirs, and on-farm tailwater recovery systems. A total of 389 acres of cleared habitat and 898 acres of forested habitat will be converted for these purposes. As for flood control impacts, conversions for water delivery that occur within existing large forest blocks will negatively impact regional efforts to preserve and enlarge these habitats to benefit interior forest breeding birds.

Waterfowl Management and Restoration

This project component will focus on restoring and managing habitat for waterfowl with emphasis on Mallards and King Rails. The benefits to these species are clear and were discussed earlier in the "Project Alternatives" section. These features will also have tremendous ancillary benefits to many species, including some that are currently rare, declining, or extirpated from the project area. Specific species or guilds that will receive ancillary benefits from the proposed waterfowl management features include Northern Pintail, Greater Prairie-Chicken, interior forest breeding birds, and numerous species that inhabit bottomland hardwood, herbaceous wetland, and tallgrass prairie habitats.

AQUATIC AND TERRESTRIAL MITIGATION

The preferred alternative will result in several negative impacts to fish and wildlife resources. These impacts should be mitigated by implementing the measures discussed below. These measures comply with the Fish and Wildlife Service's Mitigation Policy. The policy applies to all activities of the Service related to the impacts of land and water developments and the subsequent recommendations to mitigate those impacts (Service 1981). This includes five means of mitigation: 1) avoiding, 2) minimizing, 3) rectifying, 4) reducing, or (5) compensating for unavoidable adverse impacts.

Aquatic Mitigation

Abide by minimum flows established for the Arkansas River

The operating protocol for diversion of water from the Arkansas River should contain measures to ensure that pumping will cease when flows in the Arkansas River reach the minimum seasonal flows established by the ASWCC. These flows are as follows: November through March, 4,361 cfs; April through June, 6,778 cfs; and July through October, 3,000 cfs (ASWCC 1988). A written agreement between the Corps and ASWCC to this effect would help ensure that this safety measure is enforced for the life of the project.

Avoid or relocate significant freshwater mussel concentrations

Mussel surveys in the project area basin revealed limited populations of freshwater mussels which are dominated by common and tolerant species (Miller and Payne 2002). However, at least one significant mussel bed containing the black sandshell (*Ligumia recta*), a species of concern, was documented in Indian Bayou Ditch. This and other beds with significant densities or rare species should be relocated prior to channel cleanouts.

Take a conservative approach to in-channel debris removal

As noted earlier in this report, instream woody debris plays an important role as habitat for a large diversity and density of aquatic macroinvertebrates that convert the energy from plant matter into a form (themselves) usable by predatory organisms higher up the food chain. Substantial removal of woody debris from streams in the basin could lead to lowered aquatic productivity and diversity. Instream woody debris also plays an important role in natural channel formation processes. It is important to remove only those debris blockages that have resulted in significant sediment accumulations and loss of channel flow capacity. Removal of obstructions should be patterned after the recommendations in the "Stream Obstruction Removal Guidelines" (TWS and AFS 1983) published by The Wildlife Society and the American Fisheries Society.

Replace the habitat value of lost floodplain habitat due to construction impacts and lowered frequency and duration of flooding

Frequently flooded agricultural and especially forested habitats have great value to many fishes that move onto the floodplain to spawn as adults or for nursery habitat as juveniles. The proposed flood control and water delivery features will reduce this value either directly through conversion to pump stations or canals or indirectly through a lowering of the flooding frequency and duration. Killgore *et al*. (2005) estimated a floodplain habitat loss of 1,217 acres and 875 habitat units (HU) for the preferred alternative due to altered hydrology and 1,058 acres (765 HU) due to direct construction impacts. They recommended, and the Service concurs, that 1,138 acres and 995 acres, respectively, of frequently flooded agricultural land should be reforested to compensate for these indirect and direct losses.

Terrestrial Mitigation

Acquire and restore farmed wetlands

Based on the Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) (a methodology for evaluating and quantifying impacts on fish and wildlife resources) and the HGM wetlands impact analysis, the loss of forested and farmed wetlands due to impacts associated with the selected water delivery and flood control components of this project would result in a loss of habitat value for all evaluation species and a loss of wetland functions in parts of the project area (Corps, unpublished data 2005; Klimas and Blake 2005). Compensation for these values will require the acquisition and restoration (reforestation) of 4,093 acres of designated farmed wetlands or other farmed land in the two and five year floodplains. The Service will work with the Corps and AGFC to select appropriate mitigation sites. To assist the Corps in selecting potential mitigation sites, the Service has developed a hierarchy of criteria to be used to determine land type restoration potential and values. These criteria are divided into three categories: restorable land type, rehabilitation methods, and specific land location (Table 5). The Service recommends that all of the primary mitigation sites should be adjacent to Bayou Meto WMA, adjacent to the Big Ditch FBCA, or within the farmed area located in a band one and a half miles wide between these two existing forest patches. The location of mitigation tracts in these areas, in conjunction with the proposed waterfowl management features, will contribute to the LMVJV's goal of enlarging and connecting large forest patches. This effort is driven by benefits to interior nesting forest birds, but it will result in multiple species specific and ecosystem wide benefits.

Table 5. Mitigation site selection criteria

Existing Land Use Type Criteria

1. Degraded wetlands in riverine floodplains; actively farmed lands, pasture lands
2. Cut over forested wetlands
3. Mature bottomland forest

Land Rehabilitation Methods Criteria

1. Wetland restoration including replacement of hydrology and woody vegetation
2. Wetland reforestation where hydrology is in place
3. Preservation of a unique habitat, or a habitat important to a federally listed threatened or endangered species

Specific Land Location Criteria

1. Sites within or directly adjacent to Forest Bird Conservation Areas (Bayou Meto WMA and Big Ditch areas)
2. Sites within an approximately one and a half mile wide corridor between the Bayou Meto WMA/FBCA and Big Ditch FBCA

 # 1 is the most desirable condition

Locate on-farm features away from wetlands and remnant tallgrass prairie sites.

Although a large percentage of the bottomland hardwoods have been converted in the Bayou Meto area, there are still forested areas that offer food, cover, and shelter for waterfowl and other species. Even small strips of riparian timber or native grasses help reduce sediment input into streams, provide organic matter input, and supply shade for that helps buffer extreme summer water temperatures. In order to protect these resources, the Service recommends that all new canals, pipelines, regulating reservoirs, and on-farm storage reservoirs should be located in cleared upland agricultural lands. Furthermore, on-farm reservoirs should not be located on farmed wetlands as many of these areas still have hydrological functions and associated wetland values important to wildlife. Extra care should be exercised to avoid any areas within the boundaries of the historic Grand Prairie or Long Prairie that contain tallgrass prairie vegetation types such as native grasses, herbaceous wetlands, slash, or savannah. Even narrow strips of these habitats may provide important seed sources for prairie plants native to Arkansas.

If efforts to mitigate through avoidance are exhausted, any impacts to wetlands, forested uplands, or native grasslands should be regulated using the terms of an inter-agency developed general permit that limits the amount of impacts per reservoir/recovery pit and also limits the total project wide impacts associated with on-farm features. The compensation for impacts should be in the form of large contiguous habitats as opposed to small scattered on site plantings. The use of one or several large compensation sites will have greater ecosystem benefits and will ease the tasks of long term monitoring and management.

SPECIFIC CONSERVATION MEASURES

To address the fish and wildlife concerns and more fully achieve the planning objectives, the Service has formulated the following specific conservation measures. We believe that these measures could be included in the project design without significantly increasing the cost of the project.

Design on-farm reservoirs to benefit migratory birds

The construction of on-farm reservoirs would benefit migratory shorebirds and waterfowl if designed with gradually sloping sides and other features. Specific recommendations for the design of reservoirs to benefit migratory birds were discussed earlier in the "Fish and Wildlife Resource Concerns and Planning Objectives" section of this report. The Corps and NRCS possess existing general designs that were developed for the Grand Prairie Demonstration Project in coordination with the Service and AGFC.

Use Best Management Practices (BMPs) on agricultural land

Excessive sediment deposition is one of the primary stressors to aquatic life that were identified for streams in the Bayou Meto project area (Miller and Payne 2002, Killgore *et al.* 2003). Common farming practices such as fall plowing, clean tillage farming, and growth of a single crop with no fall cover crop have contributed most of this excess sediment. The Corps proposes to partially address this problem with the installation of 92 drop structures throughout the project area in existing ditches. These structures slow the runoff of water in ditches and allow some sediment to settle out prior to entering receiving streams. These structures can also be used to hold water on fields in the winter to provide habitat for migratory waterfowl. Although very beneficial, the structures will eventually become overwhelmed with sediment and require periodic maintenance. To save valuable topsoil and reduce maintenance on these structures, several options are also available to prevent the loss of topsoil from fields due to sheet and gulley erosion. The widespread adoption of BMPs such as minimum tillage or no tillage farming, grassed waterways, and filter strips would greatly reduce loss of sediment from farms, reduce excess sediment in streams, improve water quality in streams, and ultimately reduce the need for future maintenance of drop structures and channels for flood control or conveyance of irrigation water. Expertise and cost-sharing monies for most of these practices are available to participating farmers through the Conservation Reserve Program (CRP) and Environmental

Quality Incentive Program (EQIP), both administered by the NRCS. The inclusion of these practices where possible should be an integral part of each "Water Management Plan" for farmers receiving supplemental irrigation water via this project.

Install weirs and grade control structures in canals and ditches

Existing and planned canals/ditches provide marginal habitat for fish, freshwater mussels, and other aquatic organisms. Their lack of diversity in velocity, depth, and substrate limits the assemblage of organisms to tolerant or generalist species guilds. Because they are intended to move large volumes of water quickly, the flow in these waterbodies often fluctuates greatly in short periods of time. Especially detrimental to aquatic organisms are the periods when flows are very low, resulting in low dissolved oxygen and elevated water temperatures. The installation of strategically located weirs within these ditches and canals will help to maintain a minimum pool elevation and ameliorate these extremes in environmental variables.

Grade control structures should be installed at the mouth of new canals where they connect with existing streams to prevent headcutting. Headcutting can actually increase channel capacity at the site of erosion, but as the sediment settles downstream, resource impacts and additional channel maintenance often result. Headcutting also induces additional channel instability and often results in accelerated failure of stream banks. Grade control structures may be needed in existing ditches as well due to the increase in flows associated with the water delivery system. Structures on existing ditches should be installed as needed if problems with headcutting develop. All weirs and grade control structures should be designed and located to avoid impacts to wetlands or other significant resources. We request that the Service and AGFC be consulted on the placement of weirs and grade control structures outside those already outlined in the planning documents.

Revegetate Channel Rights-of-way

The Service recommends that, during channel cleanouts and canal construction, spoil be spread and the ROW revegetated with native plant species. The Corps proposes to plant approximately 200 acres of native prairie grasses along the ROW of canals that traverse the Long Prairie component of the Grand Prairie Complex. This will add a significant acreage of prairie habitat relative to the existing amount (several hundred acres). The Service recommends that the remaining canal and channel cleanout ROWs be revegetated with native riverfront/bottomland hardwood trees such as willow oak, water oak, pecan, cottonwood, or sycamore. The appropriate species will depend on the flooding frequency. In areas that require frequent access, we recommend planning a mixture of native grasses.

Establish a binding agreement that details the operation protocols and responsible parties regarding operation of the 1,000 cfs capacity pump station at the mouth of Little Bayou Meto

The operation protocol for the two 500 cfs pumps at the mouth of Little Bayou Meto should be clearly stated and include water elevation and seasonal operation restrictions. The Service, along with the AGFC and ANHC, has reviewed preliminary operation protocols issued by the Corps. We ask that all interested agencies continue to be an integral part of the team that refines the final operation protocols. The establishment of binding rules regarding the operation of these pumps is critical to achieve the ecosystem benefits claimed and to avoid potential habitat damages from over pumping during the wrong time of the year. The Service agrees that as planned the operation of these pumps will be an overall benefit to the bottomland hardwood ecosystem present in the lower Bayou Meto basin. However, if operated outside of the agreed upon restrictions, this project feature would result in negative impacts to waterfowl, fishes, plant composition, and the bottomland hardwood ecosystem as a whole. This reinforces the need for a binding agreement between the Corps of Engineers, local sponsor, and AGFC regarding the operation of these pumps. It should be made clear in this agreement which parties are responsible for the operation of the pumps and enforcement of pumping restrictions.

Develop an operation and maintenance manual for the Bayou Meto WMA features.

We recommend that the interagency environmental planning team (Corps, Service, AGFC, ANHC, ASWCC, NRCS, ADEQ, Ducks Unlimited) develop a water management manual for Bayou Meto WMA. Heitmeyer *et al.* (2004) indicated that the timber stress and death occurring on the management area was due to a variety of causes, including the inability to evacuate water in the late spring and summer. The proposed pumps could resolve this issue and contribute to the restoration of timber health and appropriate species composition on the area. However, there is also a need to address the other contributing causes to this condition, namely timing and duration of fall flooding in greentree reservoirs. The managers of the WMA are currently at the mercy of unpredictable rainfall and political/societal pressures when making management decisions on when to flood impoundments. Lack of a dependable water source in the fall often results in the need to capture early fall rain events in order to have impoundments flooded for the opening of duck hunting season. The water delivery portion of this project could potentially provide a dependable source of water each fall. With this dependable source of water would come the responsibility of managing the WMA for ecological sustainability. Societal pressures to provide dependable duck hunting opportunities throughout the management area on an annual basis dictate that a binding agreement between the local sponsors and AGFC be in place to ensure sustainable use of this resource. This agreement should state that water management on the WMA will follow the interagency developed guidance manual. This manual should be adaptive and subject to revision with approval by the inter-agency team. The Project Cooperation Agreement between the Corps and the local sponsor should also include the requirement for an interagency developed Bayou Meto WMA water management manual. These agreements will ensure that all of the assumptions regarding benefits assigned to the waterfowl management features are correct and that benefits are fully realized.

The parties responsible for completing the proposed waterfowl management features should be clearly identified and a completion schedule developed to ensure that this project component is completed concurrently with the water delivery and flood control components

We recommend that the parties responsible for completing the features described in the waterfowl management and restoration section should be clearly identified, and agree to complete these actions simultaneously with other project features. These responsibilities will include seeking willing land/easement sellers, acquiring fee title or easement rights on selected properties, conducting or contracting hydrologic restoration and/or reforestation, conducting or contracting restoration of herbaceous wetlands and planting of upland buffers, conducting or contracting cleanouts of selected ditches and streams associated with Bayou Meto WMA, and post planting monitoring to ensure success of certain features. We also recommend the inclusion of a timeline for completion of each feature to ensure that these project features are completed in the same time frame as the flood control and water delivery components.

Monitoring requirements for waterfowl management features should be developed by an interagency team in order to determine if projected benefits are realized

We also recommend that the Corps and AGFC cooperate in a long term monitoring effort to determine the success of the proposed waterfowl management and mitigation features and ensure that predicted benefits occur. This would include monitoring of restored sites to ensure the success of hydrologic restoration and/or revegetation, including both farmed wetlands restored to bottomland hardwood communities and sites on the Grand Prairie with restored wetland/upland buffer habitats. It will be especially important to devise a long term monitoring plan for the forested habitats in and adjacent to the Bayou Meto WMA. The primary justification for internal WMA waterfowl management features and the installation of the 1,000 cfs capacity pumping station at the mouth of Little Bayou Meto is to halt and reverse the damage that has occurred to the vegetation communities (primarily low to intermediate bottomland hardwoods) in the management area. In order to determine the extent of these benefits, it is imperative that a monitoring strategy be incorporated into the final project plan. The Service would like to work with the Corps and AGFC in the development of this strategy.

RECOMMENDATIONS

To protect and conserve the fish and wildlife resource values of the project area, reduce and minimize project impacts, and insure realization of project benefits, the Service recommends the following measures:

1. Institute a water withdrawal protocol that ensures the diversions from the Arkansas River do not violate the minimum flows established by the ASWCC.

2. Avoid or relocate significant freshwater mussel concentrations.

3. Removal of stream blockages should be done conservatively and with established methods acceptable to the Service (Stream Obstruction Removal Guidelines, AFS/TWS 1983).

4. Acquire in fee title and restore/reforest 4,093 acres of farmed wetlands to compensate for direct and indirect loss of habitat values due to the flood control and water delivery components.

5. Locate irrigation on-farm features away from wetlands, forested uplands, and remnant tallgrass prairie sites. Unavoidable impacts should be regulated by the terms of an inter-agency developed general permit and/or other agreements.

6. Design on-farm reservoirs to benefit migratory birds.

7. Use BMPs on agricultural land to improve water quality and reduce channel maintenance requirements.

8. Install weirs and grade control structures in canals and ditches.

9. Revegetate channel rights-of-way.

10. Establish a binding agreement that details the operation protocols and responsible parties regarding operation of the 1,000 cfs capacity pump station at the mouth of Little Bayou Meto.

11. Develop an operation and maintenance manual for the Bayou Meto WMA features in accordance with (a) the Bayou Meto Wildlife Management Area Wetland Management Plan (Heitmeyer *et al.* 2004) and (b) the recommendations and approvals of the interagency environmental planning team..

12. The parties responsible for completing the proposed waterfowl management features should be clearly identified and a completion schedule developed to ensure that this project component is completed concurrently with the water delivery and flood control components.

13. Monitoring requirements for waterfowl management features should be developed by an interagency team in order to determine if projected benefits are realized.

SUMMARY OF FINDINGS AND SERVICE POSITION

The Corps' preferred alternative will result in the need for 4,093 acres of hydrologic restoration and/or reforestation of farmed wetlands to compensate for direct and indirect loss of habitat values resulting from the flood control and water delivery components of the Bayou Meto project. The waterfowl management and restoration features proposed will result in direct benefits to both migratory and breeding waterfowl and will also provide important ancillary benefits to rare, declining, or extirpated species in the project area. We support implementation of the project provided that our mitigation measures and recommendations are incorporated into project planning. Our recommendations for inclusion of a pump operation agreement, Bayou Meto WMA water management agreement, waterfowl management features completion schedule, and monitoring are especially important to avoid negative impacts and fully realize benefits to fish and wildlife resources.

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APPENDIX A

WATERFOWL TECHNICAL APPENDIX FOR THE BAYOU METO BASIN, ARKANSAS, GENERAL REEVALUATION

EXECUTIVE SUMMARY

BAYOU METO BASIN, ARKANSAS, GENERAL REEVALUATION

WATERFOWL APPENDIX

The U.S. Fish and Wildlife Service's (Service) Waterfowl Technical Appendix (appendix) was prepared to quantify the impacts of the Memphis District, U.S. Army Corps of Engineers (Corps) Bayou Meto Basin, Arkansas, General Reevaluation on waterfowl. It is the Service's understanding that this appendix is to become an integral part of the Corp's environmental report.

Because of dry conditions in traditional breeding areas and the loss of both breeding and wintering habitat, continental waterfowl breeding populations are below long term averages. Since the loss and degradation of habitat have been identified as the major waterfowl management problems in North America, quantifying the impacts of the proposed alternatives for the Bayou Meto Basin, Arkansas, General Reevaluation in terms of alteration to wintering waterfowl carrying capacity and foraging habitat is the primary purpose of this appendix.

Using with and without hydrology modifications and land use data supplied by the Corps, the impact methodology used in this appendix was based on food as an index of wintering waterfowl carrying capacity expressed in terms of the number of duck-use-days (DUD). This methodology also accounts for the effects of seed consumption and decomposition for agricultural waste grains. Project impacts in terms of increases and decreases of average seasonal acres flooded, during the 120 day wintering period from November 15 to March 15, were also identified. Project impacts were determined by comparing existing conditions to those resulting from the direct (i.e., construction) and indirect (i.e., alteration of hydrologic regimes) impacts associated with flood control and water supply alternatives. None of the water supply alternatives would have an effect on the winter hydrology within the Bayou Meto basin, so the indirect impacts of this project component are not discussed further in this analysis.

Implementation of purely structural flood control features would result in adverse impacts to migratory waterfowl wintering habitat (maximum average annual loss of 626,375 DUD, Alternative FC3B, 3,000 cfs pump). Losses would occur both on private and public lands and would be evident in seven of the eleven hydrologic reaches. From the final array of six, alternative FC2 would reduce wintering waterfowl foraging habitat carrying capacity by 267,817 DUD due to the effects of the reduction in hydrology from channel cleanouts/enlargements. Alternative FC2A, which incorporates additional channel work, would result in a loss of 269,929 DUD. A loss of 482,948 DUD would result from Alternative FC3A which includes the addition of a 1,000 cfs pump at the mouth of Little Bayou Meto. A nonstructural plan incorporating reforestation within the two year floodplain would result in a loss of DUD compared to existing conditions. This is due to the fact that fallow cropland habitats provide 1.7 times the forage density and caloric value (and DUD/acre) of reforested habitats. The restoration of 15,140 acres of forests on cropland (including fallow land) in the two year floodplain (4,256 acres in the "waterfowl flood scene") would result in a loss of 12,304 DUD.

The Corps combined the features in water supply alternative WS4B (water conservation, 8,832 acres of storage reservoirs, and a 1,750 cfs import system) with those in flood control alternative FC3A (channel cleanouts/enlargements and a 1,000 cfs pump) to form their preferred alternative (National Economic Development, or NED plan). This assessment only addresses the impacts to waterfowl due to indirect hydrologic impacts. The preferred alternative would result in a loss of 482,948 DUD due to the flood control component. The mitigation required for direct impacts due to spoil, reservoirs, pump stations, and other infrastructure was addressed separately by the Corps using the Habitat Evaluation Procedures (HEP). The preferred alternative also includes the following proposed waterfowl management features: 1) reforestation of 23,000 acres in the post-project two and five year floodplains; 2) reforestation of 2,643 acres of riparian buffers in the two year floodplain; 3) development of 240 acres of moist soil habitat; 4) enhancement of 26,000 acres of BLH in Bayou Meto Wildlife Management Area Greentree Reservoirs; and 5) restoration and creation of 2,000 acres of seasonal herbaceous wetland and wet prairie. The benefits of these waterfowl management features in terms of DUD gains was detailed by Heitmeyer (2005).

Quantifying food availability and consumption by waterfowl represents only one facet of waterfowl biology. It also represents only part of waterfowl habitat requirements. The availability of winter water for other uses, i.e., loafing and pair bonding, are equally important and should be considered equally when a proposed alternative would reduce winter water. Forested areas contain foods (acorns and macroinvertibrates) that contribute to a nutritionally complete diet. Forested areas also provide complex cover for protection, loafing, and pair bonding. These are proven values not provided by flooded crops (or provided to a much lesser extent) but that are very difficult to quantify. Also, the reduction in wintering waterfowl habitat that has occurred due to the completion of flood control projects in the Lower Mississippi Alluvial Valley is of concern to the Service not just because of adverse impacts to migratory waterfowl, but cumulative impacts to the floodplain ecosystem.

Due to the planning efforts of the Corps, the Service, and other interested parties, decision makers now have the opportunity to reforest a significant portion of the Bayou Meto project area, benefiting all fish and wildlife species dependent on forested wetland habitats. Special emphasis should be placed on reforestation of the without project two year floodplain. This technique has been widely recognized as providing multiple benefits including reduction in flood damages on marginal farm land, increase of fish and wildlife habitat, and improvement of water quality. Much of this land was cleared when soybean prices where high enough to justify the risks associated with farming frequently flooded areas. Today prices have moderated and many such areas can no longer be profitably farmed. Because of this, the owners of these properties are much more likely to participate in incentive based reforestation initiatives than those who own property at higher elevations. Although more difficult to obtain, fee title and easement purchases of property above the two year flood frequency should be considered as well. Although these higher sites flood less frequently, they do provide important foraging opportunities for waterfowl during high flood events and will support less water tolerant native plant communities that are currently quite rare in the basin due to agricultural conversion.

INTRODUCTION

This draft Waterfowl Technical Appendix (appendix) is submitted in partial fulfillment of the Fiscal Year 2005 scope of work for U.S. Fish and Wildlife Service (Service) activities pertaining to the U.S. Army, Corps of Engineers (Corps), Memphis District activities associated with the Bayou Meto Basin, Arkansas, General Reevaluation. The purpose of this appendix is threefold: first, to identify the relative importance of the general project area in terms of historic trends in wetlands and wintering waterfowl, primarily Mallards (*Anas platyrhynchos*); secondly, to document existing wintering waterfowl carrying capacity in the project area, and thirdly, to document project induced impacts compared to future without-project conditions using food as an index of carrying capacity expressed in terms of duck-use-days (DUD). Quantifying food availability and consumption by waterfowl represents one facet of waterfowl biology, and it represents only part of waterfowl habitat requirements. The availability of winter water for other uses, i.e., loafing and pair bonding, are equally important, but difficult to quantify. Flood control projects that reduce the extent, duration, and frequency of winter water are of concern to the Service.

Flood control projects should be approached on an ecosystem basis with the goal of creating economically and ecologically sustainable land uses. The use of purely structural traditional flood control methods such as channelization, channel widening, and pumps address only the economic aspect. The adoption of incentive based two year flood zone reforestation as a major component of flood damage reduction projects considers both the economic and ecological services provided by a river basin. The Service believes the trend should be towards using primarily nonstructural methods supplemented by traditional techniques.

The information contained in this appendix is submitted in accordance with the referenced scope of work and with provisions of the Fish and Wildlife Coordination Act, but does not constitute the final report of the Department of Interior, U.S. Fish and Wildlife Service, as required by Section 2(b) of the Act.

PROJECT DESCRIPTION

The Bayou Meto Basin, Arkansas, General Reevaluation is the result of more than fifty years of efforts to implement a water development project in the Bayou Meto watershed. Authorization for a flood control project in the Grand Prairie Region and the Bayou Meto Basin in eastern Arkansas was originally given in Section 204 of the Flood Control Act of 1950 (64 Stat 174). Due to a lack of local sponsorship, the project was deauthorized by Section 1001(B) of the Water Resources Development Act of 1986 (33 U.S.C. 579A(B)). However, because of concerns about drought conditions and declining aquifers, the project was reauthorized by Section 363(a), Project Reauthorizations, of the Water Resources Development Act of 1996, Public Law 104-303. The reauthorized project expanded the original scope of work to include ground water protection and conservation, agricultural water supply, and waterfowl management in addition to flood control. In 1998 reports submitted by the U.S. House of Representatives and U.S. Senate directed the U.S. Army Corps of Engineers (Corps) to initiate a reevaluation of the Bayou Meto Basin portion of the project.

The Bayou Meto basin project area encompasses 779,109 acres in portions of Arkansas, Jefferson, Lonoke, Prairie, and Pulaski Counties. The majority of the project area drains into Bayou Meto, a tributary of the Arkansas River, although a small northeastern portion of the area drains into tributaries of the White River. Other streams in the area include Bayou Two Prairie, Indian Bayou, Little Bayou Meto, Wabbaseka Bayou, Baker's Bayou, Salt Bayou Ditch, and Crooked Creek. The major land use in the area is agriculture including production of rice, soybeans, cotton, wheat, grain sorghum, and baitfish (aquaculture). Another prominent practice in the basin is the management of land to provide fish and wildlife habitat. Bayou Meto Wildlife Management Area (BMWMA), covering approximately 32,000 acres, contains a large portion of the bottomland hardwood habitat in the basin. Early and unvaried flooding of green tree reservoir units to provide dependable waterfowl hunting opportunities has resulted in some timber mortality, loss of timber regeneration, and/or conversion to more water tolerant species. Difficulty in removing water from the timber in the spring has also contributed to these problems. Much of this late flooding is the result of or exacerbated by previous flood control projects (i.e., upper basin channelization and lower Bayou Meto and Little Bayou Meto flood gates that are closed to prevent backflow from the Arkansas River), basin wide land use practices (i.e., streams sedimented in due to agricultural runoff), and damming by beavers. The primary problems identified in the basin are agricultural flooding and depletion of the alluvial aquifer due to overuse as an irrigation source. The project seeks to address the flooding damage through a combination of structural and nonstructural methods. Some of these measures may also assist in removing water from the BMWMA during the spring. The diversion of surface water from the Arkansas River is proposed to lessen the pumping demand on the aquifer.

PROJECT ALTERNATIVES

The flood control and irrigation water conveyance components of this project are being studied separately by the Vicksburg and Memphis Districts of the Corps, therefore each has an array of alternatives. Aside from the direct impacts associated with the construction of water conveyance infrastructure, the irrigation component will have little effect upon the availability of waterfowl foraging habitat. The flood control portion of the project has greater potential for reducing the amount of available foraging habitat due to reductions in flood frequency, extent, and duration. Components of water supply alternative WS4B (water conservation, 8,832 acres of storage reservoirs, and a 1,750 cfs import system) were combined with those in flood control alternative FC3A (channel cleanouts/enlargements and a 1,000 cfs pump) to form the Corps' preferred alternative. This alternative also includes waterfowl management features including reforestation, moist soil development, herbaceous wetland and wet prairie restoration, and internal water management features with Bayou Meto WMA. All flood control and water supply alternatives and the Corps' preferred alternative are discussed separately below and in Table 1.

Four structural flood control alternatives in addition to no-action and nonstructural alternatives were carried forward for detailed investigation. For each structural alternative, the project area was divided into 11 reaches with specific actions such as channel cleanouts, excavations, or channel enlargements designated for each reach. The details of each alternative follow:

1. Alternative FC1 - This no action alternative assumes that no work will occur and conditions will remain similar to those that currently characterize the project area.

2. Alternative FC6 - This nonstructural plan would involve reforestation of 15,140 acres of cropland in the pre-project two year floodplain.

3. Alternative FC2 - This alternative would involve an array of selective clearing, channel cleanout, weir placement, and excavation work on eight stream reaches. It would provide a reduction in flooding for the most frequently flooded reaches in the project area.

4. Alternative FC2A - This alternative is identical to alternative 2 except for some additional channel enlargement in Indian Bayou Ditch, Crooked Creek Ditch, and Crooked Creek to accommodate some of the water supply features.

5. Alternative FC3A - This alternative incorporates all of the features of alternative 2A while adding additional excavation and channel enlargement in Little Bayou Meto, Boggy Slough, and Boggy Slough diversion. More notably, this alternative also includes the installation of a 1,000 cfs pump near the mouth of Little Bayou Meto.

6. Alternative FC3B - This alternative is identical to alternative 3A except that a 3,000 cfs pump would be used in place of the 1,000 cfs pump. The increase in pump capacity would also require modification of the existing Cannon Brake water control structures to pass the extra water volume.

Five water delivery alternatives, including the no action alternative, were considered for this project. They incorporate a combination of on-farm water conservation measures and supplemental water via a delivery system from the Arkansas River. Several alternatives have sub-alternatives that detail various on-farm surface water storage capacities. Descriptions of each alternative follow:

1. Alternative WS1: No Action - This alternative represents the conditions that will occur in the project area in the absence of the proposed project. The desired land use and demand for irrigation water will remain at current levels. Only 45 percent of the project area can be sustainably irrigated in an average year without the project.

2. Alternative WS2: Conservation with storage - This alternative would increase the amount of on-farm water storage and conservation measures in an effort to maximize the use of existing water sources. This would involve increasing the irrigation water use efficiency from 60 percent to 70 percent. An additional 4,941 acres of reservoirs would also be constructed. This is the maximum acreage that could be constructed without a supplemental delivery system. With this alternative in place approximately 60 percent of the area could remain irrigated if groundwater withdrawal was regulated at the safe yield level.

3. Alternative WS3: Conservation and storage plus a 1,650 cfs water import system - While this alternative would similarly increase water use efficiency to 70 percent and feature the construction of on-farm storage reservoirs, it would also incorporate a system for the distribution of supplemental water. Water from the Arkansas River would be pumped throughout the project

area via a system of new canals and pipelines in addition to existing streams. The addition of this water would allow the construction of additional acres of on-farm storage. The following sub-alternatives feature the above components plus three options for new reservoir construction.

Sub-alternative WS3A: 5,954 acres of additional storage reservoirs.

Sub-alternative WS3B: 8,832 acres of additional storage reservoirs.

Sub-alternative WS3C: 14,544 acres of additional storage reservoirs.

4. Alternative WS4: Conservation and storage plus a 1,750 cfs water import system - This alternative is identical to alternative WS3 except for a 100 cfs increase in water import capacity. The acreage of storage reservoirs (sub-alternatives WS4A-WS4C) remains the same.

5. Alternative WS5: Conservation and storage plus a 1,850 cfs water import system - This alternative is identical to alternative WS3 except for a 200 cfs increase in water import capacity. The acreage of storage reservoirs (sub-alternatives WS5A-WS5C) remains the same.

The Corps' selected plan, or preferred alternative, consists of a combination of water delivery alterative WS4B and flood control alternative FC3A. This plan will also incorporate waterfowl management features including bottomland hardwood reforestation, herbaceous wetland/wet prairie restoration, and water management improvements with Bayou Meto WMA.

TABLE 1. ARRAY OF PROJECT ALTERNATIVES, BAYOU METO GENERAL REEVALUATION.

Project Component	Alternative	Description
Water Conveyance	WS1	No action
Water Conveyance	WS2	Increase in water conservation and construction of on-farm storage
Water Conveyance	WS3	Increase in water conservation and construction of additional on-farm storage made possible by a 1,650 cfs supplemental water supply from the Arkansas River
Water Conveyance	WS4	Same as above with 1,750 cfs supplemental water supply
Water Conveyance	WS5	Same as above with 1,850 cfs supplemental water supply
Flood Control	FC1	No Action
Flood Control	FC2	Selective channel cleanouts and enlargements
Flood Control	FC2A	Same as above with additional channel reaches enlarged to handle conveyance of irrigation water
Flood Control	FC3A	Same as above with addition of a 1,000 cfs pump at the mouth of Little Bayou Meto
Flood Control	FC3B	Same as above with a 3,000 cfs pump
Flood Control	FC6	Reforestation of the two year floodplain on frequently flooded cleared areas
Multipurpose	Selected Plan	Combination of water conveyance alternative WS4B and flood control alternative FC3A plus waterfowl management features

HISTORICAL PERSPECTIVE OF WETLANDS AND WATERFOWL IN THE MISSISSIPPI ALLUVIAL VALLEY

Wetlands

Before settlement by Europeans and Africans, the Mississippi Alluvial Valley (MAV) was an intricate maze of bottomland hardwood forests, swamps, and bayous, and historically, the largest forested wetland in North America (25 million acres) extending approximately from southeastern Missouri to southern Louisiana. The transformation of this vast forest into agricultural use was gradual, yet deliberate, with more than 80 percent of the forest in this region cleared. Most of the MAV was subject to periodic flooding by the Mississippi River and its tributaries. Following the Flood Control Act of 1941, hydrologic relationships in the MAV were altered by federally funded water resource developments for flood control and agriculture (Reinecke *et al.* 1988). Despite these changes to the landscape and hydrology in the MAV, it remains a critical ecoregion for North American waterfowl and other wildlife (Kaminski 1999).

Congress enacted a series of Swamplands Acts in the mid-1800's that deeded more than 20 million acres of swamplands to the states. With the proceeds from the sale of these lands being used for reclamation, wetlands were cleared, drained, and converted to agricultural use. Extensive settlement of the MAV occurred by 1900. As the result of devastating floods (1912, 1913, 1916, and 1927), Congress enacted the comprehensive flood protection program called the Mississippi River and Tributaries Project (MR&T). As a direct result of the construction of 1,500 miles of mainline levees along both banks of the Mississippi River under the MR&T

Project, thousands of acres of bottomland hardwood forests were cleared for agricultural production. These lands were generally high in elevation for the Delta, well drained, and the most productive in the MAV. Today, these lands are primarily used for the production of cotton, corn, soybeans, rice, grain sorghum, and wheat.

Following the completion of interior flood control projects, the period from 1950 through the 1970's saw the expansion of agriculture into the lower, wetter, flood prone land. During this time period, approximately 3.5 million acres of wooded wetlands were converted to agricultural production in the MAV (MacDonald *et al.* 1979). The high price of soybeans during this period made farming even flood prone lands profitable. As soybean prices dropped, the futility of farming marginal, flood prone land was made evident during the devastating floods that occurred from 1973 through 1993, despite the occasional periods of drought. As the result of this extended period of flooding, Congress enacted legislation to protect and restore wetlands (marginal, flood prone agricultural land brought into production during the period from 1950-1970): the 1985 Farm Bill, the Emergency Wetlands Protection Act of 1986, the Water Resources Development Act of 1986, the Agriculture Credit Act of 1987, the Conservation Reserve Program, the 1990 Farm Bill, the Food Security Act of 1992, the Wetlands Reserve Program (WRP), and the Federal Agriculture Improvement and Reform Act of 1996. For example, under the provisions of WRP, the federal government pays land owners fair market value for marginal cropland (farmed wetlands) and assists in replanting these areas in bottomland hardwood species. Today, the trend of federal policy is decidedly toward (1) wetland restoration that will benefit waterfowl and other wildlife dependent on wetland habitat, and (2) sound floodplain management.

Waterfowl

Historically, the MAV served as a major wintering area for waterfowl. Waterfowl population numbers began to decline in the 1960's as the direct result of extensive droughts and loss of nesting habitat in the prairie pothole region of the North America and the conversion of wintering areas in the MAV (bottomland hardwoods) to agricultural production. Waste grain, rice, and soybeans are now the dominant food sources of waterfowl in the MAV. These crops are often grown on frequently flooded cropland. Federal flood control and drainage programs have reduced the extent of these flooded areas, the result being that naturally flooded or ponded habitat is limited for a significant portion of the wintering period and areas that do flood are less extensive and more ephemeral.

The net effect of wetland conversion and drainage has been that natural habitat is no longer sufficient to meet the needs of wintering waterfowl and other migratory birds. Clearing for grazing, timber harvesting, agriculture, and reservoir projects have all contributed to the decline of bottomland hardwoods in the region.

Over the last decade several species of North American waterfowl, including Mallards, showed signs of recovery approaching or exceeding the population levels recorded in the 1950's (Annual Breeding Duck Survey, Table 2). However, dry conditions on the traditional Canadian and northern United States nesting grounds over the last several years have resulted in declines in the overall waterfowl population. Total duck abundance in the traditional survey area for 2002 was estimated at 31.2 million birds, a decrease of 14 percent from that of 2001, and 6 percent lower than the 1955-2001 average. Mallard abundance was 7.5 million, which was near the 2001 estimate of 7.9 million and essentially equal to the long term average. Blue-winged Teal (*Anas discors*) abundance was 4.2 million, or 27 percent below the 2001 estimate. Despite this decline, the population size remains near the long term average. Northern Pintail (*Anas acuta*; 1.8 million, - 46 percent), Northern Shoveler (*Anas clypeata*; 2.3 million, - 30 percent), and Gadwall (*Anas strepera*; 2.2 million, - 17 percent) all declined since 2001. Green-winged Teal (*Anas crecca*; 2.3 million), American Wigeon (*Anas americana*; 2.3 million), Redhead (*Aythya americana*; 0.6 million), Canvasback (*Aythya valisineria*; 0.5 million), and scaup (*Aythya marila* and *A. affinis*; 3.5 million) populations remained near the 2001 estimates. Gadwall (+ 37 percent), Green-winged Teal (+28 percent), and Northern Shoveler (+10 percent) all remained above their long term averages while American Wigeon (- 12 percent), Northern Pintail (- 58 percent), Canvasback (- 14 percent), and scaup (- 34 percent) were below long term averages. The number of Redheads remained near their long term average. Northern Pintails and scaup, which exhibited the lowest and second lowest numbers on record, respectively, are of special conservation concern.

While the annual breeding duck surveys are the most reliable estimates of waterfowl populations, population estimates are also available from extensive surveys of wintering ducks as well as waterfowl harvest data. The midwinter waterfowl survey for the Mississippi Flyway, conducted in by the Service and the states, is an attempt to count the total number of ducks of each species

TABLE 2. BREEDING DUCK POPULATION ESTIMATES (in thousands) [1].

Years	Mallard	Gadwall	Am. Wigeon	Green-winged Teal	Northern Shoveler	Northern Pintail	Blue-winged Teal
1955-60	9,386	651	3,195	1,584	1,556	8,543	4,909
1961-65	6,062	928	2,310	1,228	1,368	3,514	3,601
1966-70	7,805	1,641	2,702	1,652	2,105	5,177	4,138
1971-75	8,284	1,544	2,973	1,873	2,026	5,968	4,617
1976-80	7,800	1,457	3,012	1,851	1,910	4,891	4,695
1981-85	5,915	1,483	2,616	1,612	1,934	3,240	3,645
1986-90	5,932	1,443	2,002	1,860	1,789	2,334	3,584
1991	5,444	1,584	2,254	1,558	1,716	1,803	3,764
1992	5,976	2,033	2,208	1,773	1,954	2,098	4,333
1993	5,708	1,755	2,053	1,694	2,046	2,053	3,193
1994	6,980	2,318	2,382	2,108	2,912	2,972	4,616
1995	8,269	2,836	2,614	2,301	2,855	2,758	5,140
1996	7,941	2,984	2,272	2,500	3,449	2,736	6,407
1997	9,940	3,897	3,118	2,507	4,120	3,558	6,124
1998	9,640	3,742	2,857	2,087	3,183	2,520	6,398
1999	11,257	3,235	2,983	2,834	3,889	3,057	7,149
2000	9,470	3,158	2,733	3,193	3,520	2,907	7,431
2001	7,904	2,679	2,493	2,508	3,313	3,296	5,757
2002	7,503	2,235	2,334	2,333	2,138	1,789	4,206

[1] U.S. Fish and Wildlife Service 2002a.

(Table 3). Total duck abundance in 2002 was 7.2 million birds, a decrease of 7 percent over that of 2001, but exceeding the 1992-2001 average by 16 percent. Mallard abundance was 2.8 million, an increase of 10 percent over 2001 and 18 percent over the 1992-2001 average. Numbers of most other ducks decreased from 2001 and fell below the 1992-2001 average. Midwinter population estimates for the most common species follow, with the first percentage representing the change since 2001 and the second percentage representing the deviation from the 1992-2002 average: Blue-winged Teal (68,212; - 3 percent, - 41 percent), Northern Pintail (417,918; -65 percent, - 17 percent), Green-winged Teal (625,204; - 28 percent, - 18 percent), Northern Shoveler (189,359; - 17 percent, - 5 percent), American Wigeon (158,321; - 30 percent, -39 percent), Redhead (55,074; + 206 percent, + 101 percent), Canvasback (105,171; - 52 percent, - 24 percent), scaup (308,508; - 22 percent, + 34 percent). These population estimates are not considered of sufficient reliability to measure trends in abundance of most duck species because of the large area which must be surveyed and the difficulty of counting birds, especially in wooded habitats, and the lack of a valid statistical sampling scheme. Mid-winter waterfowl surveys provide useful, general information on wintering waterfowl population levels. Further, comparing the statewide numbers from year to year does not account for extremes of temperature or above or below normal rainfall; factors known to influence the arrival and departure of wintering waterfowl. Therefore, these surveys tend to count fewer ducks than are actually present, but the amount of undercount is unknown and is likely variable from year-to-year.

Waterfowl harvests have fluctuated since records have been kept, being lowest during the early 1960's when waterfowl populations, potential hunters, and days afield were low. In most years,

TABLE 3. MIDWINTER WATERFOWL SURVEYS, ARKANSAS in thousands [1].

Years	Mallard	Northern Pintail	Dabbling Ducks (all)	Diving Ducks (all)	All Ducks *
1971-1975	1,053	81	1,196	28	1,230
1976-1980	557	19	606	8	633
1981-1985	698	50	831	73	912
1986-1990	833	57	1,035	64	1,099
1991-1995	691	163	1,067	70	1,137
1996	581	59	812	14	827
1997	373	68	556	111	668
1998	526	24	784	8	792
1999	397	50	604	18	622
2000	236	10	316	4	320
2001	439	52	581	23	604
2002	810	93	1,119	18	1,143

[1] Gamble 2002
* May not be equal to the sum of dabbling and diving ducks due to rounding.

harvests have tracked the fluctuation of these factors, especially waterfowl populations. In recent years, nationwide harvests of the heavily hunted mallard and of total ducks remained relatively constant, while hunter numbers declined and hunter success increased. It appears that fewer hunters have been increasingly successful at harvesting ducks. In the Mississippi Flyway, preliminary estimates are that 2.5 million Mallards were harvested in 2001, or 48 percent of the total Mallard harvest in the United States, followed by 873,200 Gadwall (61.6 percent of the total harvest), 628,700 Green-winged Teal (43.9 percent of the total harvest), and 561,000 Wood Ducks (*Aix sponsa*) (61.2 percent of the total harvest). Within Arkansas, Mallards also comprised the majority of the ducks harvested (57.2 percent), followed by Gadwall (16.3 percent), Green-winged Teal (9.2 percent), and Wood Duck (4.1 percent) (U.S. Fish and Wildlife Service 2002b). Active adult hunters afield in Arkansas totaled 57,797 in 2001 (4 percent more than 2000) and total hunter days equaled 790,361 days (10 percent more than 2000). Total duck harvest in Arkansas in 2001 was 1,113,800 ducks with an average annual bag of 14.4 ducks per adult hunter.

WINTERING WATERFOWL BIOLOGICAL CHARACTERISTICS

The loss and degradation of waterfowl habitat has been identified as the major waterfowl management problem in North America (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986). Wintering waterfowl habitat requirements can be broken down into three components: habitat availability, utilization, and suitability in meeting social behavioral requirements. Waterfowl populations and recruitment in the MAV are a direct function of these three components.

Habitat Availability

Relationships exist among availability of wetland habitat and food during winter and waterfowl physiological, behavioral, and population responses (Kaminski 1999). Hydrology and resulting wetland habitat and intrinsic resources are critical proximate factors related to waterfowl use of alluvial environments like the lower Mississippi Delta (Fredrickson and Heitmeyer 1988). Additionally, current and cross seasonal physiological status, survival, and reproductive performance of waterfowl have been linked to winter habitat and food resources (Table 4).

Studies of wild Mallards and Wood Ducks have revealed that landscape scale flooding and dry conditions during winter influence distribution and abundance of these and likely other species of waterfowl and wetland birds (Kaminski 1999). Widespread winter flooding in the MAV resulted in regional increases in Mallards (Nichols *et al.*. 1983), and below average precipitation during spring and summer in southeastern United States caused Wood Ducks to disperse to more southerly latitudes during fall and winter where wetland availability apparently was greater (Hepp and Hines 1991). Additionally, increased wetland availability during winter presumably enhances foraging opportunities and food availability for Mallards and other waterfowl (Wright 1961, Delnicki and Reinecke 1986, Reinecke *et al.* 1988, Wehrle *et al.* 1995), which in turn have been related to increased body weights in mallards (Delnicke and Reinecke 1986), earlier prebasic molt and acquisition of basic (breeding) plumage in female mallards (Heitmeyer 1987, Richardson and Kaminski 1992), and increased mallard survival (Reinecke *et al.* 1987) and reproductive rates (Heitmeyer and Fredrickson 1981, Kaminski and Gluesing 1987). The results of recent research shows that winter wetland availability is linked to current and cross seasonal

TABLE 4. POTENTIAL GENERIC BENEFITS TO MALLARDS AND WOOD DUCKS FROM FAVORABLE WINTER WATER (HABITAT) AND FEEDING CONDITIONS IN THE MISSISSIPPI ALLUVIAL VALLEY OR UNDER CAPTIVE CONDITIONS (adapted from Reinecke *et al.* 1988)

POTENTIAL BENEFIT	REFERENCE
Improved foraging	
Natural foods (e.g. seeds, invertebrates)	Wright (1961), Wehrle *et al*. (1995)
Agricultural seeds (rice)	Reinecke *et al*. (1988)
Improved physiological condition	
Increased body weight	Delnicki and Reinecke (1986), Demarest *et al*. (1997)
Earlier prebasic molt in females	Heitmeyer (1987), Richardson and Kaminski (1992), Barras (1993)
Increased pair formation	Demarest *et al*. (1997), Vrtiska (1995)
Changes in distribution and habitat use	
Response to local/regional flooding	Reinecke (unpubl. data), Hepp and Hines (1991)
Regional increase in winter population	Nichols *et al*. (1983)
Increased survival and reproductive performance	
Survival	Reinecke *et al*. (1987), Demarest *et al*. (1997), Vrtiska (1995)
Reproductive performance	Heitmeyer and Fredrickson (1981), Kaminski and Gluesing (1987), Dubovsky and Kaminski (1994), and Vrtiska (1995)

life cycle events of Mallards and Wood Ducks, and possibly other waterfowl using alluvial environments like the Delta (Kaminski 1999).

Managed and unmanaged wintering waterfowl habitats are present in the MAV. Managed habitats, using structural measures and vegetation manipulation, are primarily found on federal and state lands, and represent the core wintering habitat during dry (below normal rainfall) years.

As of 2003 the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife program and the Arkansas Partners program (a cooperative effort by the U.S. Fish and Wildlife Service, Ducks Unlimited, and the Arkansas Game and Fish Commission) have provided assistance to hundreds of private land owners to manage 137,028 acres as winter waterfowl habitat (2,028 acres under the Partners for Fish and Wildlife program and 135,000 acres under the Arkansas Partners program).

Unmanaged winter habitat provides important foraging habitat to wintering waterfowl during years of normal or above normal rainfall. These periods of above normal rainfall show increases in available foraging habitat from 900 percent in Mississippi to 1,200 percent in Arkansas (Reinecke *et al.* 1988). The increased availability of wintering habitat also effects the distribution of wintering waterfowl in the MAV. Proportionately more waterfowl have been found to winter in the MAV during periods of above normal rainfall and cold winters (Nichols *et al.* 1983, Reinecke *et al.* 1987). This unmanaged and flood susceptible habitat, which is so important to wintering waterfowl, has long been subject to federal flood control drainage projects in the MAV.

Habitat Utilization

Waterfowl are mobile and opportunistic, and their feeding habits have changed over time, presumably in response to the large scale conversion of native wooded wetlands to small grain agricultural crops. The principal foods of Mallards generally include agricultural grains; seeds and tubers of native plants; acorns; and invertebrates such as isopods, snails, and fingernail clams (Reinecke *et al.* 1987). Heitmeyer (1985) and Combs (1987) found that pin oak (*Quercus palustris*) and cherrybark oak (*Quercus falcata* var. *pagodaefolia*) acorns dominate the Mallard diet during years of good mast production and favorable water conditions in southeastern Missouri. Nuttall oak (*Quercus nuttalli*) fills the same ecological niche in the Bayou Meto basin as pin oak in Missouri.

In the early fall, Mallards concentrate on shallowly flooded openings in bottomland forests. Shortly after arrival, Mallards complete prealternate (breeding plumage) molt and consume aquatic insects and moist soil seeds. Following molt, Mallards begin courtship and by early January 90 percent of the birds are paired (Bellrose 1980). During pairing Mallards forage intensively in flooded forests or agricultural fields, where they consume acorns and cereal grains. After pairing Mallards readily use shallowly flooded forests and continue to consume acorns, but increase consumption of macroinvertebrates (Fredrickson and Batema 1992).

Wood Ducks and Hooded Mergansers (*Lophodytes cucculatus*) use overcup oak, cypress/tupelo forest types, and scrub/shrub habitats during fall courtship and pairing (Bellrose 1980). Both species breed in Arkansas and nest in natural tree cavities or artificial nest boxes. After pairing, wintering habitat includes the deeper areas of lowland hardwoods, cypress/tupelo, overcup oak, and scrub/shrub habitats.

Wright (1961) and Delnicki and Reinecke (1986) demonstrated the importance to waterfowl of large areas of flooded rice and soybean fields. Seeds and tubers of grasses, sedges, and other moist soil plants are also important components of the diet (Wright 1961, Wills 1970, Heitmeyer 1985, Delnicki and Reinecke 1986, Combs 1987). Invertebrates generally provide less than 10 percent of the diet in agricultural (Delnicki and Reinecke 1986) and moist soil (McKenzie 1987) habitats, but may be more important in forested wetlands (Heitmeyer 1985).

Although the nutrition of wintering waterfowl is not well understood, it is, however, increasingly clear that nutrition affects dietary energy and protein intake, and that meeting these dietary requirements is positively related to winters with normal or above normal rainfall. Studies conducted in Mississippi during the wet winter of 1982-83 show increased Mallard body weights while the dry winter of 1980-1981 show decreased Mallard body weights (Delnicke and Reinecke 1986). Similar results in Missouri indicated that Mallard body weights increased when water conditions and mast production were favorable, or when rainfall was sufficient to flood low lying cropland (Heitmeyer 1985, Combs 1987). The condition in which waterfowl return to the breeding grounds has been shown to have a major impact on their breeding success and survival (Bellrose 1980, Reinecke *et al.* 1989).

In recent years, research has focused on relative waterfowl use and associated food availability in natural and agricultural foraging habitat. Use of agricultural fields differs among crops (Nelms and Twedt 1996). Herbaceous native vegetation is used to a greater extent than any agricultural crops. Bottomland hardwoods are used for foraging to a certain extent and roosting, loafing, and pair formation to a large extent (Reinecke *et al.* 1989). (Caloric values, seed consumption, and seed decomposition rates of available waterfowl foraging habitat form the basis for determining project impacts and are discussed in detail in the Impact Assessment Methodology section of this appendix.)

Social Behavior

During winter, courtship and pair formation dominate the social behavior of dabbling ducks. Most of the project area is agricultural land, replacing forested wetlands as the primary foraging habitat. The forested wetlands and normally associated shrub swamps, beaver ponds, riparian habitat, and other deep water habitat are used as resting or roosting areas and provide isolation from human disturbance, protection from predators, and a location for courtship and other social activities where pairs are visually isolated. Whereas much of the foraging and nutritional requirements can be met by flooded agricultural lands, a variety of habitats is needed to satisfy the total biological requirements of wintering waterfowl, because members of the population may differ in their habitat needs at any particular time (Reinecke *et al.* 1987). Examples include the likelihood of juvenile or unpaired Mallards feeding in agricultural lands and adults and pairs seeking the isolation of shrub swamps to avoid harassment from courting parties (Heitmeyer 1985).

PROJECT IMPACTS

Project adverse impacts include the direct loss of wooded wetlands and seasonally flooded farm fields due to construction of the water delivery system, storage reservoirs, and flood control measures and indirect loss of wintering waterfowl habitat due to the flood reduction provided by the channel modifications and operation of the pump.

Impact Assessment Methodology

In this section, the term wintering waterfowl includes primarily puddle ducks consisting of the Mallard, Northern Pintail, American Wigeon, Gadwall, Green-winged Teal, Northern Shoveler, and Blue-winged Teal.

Prior waterfowl appendices incorporated a methodology that used available food (energy) as an index of the carrying capacity of winter foraging habitat for dabbling ducks in the MAV. This methodology was developed in 1992 by Mr. Robert Barkley (U.S. Fish and Wildlife Service, Vicksburg Field Office) and Dr. Kenneth J. Reinecke (United States Geological Survey, Mississippi Valley Research Field Station). This method was used on several Corps flood control projects to quantify the impact of altering hydrology on traditional waterfowl wintering areas and for designing appropriate mitigation measures (U.S. Army Corps of Engineers 1991, 1993). This method has also been used in setting habitat management goals for wintering waterfowl habitat in the MAV (Loesch *et al.* 1994).

The Corps prepared a hydrologic model tailored to identify the acres of available foraging habitat under existing conditions and future conditions with and without the project. For a determination of existing and future carrying capacities (based on the implementation of an alternative), land use was broken down into available foraging habitats having food value to wintering waterfowl: soybeans, rice, moist soil, bottomland hardwood forested wetlands, and other (includes pasture, open water, etc.).

To determine carrying capacity in terms of numbers of duck-use-days (DUD), data requirements include land use, hydrology, and available food during the 120 day (November 1 to March 1) waterfowl wintering period. The data were specific to those habitats and food resources that were available and used by foraging waterfowl.

The amount of food available on a unit area of agricultural land (small grain crop residue, native moist soil seeds, and invertebrates) was determined by Reinecke *et al.* (1989), McAbee (1994), and Stafford *et al.* (2005). The amount of food available in bottomland hardwood and moist soil habitats (acorns, invertebrates, moist soil seeds, roots, and tubers) was determined by Heitmeyer (2005).

For this waterfowl appendix the previously described methodology was further refined to include information on crop seed deterioration rates and seed abundance, invertebrate abundance, as well as depth and duration of flooding (Nelms unpublished). Waterfowl foraging habitat, regardless of food value, is only of use to wintering waterfowl if available. Food availability is dependent on flooding. Waterfowl use relatively shallow water areas, eighteen inches or less, for feeding.

Through the use of extensive hydrological data (1949-1997), the Corps provided seasonal acres flooded eighteen inches or less for the wintering season. The land use data provided for the study area were specific to those acres inundated and represent only potential available foraging habitat. By including the factors described above, the present methodology is more representative of winter waterfowl foraging habitat.

The index of carrying capacity for wintering waterfowl foraging habitat is expressed in duck-use-days (DUD) per acre which represents the capacity of the available forage per acre that meets the energy requirements of one duck for one day. The information used to estimate DUD for agricultural lands were: (1) current land use, including crop type, (2) extent, duration, and depth of flooding, (3) amount of winter food present by land use, (4) energy of food items, (5) deterioration rates of food items, (6) energy requirements of waterfowl, and (7) estimated density of waterfowl. The equation for this is as follows:

$$DUD\ /\ Acre = \frac{Food \times Energy}{Duck\ \ Energy\ \ Needs}$$

The equation used to estimate DUD was further refined by factoring in the amount of seed deterioration that occurs over time because seed deterioration has a significant impact on DUD. Deterioration rates were estimated from experimental data using the best fitting regression model (Nelms and Twedt 1996). Daily seed consumption estimates were also incorporated into the equation to preclude overestimating the influence of seed deterioration because foods consumed by ducks are not subject to deterioration. Since DUDs are a function of the weight of the food available and food is easily converted to calories, calculations are in terms of the weight of food. The equation for food available to ducks on a given day when seed consumption and deterioration are taken into account is:

$$Food_j = Food_0 - \sum_{i=0}^{j} (Food_{consumed_i} + Food_{deteriorated_i})$$

where:

$$Food_{consumed} = \frac{Mean\ duck\ density \times Kcal\ consumed / duck / day}{Kcal / kg\ of\ food}$$

and

$$Food_{deteriorated} = Food \times Deterioration\ rate \times Days_i$$

where i and j are days.

Duck-use-days per acre, adjusted for deterioration, are calculated by multiplying the number of days times the projected density of ducks. By converting to DUD, units are comparable across habitats which facilitates both wetland mitigation efforts and management decisions. This is particularly useful when the loss of one habitat must be mitigated with another habitat type due to practical constraints or the need to meet multiple ecosystem management goals. DUD provide an objective index of the relative value of different habitats for dabbling ducks as winter foraging habitats.

To facilitate calculation, food item densities, deterioration rates, and energy values were aggregated within a given habitat type. Weighted averages based on weights of food items were used to calculate the aggregate values. Aggregate values are representative of any generic unit of food in the habitat of interest.

Once aggregate values were calculated, the density of ducks feeding in the habitats of interest is projected so that daily consumption can be estimated. An overall average of systematic observations of waterfowl in flooded moist soil, rice, and soybean fields in the MAV was used to estimate duck density. The estimated diurnal density of ducks in flooded rice, soybean, and moist soil fields in the MAV from data collected by McAbee (1994) and Dr. Dan Twedt (U.S. Geological Survey) and Mr. Curtis Nelms (U.S. Fish and Wildlife Service, Vicksburg) (unpublished data) is 10.1 ducks/ha. Little information is available on nocturnal feeding densities of waterfowl, although this has been shown to be an important phenomenon (Paulus 1980, Reinecke unpublished data). To adjust for nocturnal foraging, the estimate of diurnal density is doubled to 20.2 ducks/ha. The role of the projected density and subsequent consumption estimates is to dampen the effects of seed deterioration on food availability. If the average daily consumption estimates were not included in the model then the influence of seed deterioration would be overestimated because foods consumed by ducks are no longer subject to deterioration.

Reasonable estimates were generated for the number of days of flooding until exhaustion of food resources occurred at an average duck density. This density is assumed to be the point where declining foraging efficiency causes ducks to abandon a field. Reinecke *et al.* (1989) found this threshold foraging efficiency to be 50 kg/ha. The estimated Days To Exhaustion (DTE) of food resources is useful for determining the impact of the length of flooding on habitat values. DTE allows the inclusion of data on flood duration and is useful in determining the impacts of flood control projects on wintering waterfowl foraging habitat.

From the above calculations and assumptions, DUD/acre was generated for agricultural crops. Generally in waterfowl impact analyses the same technique would also be applied to moist soil and forested habitats. However, waterfowl experts from the Lower Mississippi Valley Joint Venture (LMVJV), in conjunction with experts from academia, are currently in the process of revising the DUD/acre values for forested and moist soil habitats in the lower Mississippi Alluvial Valley (MAV). In the interim, Heitmeyer (2005) provided estimates of food availability and waterfowl consumption rates in the MAV and calculated DUD values to determine the benefits of proposed waterfowl management actions associated with the Bayou Meto project. In an effort to maintain the ability to compare benefits and impacts in terms of DUD loss/gains, the Service has adopted these values until new estimates are issued by the LMVJV. All DUD/acre values used in this assessment are detailed in Table 5.

TABLE 5. DUCK-USE-DAYS (PER HECTARE AND PER ACRE) FOR FLOODED MOIST SOIL, RICE, SOYBEAN, AND BOTTOMLAND HARDWOOD FORESTS.

Habitat	Duck-use-days/ha	Duck-use-days/ac
Moist Soil (managed)[1]	4,216	1,706
Moist Soil (natural)[2]	2,108	853
Rice[3]	324	131
Soybean[3]	299	121
BLH (≥ 30% Red Oak)[1]	1,243	503
BLH (< 30% Red Oak)[4]	1,171	474

[1]Heitmeyer 2005

[2]The value of "natural" moist soil areas such as fallow fields was adjusted to half that of intensively managed units to account for variability in the disturbance and flood regime and the resultant variance in seed and invertebrate production.

[3]Stafford *et al*. 2005

[4]The value of 503 DUD/acre estimated by Heitmeyer (2005) assumed a forest containing ≥ 30% red oak component, ≥ 50% herbaceous ground cover, and less than 10% damage to red oaks. We calculated an average of these variables for existing forests (excluding those influenced by levees and greentree reservoir management) using data from Heitmeyer and Ederington (2004) and adjusted the DUD/acre figure accordingly.

CONSTRUCTION IMPACTS

Construction impacts are those impacts that would be associated with the construction of the pumps, reservoirs, canals/ditches, and pipelines; maintenance of rights-of-way; or placement of dredged/fill material from ditch cleanouts/enlargements. These impacts are "direct" in that an acre-for-acre change in land use occurs. Although mitigation for some of these direct impacts will be required, they are not used in the calculations of gained or lost DUD due to operational impacts. All alternatives from the irrigation component will directly impact 798 acres of forested wetlands and 289 acres of farm land. The Corps estimates that up to 12 acres of the affected farm land will be classified as “farmed wetland”. Additionally, the on-farm construction of reservoirs and tailwater recovery systems is estimated to affect up to 100 acres of farmed wetlands and 100 acres of forested wetlands. The selected flood control plan (FC3A) will directly impact 797 acres of forested wetlands and 572 acres of farm land (estimated 23 acres of farmed wetland). The total acreage of directly impacted forested wetlands for both the irrigation and flood control components is 1,695 acres (including on-farm features). The total acreage of cleared lands impacted is 961 acres (including on-farm features), with 135 acres of this estimated to fall within designated “farmed wetlands”.

OPERATIONAL IMPACTS (CHANGES IN SEASONAL FLOODING)

Future With and Without-Project Analysis

For existing habitats with value as waterfowl foraging areas and that would be impacted by the hydrology alteration resulting from the operation of a pump and channel modifications, foraging value could be reduced or eliminated. The waterfowl management component of the project will have positive benefits for waterfowl, however that portion of the project is designed as a separate component intended to restore and manage habitat above and beyond that required for compensatory mitigation. The benefits of the waterfowl management component are detailed by Heitmeyer 2005 and elsewhere in the "Waterfowl Management and Restoration Plan" description.

According to the Bayou Meto WMA Wetland Management Plan (Heitmeyer *et al*. 2004) and an assessment of forest health elsewhere in the Bayou Meto basin (Heitmeyer and Ederington 2004), there are significant forested areas in the lower portion of the basin that would benefit from a reduction in flooding duration. Most notably, many red oaks in and adjacent to greentree impoundments in Bayou Meto WMA (and on private land) are currently stressed, dying, and/or converting to more water tolerant species such as overcup oak or green ash. The proposed pump station at the mouth of Little Bayou Meto and internal WMA drainage improvement will help alleviate extended spring flooding that has contributed to this problem. To account for areas that are hydrologically disconnected from the floodplain (GTRs) or that will benefit from a reduction of flood duration during the spring (Bayou Meto WMA), these areas were treated as separate land use categories and given a value of zero DUD/acre to exclude them from the impacts analysis. The true value of these habitats and potential benefits that will result from the waterfowl management components of the project are detailed by Heitmeyer (2005).

Total DUD for baseline conditions and each alternative plan (including the selected plan) are presented in Tables 6 through 12. Based on the Corps' data analysis, seasonal acres flooded by land use categories, for all hydrological reaches flooded 18 inches deep or less, total 14,620 acres for baseline conditions. This value included a land use category "other" that does not provide waterfowl foraging habitat (i.e., roads) and habitats that will be neutrally or positively impacted (GTRs, Bayou Meto WMA). Baseline seasonal acres flooded were adjusted based on the percent of actual foraging habitat by reach and was determined to be 9,427 acres. Using these acres of habitat average seasonal duck-use-days for all hydrological reaches total 3,523,197 duck-use-days (baseline conditions). Implementation of purely structural flood control features would result in adverse impacts to migratory waterfowl wintering habitat (Alternatives FC2, FC2A, FC3A, FC3B). Losses would occur both on private and public lands and would be evident in seven of eleven hydrological reaches. For example, wintering waterfowl foraging habitat carrying capacity would be reduced annually by 267,817 DUD and 269,929 DUD for alternatives FC2 and FC2A. Alternatives FC3A and FC3B, which incorporate 1,000 and 3,000 cfs pumps, would result in losses of 482,948 DUD and 626,375 DUD, respectively. Alternative FC6, which consists of reforesting 15,140 acres of cropland in the two year floodplain, would result in a small loss of 12,304 DUD. This loss of DUD is not due to reduced hydrology. This loss is result of the assumption that all available farm land in the "waterfowl scene" would be reforested. A component of this includes reforestation of fallow fields (853 DUD/acre verses

503 DUD/acre) which accounts for the small loss of DUD. The selected plan, which is a combination of water conveyance alternative WS4B and flood control alternative FC3A would result in an indirect loss of 482,948 DUD due to decreased extent and duration of flooding.

CONCEPTUAL MITIGATION MEASURES

Depending on the alternative selected, wintering migratory waterfowl habitat losses could occur in seven of the eleven reaches. The following discussion, which is conceptual, is intended to provide examples of how intensively managing wintering waterfowl habitat can both increase foraging habitat for wintering waterfowl and meet their broader ecological requirements.

Reforestation

Reforestation is the Service's preferred mitigation technique for several reasons: 1) Reforestation constitutes an ecosystem approach to replacing the waterfowl values that would be lost through project construction. Instead of concentrating on implementing a mitigation feature aimed at primarily replacing the lost food values, reforestation would address all wintering waterfowl habitat requirements. In this appendix we have used food as an index of waterfowl habitat needs. Waterfowl are not able to divide their world and habitat needs into such specific compartments. A bottomland hardwood forest ecosystem provides food and other waterfowl habitat needs such as courtship sites, protection from predators and adverse weather, resting and roosting areas, and isolation from human disturbance. 2) Reforestation would provide a stable, low maintenance, high reliability mitigation feature. These mitigation features are supposed to last for the 50 year project life. Other mitigation techniques that would replace lost waterfowl food values, such as moist soil management areas, would require periodic maintenance and/or active operation in order to provide the predicted food supply. With constantly changing funding priorities a "no maintenance-no operation-self sustaining" mitigation feature is much more reliable and cost effective. 3) The chance of successful waterfowl habitat value replacement is highest with reforestation. Reforestation would create a system that would mimic the previously existing bottomland hardwood ecosystem, which historically had a proven record of providing high quality waterfowl habitat (Reinecke *et al.* 1989). 4) Application of the principles of landscape ecology dictates that we use reforestation as the primary mitigation technique. The project area contains large blocks of agricultural land and few large blocks of forested habitat. To establish ecosystem diversity, additional large blocks of forested habitat should be established by enlarging or connecting existing blocks. While meeting the goals of waterfowl, reforestation of large tracts of bottomland hardwood forests could also meet the needs of neotropical migratory birds many of which are declining (Hunter *et al.* 1993). Other management techniques would not benefit neotropical migratory birds. 5) Reforestation would also offset terrestrial and wetland losses. 6) Reforestation of the floodplain would offset losses to fishes that use such habitats for spawning, foraging, or as nurseries. 7) Reforestation would take irrigated agriculture out of production, thus lessening the demand on the aquifer. 8) Reforestation of marginal agricultural (farmed wetlands) or other cleared lands is easily accomplished. Actions required include direct seeding or planting seedlings and other activities ranging from extensive mowing and fertilization to only seed bed preparation.

Reforested mitigation areas should be subject to frequent and sustained winter flooding 18 inches deep or less. Forest stand composition should intentionally favor, but not be exclusively composed of, heavy seeded species dominated by red oaks for maximum benefits to wintering waterfowl. Table 13 shows the potential mitigation acres that would be required for the four structural flood control plans that result in a loss of DUD. For example, if a mitigation site was reforested and contained at least 30% red oaks then the acres required (assuming 503 DUD/acre) to mitigate for impacts associated with Alternative FC3A would be as follows: 482,948 DUD lost and 960 acres required to offset impacts. Through the use of water control structures, moist soil and rice fields could be used to offset impacts resulting from project construction, and further reduce the mitigation acres required. However, costly and intensive management would be required to achieve desired results with these two methods and the multiple benefits of reforestation mentioned above would not be realized. Benefits from reforestation could be expected immediately due to the presence and availability of native moist soil plants in the newly planted "forest" and would gradually change to those benefits associated with forests dominated by red oaks and the associated invertebrate community.

Based on costs developed by the Service and the Corps, seed bed preparation for either direct seeding or planting seedlings amounts to approximately $10 per acre using a bush-hog or $20 per acre using a disc (Mr. John Kaiser, Vicksburg District Corps, pers. comm.; Eric Johnson, USFWS, Cache River NWR, pers. comm.). Depending upon the availability of seeds or seedlings, planting costs are approximately $130 per acre. Bare root seedlings, purchased in lots of 100,000 or more, cost $195 per thousand; containerized seedlings cost $298 per thousand. Annual operation and maintenance costs vary from $1 to $20 per acre depending on the intensity of management efforts.

TABLE 6. DUCK USE DAYS AVAILABLE FOR BASELINE CONDITIONS (INCLUDES ALTERNATIVE FC1 OF NO ACTION)

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6 *	R7	R8	R9	R10	R11				
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	29	52	74	107	6	130	16	42	103	751	853	640,212	
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	6	36	156	38	13	456	15	65	134	1,120	131	146,676	
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	32	105	219	129	29	666	124	271	451	2,394	121	289,678	
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	68	193	450	274	48	1,253	155	377	689			1,076,566	
BLH	52	61	63	30	31	73	16	23	30	28	31	221	1,206	135	93	260	910	56	1,688	77	173	343	5,162	474	2,446,631	***
Acres Subtotal												374	1,810	203	287	711	1,184	104	2,941	232	550	1,032			3,523,197	
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	11	25	137	62	246	4,346	23	68	66	5,193	0	0	
Total Acres												425	1,968	213	312	847	1,246	351	7,287	255	617	1,097			3,523,197	

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 7. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC2

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6*	R7	R8	R9	R10	R11				
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	23	30	51	107	6	119	14	42	93	676	853	576,694	
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	5	21	107	38	13	417	13	65	121	1,000	131	130,964	
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	26	61	151	129	29	608	109	271	408	2,158	121	261,067	
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	54	112	309	274	48	1,144	136	377	622			968,724	
BLH	52	61	63	30	31	73	16	23	30	28	31	221	1,206	108	54	179	910	56	1,541	68	173	310	4,824	474	2,286,655	***
Acres Subtotal												374	1,810	162	166	488	1,184	104	2,685	204	550	932			3,255,380	
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	9	15	94	62	246	3,968	20	68	59	4,750	0	0	
Total Acres												425	1,968	170	181	581	1,246	351	6,654	224	617	991			3,255,380	

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 8. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC2A

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6*	R7	R8	R9	R10	R11				
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	23	30	51	107	6	119	14	42	93	675	853	575,969	
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	5	20	107	38	13	417	13	65	121	999	131	130,823	
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	26	60	150	129	29	608	109	271	408	2,156	121	260,821	
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	54	110	307	274	48	1,144	136	377	622			967,614	
BLH	52	61	63	30	31	73	16	23	30	28	31	221	1,206	108	53	178	910	56	1,541	68	173	310	4,822	474	2,285,655	***
Acres Subtotal												374	1,810	162	163	484	1,184	104	2,685	204	550	932			3,253,268	
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	9	14	93	62	246	3,968	20	68	59	4,750	0	0	
Total Acres												425	1,968	170	178	577	1,246	351	6,654	224	617	991			3,253,268	

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 9. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC3A WITH LOSSES COMPARED TO BASELINE CONDITIONS

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6*	R7	R8	R9	R10	R11				
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	23	30	51	107	4	94	14	42	93	648	853	553,051	
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	5	20	107	38	9	329	13	65	121	907	131	118,826	
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	26	60	150	129	20	481	109	271	408	2,019	121	244,272	
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	54	110	307	274	33	905	136	377	622			916,148	
BLH	52	61	63	30	31	73	16	23	30	28	31	221	1,206	108	53	178	910	38	1,218	68	173	310	4,481	474	2,124,101	***
Acres Subtotal												374	1,810	162	163	484	1,184	70	2,123	204	550	932			3,040,249	
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	9	14	93	62	167	3,137	20	68	59	3,839	0	0	
Total Acres												425	1,968	170	178	577	1,246	237	5,260	224	617	991			3,040,249	

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 10. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC3B

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6*	R7	R8	R9	R10	R11				
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	23	30	51	107	3	77	14	42	93	630	853	537,722	
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	5	20	107	38	7	269	13	65	121	845	131	110,718	
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	26	60	150	129	16	393	109	271	408	1,927	121	233,186	
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	54	110	307	274	26	740	136	377	622			881,626	
BLH	52	61	63	30	31	73	16	23	30	28	31	221	1,206	108	53	178	910	30	996	68	173	310	4,251	474	2,015,197	***
Acres Subtotal												374	1,810	162	163	484	1,184	57	1,736	204	550	932			2,896,822	
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	9	14	93	62	134	2,565	20	68	59	3,233	0	0	
Total Acres												425	1,968	170	178	577	1,246	190	4,301	224	617	991			2,896,822	

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 11. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC6 *

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11			
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	29	52	74	107	6	130	16	42	103	751	853	640,212
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	6	36	156	38	13	456	15	65	134	1,120	131	146,676
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	32	105	219	129	29	666	124	271	451	2,394	121	289,678
Crop Subtotal *	36	31	32	62	53	22	14	17	61	61	63	153	604	68	193	450	274	48	1,253	155	377	689			1,076,566
BLH (existing)	52	61	63	30	31	73	16	23	30	28	31	221	1,206	135	93	260	910	56	1,688	77	173	343	5,162	474	2,446,631
Acres Subtotal												374	1,810	203	287	711	1,184	104	2,941	232	550	1,032			3,523,197
Other	12	8	5	8	16	5	70	60	9	11	6	51	158	11	25	137	62	246	4,346	23	68	66	5,193	0	0
Reforestation *	36	31	32	62	53	22	14	17	61	61	63	154	614	68	195	453	273	49	1,231	155	375	689	4,256	503	2,140,828
Total Acres												579	2,582	282	506	1,300	1,519	400	8,519	410	993	1,786			

Total existing forest and reforested value	4,587,459
Existing crop value	1,076,566
Final value	3,510,893

* This alterative would consists wholly of non-structural flood damage reduction in the form of reforestation of 15,140 acres of the pre-project two year floodplain. We maximized the potential reforestation within the "waterfowl scene" by assuming that all fallow fields, rice, and soybeans within this scene would be reforested (4,256 acres). Due to the high food value of fallow fields, this reforestation would actually result in a small loss of DUD.

TABLE 12. GAINS OR LOSSES IN DUCK-USE-DAYS FOR EACH FLOOD CONTROL ALTERNATIVE COMPARED TO BASELINE CONDITIONS

Alternative	DUD	Baseline DUD	Change in DUD
FC1	3,523,197	3,523,197	0
FC2	3,255,380	3,523,197	-267,817
FC2A	3,253,268	3,523,197	-269,929
FC3A	3,040,249	3,523,197	-482,948
FC3B	2,896,822	3,523,197	-626,375
FC6	3,510,893	3,523,197	-12,304

Average Annual Benefits

Mitigation values achieved would vary depending on the cover type established. Average annual duck-use-days/acre within the project area could be expected to range from 1,706 DUD/acre for a moist soil area exclusively devoted to wintering waterfowl to 503 DUD/acre for reforested bottomland hardwoods with at least 30 percent red oak composition to 121 DUD/acre for a flooded harvested soybean field that has not been fall plowed or burned. Potential mitigation acres required for various alternatives and land management schemes are shown in Table 13.

In addition to food values, other benefits to wintering waterfowl would also be realized from the establishment or enhancement of forested wetlands. Benefits would include isolation for pair bonding, better protection from disturbance and harassment than in more open areas, and protection from predation and extremes in weather conditions.

Unquantified benefits resulting from establishment of more dependable wintering waterfowl foraging habitat accrue to the whole range of resident and migratory species attracted to wetlands as well as overall wetland functional values. Not intended as all inclusive, the list of fauna benefiting would include resident aquatic furbearers, resident and migrant shore and water birds, insectivorous and granivorous neotropical migratory birds, native amphibians and reptiles, and the broad range of resident game and nongame birds and mammals known to inhabit forested wetlands and herbaceous wetlands (such as moist soil areas). Other functional wetland values attributable to reforested areas include flood water storage, improved water quality, ground water recharge, esthetics, and scientific study opportunities. Additionally, economic benefits resulting from crop damage reduction, added outdoor recreation opportunities, and the harvest of timber and other wood products could offset economic losses resulting from instances where existing agricultural practices/leases might have to be modified.

CONCLUSIONS

Implementation of purely structural flood control features (e.g., Alternatives FC2-FC3B) would result in adverse impacts to migratory waterfowl wintering habitat. Losses would occur both on private and public lands and would be evident in seven of eleven hydrological reaches. Project alternatives that reduce the extent, duration, and frequency of winter water are of concern to the Service. The no action plan would result in no loss of DUD while Alternative FC6 would result in a small loss of 12,304 DUD. This nonstructural alternative, while resulting in small loss of DUD from a caloric standpoint, would provide multiple unquantifiable benefits to many species and reduce flood damages on frequently flooded farmland.

The purpose of this appendix was threefold: first, to identify the relative importance of the general project area in terms of historic trends in wetlands and wintering waterfowl; secondly, to document existing (baseline) wintering waterfowl carrying capacity in the project area, and thirdly, to document project induced impacts by comparing future with and without-project conditions using food as an index of carrying capacity expressed in terms of duck-use-days (DUD). However, quantifying food availability and consumption by waterfowl in shallow water (18 inches deep or less) represents only one facet of waterfowl biology and only part of waterfowl habitat requirements. The availability of winter water at depths greater than 18 inches and for other uses, i.e., loafing and pair bonding, is equally important and should be considered when selecting a plan that could reduce the extent of wintering waterfowl habitat.

Table 13. PLANS THAT RESULT IN A LOSS OF DUCK-USE-DAYS AND THE POTENTIAL MITIGATION ACRES REQUIRED UNDER VARIOUS MANAGEMENT OPTIONS

		Management Schemes			
Alternative	Loss of DUD	Moist Soil acres @ 1,706 DUD/ac	Rice acres @ 131 DUD/ac	Soybean acres @ 121 DUD/ac	≥ 30% Red Oak BLH acres @ 503 DUD/ac
FC1*	0	0	0	0	0
FC2	267,817	157	2,044	2,213	532
FC2A	269,929	158	2,061	2,231	537
FC3A	482,948	283	3,687	3,991	960
FC3B	626,375	367	4,781	5,177	1,245
FC6**	12,304	7	94	102	24

* FC1 represents the "no action" alternative, therefore no mitigation is recommended.
** FC6 represents the "non-structural" alternative which would result in a loss of 12,304 DUD due to the reforestation (503 DUD/acre) of fallow fields (853 DUD/acre).

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APPENDIX B

SHOREBIRD HABITAT AND BIOLOGY

SHOREBIRDS

Introduction

Wetland management efforts have historically been focused primarily on waterfowl, but in the 1990's shorebirds (Aves: Charadriiformes) and other nongame waterbirds have become increasingly appreciated by the public and subsequently wetland management efforts have expanded to include them (Helmers 1992). Although data are limited, significant population declines in most shorebird populations are evident (Helmers 1993). The North American Waterfowl Management Plan, a large scale multi-organization wetland management effort, has incorporated shorebirds into its management strategies (Helmers 1992, 1993; Streeter *et al*. 1993). The study area falls within the review of the Mississippi Alluvial Valley (MAV) Migratory Bird Initiative, which identifies habitat goals for migratory birds including shorebirds (Loesch *et al.* 2000). The well being of shorebirds has been compromised by wetland losses, hydrologic alterations due to stream channelization and flood control efforts, human development, and environmental contaminants. Shorebirds include a diverse assemblage of birds that breed, migrate, and winter throughout the Bayou Meto basin. Thirty-six species of shorebirds occur in Arkansas on a regular basis, nearly all of which have been observed in the project area, and several more species have been observed in isolated instances (James and Neal 1986).

American Woodcock (*Scolopax minor*) and the Black-necked Stilt (*Himantopus mexicanus*) may breed in the project area. However, the only species of shorebird that has been documented to breed in this part of the state is the Killdeer (*Charadrius vocerifus*). This species is thriving in the area and has adapted well to modern land uses. Killdeer are anticipated to maintain relatively stable populations in the foreseeable future.

Killdeer and Wilson's Snipe (*Gallinago delicata*) are common throughout the winter whereas yellowlegs (*Tringa* spp.) and Calidrid sandpipers (*Calidris* spp.) are consistently present, but less abundant. Shorebird densities were greater in soybean fields than in rice fields and moist soil units from November to January (Twedt *et al*. in press). During February and March, shorebird densities in soybean and rice fields were similar, but greater than in moist soil units.

Seasonal Movements

Spring--It is usually wet during spring and flooded habitat is abundant. Shorebirds are most often observed on mudflats and on rice fields with little cover. More than 70 percent of shorebirds are associated with areas having water approximately two inches deep. Black-necked Stilts and yellowlegs (*Tringa flavipes* and *T. melanoleuca*) are associated with water deeper than two inches. Whereas, Killdeer, Pectoral Sandpipers (*Calidris melanontos*), and many of the smaller species were commonly observed on mudflats. In northeastern Louisiana, Ouchley (1992) observed shorebirds most often on shallow flooded areas with little cover, such as rice fields with little post-harvest residue. Flooding fields with about two inches of water is most beneficial to shorebirds, but deeper flooding is also beneficial if shallow water edge habitat is associated with the flood regime.

Summer—Suitable shorebird habitat in late summer is limited, with most of the habitat being provided by moist soil areas on national wildlife refuges. High species diversity and abundance of shorebirds during July, August, and early September underscore the need for shallow flooded habitat during summer. However, excess summer water is usually not available and flooding is not compatible with agricultural practices during this time. Suitable stopover habitat, particularly during the late summer is likely a limiting factor for shorebird populations that migrate through the Mississippi Alluvial Valley (Helmers 1992).

Fall/Winter—Intensive management of small areas can provide valuable fall and winter shorebird habitat. Rice fields and plowed fallow fields provide shorebird habitat from early fall through early winter. Rolling or lightly discing rice fields tends to break down stubble, increasing their value to shorebirds. Drawn-down impoundments (including aquaculture ponds), with exposed mudflats and little cover, seem to attract more fall migrants than disced fields. Higher shorebird use of flooded soybean fields may be due to sparse vegetation cover and looser textured soil surface; these characteristics probably increase invertebrate productivity. Soybean is one of the most widely planted crops in the MAV, but soybean fields are not usually artificially flooded during winter. The opportunity exists to greatly increase shorebird winter habitat by artificially flooding soybean fields.

Many species of shorebirds migrate from Arctic breeding grounds to Central and South American wintering grounds with a major migration corridor passing through the MAV (Helmers 1992). Some shorebirds migrate up to 7,500 miles between their breeding and wintering areas. To migrate successfully, shorebirds require highly productive stopover sites where they can efficiently forage to replenish fat reserves. They typically require habitat with an abundance of invertebrates that is either shallowly flooded (< four inches) or comprised of mudflats. This habitat can be provided by impounding water on agricultural fields and moist soil units and by drawing down reservoirs in a timely fashion (Twedt *et al.* in press). Most species of shorebirds avoid wooded wetlands although they may use suitable openings in them occasionally.

Shorebird Behavior

Cotton, soybean, and rice are the three most common crops within the MAV (Bellow and Graham 1992). Flooded cotton fields offer only limited benefits to shorebirds; however, rice and soybean are used extensively by wintering and migrating shorebirds (Twedt and Nelms 1995).

Diurnal observations were made of behavior of flocks of birds using rice, soybean, and moist-soil habitats in Arkansas and Mississippi (Twedt and Nelms 1995). Specifically, behavior of flocks of Wilson's Snipe and yellowlegs were compared among habitats and among seasonal periods during winter and early spring. Study areas included the Lower Yazoo River basin in Mississippi and the Grand Prairie in Arkansas. During the winters of 1991-92 and 1992-93, sixty fields, 20 of each habitat type, were selected from landowners enrolled in cooperative "private lands" projects supplemented with eight moist-soil habitats which were not under cooperative agreements but on which water was managed during winter.

Beginning November 15 of both winters, flocks of specific bird species were observed on selected fields twice during each of nine consecutive two-week periods and once during each of three additional consecutive two-week periods. If the selected fields did not have bird flocks present, the next flock of birds was observed in the appropriate habitat encountered. Observations were made systematically on randomly selected dates (within each period) beginning at randomly selected times, but all observations were diurnal. During each visit scan-sampling was used to record the behavior of all individuals within small flocks (six bird minimum flock size) or the first 200 individuals encountered in large flocks. Behaviors were recorded as: feeding, moving, resting, flying, alert, social, and other. Before statistical analysis, the proportions of the four primary behaviors; feeding, resting, moving, and alert; within each flock were subjected to arcsine transformation (Zar 1984). Also the twelve two-week observation periods were equally grouped in four seasons: early winter, mid winter, late winter, and spring. For Wilson's Snipe and yellowlegs, a separate multivariate analysis of variance (MANOVA) was performed on the transformed behavioral proportions of flocks to examine differences among habitats or in all seasons, comparisons were only made where representative date were available. Seasonal comparisons for snipe and yellowlegs were between the aggregate of all winter periods and spring. Additionally, snipe behaviors were only compared between rice and soybean habitats.

Thirty-three Wilson's Snipe flocks with a mean flock size of 24 birds and 29 yellowlegs flocks with a mean of 22 birds per flock were observed (Twedt and Nelms 1995). Preliminary analyses indicate that the interaction of habitat and season did not significantly impact the analyses for either Wilson's Snipe or yellowlegs and was removed from these MANOVA. No significant differences were detected among habitats for either snipe or yellowlegs. However, significant differences in behavior were detected between winter and spring seasons for both snipe and yellowlegs in preliminary analyses. Greater proportions of both snipe flocks and yellowlegs flocks moved during winter than during spring. Additionally, snipe flocks had a greater proportion of individual feeding during spring than during winter. Increased feeding behavior of snipe flocks during late winter and spring may be the result of hyperphagia to develop fat deposits for northward migration and subsequent breeding. Alternatively, this increase in feeding behavior may be a response to diminished food resources on areas depleted earlier in the winter.

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Arkansas Game and Fish Commission

2 Natural Resources Drive Little Rock, Arkansas 72205

Scott Henderson
Director

Mike Gibson
Deputy Director

David Goad
Deputy Director

Loren Hitchcoc
Deputy Director

November 21, 2006

Ms. Marge Harney
U. S. Fish and Wildlife Service
110 South Amity Rd., Suite 300
Conway, AR 72032

Dear Ms. Harney:

The Arkansas Game and Fish Commission, as an active member of the U. S. Army Corps of Engineers' (USACE) Bayou Meto Basin Interagency Environmental Planning Team, has conducted in-depth coordination efforts with the U.S. Fish and Wildlife Service (USFWS), USACE, and other State and Federal agencies, in efforts to avoid and minimize any adverse fish and wildlife resource impacts in connection with the above referenced project.

Our agency biologists, in cooperation with USFWS, have also developed measures to compensate and/or mitigate for unavoidable fish and wildlife resource losses, and have included other ecosystem restoration features throughout the project planning process. Additionally, we had the special opportunity to develop the Waterfowl Management Component, a Congressionally authorized project purpose included along with the Water Supply and Flood Control Components of the project plan.

As you are aware, the Bayou Meto Basin Project has a tremendous potential to help meet our goals of restoring and enhancing prime wetland waterfowl habitat, and other fish and wildlife resources, particularly on our World Renown Bayou Meto Wildlife Management Area, as well as the entire Bayou Meto Basin.

The Arkansas Game and Fish Commission, meeting in regular session on January 19, 2006 unanimously approved AGFC Minute Order No. 06-004, which is attached, along with a copy of a Letter of Intent dated January 20, 2006 committing up to $8M over a period of years to help the project sponsor fund the $101M Waterfowl Management Component of the U. S. Army Corps of Engineers' Bayou Meto Basin Project.

Please be advised that the AGFC is a project partner, and we have no objections and no additional comments at this time.

We appreciate the opportunity to provide these comments and look forward to working cooperatively with all interested parties as project planning and funding processes continue.

Yours very truly,

CRAIG

Craig K. Uyeda, Chief
River Basins Division

CKU/jah

Enclosures

Phone: 501-223-6300 Fax: 501-223-6448 Website: www.agfc.com

ARKANSAS GAME AND FISH COMMISSION
Little Rock, Arkansas

MINUTE ORDER NO:	06-004	SUBJECT:	Bayou Meto Basin Improvement Project Plan
DATE PASSED:	January 19, 2006		
PAGE 1 of 1 PAGES		LOCATION:	Arkansas and Jefferson Counties

WHEREAS, the Arkansas Game and Fish Commission has received information from the Bayou Meto Regional Irrigation Water Distribution District, the Arkansas Natural Resources Commission, the United States Army Corps of Engineers, the United States Natural Resources Conservation Service, and the United States Fish & Wildlife Service indicating that the Bayou Meto Basin Improvement Project Plan, if implemented, will produce management features that will significantly restore and enhance fish and wildlife habitat throughout the Bayou Meto Basin, especially including AGFC's Bayou Meto Wildlife Management Area; and

WHEREAS, co-sponsors for the Bayou Meto Basin Improvement Project Plan are now seeking a preliminary, non-binding commitment for this Commission to join with the state and local sponsors, and contribute up to eight million dollars to help fulfill the non-federal cost share for the project; and

WHEREAS, given this important opportunity to help achieve such extensive and valuable benefits for fish and wildlife, this Commission is indeed willing to commit a sum of up to eight million dollars in support of the project upon the condition that the Commission will be able to arrange to finance its contribution over a term of years mutually satisfactory to all project co-sponsors.

NOW, THEREFORE, BE IT ORDERED, that the Arkansas Game and Fish Commission does hereby direct that its Director shall be, and hereby is, authorized to execute a letter, addressed to one or more co-sponsors for the Bayou Meto Basin Improvement Project Plan, to express intent that the Commission is agreeable to contributing up to eight million dollars as a non-federal sponsor for the project, conditioned upon the Commission making satisfactory arrangements for such financing.

STAFF APPROVAL

Submitted by: Craig K. Uyeda CKU

Division: Administrative

Approved: Scott Henderson
Director

Approved: A F X Norrhart
Legal

Approved: Ray Roberts
Fiscal

COMMISSION APPROVAL

Mike Freeze
Chairman

Brett May
Commissioner

Vice Chairman

John Benjamin
Commissioner

Commissioner

Commissioner

Commissioner

Arkansas Game and Fish Commission

2 Natural Resources Drive Little Rock, Arkansas 72205

January 20, 2006

J. Randy Young, PE
Executive Director
Arkansas Natural Resources Commission
101 E. Capitol Avenue Suite 350
Little Rock, AR 72201

Re: Bayou Meto Basin Project – Local Cost Share of the Waterfowl Management Features

Dear Mr. Young:

The Arkansas Game and Fish Commission (AGFC) has reviewed the Bayou Meto Basin Project plan and believes the construction of the Waterfowl Management features of the project would be beneficial to the Bayou Meto Wildlife Management Area and Arkansas' fish and wildlife resources. The Commission would be willing to partner on the local cost share associated with the waterfowl management features and make the necessary payments (up to $8 million) as our part of the local sponsor's share.

We ask the Arkansas Natural Resources Commission (ANRC) to work with the AGFC staff to develop a financing plan that would allow AGFC to make payments over the next 20 plus years. Upon completion of a proposed plan, it will be submitted to the AGFC for approval, and if such plan contains financing from the ANRC, we understand the plan would be subject to approval from the ANRC.

This letter was authorized by AGFC action, which was taken at the January 19, 2006 Commission meeting.

Sincerely,

Scott Henderson

Scott Henderson
Director

Cc: Bayou Meto Regional Irrigation Water District

Phone: 501-223-6300 Fax: 501-223-6448 Website: www.agfc.com

SECTION II

COORDINATION

Part B. Prime and Unique Farmland

Prime and Unique Farmland

Identification of impacts resulting from project implementation to prime and unique farmlands within the project area was accomplished through coordination with the Natural Resources Conservation Service (NRCS) office in Little Rock, Arkansas. Due to data lost during computer changes (Tony Stevenson pers. comm.), NRCS was unable to provide acreages; however they did send the Memphis District a shapefile that showed the prime and unique farmlands in the project area. The Memphis District GIS person overlayed the farmland shapefile with the file containing all work associated with the Bayou Meto project and generated an impact to prime and unique farmlands of 5,366 acres.

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 1/21/05
Name Of Project Bayou Meto Basin General Evaluation	Federal Agency Involved Memphis District Corps of Engineers
Proposed Land Use Canals, ditches, and reservoirs	County And State Lonoke, Jefferson, Prairie, Arkansas, Pulaski AR
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 1/21/05

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply -- do not complete additional parts of this form).*	Yes ☑	No ☐	Acres Irrigated	Average Farm Size

Major Crop*(s)* Soybeans, Rice, Wheat	Farmable Land In Govt. Jurisdiction Acres: 431,040 % 96	Amount Of Farmland As Defined in FPPA Acres: 382,994 % 86
Name Of Land Evaluation System Used LESA - SCS	Name Of Local Site Assessment System	Date Land Evaluation Returned By NRCS 2/18/05

PART III *(To be completed by Federal Agency)*		Alternative Site Rating			
		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		5,366.0			
B. Total Acres To Be Converted Indirectly					
C. Total Acres In Site		5,366.0	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		4,507.0			
B. Total Acres Statewide And Local Important Farmland					
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted		1.2			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		75.0			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*		80	0	0	0
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use	15	15			
2. Perimeter In Nonurban Use	10	10			
3. Percent Of Site Being Farmed	20	0			
4. Protection Provided By State And Local Government	20	0			
5. Distance From Urban Builtup Area	15	15			
6. Distance To Urban Support Services	15	15			
7. Size Of Present Farm Unit Compared To Average	10	10			
8. Creation Of Nonfarmable Farmland	0	0			
9. Availability Of Farm Support Services	5	5			
10. On-Farm Investments	20	20			
11. Effects Of Conversion On Farm Support Services	0	0			
12. Compatibility With Existing Agricultural Use	0	0			
TOTAL SITE ASSESSMENT POINTS	160	90	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	80	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	90	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	170	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ▣

Reason For Selection:

(See Instructions on reverse side) **Form AD-1006 (10-83)**

This form was electronically produced by National Production Services Staff

SECTION II

COORDINATION

Part C. Pertinent Correspondence

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

MAR 02 2005

Mark R. Smith
U.S. Army Corps of Engineers
167 N. Main St, B-202
Memphis, TN 38103 - 1894

Dear Mr. Smith,

Thank you for the opportunity to review the document entitled "Hydrogeomorphic (HGM) Assessment of sites Projected to Be Hydrologically Altered in the Bayou Meto Improvement Project Area, Arkansas", by Charles Klimas and Matt Blake, U.S. Army Engineer Research and Development Center, Vicksburg Mississippi. What follows are Environmental Protection Agency comments specific to issues contained in that document.

The HGM report focuses on proposed hydrologic changes to bottomland hardwoods (BLH) within the Bayou Meto project area. The report categorizes the BLH community into stressed, non-stressed and private Green Tree Reservoir units. It assumes that the private GTRs will not be affected due to levee systems that allow operators to manage internal water levels. It also assumes that reducing flood duration during the growing season will net a benefit for those areas identified as stressed. Leaving approximately 1,384 (per Dr. Heitmeyer's report) acres identified as risk of "negatively" impacted.

The report proposes a mitigation scenario that addresses three identified wetland functions as being negatively-impacted in the Non-Stressed and Stressed BLH types. Those functions are, flood water detention, export of organic carbon and removal of elements and compounds. The report concludes that approximately 1,340 acres of mitigation (BLH restoration) with specific mitigation conditions would offset all functional losses in the BLH community.

The HGM study makes the assumption that BLH areas subject to hydrologic changes will remain forested for the life of the project. A reduction of hydrology below the 5% duration period will result in the elimination of federal jurisdiction and protection under Section 404 of the Clean Water Act. Such a scenario puts those areas at risk of unregulated conversion and total elimination of all wetland functions. Any alteration of waters of the U.S. that render those areas non-jurisdictional must be evaluated as though all functions will be lost and appropriate mitigation should required to compensate for such losses. "Stressed" BLH areas that will "benefit" as a result of reduced flooding duration during the growing season, while still maintaining the required jurisdictional hydrology, will be considered by EPA partially impacted and subject only to replacement of negatively impacted functions as identified in the report.

The report also assumes that private GTRs will not be affected by the hydrologic changes. EPAs concern is that the project may facilitate drainage of GTRs such that current jurisdiction wetlands may be eliminate simply by disarming existing water control features on those properties. EPA recommends that the Corps of Engineers evaluate the extent of jurisdiction wetlands as risk within the private GTRs and include those acres in it's mitigation requirements.

EPA still lacks sufficient information to adequately evaluate the overall impacts to aquatic resources and the projects compliance with the Clean Water Act, Section 404 (b)(1) Guidelines. EPA request that the COE identify the full extent of jurisdictional waters of the U.S. that will be converted to non-jurisdictional status (as defined by the 1987 Manual). That assessment should include the extent and nature of impacts to all wetlands including herbaceous wetlands, farmed wetlands, streams and all other jurisdictional waters within the project area not addressed by the HGM report.

At this time, EPA maintains it's concern that the proposed project may not be in compliance with Section 404 of the Clean Water Act or the administrations policy of regulatory no-net-loss of wetlands.

Thank you for the opportunity to comment on the HGM report. EPA looks forward to receiving the additional information that has requested in this letter so as to better evaluate the project's overall impacts to aquatic resources.

Sincerely,

David W. McQuiddy
Acting Chief,
Marine and Wetlands Protection Section

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

AUG 19 2004

Mark R. Smith
U.S. Army Corps of Engineers
167 N. main St. B-202
Memphis, TN 38103-1894

Dear Mr. Smith:

Thank you for providing the Environmental Protection Agency (EPA) a copy of the report prepared by Dr. Heitmeyer and Belinda Ederington, "An evaluation of bottomland hardwood forest in the Bayou Meto Basin Improvement Project Area". We have reviewed the report and have some questions regarding it and the extent of impacts posed by the Bayou Meto Flood Control Project.

How was the estimated 10,000 acres of wetlands with a 5% or greater inundation period determined. Does that figure represent the total extent of wetland impacts predicted by the Corps? It is not clear if wetlands with saturated only soil conditions were included? If not, how would these areas be addressed? EPA is also interested in knowing what other wetland types are present in the remaining 3000 acres not classified as bottomland hardwoods.

The report concludes that approximately 4000 acres of bottomland hardwoods would either benefit (reduced stress) or have a natural response to a reduction in inundation, EPA must point out that such a reduction (<5%) in hydrology would eliminate one of the three parameters required to meet the federal definition of a jurisdictional wetland thus rendering these wetlands non-jurisdictional. EPA would consider these acres converted to non-wetlands and therefore a loss to the national wetlands base and subject to mitigation.

EPA recognizes that the Bayou Meto project includes many positive environmental features such as restoration of the two year flood plan and reestablishment of native prairies patches. However, in light of the current administrations pledged to go beyond it's "no-net-loss" policy to a national goal of increasing wetlands over the next 5 years, the conversion of wetlands to upland (non-wetland) for the sole benefit of agricultural production, is in EPA's opinion, contrary to that goal.

EPA would welcome an opportunity to gain an better understanding of the proposed project and discuss it's concerns regarding wetland impacts with your agency. If the Corps would be interested in such a meeting please contact Richard Prather of my Staff at (214) 665-8333 or prather.richard@epa.gov to make arrangements. Again, we thank you for the opportunity to review this report.

Sincerely,

Sharon Fancy Parrish
Chief
Marine and Wetlands Section

Arkansas Soil and Water Conservation Commission

J. Randy Young, P.E.
Executive Director

101 EAST CAPITOL
SUITE 350
LITTLE ROCK, ARKANSAS 72201

PHONE 501-682-1611
FAX 501-682-3991

March 1, 1999

Mr. David W. Wolfe, P.E.
Deputy for Project Management
Department of the Army
Memphis District Corps of Engineers
167 North Main Street, B-202
Memphis, Tennessee 38103-1894

Dear Mr. Wolfe:

Thank you for the opportunity to participate with environmental planning efforts associated with the Bayou Meto Irrigation Project. There are many aspects of the project related to flood control, drainage, irrigation, and fish/wildlife resources that should be addressed in this project. Please note that Ken Brazil of my staff (501-682-3980) will represent the Commission on the environmental planning team. Correspondence concerning this effort should be addressed to Mr. Brazil in the future.

Sincerely,

J. Randy Young, P.E.
Executive Director

JRY/KWB/ddavis

cc. Ed Lambert, Memphis District Corps of Engineers

USDA NRCS
Natural Resources Conservation Service

United States
Department of
Agriculture

Room 3416, Federal Building
700 West Capitol Avenue
Little Rock, Arkansas 72201

FEB 25 1999

Mr. David W. Wolfe, P.E.
Deputy for Project Management
Planning, Programs, & Project Management Division
Environmental & Economics Analysis Branch
Department of the Army
Memphis District Corps of Engineers
167 North Main Street, B-202
Memphis, Tennessee 38103-1894

Dear Mr. Wolfe:

In a letter dated February 17, 1999, you requested that I identify a person to serve as my representative on an environmental planning team for the Grand Prairie and Bayou Meto Basin, Arkansas, reevaluation. My representative will be:

Dennis K. Carman, P.E.
State Conservation Engineer
Natural Resources Conservation Service
700 West Capitol Avenue, Room 3416
Little Rock, Arkansas 72201

Phone: (501) 301-3141
FAX: (501)-301-3189
Email: dcarman@ar.nrcs.usda.gov

The Natural Resources Conservation Service is committed to the protection of our natural resources and treatment of the critical natural resource concerns in Arkansas. The resource issues identified in the Water Resources Development Act of 1996 included groundwater protection and conservation, agricultural water supply, and waterfowl management. We look forward to working with you to protect and conserve these critical resources in the Grand Prairie and Bayou Meto Basin.

The partnership that has developed between the Memphis District Corps of Engineers, Natural Resources Conservation Service, Arkansas Soil and Water Conservation Commission and the local irrigation district is truly one of the best federal/state/local partnerships anywhere. We look forward to continuing our efforts in protecting and enhancing our environment.

If I can be of further assistance, please call.

Acting for

KALVEN L. TRICE
State Conservationist

Arkansas Game & Fish Commission
2 Natural Resources Drive Little Rock, Arkansas 72205

Scott Henderson
Assistant Director

Scott Yaich
Assistant Director

Steve N. Wilson
Director

February 23, 1999

Mr. David W. Wolfe, P. E.
Memphis District Corps of Engineers
167 North Main Street B-202
Memphis, TN 38103-1894

Dear David:

We are in receipt of your letter of February 17, 1999 concerning the Eastern Arkansas Region Comprehensive Study, Bayou Meto Irrigation Project, in which the Corps is initiating a reevaluation study of the Bayou Meto basin to include ground water protection and conservation, agricultural water supply, and waterfowl management.

I would like for Craig Uyeda, of my staff, to represent this agency and serve on the environmental planning team. He will coordinate specific agency issues and concerns with the appropriate members of my staff in the usual manner associated with the planning of federally sponsored water related development projects.

We have been working cooperatively with the Memphis District – U. S. Corps of Engineers, Natural Resources Conservation Service, and others in the preliminary planning phases of the project. Craig has just initiated coordination of the Bayou Meto Study Plan with our Fisheries and Wildlife Management Division personnel (attached memorandum dated February 17, 1999).

We shall look forward to the opportunity to work cooperatively with the Memphis District – U. S. Corps of Engineers, Natural Resources Conservation Service, U. S. Fish & Wildlife Service, and other interests on the environmental planning team. We will be identifying environmental impacts and opportunities, developing and evaluating fish and wildlife environmental features, identifying the optimum plan for habitat restoration and enhancement, and providing input on the design of irrigation and flood control features.

Please contact Craig Uyeda at 501-219-4310, Arkansas Game & Fish Commission, #2 Natural Resources Drive, Little Rock, AR 72205, regarding our agency's interests pertaining to the Bayou Meto Basin Reevaluation.

Cordially,

Steve N. Wilson
Director

SNW/CKU/jah
Attachment

Cc: Steve N. Wilson
Scott Henderson
Scott Yaich
Donny Harris
Don McKenzie
Allen Carter
Mike Armstrong
Larry Rider
Steve Filipek
Levi Davis
Jeff Farwick
Roger Milligan
Rob Holbrook
Jeff Quinn
Bob Price, NRCS
Tony Stevenson, NRCS
U. S. Fish & Wildlife Service
Conway, AR
Ed Lambert, Environmental Branch
MD-USCE

February 17, 1999

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Allan J. Mueller
U.S. Fish and Wildlife Service
Ecological Services
1500 Museum Road, Suite 105
Conway, Arkansas 72032

Dear Mr. Mueller:

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, was reauthorized by the Water Resources Development Act of 1996 to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Bill, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto basin. This reevaluation has been initiated.

The study provides the opportunity to address the total spectrum of water resources problems within the basin. Major concerns within the Bayou Meto project area include agricultural flooding, degradation of environmental resources, and depletion of the alluvial aquifer. Significant opportunities exist for restoration, enhancement, conservation, and improved management of natural resources.

An environmental planning team is being established to identify environmental problems and opportunities, develop and evaluate environmental features for plan formulation, identify the optimum plan for environmental restoration and enhancement, and provide input on the design of irrigation and flood-control features. This team will be comprised of representatives from state and Federal natural resource agencies as well as conservation organizations. It would be greatly appreciated if you or your representative would serve on the team. An initial meeting will be scheduled in the near future to develop the team's goals, objectives, and mission statement. Please provide the name, address, and telephone number of your team member. Information on the upcoming meeting will be forwarded to that individual.

Lambert/0707____
CEMVM-PM-E

Contact Edward Lambert (901-544-0707) or Ken Bright (901-544-0745) of my staff if you have questions or need additional information. We look forward to working with your agency on this important project.

Sincerely,

David W. Wolfe, P.E.
Deputy for Project Management

CF:
Gene Sullivan, Bayou Meto Irrigation District
Deborah Ryckeley, USFWS

Reece____
CEMVM-PM-E
Bright____
CEMVM-PM-P
Callaway____
CEMVM-PM-P

February 17, 1999

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Steve N. Wilson
Director
Arkansas Game and Fish Commission
2 Natural Resources Drive
Little Rock, Arkansas 72205

Dear Mr. Wilson:

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, was reauthorized by the Water Resources Development Act of 1996 to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Bill, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto basin. This reevaluation has been initiated.

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Lambert/0707____
CEMVM-PM-E

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Sincerely,

David W. Wolfe, P.E.
Deputy for Project Management

CF:
Gene Sullivan, Bayou Meto Irrigation District
Craig Uyeda, AGFC

Reece____
CEMVM-PM-E
Bright____
CEMVM-PM-P
Callaway____
CEMVM-PM-P

February 17, 1999

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Mike Jansky
EIS Coordinator
U.S. Environmental Protection Agency
Region XI
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Dear Mr. Jansky:

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, was reauthorized by the Water Resources Development Act of 1996 to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Bill, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto basin. This reevaluation has been initiated.

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Lambert/0707____
CEMVM-PM-E

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Sincerely,

David W. Wolfe, P.E.
Deputy for Project Management

CF:
Gene Sullivan, Bayou Meto Irrigation District

Reece____
CEMVM-PM-E
Bright____
CEMVM-PM-P
Callaway____
CEMVM-PM-P

February 17, 1999

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Randall Mathis
Director
Arkansas Department of Pollution Control
and Ecology
P.O. Box 8913
Little Rock, Arkansas 72219-8913

Dear Mr. ~~Wilson~~ Mathis:

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, was reauthorized by the Water Resources Development Act of 1996 to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Bill, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto basin. This reevaluation has been initiated.

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Lambert/0707____
CEMVM-PM-E

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Sincerely,

David W. Wolfe, P.E.
Deputy for Project Management

CF:
Gene Sullivan, Bayou Meto Irrigation District
Steve Drown, ADPCE

Reece____
CEMVM-PM-E
Bright____
CEMVM-PM-P
Callaway____
CEMVM-PM-P

February 17, 1999

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Ross Melinchuk
Director of State and Federal Coordination
Ducks Unlimited, Inc.
193 Business Park Drive, Suite E
Ridgeland, Mississippi 39157

Dear Mr. Melinchuk:

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, was reauthorized by the Water Resources Development Act of 1996 to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Bill, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto basin. This reevaluation has been initiated.

The study provides the opportunity to address the total spectrum of water resources problems within the basin. Major concerns within the Bayou Meto project area include agricultural flooding, degradation of environmental resources, and depletion of the alluvial aquifer. Significant opportunities exist for restoration, enhancement, conservation, and improved management of natural resources.

An environmental planning team is being established to identify environmental problems and opportunities, develop and evaluate environmental features for plan formulation, identify the optimum plan for environmental restoration and enhancement, and provide input on the design of irrigation and flood-control features. This team will be comprised of representatives from state and Federal natural resource agencies as well as conservation organizations. It would be greatly appreciated if you or your representative would serve on the team. An initial meeting will be scheduled in the near future to develop the team's goals, objectives, and mission statement. Please provide the name, address, and telephone number of your team member. Information on the upcoming meeting will be forwarded to that individual.

Lambert/0707____
CEMVM-PM-E

Contact Edward Lambert (901-544-0707) or Ken Bright (901-544-0745) of my staff if you have questions or need additional information. We look forward to working with your agency on this important project.

Sincerely,

David W. Wolfe, P.E.
Deputy for Project Management

CF:
Gene Sullivan, Bayou Meto Irrigation District

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Callaway____
CEMVM-PM-P

February 17, 1999

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. J. Randy Young
Director
Arkansas Soil and Water Conservation
Commission
101 East Capitol Avenue, Suite 350
Little Rock, Arkansas 72201

Dear Mr. Young:

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, was reauthorized by the Water Resources Development Act of 1996 to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Bill, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto basin. This reevaluation has been initiated.

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CEMVM-PM-E

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Sincerely,

David W. Wolfe, P.E.
Deputy for Project Management

CF:
Gene Sullivan, Bayou Meto Irrigation District

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February 17, 1999

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Kalven Trice
State Conservationist
Natural Resources Conservation Service
Federal Building, Room 3416
700 West Capitol Avenue
Little Rock, Arkansas 72201

Dear Mr. Trice:

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, was reauthorized by the Water Resources Development Act of 1996 to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Bill, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto basin. This reevaluation has been initiated.

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Lambert/0707____
CEMVM-PM-E

Contact Edward Lambert (901-544-0707) or Ken Bright (901-544-0745) of my staff if you have questions or need additional information. We look forward to working with your agency on this important project.

Sincerely,

David W. Wolfe, P.E.
Deputy for Project Management

CF:
Gene Sullivan, Bayou Meto Irrigation District
Bob Price, NRCS
Tony Stevenson, NRCS

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CEMVM-PM-E
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CEMVM-PM-P
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CEMVM-PM-P

February 17, 1999

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Harold K. Grimmett
Director
Arkansas Natural Heritage Commission
1500 Tower Building, 323 Center Street
Little Rock, Arkansas 72201

Dear Mr. Grimmett:

The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, was reauthorized by the Water Resources Development Act of 1996 to include groundwater protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Bill, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto basin. This reevaluation has been initiated.

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Lambert/0707____
CEMVM-PM-E

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Sincerely,

David W. Wolfe, P.E.
Deputy for Project Management

CF:
Gene Sullivan, Bayou Meto Irrigation District
Thomas L. Foti, ANHC

Reece____
CEMVM-PM-E
Bright____
CEMVM-PM-P
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CEMVM-PM-P

DUCKS UNLIMITED INC.

DUCKS UNLIMITED, INC
SOUTHERN REGIONAL OFFICE

193 Business Park Drive, Suite E
Ridgeland, Mississippi 39157
Office (601) 956-1936 Fax (601) 956-7814

* Forn : Mgr to Proj

March 4, 1999

Mr. David Wolfe
Deputy for Project Management
Department of the Army
Memphis District Corps of Engineers
167 North Main Street B-202
Memphis, TN 38103-1894

Dear Mr. Wolfe:

Thank you for your letter of February 17th seeking a Ducks Unlimited representative to sit on the Bayou Meto Basin Project Environmental Planning Team.

I will represent Ducks Unlimited on this team at the onset and until it appears that one of our Arkansas field office staff would be a more appropriate representative. My mailing address and phone number are listed above (and title below). My e-mail address is: rmelinchuk@ducks.org

Thank you for this opportunity. I trust I will hear from you in the near future regarding an initial meeting date.

Sincerely,

Ross Melinchuk
Director, State & Federal Coordination
Southern Regional Office

RM:kw

cc: Ken Babcock
Curtis Hopkins
Jon Schneider
Steve Frick

Wildlife Management Institute

Donald F. McKenzie, Field Representative
2396 Cocklebur Road • Ward, Arkansas 72176
Phone (501) 941-7994 • Fax (501) 941-7995
E-mail - wmidm@ipa.net

April 18, 2000

U.S. Army Corps of Engineers, Memphis District
167 North Main Street, Rm B-202, CEMVM-PM-E
Memphis, TN 38103-1894

Subject: Bayou Meto Basin, Arkansas General Reevaluation project

Dear Corps of Engineers:

Thank you for this opportunity to provide written comments in follow-up to the verbal comments I provided at the February 16, 2000 Public Scoping Meeting in Lonoke, Arkansas for the Bayou Meto Basin, Arkansas General Reevaluation project.

The Bayou Meto Basin, Arkansas General Reevaluation project purpose overtly is to save the aquifer, yet the project design is built upon the assumption that more crop production is better. There is little acknowledgement that current levels of production already are unsustainable. Under this assumption of perpetuating unsustainable uses of the land, the automatic conclusion is that additional off-site irrigation water must be secured, and all excess water must be removed. The unsustainability assumption also results in some of the most cost-effective options for conserving the aquifer being removed from consideration before they are even considered.

WMI believes this water debate should *begin* with goal of achieving sustainability. Public funds can justifiably be used in the project area to encourage sustainable use of the land and of the public's natural resources. The biggest challenge of striving for sustainability, however, is that difficult questions necessarily arise about what responsibilities government and private landowners have for social, economic and environmental issues. On the other hand, the process of striving for sustainability necessitates that the full array of possible options be considered from the beginning, to assemble the best set of valid tools for the long term.

In short, WMI urges reliance on sound, long-term solutions rather than on expensive, short-term band-aids that address only the symptoms of the problem. The much larger and most important societal issue here is how to equitably share, sustainably manage and live compatibly with the public water resources of eastern Arkansas. Following are major issues that WMI urges the Corps to consider seriously.

1. The drainage and water distribution portions of the Bayou Meto Basin project should be withdrawn.

This project is intended primarily to perpetuate unsustainable agriculture irrigation practices and foster improved commodity production on marginal, flood-prone cropland. WMI does not support federal subsidies for further expansion of already-excessive agricultural commodity production capacity, especially when the environment likely will be impacted as a result. The federal government already is paying some $1.5 billion per year to retire surplus, marginal cropland via the U.S. Department of Agriculture's Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP). Nonetheless, commodity prices remain at or near all-time lows due to surplus production. WMI finds no rational basis for the federal government simultaneously paying to retire surplus, marginal cropland while paying to make yet more surplus, marginal cropland available.

Drainage projects generally cause wetland losses; reward past unsound land use decisions; foster future unsound land use decisions; and fail to work as well as anticipated. Such projects generally cost too many tax dollars for too little solution and too much environmental harm, while giving false hope that encourages people to move further into harm's way. This proposed project is a case in point: it is deemed needed because of problems exacerbated by previous drainage and watershed-engineering work in the Bayou Meto basin and on the Arkansas River. The previous work encouraged agricultural and residential encroachment into the floodplain; yet the project did not work as well as promised. Thus, more spending and environmental impact is needed now to fix the fix. It is time to try a different approach. *WMI recommends that the drainage and Arkansas River water delivery portions of the proposal be withdrawn.*

2. Use nonstructural measures--such as WRP--to address flooding problems.

Instead of attempting yet more costly, high-impact structural measures to move harm out of people's way, the Corps should consider helping move people out of harm's way. Given this country's long track record of mixed success in taming floodplains, nonstructural alternatives likely will be a more cost-effective alternative that saves taxpayer dollars, protects people, conserves the environment, and provides a firm basis for increasingly substantial wildlife-based economic benefits. The Corps already intends for bottomland hardwoods restoration to be a substantial part of the project. Why not save everyone a lot of time, energy and money--and save the basin unneeded structural work--by simply offering to buy out willing landowners' agricultural or residential interests in much of the flood-prone land? The land could be converted back to natural wetland habitats, which would yield tremendous recreational and economic opportunity for the Natural State.

The Wetlands Reserve Program is a cropland retirement program that buys out farmers' agricultural interests in marginal, flood-prone land, and pays to restore the land to wetland conditions. The WRP is so popular that some 60,000 acres already are enrolled in Arkansas, with another 70,000 acres currently on the waiting list. Landowners receive fair market value for their long-term or permanent no-cropping easements, keep title to the land, and still are able to make certain economic uses of the land. For the flood-prone areas of the Bayou Meto project area, a special WRP-type land retirement buy-out program could be created as a cost-efficient alternative to the structural ditching, draining and pumping proposed in the General Reevaluation. *WMI recommends thoroughly evaluating the feasibility, benefits and costs of nonstructural measures--such as the Wetlands Reserve Program--as an alternative means to address flooding problems.*

3. Address water shortages at the source--unsustainable irrigation demand.

Project proponents are so eager to figure out whether they *can* get more irrigation water, no one has stopped to ponder whether they *should*. Aquifer depletion and irrigation water shortages are self-imposed problems for agriculture, and are problems imposed upon the public by agriculture. WMI rejects the premise that the agricultural community has a right to tap other public water resources at public expense simply because it has mismanaged and depleted the aquifers. Solutions should be found within the agricultural community, rather than by compromising additional public water resources such as the myriad natural creeks that would be transformed into water conveyances.

Irrigation water shortages should be addressed beginning at the source--too much demand. The *first* course of action should be to strongly encourage--even mandate--water conservation on all irrigated cropland. Tailwater recovery systems and myriad other irrigation efficiency technologies should be maximized throughout the project area, *before* any activity to secure additional off-farm water. The scoping meeting's information pamphlet states 10 percent of water needs could be accounted for by natural runoff and tailwater recovery. However, the document does not indicate how much of the current demand could be eliminated by maximizing irrigation efficiency technologies across the project area.

WMI would support use of federal cost-share funds for on-farm measures to maximize water conservation, as long as structures were located in uplands or prior-converted cropland. Structures placed in upland or prior-converted cropland not only conserve water, but also directly remove irrigated acres from production, thus reducing water demand. On the other hand, WMI does not support expenditure of any federal funds for converting wetlands or farmed wetlands to on-farm water conservation structures. *WMI recommends aggressively maximizing water conservation as the first course of action to address water shortages, in lieu of any action to secure additional off-farm water.*

4. Rely on on-farm storage to supply any needed additional water.

Rather than building a massive Arkansas River pumping station and elaborate water distribution system, WMI prefers to solve water quantity problems on the farm, within important parameters. WMI would support using federal cost-share funds to maximize use of on-farm storage reservoirs built on upland or prior-converted cropland sites. Reservoirs placed in upland or prior-converted cropland not only provide supplemental water, but also directly remove irrigated acres from production, thus reducing water demand. On the other hand, WMI does not support the use of public funds to convert wetlands or farmed wetlands to irrigation reservoirs. *WMI recommends maximizing on-farm water storage as the second course of action, in lieu of any action to secure additional off-farm water.*

5. Make up the remaining water deficit by retiring surplus cropland or converting to dry-land farming.

The need to reduce the acreage of irrigated agriculture in Arkansas should be discussed openly, rather than being treated virtually as taboo. This project's sister project--the Grand Prairie Area Demonstration Project (GPADP)--began with the assumption that the current level of irrigated agriculture must be maintained. Yet, the Final Environmental Impact Statement acknowledges that even with the GPADP in place a 12% decrease in irrigated agriculture likely would occur. Thus, even the proponents of that project eventually recognized that unsustainable levels of irrigation cannot be maintained. Now, the pivotal question remaining for debate is *how much* reduction in irrigated acreage is necessary and appropriate in the Bayou Meto Basin?

Any water deficit remaining, after maximizing conservation measures and on-farm storage, should be addressed by retiring surplus cropland acres or converting to dry-land farming. Commodities that are irrigated in the Bayou Meto Basin already are in such surplus nationwide that prices continue to hover at or near all-time lows. It makes no economic sense to perpetuate--much less further expand--existing surplus production capacity. The same cropland retirement approach mentioned previously as a means to address flood-prone land could be one of the tools applied to further reduce irrigation water demand. *WMI recommends retiring, or converting to dry-land farming, surplus irrigated cropland, as the third course of action, to eliminate the remaining water deficit after maximizing conservation and on-farm storage.*

6. Follow Stream Obstruction Removal Guidelines for all stream channel work.

Any and all work done in stream channels should be conducted in accordance with the Stream Obstruction Removal Guidelines (SORG) published by the American Fisheries Society. WMI vigorously opposes stream channelization or other high-impact work in stream channels; no such work should be conducted. *WMI recommends minimizing any work conducted in stream channels, using SORG operating guidelines.*

7. Analyze impacts of ample "duck water" on bottomland hardwoods.

The limited information currently available on this project implies two seemingly conflicting objectives for bottomland hardwoods--to remove excess water and to provide more water. The first objective is to protect hardwoods from stress and damage associated with excessive growing-season flooding caused mainly by cumulative effects of previous water projects in the basin. WMI concurs that potential for such timber stress and damage is well documented, and that this issue merits attention.

However, the second implied objective--to provide more water to reliably flood bottomland hardwoods every year for duck hunting--could effectively neutralize any timber protections achieved from the first objective. For example, the fall flooding regime of green-tree reservoirs (GTRs) on Bayou Meto WMA is restricted by inadequate availability of water in the fall. The WMA generally doesn't flood completely until late in the year or even after the New Year. In large part because of unavailable water, Bayou Meto WMA's bottomland hardwoods remain in fair shape even after decades of GTR management. If, however, ample project water is made available each year to flood the WMA's GTRs earlier and deeper, WMI is convinced local duck-hunting politics will ensure that such earlier and deeper flooding is conducted every year. The certain long-term consequence of this prospective annual action will be stress and damage to the bottomland hardwoods. *WMI recommends a full evaluation of the potential impacts to bottomland hardwoods of using project water to reliably flood green-tree reservoirs on public and private land.*

7. **Include the following data in the environmental assessment:**
(a) an analysis of the acres, distribution and characterization of wetlands and farmed wetlands in the area of the irrigation project and the drainage project;
(b) that all available data be made public on the extent and severity of loss, damage or stress to bottomland hardwoods in the basin, on both private and public land.

Thank you for this opportunity to provide these comments.

Sincerely,

Donald F. McKenzie
Field Representative

Cc: The Honorable Tim Hutchinson
The Honorable Blanche Lincoln
The Honorable Marion Berry
The Honorable Jay Dickey
U.S. Army Corps of Engineers, Vicksburg, MS
U.S. Fish and Wildlife Service
Field Office, Conway, AR
Regional Office, Atlanta, GA
U.S. Environmental Protection Agency, Dallas, TX
U.S.D.A. Natural Resources Conservation Service, Little Rock, AR
Arkansas Game & Fish Commission
Headquarters, Little Rock, AR
District Office, Monticello, AR
District Office, Brinkley, AR
Arkansas Soil & Water Conservation Commission, Little Rock, AR
Arkansas Wildlife Federation
National Wildlife Federation, Austin, TX
Arkansas Nature Conservancy, Little Rock, AR

SECTION III

LANDSCAPE RESTORATION OPTIONS

AN EVALUATION OF

ECOSYSTEM RESTORATION OPTIONS

FOR THE BAYOU METO BASIN OF ARKANSAS

Prepared For:

U.S. ARMY CORPS OF ENGINEERS

MEMPHIS DISTRICT

By:

Mickey E. Heitmeyer, Leigh H. Fredrickson and Belinda Ederington
Gaylord Memorial Laboratory
University of Missouri-Columbia
Puxico, MO

and

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University of Tennessee
Knoxville, TN

August 2002

(Cover photo: Leigh H. Fredrickson)

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EXECUTIVE SUMMARY

This report provides an analysis of options for restoring native ecosystems and habitats in the Bayou Meto Basin of east-central Arkansas. Objectives were to: 1) synthesize information on geology, geomorphology, hydrology, and natural history of the Bayou Meto Basin; 2) identify how structure and function of the basin have been altered since the pre-European settlement (Presettlement) period; and 3) identify restoration approaches and ecological attributes needed to successfully restore specific habitats and conditions. This study uses the mid-1800s as the benchmark for what restored ecosystem elements should contain. This Presettlement period was a time when most ecosystem components were intact and functional in the basin. Certain areas of the basin cannot be restored to Presettlement conditions, but this baseline represents a model for restoration that is practical in many locations.

This report also specifically considers ecosystem restoration issues associated with the U.S. Army Corps of Engineers (USACE) Bayou Meto Basin Improvement Project Plan for irrigation and flood control. This project proposes to: 1) construct on-farm conservation works, 2) import surface water by diverting flows from the Arkansas River, and 3) undertake a variety of flood control measures in the southern part of the basin. The project also has the potential to conduct several structural modifications to the Bayou Meto Wildlife Management Area (WMA) owned and managed by the Arkansas Game and Fish Commission (AGFC).

The Bayou Meto Basin contains 3 distinct Quaternary-derived geologic regions. The northeast part of the basin is part of the Pleistocene "Prairie Complex" terrace created about 120,000 years before present (BP). A second terrace region, the "Deweyville Complex," is present along the western edge of the Grand Prairie where the Arkansas River meandered into and truncated part of the Prairie Terrace starting about 25,000 BP. The southwestern (and largest) part of the basin is the Arkansas River Lowland formed by historic Arkansas River meander belts and subsequent course changes over the past 14,000 years. The modern Arkansas River course has been active the past 2000 years.

The multiple formative processes and varying chronology of geological regions have caused the Bayou Meto Basin to contain a complex pattern of topography and land forms, soils, and surface hydrology. The principal hydrologic action on terraces is incision of higher elevations by downward cutting of streams. In contrast, the lower elevation Arkansas River Lowland was formed by floodwater and riverine deposition and scouring. This dichotomy of forces creates 2 distinct hydro-geomorphic regions in the Bayou Meto Basin.

Drainages in the Arkansas River Lowland are highly connected and follow relatively minor changes in elevation gradient. Even small floods connect bayous and inundate extensive areas. Consequently, watersheds in the area are not well defined. Early records and river gage data since the 1850s indicate periodic flooding of most of the Bayou Meto Basin by high flows of the Arkansas River. Major streams in the basin also flood frequently and some flooding occurs almost annually.

Boreal forest covered much of eastern North America, including the Bayou Meto Basin, during the late Wisconsin glacial interval. As early as 16,500 BP climate ameliorated, and deciduous forest replaced boreal species. At that time, probably all of the Bayou Meto Basin was covered by bottomland hardwood forest (BLH). During the 4000-8000 BP "Altithermal," climate warmed and precipitation was low. At that time xeric grasslands spread onto higher terraces in the basin and covered most of the Prairie and Deweyville terraces. In the last 4000 years, increased rainfall and runoff caused streams to incise terraces and trees expanded onto terraces. During the Presettlement period, most of the Bayou Meto Basin was BLH.

We distinguish 12 vegetation community types that are present in the Bayou Meto Basin: 1) prairie grassland, 2) slash, 3) savanna, 4) seasonal herbaceous wetland/wet prairie, 5) cypress/tupelo, 6) low

elevation BLH, 7) intermediate elevation BLH, 8) high elevation BLH, 9) post oak flat, 10) riparian forest, 11) natural levee forest, and 12) riverfront forest. Distribution of these habitats is related to geomorphic setting, elevation, and surface and subsurface hydrology.

We used a combination of historic records, maps, and naturalist accounts to determine distribution of general Presettlement habitats in the Bayou Meto Basin. Specific Presettlement habitats were predicted by sampling contemporary habitats present in different geomorphological, soil, topography, and flood frequency settings and modeling this distribution back to historic periods. A hydrogeomorphic (HGM) matrix model of habitats developed by Klimas et al. (2002) was used to determine habitat distribution and area we believed existed in the Bayou Meto Basin prior to significant degradation from anthropogenic activities.

Prairie grassland occurred mostly on the top of the Prairie and Deweyville terraces during the mid-1800s. Seven disjunct patches of prairie covered about 21,000 acres. Other Presettlement "prairie-type" vegetation included slash along small drainages (600-700 acres), seasonal herbaceous wetland/wet prairie in small depressions and seeps along slopes within grasslands (200-400 acres), and savanna along the edges of grasslands where herbaceous habitats transitioned into forest (2000-4000 acres).

BLH occupied all of the Arkansas River Lowland and floodplains within prairie terraces during the Presettlement period. Cypress/tupelo accounted for about 10,000 acres and occurred in the lowest and wettest areas of the basin along steams, in abandoned courses and channels, and in low depressions. Low BLH covered about 217,000 acres in the 2-year flood frequency zone of the basin in backswamp, swales in point bar deposits, and along edges (but not on natural levees) of abandoned courses and channels. Intermediate BLH was present between the 2- and 5-year flood frequency zone in higher backswamp sites that had local natural levee veneers and isolated point bar deposits: it covered about 250,000 acres. High BLH "flats" occupied higher elevations that were above the 5-year flood frequency zone yet within elevations flooded during larger Arkansas River and tributary floods. About 220,000 acres of high BLH were present on high elevations in backswamp, point bars, and high natural levees adjacent to abandoned courses.

Post oak flat occupied high ridges of the Arkansas River Lowland and higher well-drained areas on the edges of the Prairie and Deweyville terraces. These sites were not flooded except during extreme Arkansas River floods: they covered about 14,000 acres. Riparian forests covered 3000 acres in narrow corridors along abandoned courses and small streams. These riparian forests were bounded by natural levee habitats on higher portions of abandoned courses and either open water or cypress/tupelo along the fringes of streams. Natural levees historically covered about 10,000 acres adjacent to streams and abandoned courses and are outside the 5-year floodplain. Riverfront forest occurred on 28,000 acres along the Arkansas River

About 85% of native Presettlement vegetation communities within the Bayou Meto Basin have been destroyed. The percentage loss is greatest (>95%) for prairie grassland, seasonal herbaceous wetland/wet prairie, savanna, and high BLH and least (<50%) for cypress/tupelo and riparian habitats. Remnant BLH is present primarily in 2 large tracts along the lower ½ of the Bayou Meto floodplain. Almost all terrace-type habitats have been destroyed on the Prairie and Deweyville terraces.

Destruction of Presettlement habitats began as early as the mid-1800s. Initial clearing of BLH was restricted to high elevations along natural levees and point-bar ridges, mainly high BLH and post oak flat. Intense timber harvest occurred during 1900-20. Most grassland was converted to rice production from 1910-30. Subsequent large clearing of BLH occurred from the mid-1950s to about 1975.

Significant changes have occurred in the Mississippi Alluvial aquifer that underlies the basin. Pumping groundwater primarily for agricultural irrigation has exceeded recharge capabilities since the mid-1900s and current withdrawals exceed recharge by 65% annually. Many factors have significantly changed surface water dynamics including clearing of forests, altered topography and land leveling (about 50,000 acres), construction of hundreds of miles of roads and ditches, construction of storage reservoirs and fish ponds (>30,000 acres), and pumping water from streams. Water quality is degraded by soil erosion, high nutrient concentrations, and pesticide residues (e.g., dioxin contamination). Frequency of flooding in the Bayou Meto Basin is greatly altered from historic periods. Flooding and flows are reduced in the upper 2/3 of the basin, but greatly increased in the lower 1/3.

Fish and wildlife populations in the Bayou Meto Basin have been greatly reduced in the 1900s. Diversity of fish in Bayou Meto decreased from 79 species found in the 1960s to 64 species in

1992. Recent sampling of mussels found no mussels remaining in Crooked Creek, Bayou Two Prairie, and Wabbaseka Bayou and only limited numbers in Salt Bayou and Indian Bayou. Bison, mountain lion, prairie chicken, and red wolf are extirpated from the basin and Carolina parakeet and passenger pigeon are extinct. Only a few black bear remain in the basin. Armadillo and nutria have invaded the basin. Waterbird populations are greatly reduced from historic levels because of large loss of wetland, stream, and riparian habitats. Midwinter inventories of ducks in the basin decreased from over 100,000 through much of the 1960s and 1970s to less than 50,000 in the 1990s.

Despite significant alterations to ecosystems in the Bayou Meto Basin, many opportunities exist to restore functional areas of all habitat types. The success of restoring habitats will depend on matching potential restoration sites with the defining ecological characteristics of each habitat type. We offer a set of principles for guiding restoration activities that address: 1) appropriate conservation objective for a site, 2) structure and function, 3) matching restored habitats with what originally occurred on the site (like-for-like), 4) landscape ecology, 5) practicality, 6) management intensity required to maintain a restored site, and 7) limits and threats to a site/habitat type.

Restoration of prairie grassland should target those areas of the Prairie and Deweyville terraces that formerly supported prairie, especially on Stuttgart and DeWitt soils above 200', are at least 100 acres, not in areas laser-leveled, not immediately adjacent to forest edges, and where multiple patches can be restored within 2-3 miles of each other. Maintenance of restored grassland will require periodic disturbance, especially fire. Seasonal herbaceous wetland should be restored within prairie grassland patches in small depressions and where some surface water sheetflow can fill basins. Slash can be restored on upper ends of small streams incised into prairie terraces. These areas typically have Tichnor and Calhoun soils with at least 2% slopes. Restoration of savanna will be complex because of the large loss of prairie grassland and because the controlling processes of fire and herbivory have been reduced or eliminated. Sites best suited for savanna include the ecotone of former prairie grasslands, pasture, and hayland on prairie terraces, Loring and Immanuel soils with 1-3% slopes, and edges of towns and other building sites (i.e., rural churches, cemeteries, farmsteads).

BLH types should be restored throughout the Arkansas River Lowland. Specific BLH community types should match geomorphology, soils, and hydrology conditions where they historically occurred. For example, low BLH is best suited within the 2-year floodplain, in backswamp deposits, and with Perry-Portland soils. Restoration of BLH and other forest types (e.g., post oak flat, riverfront forest) should seek to: 1) reconnect fragmented patches, 2) expand corridors and patch sizes, 3) replicate mosaics of interspersed BLH habitats, and 4) emulate natural hydrological dynamics. If possible, restoration of hydrology in BLH habitat should be made with limited structural modifications. Where additional levees, ditches, and water-control structures are needed to restore water regimes to more natural patterns, they must be designed carefully so that they do not further fragment forest patches and further disrupt regional sheetwater flow and flood events.

Restoration of abandoned courses in the Arkansas River Lowland should not attempt to create single channels into the course, but rather should reintroduce adequate seasonal water flows to reflood and create flows throughout the course. Widening riparian corridors along abandoned courses will greatly enhance resource values of these areas. Restoration of abandoned channels should attempt to restore some hydraulic connection with regional bayous and streams, reduce sediment and contaminant runoff into channels, remove ditches that drain them, reshape bottoms of filled depressions, and restore fringe vegetation communities such as cypress/tupelo and natural levee forests.

Many conservation measures proposed by the USACE Bayou Meto Improvement Project offer opportunities for ecosystem restoration. Generally on-farm conservation developments do not directly promote habitat restoration, but they can be designed to minimize degrading impacts and carefully mitigate habitat loss. Some opportunities to create small wetland areas in corners of fields and low areas exist and lands adjacent to reservoirs might be good sites for restoring BLH.

Importing water into the Bayou Meto Basin could provide opportunities to: 1) plant prairie grassland vegetation on canal and ditch rights-of-way, 2) purchase wide easements next to canals to restore slash and some BLH habitats, and 3) restore flows in streams and cross-bayous. Using existing streams for water conveyance should be carefully evaluated and avoided if possible.

Efforts to improve drainage and reduce floods in the lower basin during late spring, summer, and fall will help restore natural drainage patterns and reduce extended hydroperiods that are killing BLH in some low areas and changing vegetation species composition to wetter community types (i.e., from intermediate BLH to low BLH) in other areas. Flood-control proposals that seem most conducive to BLH restoration are: 1) a pump station at the confluence of Little Bayou Meto and the Arkansas River; 2) greenways and drop-structures that reduce sedimentation in streams; and 3) reforestation of low elevation flood-prone lands, especially within the 2-year flood frequency zone. Restoration of BLH should not be confined to just the 1- or 2-year floodplain, however, and should include key corridors along drainages that extend into higher elevations (e.g., along Wabbaseka, Indian, and Baker's bayous).

Several projects considered for the Bayou Meto WMA appear to be helpful in sustaining existing BLH communities and facilitating restoration of habitats on lands adjacent to the area. These projects will be most helpful if they can: 1) help emulate natural water regimes and reduce prolonged and deep flooding, 2) supply dependable and adequate seasonal water during winter and early spring, and 3) effectively and independently discharge water from impoundments. In all developments, attempts should be made to avoid further fragmentation of existing forest patches. Generally, additional compartmentalization of greentree reservoirs (GTRs) is not desirable because it disrupts overland flow of water and nutrients; further fragments forest patches; increases levees, roads, water-control structures, and ditches that can become plugged by siltation, beaver, and debris; increases disturbance of forest patches; and increases management costs. Management of GTRs must be carefully designed and continually monitored to avoid long-term problems with artificial hydrological regimes, tree health, and nutrient cycling.

INTRODUCTION

The Bayou Meto Basin covers about 1500 square miles in east-central Arkansas (Fig. 1). It is bounded by the drainage headwaters of Bayou Meto in the Fouche Mountains subdivision of the Ouachita Mountains natural division (Foti 1974) on the north and west, the Plum Bayou drainage on the west, the Arkansas River on the south, and the Prairie Terrace on the north and east. The basin lies almost entirely within the Mississippi Alluvial Valley (MAV) and most landscapes were formed and shaped by deposition and erosion dynamics of the Arkansas River. The northeastern portion of the basin contains older Pleistocene terraces while the southwestern part of the basin is relatively young (7000-14,000 years old) Holocene Arkansas River Lowland (Fig. 2).

Landscapes in the Bayou Meto Basin range from high elevation prairie terrace in the northeast to an interspersed mosaic of drainages, abandoned courses and channels of the Arkansas River, natural levees, point bars, and backswamp deposits in the south. The Mississippi Alluvial aquifer underlies the basin. Surface and groundwater dynamics in the region are controlled by local precipitation and fluctuations in the Arkansas River and its primary tributaries.

The structure and function of the Bayou Meto Basin have changed significantly from the Presettlement period of the mid-1800s. Primary ecosystem changes and degradations include: 1) altered hydrology including contamination of surface and groundwater, 2) depletions in the alluvial aquifer that underlies the basin, 3) altered topography, 4) conversion of nearly all native prairie grasslands and large areas of BLH to agricultural production, 5) urban development, and 6) reduced fish and wildlife populations. Despite these changes, the Bayou Meto Basin still contains relatively large areas of BLH and abandoned channels (compared to most other regions of the MAV) and provides numerous ecologically important functions and values (Table 1). Especially noteworthy is the 33,700 acre Bayou Meto WMA located in the southeastern part of the basin which is owned and managed by the AGFC.

Concerns over continued ecosystem degradation, especially surface and groundwater supplies, have caused many natural resource agencies and private organizations to consider changes in the management of land and water resources in the Bayou Meto Basin. In 1982, the USACE was authorized by

Table 1. Ecological functions and values (after Richardson 1994) of native ecosystems in the Bayou Meto Basin, Arkansas, at local, regional, and continental scales.

Functions and values	Scale		
	Local	Regional	Continental
Hydrology			
Groundwater recharge	+[a]	+ +	
Surface water storage	+ + +	+ +	
Flood control	+ + +	+ + +	+
Stream flows	+ + +	+ +	+
Climate control	+ +	+	+
Biological productivity			
Net primary production	+ + +	+ +	+
C storage and fixation	+ + +	+ +	+
Secondary production	+ + +	+ +	+
Biogeochemical cycling/storage			
C, N, S, P transformation	+ +	+	+
Denitrification	+ + +	+ +	+
Water quality			
Erosion/sediment control	+ + +	+ + +	+
Nutrient release	+ + +	+ +	+
Filtration of chemicals	+ + +	+ +	+
Decomposition			
Carbon release	+ + +	+ +	+
Stream detritus	+ + +	+ +	+
Floodplain detritus	+ + +	+ +	+
Community/fish and wildlife habitat			
Habitat for unique species	+ +	+ +	+
Biodiversity	+ + +	+ +	+
Fish/wildlife habitat	+ + +	+ + +	+ +
Timber production	+ +	+ +	+
Non-ag food production	+	+	
Cultural resources	+ + +	+ +	+
Medicinal	+	+	
Education/research	+ + +	+ + +	+

[a] Pluses indicate relative importance to the specific geographical scale, + + + = greatest importance and + = least importance.

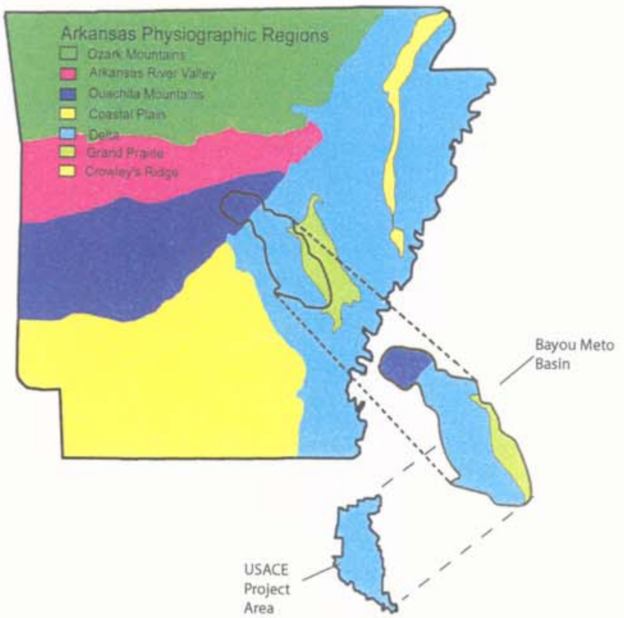


Figure 1. Location of Bayou Meto Basin, Arkansas, and U.S. Army Corp of Engineers (USACE) Bayou Meto Improvement Project Area (modified from Gandy et al. 2000).

Congress to investigate the feasibility of developing water conservation and water supply improvements in the MAV portion of eastern Arkansas including the Bayou Meto Basin (USACE 1998). In 1996, the Water Resources Development Act conditionally reauthorized a project for flood control (originally authorized in 1950) in the Bayou Meto Basin and expanded the scope of the original project to include groundwater protection and conservation, agricultural water supply, and environmental enhancement. Congress subsequently provided support for a reevaluation of this proposed project via the FY1999, 2000, and 2001 Appropriations Acts (USACE 2001).

In addition to USACE interests, several entities have considered or initiated significant ecosystem restoration projects in the Bayou Meto Basin. For example, the Natural Resources Conservation Service (NRCS) has proposed a Conservation Reserve Enhancement Program to restore riparian buffers along the streams and tributaries of the Bayou Meto watershed to provide wildlife habitat corridors and improve water quality. The U.S. Fish and Wildlife Service (USFWS) (USFWS 1978) and AGFC (e.g., Holder 1972) have long-standing interests in wetland protection in the basin. Recently, they and other partners of the North American Waterfowl Management Plan identified needs for wetland protection and restoration in the Basin (Yaich 1990). The Arkansas Natural Heritage Commission (ANHC) owns natural areas in the Basin and has worked to identify sites that could potentially be restored to unique native habitats. The Arkansas Multi-agency Wetland Planning Team (MAWPT), which represents a consortium of resource organizations, also has established restoration and protection goals for the basin (Gandy et al. 2000).

Natural resource projects in the Bayou Meto Basin must attempt to meet many varied interests and multiple objectives of flood control, groundwater protection and conservation, agricultural water supply, fish and wildlife management, and environmental restoration and enhancement. Integrating habitat restoration projects in this mix of sometimes competing objectives will require that restoration projects in the basin be "system-based" and strategically located to meet both local and regional resource needs. Options for restoration projects must be carefully evaluated to identify the most economically and ecologically feasible opportunities that can reduce certain current problems (such as flood water retention and groundwater recharge) and restore at least some elements of system integrity and sustainability within constraints of past degradations.

This report provides an analysis of options for restoring native ecosystems and habitats in the area of the Bayou Meto Basin included in the USACE Bayou Meto Basin Improvement Project Plan Area (Fig. 1); (USACE 2001). This area contains 779,109 acres in Lonoke, Jefferson, Prairie, and Arkansas counties. This area contains short stretches of the Plum Bayou drainage, but most of Plum Bayou is outside the Improvement Project Plan Area and therefore it is not addressed in this report. Also, a portion of this area previously was addressed in an evaluation of restoration options for the adjacent Grand Prairie region (Heitmeyer et al. 2000).

Objectives of this report include:

1. Synthesize information on the geology, geomorphology, hydrology, and natural history of the Bayou Meto Basin.

2. Identify how the structure and function of the Bayou Meto Basin have been altered since the Presettlement period.

3. Identify restoration approaches and ecological attributes needed to successfully restore specific habitats and conditions within the Bayou Meto Basin.

For purposes of this report, we use the mid-1800s as the benchmark for what restored ecosystem

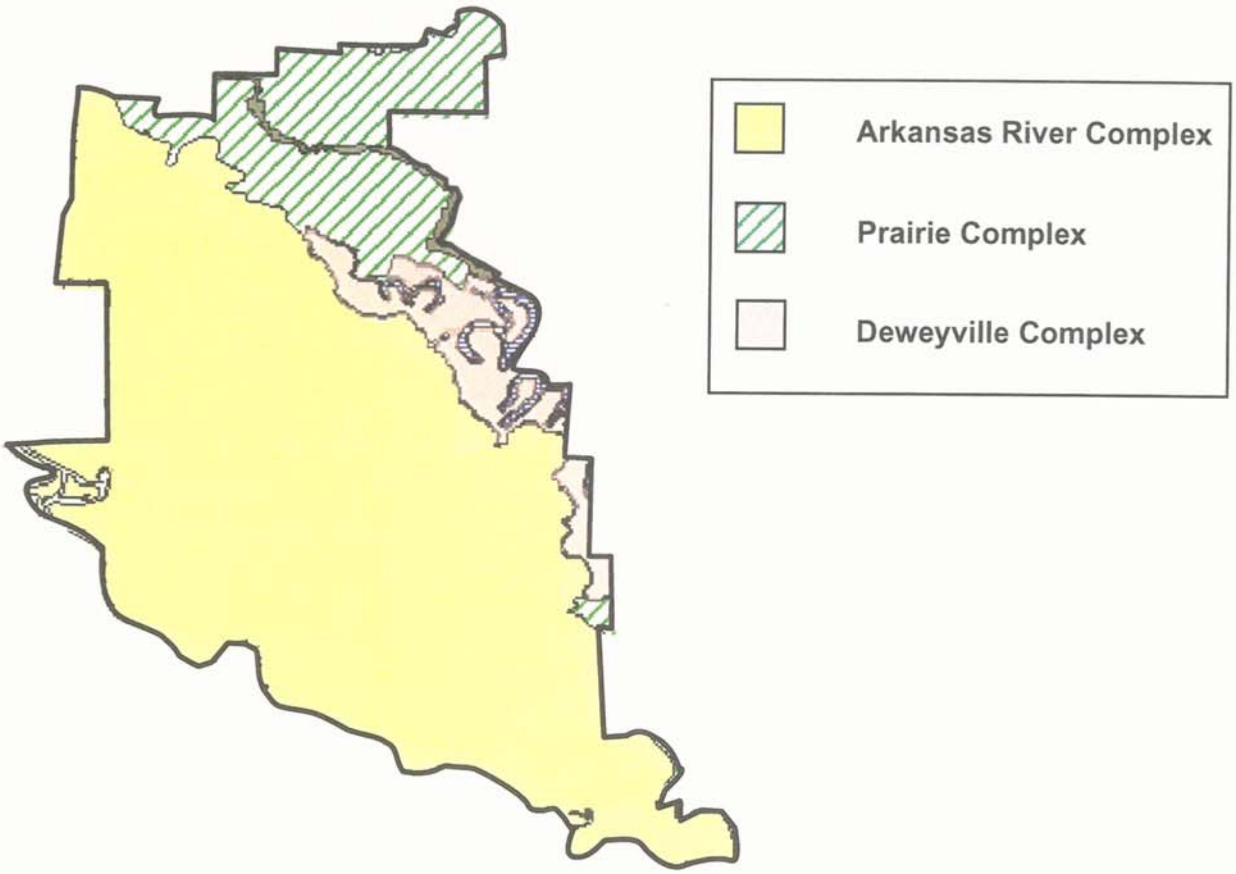


Figure 2. Geomorphic regions of the Bayou Meto Basin, Arkansas (after Saucier 1994).

elements should contain. We believe the Bayou Meto ecosystem present in the mid-1800s was relatively unchanged from the previous ca. 2000 years when the Arkansas River meander belt shifted to its present position. It is uncertain how native American Indians influenced Bayou Meto landscapes in the last 2000 years. Small Indian villages (mostly <5 acres) were present on higher ridges and natural levees along the Arkansas River and some clearing of BLH for agriculture occurred in small patches (Schambach and Newell 1990, Hudson 1999). Excavations at the Toltec site, occupied by the Plum Bayou culture ca. 700-950 AD, do not contain much maize. Information from these excavations suggests most agrarian activity was relatively limited cultivation of native plants such as maygrass, lamb's quarter, and knotweed (House 1996). The low elevation and frequent extensive flooding of the Bayou Meto Basin would have further limited Indian clearing of most BLH habitats. Indian populations were decimated in the region following exposure to diseases contracted from DeSoto's entourage in the mid-1500s. Small numbers of European settlers moved to the Bayou Meto Basin, especially on ridges adjacent to the Arkansas River, by the early 1800s, but significant settlements, organization of counties, and alterations to regional landscapes did not occur until the 1870s (Knobel 1921). Most clearing of BLH did not occur until the early 1900s (Holder 1970). Certain areas of the Bayou Meto Basin cannot be restored to Presettlement conditions, but this baseline represents a model for restoration that is practical for many locations.

This report also specifically considers ecosystem restoration issues associated with the USACE Bayou Meto Basin Improvement Project Plan for irrigation and flood control (USACE 2001). Presently, this project proposes to: 1) construct on-farm conservation and improvement works that include 738 miles of new pipeline and appurtenances, 312 miles of tailwater recovery systems, 768 water control structures to manage water, 1212 pumping stations to move water, and 10,539 acres of new on-farm storage reservoirs; 2) import surface water to the basin by diverting flows from the Arkansas River just north of David D. Terry Lock and Dam at River Mile 109 into 81 miles of new canals, 383 miles of existing streams, and 270 miles of pipelines and lifting water through 3 large pumping stations each with a storage reservoir; and 3) undertake a variety of flood control measures in the southern part of the Bayou Meto Basin including channel improvements and diversions, additional water control structures, pumping stations, and reforestation of certain flood-prone lands. The proposed Improvement Project also has the potential to conduct several structural modifications to the Bayou Meto WMA to provide better capabilities for efficiently flooding and draining forested areas, especially GTRs.

THE PRESETTLEMENT BAYOU METO BASIN ECOSYSTEM

GEOLOGICAL AND HYDROLOGICAL HISTORY

The Bayou Meto Basin contains 3 distinct Quaternary-derived geologic regions (Fig. 2). The northeast part of the Basin is part of the isolated Prairie Complex terrace plain created in the Pleistocene period (Saucier 1974, 1994). This Prairie Terrace is commonly known as the Grand Prairie region and was formed primarily during the Sangamon interglacial stage about 120,000 BP. This terrace was created by fluvial processes of both the historic Mississippi and Arkansas rivers and was subsequently shaped by backswamp deposits of the Arkansas River and wind blown silts in the late Wisconsin age (see Heitmeyer et al. 2000 for discussion of geological history in the Grand Prairie). The Prairie Terrace is mostly >200' above mean sea level (amsl) and elevation gradients are marked along drainages and where the terrace transitions into interior uplands. The highest elevations of the tops of terrace "flats" contain Stuttgart and DeWitt (formerly Crowley) soils that are poorly drained and contain an impervious fragipan 18-24" below the surface. Calloway-Calhoun-Loring soils are poorly drained loamy soils that occupy gently sloping areas adjacent to the top of terraces. Tichnor soils are poorly drained loamy soils present in narrow terrace floodplains. Claiborne and Jackson Tertiary deposits underlie Quaternary surface soils.

A second terrace region, the Deweyville Complex, is present along the western edge of the Grand Prairie where the Arkansas River meandered into and truncated part of the Prairie Terrace (Fig. 2). This Deweyville Terrace apparently was formed starting about 25,000 BP when the regional climate became wetter and created high-water tables, increased soil moisture, and caused large increases in runoff under late waxing to near-full glacial stage conditions. Discharges of the Arkansas River were much greater than at present and streams meandered widely and created a series of fluvial terraces as they degraded their entrenched valleys in response to lowered base levels along the Gulf Coast. Most formation of the Deweyville Terrace correlates best with full-glacial conditions about 18,000 BP and continued up to a cessation of significantly greater than present river discharges about 14,000 BP. Elevations in the Deweyville Terrace are slightly lower than on the Prairie Terrace (mostly >190' amsl) and several feet higher than the adjacent Arkansas River Lowland. Current soils mapping classifies the top of the relatively narrow Deweyville Terrace as Stuttgart-DeWitt soils; Calloway-Calhoun-Loring soils occupy the wider slopes of the terrace. Tichnor soils occur in the Bayou Two Prairie floodplain. A small area of Perry soils is currently mapped in the southwestern part of the Deweyville Terrace next to Bayou Meto. Jackson Tertiary deposits underlie most of the Deweyville region.

The southwestern (and largest) part of the Bayou Meto Basin is the Arkansas River Lowland formed by historic Arkansas River meander belts and subsequent course changes. Eight major Arkansas River courses were active during the last 14,000 years of the Holocene and 5 were in the Bayou Meto Basin (Figs. 3 and 4). The oldest courses, Boggy and Bayou Meto were active up to about 10,000 BP and were present along the western edge of the Prairie Terrace. The Arkansas River moved progressively west into the Bakers Bayou area about 6000 to 8000 BP (Dunbar 2001) and into the Plum Bayou area during 2000 to 5000 BP. The modern Arkansas River course and meander belt has been active the past 2000 years. Elevations in the Arkansas River Lowland range from 170-190' amsl. Claiborne, Jackson, and Wilcox Tertiary deposits underlie surface Quaternary deposits.

The specific geomorphic features in the Arkansas River Lowland include abandoned river courses, abandoned channels, point bars, natural levees, and backswamp deposits (Fig. 5). Most areas have a shallow veneer of silt, originating from floodwaters, overlaying older deposits. The abandoned courses in the basin (Bayou Meto, Bakers Bayou, and Plum Bayou) maintain hydraulic connections to the Arkansas River floodplain and carry low stage flows (Fig. 6). Primary tributaries into Bayou

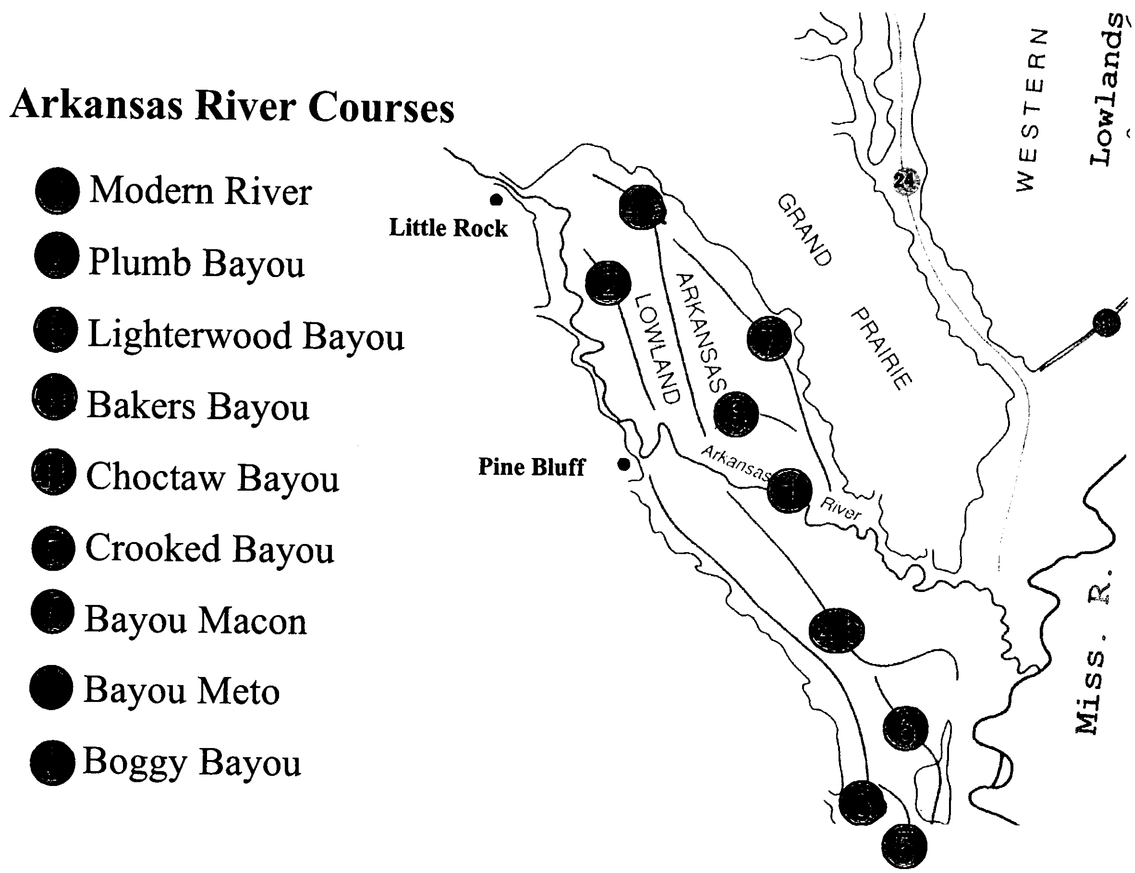


Figure 3. Major Holocene Arkansas River courses (from Saucier 1994).

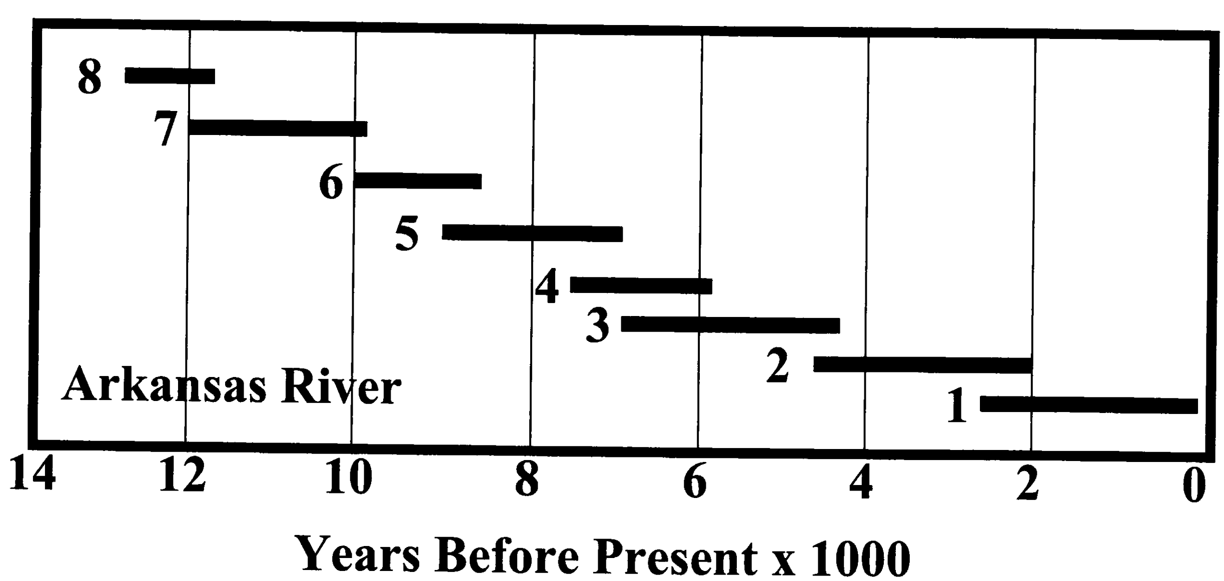


Figure 4. Estimated chronology of the major Arkansas River courses (from Saucier 1994).

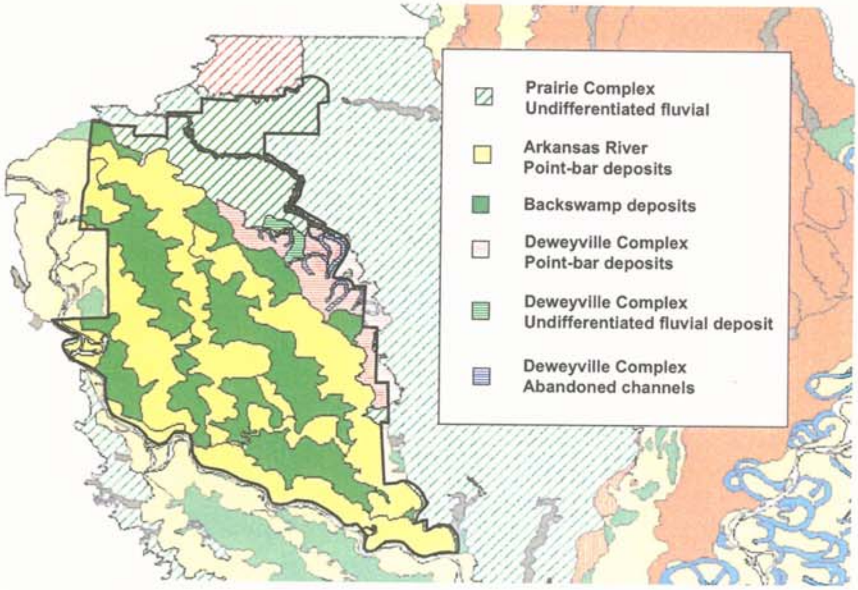


Figure 5. Geomorphic landforms and distribution in the Bayou Meto Basin, Arkansas (after Saucier 1994).

Meto include Two Prairie Bayou, Crooked Creek, Mill Bayou, Hurricane Bayou, Fishtrap Slough, and Caney Creek. Little Bayou Meto and Bayou Meto merge via a labyrinth of "cross bayous" and a man-made canal in the very southern end of the basin. Indian Bayou and Bakers Bayou run north-south, parallel to each other, and are connected at one point by a cross bayou. Indian Bayou eventually joins with Wabbaseka and Flat bayous and Bakers Bayou joins with Salt Bayou. All of these bayous drain into a low elevation (170-180' amsl) "bowl-shaped" sump in the vicinity of the current Bayou Meto WMA in the southern part of the basin. King Bayou is a short drainage in the very southeastern part of the basin that drains directly into the Arkansas River.

Abandoned courses are mostly filled with sediments dominated by coarse-grain sand and silty sand at the base of the channel and overlain by silt and clay at the surface. Soils in abandoned courses are mostly Perry and Keo clays; Rilla soils occupy the parallel natural levees. The abandoned Bakers Bayou course contains about 50' deep sediments; other abandoned courses probably are similar (Fig. 7). The abandoned courses are shallow and wide and lack a well defined channel. Recent investigations suggest the Arkansas River was 600-900' wide when it occupied the Bakers Bayou course (Dunbar 2001). After it was abandoned, the Bakers Bayou channel was 60-250' wide. Water flows down abandoned courses in a "sheetflow" manner through a network of open deeper pools and shallow forests.

Many abandoned Arkansas River channels are present in the Bayou Meto Basin. Most of these "cutoffs," "oxbows," and "brakes" generally are not hydraulically connected to bayous and streams. Nonconnected, abandoned channels typically are wider and deeper than those that retain some hydraulic connection to bayous. Abandoned channels receive surface water inputs and sediments during high water flood flows and from local runoff. Both neck and chute cutoffs are present (Saucier 1994). The location of abandoned channels defines the historic boundaries of Arkansas River meander belts. Over 20 oxbows >30 acres remain in the basin (Ryckeley 2000). Abandoned channels typically contain finer grain sediments and deposits than active bayous and abandoned courses because they receive sediments only during flood flows. Generally, a sand or silty sand wedge forms in the arms of a cutoff during early stages of separation from the historic river. Following separation from the river, silts and silty clays are deposited on top of sands and form a "plug" that fills the abandoned

Figure 6. Hydrographic features of the Bayou Meto Basin, Arkansas (from Gandy et al. 2000).

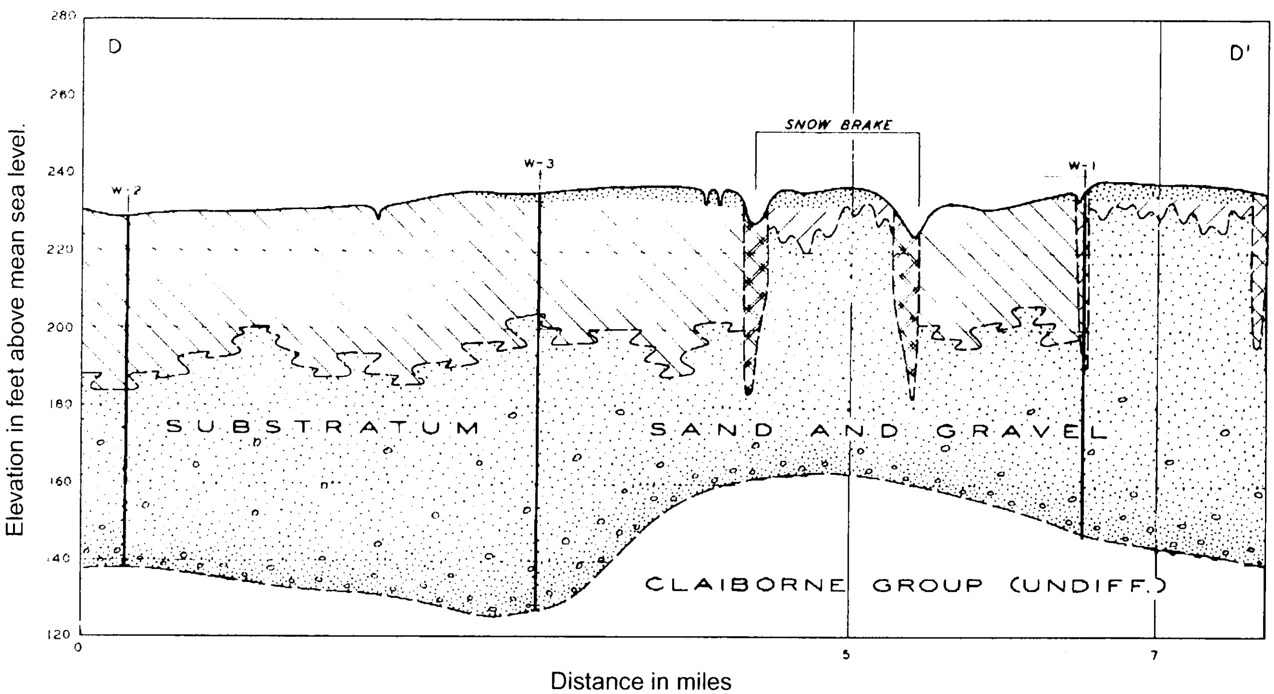


Figure 7. Typical geologic cross section of the Bayou Meto Basin, Arkansas (after Dunbar 2001).

channel. Distinct layering of silts and clays often is present and reflects sedimentation associated with various flood events. Most soils in abandoned channels are classified as Yorktown clays.

Backswamp deposits accreted in low floodplain areas behind natural levees of former Arkansas River courses during high-water flows. Backswamp deposits mostly contain fine silts, and are about 40-50' thick. Backswamp deposits in the Arkansas River Lowland are coarser texture than in other parts of the MAV and are predominantly silty clays. Because of the proximity and numbers of meander belts in the Bayou Meto Basin, backswamp deposits are frequently layers of silts and silty sands, and organic content of soils are low compared to other MAV backswamp areas (USACE 1951, Saucier 1994). Backswamp soils are mostly Portland-Perry series.

Natural levees formed adjacent to streams where rivers overtopped banks during floods and dropped suspended sediments. These levees are low ridges and decrease in height and thickness away from the levee crest. Natural levees eventually merge with backswamp and point-bar deposits in the basin and represent both old Arkansas River courses and channels and modern bayous and streams. Natural levees of currently active streams often are >5' higher than stream channels. Natural levees representing

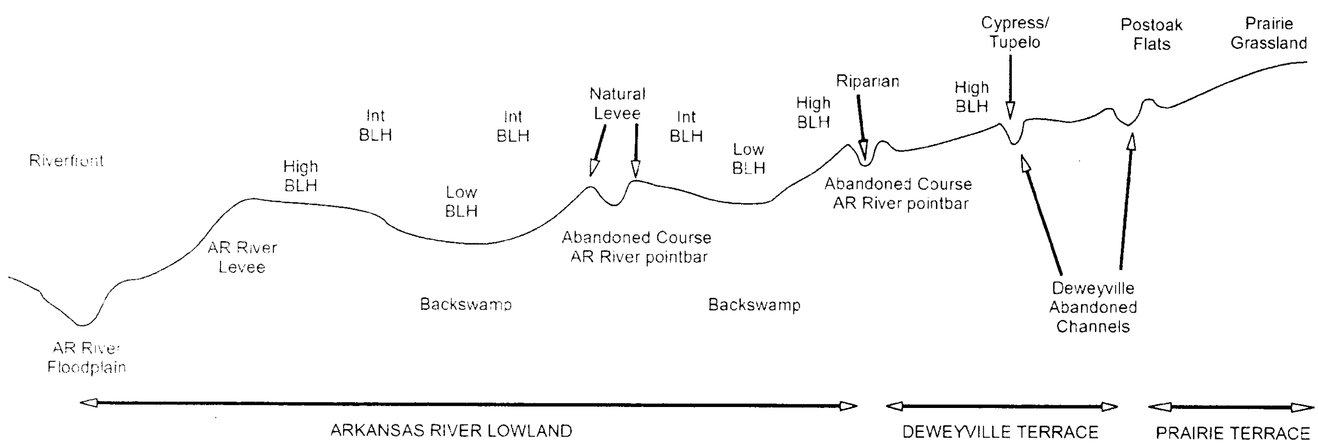


Figure 8. Landscape relationships of habitat types in the Bayou Meto Basin, Arkansas.

old Arkansas River channels often are considerable distance (>500') from current streams. Consequently, current streams and their natural levees often are higher elevation than surrounding lands (Fig. 8). Natural levees of currently active bayous and old Arkansas River courses are mostly Rilla soils. Natural levees along the current Arkansas River channel include Roxana-Coushatta, Desha-Wabbaseka-Latanier, and Crevasse-Oklared association soils.

Point-bar deposits represent gradual changes in river and stream courses where the inside part of bends or meanders accumulate coarse sandy sediments. These deposits are as thick as the depth of the river channel from which they formed. These deposits are up to 50' thick in the Bayou Meto Basin. Coarse sand and gravel are present at deeper depths, and silts and clays are present immediately below the current surface. The point bar accretions in the basin have created numerous "ridge-and-swale" complexes (Fig. 9). Most swales in the basin generally are relatively narrow and shallow and contain only a few feet of silty or sandy clay overlying clean sands. However, some larger swales are over 100' wide and thousands of feet long and contain organic clays or clayey silts over lower sands. Most soils in old point bar environments are Rilla-Herbert while much of the active Arkansas River point-bar environment is Crevasse-Oklared, Desha-Wabbaseka-Latanier, and Roxana-Coushatta soils.

The multiple formative processes and varying chronology of geological regions (i.e., Prairie and Deweyville terraces and Arkansas River Lowland) have caused the Bayou Meto Basin to contain a complex pattern of topography and land forms (Fig. 5), soils (Table 2), and surface hydrology (Fig. 6). The principal hydrologic actions in terrace plains are incision and erosion of the relatively flat and higher elevation terrace by downward cutting action of streams and local runoff. In contrast, the lower Arkansas River Lowland has been formed and shaped by floodwater and riverine deposition and scouring. This dichotomy of forces creates 2 distinct hydro-geomorphic regions in the Bayou Meto Basin.

The portion of the Bayou Meto Basin that includes the Prairie and Deweyville terraces contains several small streams that primarily flow into Wattensaw Bayou and Bayou Two Prairie. These streams originate in the higher elevation terraces and are distinctly branched and nonbraided until they reach the flat floodplains of Wattensaw Bayou and Bayou Two Prairie. These small streams are actively head cutting into the prairie terraces.

In contrast to the prairie terraces, major drainages in the Arkansas River Lowland represent former Arkansas River courses and they are highly connected, often in a labyrinth manner. Bayous and

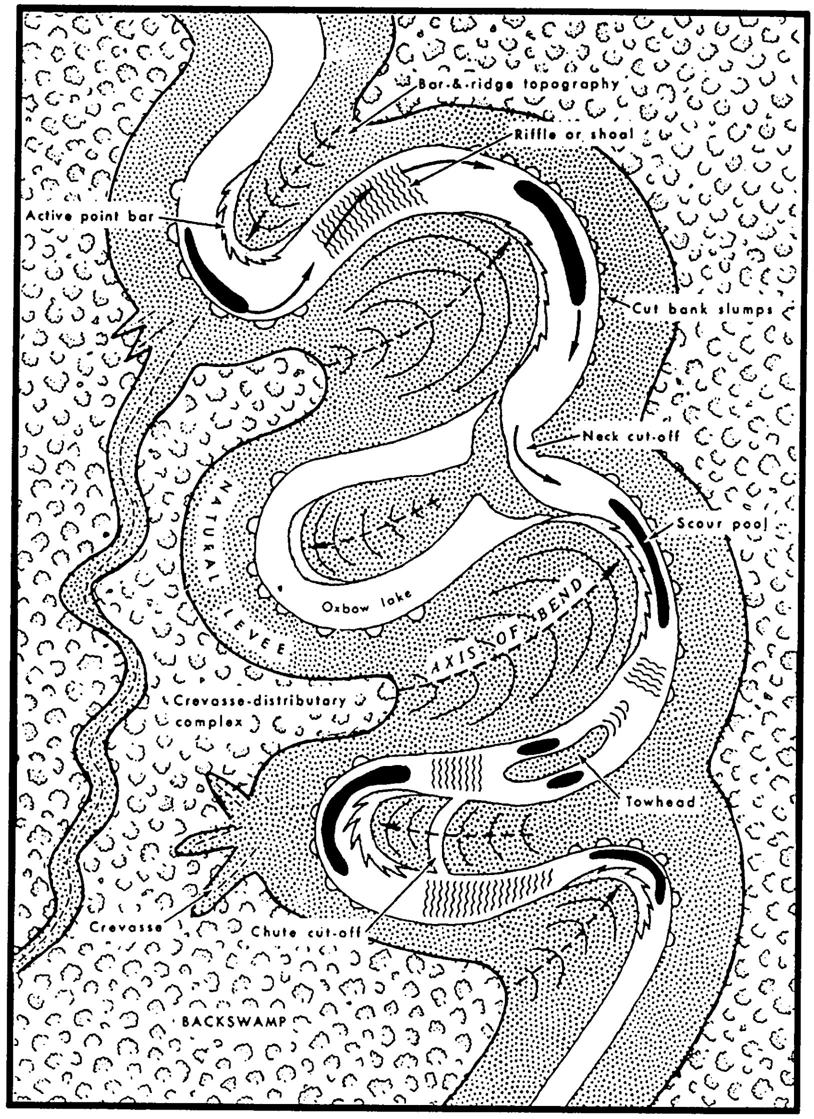


Figure 9. Topographic relationships of Holocene point-bar environments (from Saucier 1994).

streams follow relatively minor changes in elevation gradient created by dynamic deposition processes. Even small floods connect bayous and inundate extensive areas. Consequently, watersheds in the Arkansas River Lowland are not well defined. The current floodplain of the Arkansas River is fairly confined in the Ouachita Mountains, but expands to include almost all of the Arkansas River Lowland during high flow periods. During high flow periods, Arkansas River floodwaters spread shallowly over hundreds of thousands of acres and the river occasionally flows throughout the basin in a distributary manner. Regular flood events created and maintained the "labyrinth" nature of current bayous and streams in the basin (Dunbar 2001). In addition to major Arkansas River floods, the larger streams in the Basin (e.g., Bayou Meto) flooded frequently from local precipitation.

The frequency, height, and extent of historical Arkansas River floods is unknown. The first gage stations on the Arkansas River were established in the mid-1800s. Records indicate large floods in 1858-59, 1866, 1882, 1894, 1897, 1903, 1912-13, and 1916 (Hubbell and Lunon 1990). Extremely large floods subsequently occurred in 1927 and 1937. Almost all major floods of the Arkansas River historically occurred during winter and spring when regional precipitation and runoff was greatest (Table 3). Since dams were constructed on the Arkansas River beginning in the 1940s (see later discussion), Arkansas River flooding in the Bayou Meto Basin has been dampened and mostly confined to backwater flooding from the lower end of Bayou Meto. Nonetheless, high flows and significant flooding of the Arkansas River Lowland occurred in 1969, 1973, and 1983. Collectively, early records indicate extensive flooding of most of the Bayou Meto Basin from high flows in the Arkansas River at least 10 times in the last 150 years.

Major streams in the Bayou Meto Basin flood frequently and some flooding occurs almost annually. The only stream in the Bayou Meto Basin that has historic gage data is Bayou Meto at Lonoke. Data from this station and other records upstream near Jacksonville (USACE 1970) indicate some local flooding of Bayou Meto almost annually, usually during late winter and early spring (Fig. 10). Flows above 3000 cubic feet per second (cfs) represent extensive flooding in the Bayou Meto drainage. Data since 1955 indicate flows exceeded 3000 cfs in 1957, 1958, 1959, 1968, 1969, 1973, 1974, 1983, and 1988. During the 1990s, flows did not exceed 3000 cfs but were above 2500 cfs in 1991 and 1997. These data suggest an average of 2 large floods on Bayou Meto per decade. In addition to the frequent overbank flooding that sometimes covers only small areas, large local and regional rainfall and runoff events also occur regularly and con-

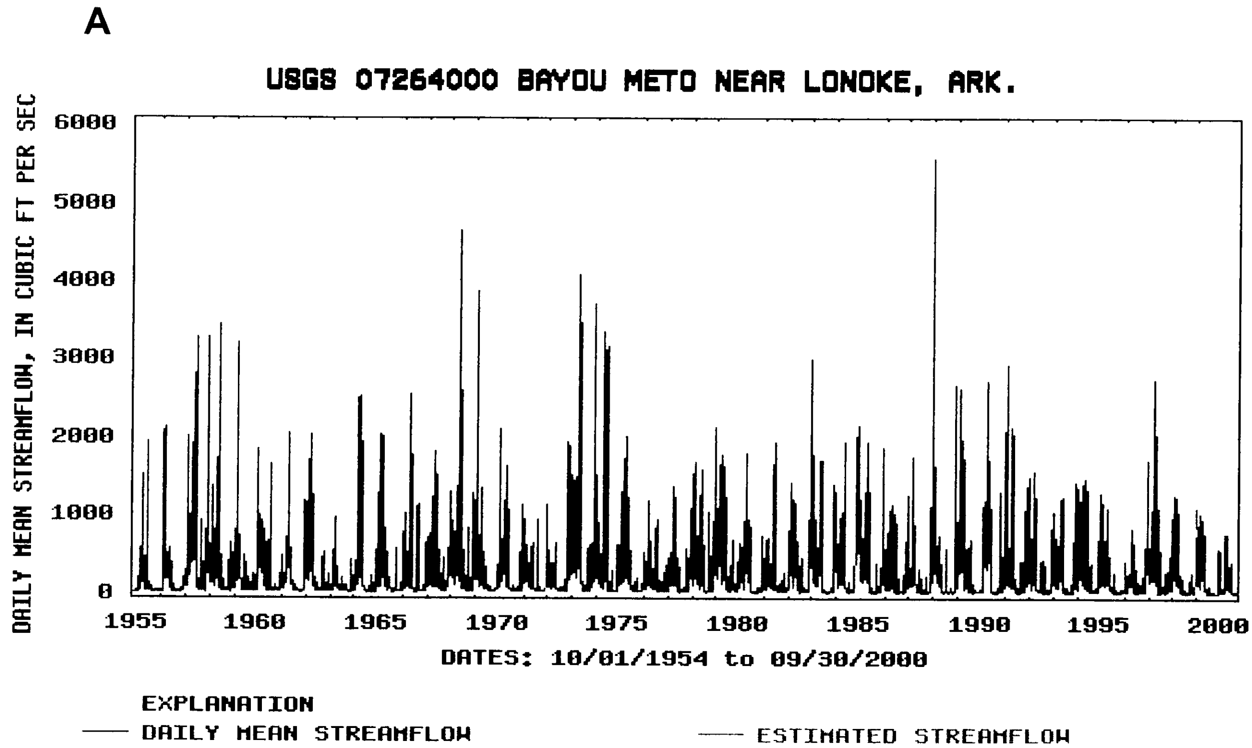
Table 2. Dominant soil associations in the Bayou Meto Basin, Arkansas.[a]

Landscape position	Soil association	Drainage
Upper 1/3 of basin		
Uplands and ridges	Linker-Mountainburg	Well-drained
Bottomlands	Rilla-Keo	Well-drained
	Perry-Norwood	Poorly-drained
Middle 1/3 of basin		
Bottomlands	Perry-Portland	Poorly-drained
	Herbert-Rilla	Medium-drained
Bottomland flats	Calhoun	Poorly-drained
Bottomland terraces	Calloway	Medium-drained
Bottomland ridges	Loring	Medium-drained
Prairie terraces	Stuttgart-DeWitt	Poorly-drained
Lower 1/3 of basin		
Bottomland flats	Perry-Portland	Poorly-drained
Bottomland levees	Rilla	Well-drained
Prairie terraces	Stuttgart-DeWitt-Grenada	Poorly-drained

[a] Adapted from Fielder et al. 1981, Gandy et al. 2000, Gill et al. 1980, and Haley et al. 1975.

Table 3. Mean daily maximum temperature (° F) and precipitation (inches) for the Bayou Meto Basin, Arkansas (Little Rock recording station).

Month	Temperature	Precipitation
January	50.6	5.22
February	54.6	4.33
March	62.7	4.81
April	73.5	4.93
May	81.5	5.28
June	89.7	3.61
July	92.7	3.34
August	92.4	2.82
September	86.3	3.23
October	76.0	2.88
November	61.3	4.12
December	52.1	4.09



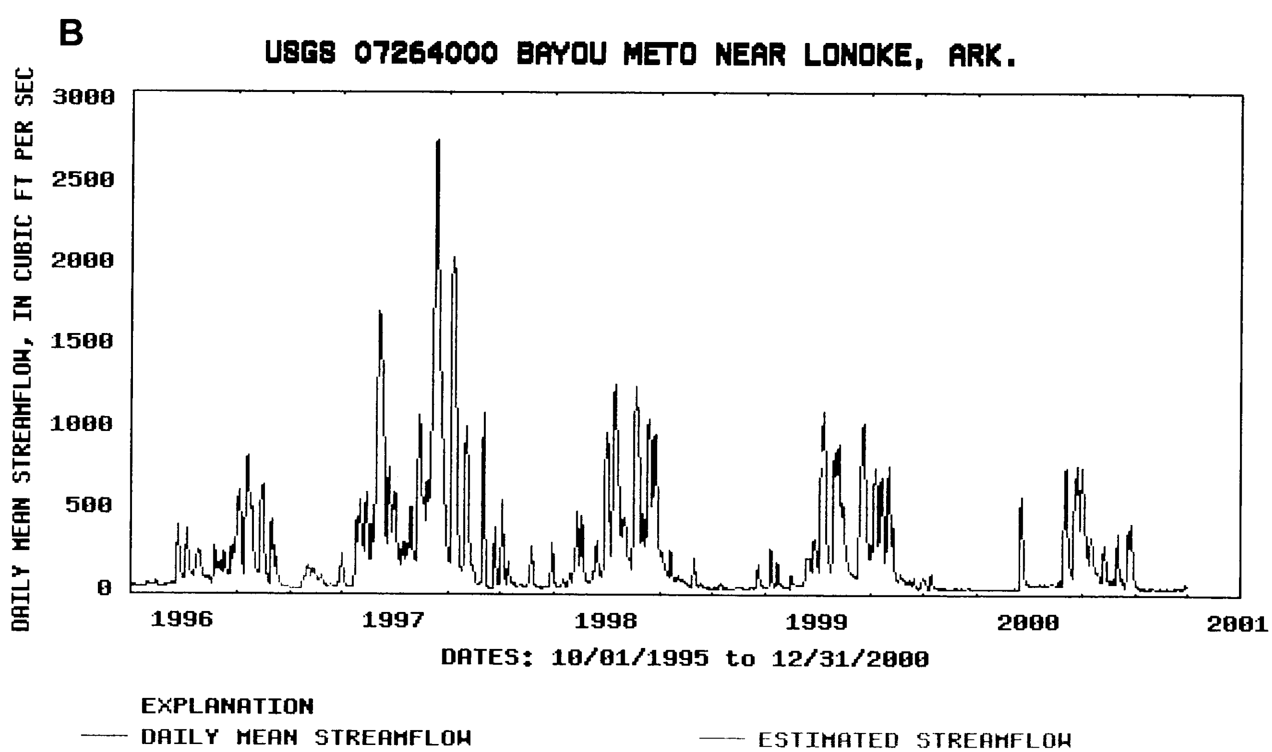


Figure 10. Daily stream flow for Bayou Meto near Lonoke, Arkansas, demonstrating a) long-term, 1955-2000, and b) typical seasonal, 1996-2000 patterns (U.S. Geological Survey [USGS], unpublished data).

tribute to large Arkansas River flooding such as in 1927 and 1937.

ESTABLISHMENT OF PRESETTLEMENT VEGETATION

Historic vegetation communities in the Bayou Meto Basin reflect the chronology of Quaternary geologic events and changes in regional and continental climate. It is generally accepted that during the late Wisconsin glacial interval the climate of the region was cool and humid and boreal coniferous forest covered much of eastern North America including the Bayou Meto Basin (Delcourt and Delcourt 1981, 1990). As early as 16,500 BP, climate ameliorated and deciduous forest replaced boreal tree species. At that time, probably all of the Bayou Meto Basin was covered by BLH species including sweetgum, oaks, baldcypress, and water tupelo. BLH remained in most of the basin from that time to the present except on the higher elevation Prairie and Deweyville terraces.

During the 4000-8000 BP "Altithermal," climate warmed significantly and precipitation was low. At that time, xeric grasslands spread onto higher terraces in the Grand Prairie region (see Heitmeyer et al. 2000:12-13). Drought conditions during the Altithermal made impervious claypan soils on higher terraces intolerable to trees, and these areas changed to grasslands. The extent of prairie grasslands on the Prairie and Deweyville terraces during the Altithermal is not known, but may have covered most of the terraces except along drainages, former courses and channels of the Arkansas River, and in low depressions.

Following the Altithermal, climate in the MAV became more humid and warm temperate. In the last 4000 years, increased rainfall and runoff caused streams to incise the Prairie and Deweyville terraces at an accelerated rate and expanded the network of bayous and streams throughout the Bayou Meto Basin. Greater drainage and wetter conditions allowed deciduous trees to expand their range back onto the higher elevation terraces and most of the Bayou Meto Basin eventually became BLH. Vegetation communities probably have not changed much in the Bayou Meto Basin over the last 2000 years except for a gradual transition of prairie to forest on the Prairie Terrace (Heitmeyer et al. 2000). When European settlers moved to the region, BLH dominated the basin (Nuttall 1821).

ECOLOGICAL ATTRIBUTES AND PROCESSES OF PRESETTLEMENT HABITATS

In this report we distinguish 12 vegetation community "types" that are present in the Bayou Meto Basin: 1) Prairie Grassland, 2) Slash, 3) Savanna, 4) Seasonal Herbaceous Wetland/Wet Prairie, 5) Cypress/Tupelo, 6) Low Elevation BLH, 7) Intermediate Elevation BLH, 8) High Elevation BLH (Flats), 9) Post Oak Flats, 10) Riparian Forest, 11) Natural Levee Forest, and 12) Riverfront Forest. The landscape positions of these habitat types (Fig. 8) are related to geomorphological setting, elevation, and surface and subsurface hydrology. Forest types, especially BLH, represent gradual, often subtle, gradations of tree and shrub species composition in relation to hydrological regime, soil type, and elevation (Huffman 1976, Wharton et al. 1982, Dale 1998). In some locations extensive stands of a BLH type may occur in a distinct "zone" or "band." However, BLH types usually are interspersed and even slight changes in elevation (<5") often have enough difference in soil saturation and surface hydrology to cause different trees to be present within a site. Consequently, species dominant in 1 community type (e.g., baldcypress) often are present in scattered locations within another community type (e.g., Intermediate BLH). Also some tree species such as willow oak have relatively wide tolerances for certain environmental factors such as soil chemistry and saturation and may be found in significant numbers in more than 1 habitat type.

Prairie grassland.—Prairie grassland historically occurred on most of the Prairie and Deweyville terraces. The largest patch of prairie in the Bayou Meto Basin has typically been called the Long Prairie and was a relatively narrow area separated from the larger contiguous prairie on top of the Prairie Terrace (Fig. 11). Grasslands in the Grand Prairie are wetter than prairies found in western and northern regions of the United States and include many relatively water tolerant grasses, forbs, and shrubs. Dominant vegetation includes switchgrass, little and big bluestem, Indian grass, splitbeard, coneflower, bitterweed, and scattered shrubs including sassafras and sumac (Irving et al. 1980, Sims 1988). Diversity of animals in the historic Grand Prairie was high, especially for birds (Heitmeyer et al. 2000).

Nutrient cycling and food webs in prairies are dominated by grasses and forbs and processes tend to conserve nutrients. Nutrient cycling is relatively rapid in prairies and causes nutrients to be greater in soils than in biomass. Export of nutrients from prairie terraces was limited by flat topography, limited drainage, and restrictive soil layers. The Deweyville Terrace may have had greater nutrient export and loss than the Prairie Terrace because of its narrow configuration and close proximity to larger drainages. In both terraces the viability of grasslands and nutrient conservation depended on low soil erosion, the relatively flat high terrace topography, larger interconnected patches of grassland, and rapid cycling of grass litter and detritus. Nutrient cycling in prairies depends on periodic disturbances such as fire and grazing by herbivores.

Large herbivores apparently were not abundant in the Grand Prairie region, at least in recent centuries, and herbivory was mostly from small mammals, especially rodents (Heitmeyer et al. 2000). Fire was likely the dominant controlling process in the Grand Prairie. The close proximity of forests adjacent to grasslands and the extensive drainage network of the nearby Arkansas River Lowland created an environment where trees were expanding rapidly onto the terrace at the Presettlement period. It is likely that prairies in the region were gradually shifting from a grass to a tree-dominated setting. Consequently, the regular presence of fire was critical to maintain grass and deter invasion by trees. This grassland setting was not resilient to changes in land use that occurred after European settlement.

Slash.—Slash habitats occupy narrow corridors along the upper ends of drainages that extend into prairie terraces (see Heitmeyer et al. 2000). As

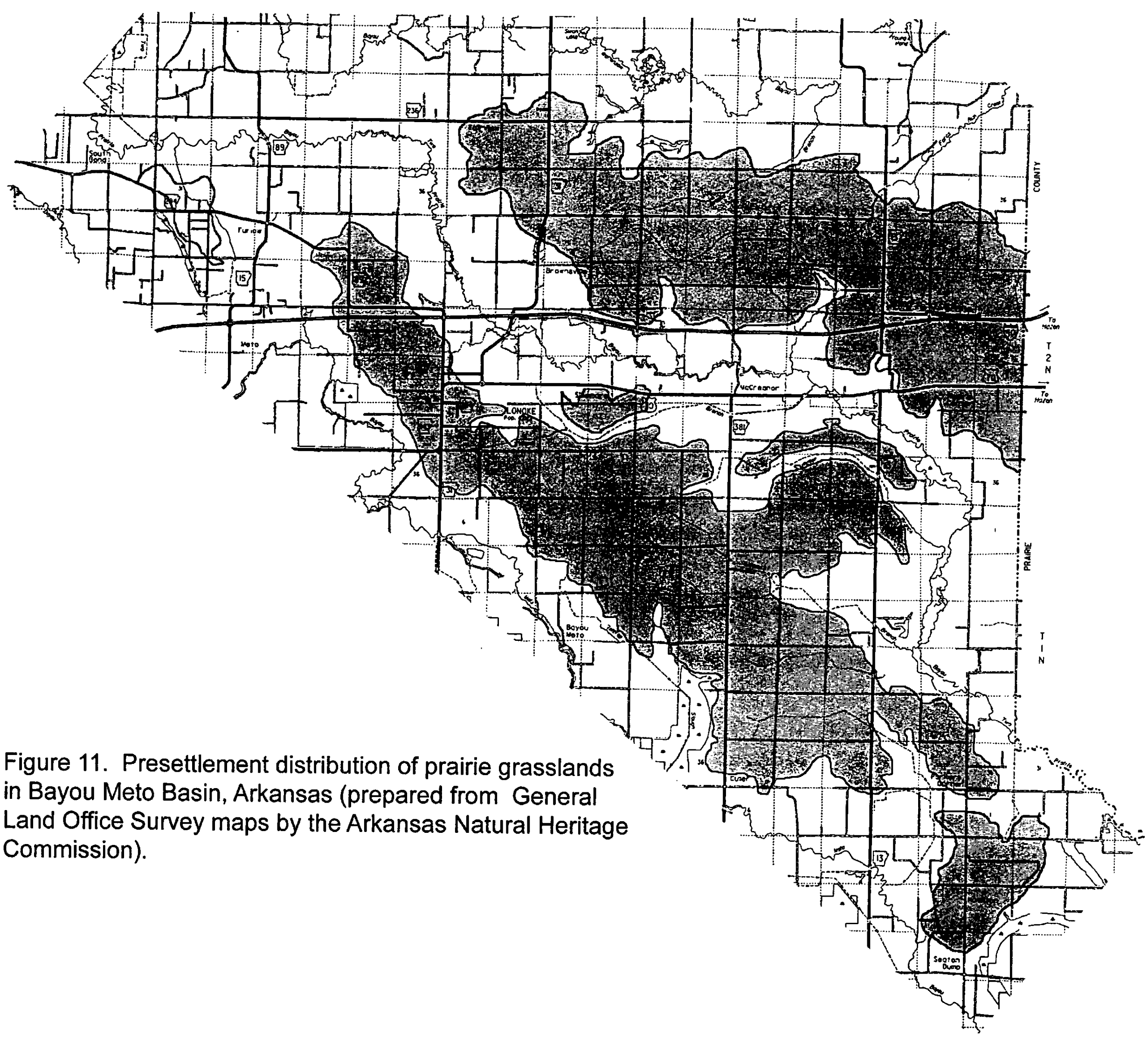


Figure 11. Presettlement distribution of prairie grasslands in Bayou Meto Basin, Arkansas (prepared from General Land Office Survey maps by the Arkansas Natural Heritage Commission).

drainages head-cut into terraces it creates areas with higher soil moisture and provides growth conditions for plant species beyond grasses. Slash areas contain many pioneer shrub, forb, and tree species. Diversity of plant species in slashes often is high and includes sugarberry, green hawthorn, stiff dogwood, deciduous holly, and American elm. Slash vegetation typically has rapid and punctuated reproductive periods, high seed production, short life spans, and wide tolerances for soil moisture and chemistry.

Slash habitats contain nutrient cycling and energy flow processes that occur in both prairies and forested systems. These processes resemble forest systems on the lower down-stream side of the slash and more closely resemble prairies at the front, up-stream side. Slash habitats are transitory and move forward as streams head cut farther into terraces. This movement causes species and ecological processes to change at a site depending on the rate of head cutting by the drainage. Undoubtedly, fire was a primary force limiting movement of slash onto prairie terraces. Trees in slash generally are not long lived and turnover of biomass is rapid, causing relatively fast nutrient cycling and pulsed energy flow to higher level consumers during certain seasons. This seasonal energy flow attracts numerous birds and mammals to slashes during certain seasons and includes a somewhat unique mixture of both grassland and forest species (Heitmeyer et al. 2000).

The transitory nature of slash habitats allows them to be resilient to changes in land use and disturbance. Slashes quickly recover from disturbances and can quickly change location where conditions are suitable. Native people probably had little influence on slashes except for setting wildfires that set back the progression of woody vegetation. Following settlement of the region by European people, many slash areas were cleared, but its resilient nature sustained its presence in some locations.

Savanna.—By definition, savanna habitats contain at least 50% grassland, with the remainder being scattered or clumped trees. The amount of forest vs. grass in savannas depends on the soils, drainage, and disturbance (e.g., regularity of fire) on a site. A few areas of "true" savanna were present in the Bayou Meto Basin at the Presettlement time, mostly on the edges of prairie grasslands. These savannas probably were disjunct bands of mixed trees/grass and represented the zone of active competition between the prairie and adjacent upland hardwood forest, BLH, and post oak flats. Grass, forb and shrub species in savannas were those common to adjacent grassland, and trees were the dominant types on adjacent forests. Along the Long Prairie edge, most trees probably were delta post oak on higher ridges and flats and a combination of willow and blackjack oak, hickory, and elm on lower sites. Other common species in savannas were ironweed, persimmon, sumac, and bramble. Similar to plants, animals found in savannas included species common to both prairie and forest and most animals readily moved between habitat types during different seasons or annual events, depending on food and cover requirements.

In addition to the edges of prairies, several higher ridges and flats in the Bayou Meto Basin may have contained a somewhat open mix of grass and forest, but not at the 50% grass level. Many of these areas we define as post oak flat (see below), but they resemble savannas in some respects. In these areas, 60-80% may be forest; grass area is maintained by processes similar to true savannas, especially periodic fire.

The ecological processes in savannas represent a transition from grassland to forest. The presence of trees causes nutrients to be bound in tree biomass for extended periods, structural heterogeneity is high, and trophic dynamics and reliance on detrital processing are significant. Grasslands were gradually being converted to forest at the Presettlement period and savannas represented the area of active conversion. Persistence of grass in savannas depended on soil types and regular disturbance such as fire, and perhaps grazing and herbivory by mammals. We doubt large numbers of large herbivores were present in the Grand Prairie during the Presettlement period because of its small size and disjunct configuration. Consequently, fire, coupled with the drier impermeable terrace-top soils, likely controlled expansion of forest. Conversely, increased incision of the high terrace by drainages and large flood events of the adjacent Arkansas River Lowland probably encouraged expansion of trees onto the terraces. These factors probably "squeezed" savanna into narrow bands along the boundary of prairie and forest.

Seasonal herbaceous wetland/wet prairie.—Small topographic depressions and groundwater seeps along slopes in prairie terraces historically contained saturated soils and short periods of surface flooding that supported annual and perennial herbaceous vegetation. These wet sites typically are referred to as wet prairie or seasonal herbaceous wetlands; we use these terms interchangeably in the text. Generally, seasonal herbaceous wetland basins are small depressions that have small watersheds and receive water mainly from surface sheetflow runoff following local rains. These seasonal herbaceous wetlands typically are flooded for short periods from winter to early-summer depending on timing of rainfall. In contrast, wet prairie sites seldom are flooded (if at all) for more than a few weeks in late winter and early spring but they do have extended periods of saturated soils. Gradation from prairie grasses to more water tolerant herbaceous species in depressions and seeps often is subtle, and seasonal wetlands typically occur in small pockets within larger expanses of grassland. Soils on prairie terraces have an impermeable clay layer 18-24" below the surface and allow seasonal basins to hold water while simultaneously retarding growth by trees. In contrast, small depressions in more highly drained areas and in the Arkansas River Lowland become forested instead of supporting herbaceous plants. Vegetation in seasonal basins is dominated by annual and perennial species that have rapid growth, high seed production, and life cycles adapted to short, often irregular, dynamics of flooding and drought. Animals using seasonal wetlands also tend to have rapid reproduction and short life cycles (e.g., invertebrates and some amphibians) or are seasonal visitors primarily during the period of flooding (e.g., water birds).

Energy flow and nutrient cycling in seasonal herbaceous wetlands are relatively rapid and punctuated during the periods when basins are flooded. Seasonal water mobilizes soil and detrital nutrients and causes pulses of nutrient availability. Food webs usually begin when dead and decaying vegetation is processed by a diverse invertebrate and fungi/bacteria community. Decomposition is fairly rapid because of the warm regional climate and prolonged drying periods when wildfires would have easily burned the basins. The dynamic nature and isolated location of these wetlands causes them to be resilient to disturbance and persistent over time so long as watersheds are not significantly degraded. These wetlands are dependent on adjacent prairie land, however, and changes to prairie grasslands following settlement likely changed these basins as well. Native people had little impact on these wetlands except to occasionally set fires that burned through basins.

Bottomland hardwood forest types.—A gradation of BLH types occurs throughout the Bayou Meto Basin along drainages and in floodplains. BLH areas typically are inundated for at least some period in most years and plant species composition at a site reflects the frequency, depth, and duration of flooding (Fig. 12). In this report we distinguish 6 BLH types: cypress/tupelo; low, intermediate, and high (flat) BLH; riparian forest, and natural levee forest along a continuum of hydrological regime from wet to relatively dry.

Cypress/tupelo habitats occur in the lowest elevations in the Bayou Meto Basin and are flooded for extended periods during the year, occasionally year round. Flooding usually is at least 3 months duration and soils are saturated almost constantly (Dale 1998). Because of extended flooding, vegetation is very tolerant of flooding yet it

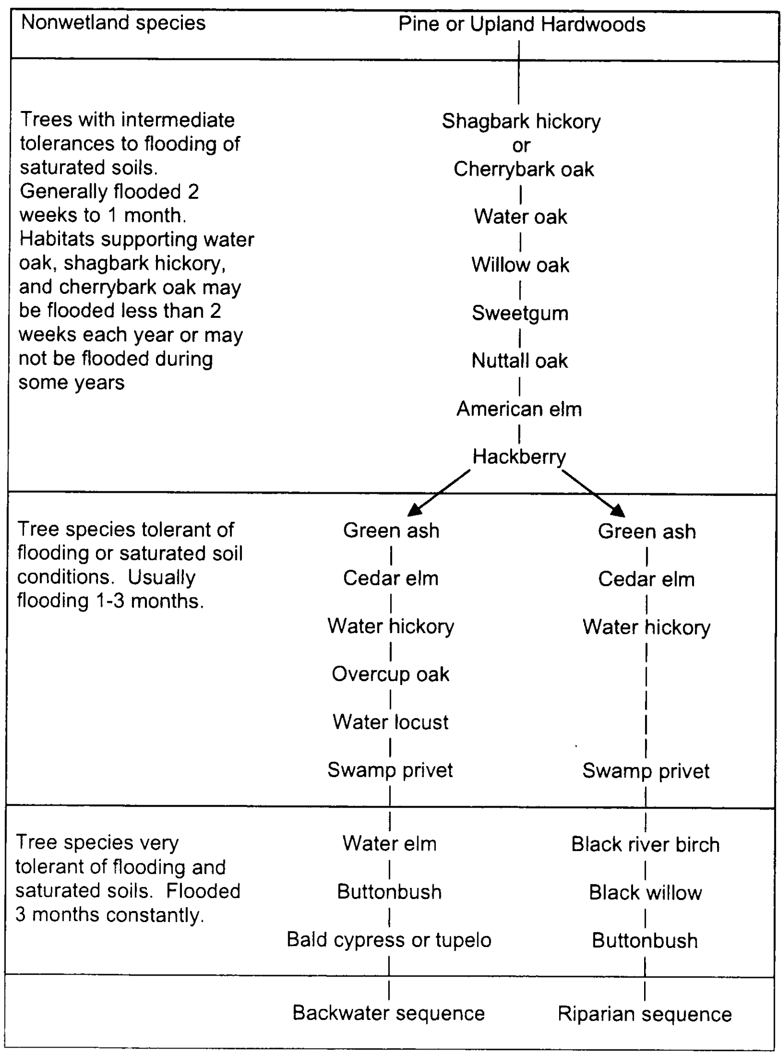


Figure 12. Relative sequences of common bottomland hardwood forest tree species along an elevation and moisture gradient (from Dale 1998).

Table 4. Dominant plant species in forested habitats of the Bayou Meto Basin, Arkansas. Data from Godfrey and Wooten (1979a,b).

Species	Common name	Habitat							
		Riverfront	Cypress/ tupelo	Low BLH	Inter- mediate BLH	High BLH	Post oak flat	Natural levee	Riparian forest
Saururus cernus	Lizard's tail		X	X					
Carya illinoensis	Pecan	X				X		X	
Carya aquatica	Bitter pecan			X					X
Carya cordiformis	Bitternut hickory					X	X	X	
Carya ovata	Shagbark hickory					X	X		
Populus deltoides	Eastern cottonwood	X						X	
Populus heterophylla	Swamp cottonwood		X	X	X				X
Salix nigra	Black willow	X						X	
Salix interior	Sandbar willow	X							
Betula nigra	River birch							X	
Carpinus caroliniana	Ironwood				X	X		X	
Quercus lyrata	Overcup oak	X		X					X
Quercus michauxii	Swamp chestnut oak					X		X	
Quercus falcata	Cherrybark oak					X	X	X	X
Quercus macrocarpa	Bur oak					X		X	
Quercus palustris	Pin oak	X			X				
Quercus nutalli	Nuttall oak	X			X				
Quercus phellos	Willow oak				X	X	X	X	X
Quercus nigra	Water oak				X	X	X	X	X
Quercus stellata	Post oak						X		
Boehermia cylindrica	False-nettle	X	X	X				X	X
Morus rubra	Red mulberry	X				X		X	
Celtis laevigata	Sugarberry	X			X	X		X	
Planera aquatica	Water elm		X	X					X
Ulmus crassifolia	Cedar elm					X			
Ulmus americana	American elm				X	X		X	X
Brunnichia ovata	Ladie's eardrop			X		X		X	X
Polygonum spp.	Smartweed		X	X					X
Brasenia schreberi	Water-shield		X						
Nymphaea odorata	Pond-lily		X						
Nuphar luteum	Spatter-dock		X						
Itea virginica	Virginia willow		X						
Liquidambar styraciflua	Sweetgum			X	X	X	X		
Hamamelis virginiana	Witch hazel					X			
Platanus occidentalis	Sycamore	X						X	
Crataegus viridus	Green haw				X	X		X	
Crataegus aestivalis	May haw		X	X					X
Gleditisia aquatica	Water locust			X				X	
Gleditisia triacanthos	Honey locust					X			
Impatiens capensis	Jewel weed		X	X				X	X
Toxicodendron radicans	Poison ivy			X	X	X		X	X
Ilex decidua	Possum-haw	X			X	X			
Acer negundo	Box elder	X						X	
Acer rubrum	Red maple				X	X		X	
Acer saccharinum	Silver maple				X	X		X	
Berchemia scandens	Rattan-vine			X	X	X		X	X
Ampelipsis arborea	Pepper-vine	X		X	X	X		X	X
Vitis rotundifolia	Muscadine grape	X		X	X	X		X	
Hibiscus spp.	Marsh mallow	X	X	X	X			X	X
Nyssa aquatica	Water tupelo	X	X						X
Nyssa sylvatica	Black gum				X	X			
Cornus spp.	Dogwood			X	X			X	
Styrax americana	Mock-orange		X	X	X	X			
Diospyros virginiana	Persimmon	X			X	X			X
Fraxinus caroliniana	Carolina ash	X	X	X	X			X	
Fraxinus pennsylvanica	Green ash	X		X	X			X	X
Forestiera acuminata	Swamp-privet	X	X	X					
Trachelospermum difforme	Climbing dogbane					X		X	
Bignomia capreolata	Cross-vine	X		X		X		X	
Catalpa bignonioides	Indian-bean				X	X		X	
Campsis radicans	Trumpter-creeper			X	X	X		X	X
Cephalanthus occidentalis	Common buttonbush	X	X	X					X
Viburnum dentatum	Arrowwoods				X			X	
Lobelia cardinalis	Cardinal flower		X	X	X			X	X
Arundinaria gigantea	Giant cane	X						X	
Smilax spp.	Greenbriar	X		X	X	X		X	X
Cocculus carolinus	Carolina moonseed					X		X	
Taxodium distichum	Baldcypress	X	X	X					X

[a] BLH = Bottomland hardwood forest

needs occasional drying periods for germination of seeds and regeneration of plant communities. Baldcypress and water tupelo are dominant species in these locations (Table 4). Edges of this habitat often include buttonbush, water elm, and swamp privet. Cypress/tupelo habitats occur in a variety of locations within the Bayou Meto Basin including abandoned courses and channels, isolated sumps or depressions, deeper swales in old point-bar deposits, and along active drainages.

Low BLH sites also occur in relatively low elevation areas that typically flood each year and have extended soil saturation. Flooding and soil saturation of low BLH sites is not as extended as in cypress/tupelo sites and low BLH habitats typically are flooded for 1-3 months usually in late winter and spring. Low BLH habitats are almost entirely within the 2-year flood frequency zone of the Bayou Meto Basin which includes predominantly backswamp areas, swales in point bars, and abandoned courses. Dominant vegetation in low BLH habitats includes green ash, cedar elm, water hickory, overcup oak, water locust, and swamp privet (Table 4). High understory vines include rattan vine, eardrop vine, greenbrier, and poison ivy. The forest floor of low BLH sites usually is sparse to bare because of extended flooding; poison ivy is abundant during dry periods. Low BLH sites often occur directly adjacent to cypress/tupelo habitats and may include scattered baldcypress and buttonbush in deeper areas.

Intermediate BLH habitats occur in floodplain locations that are flooded on average for a few weeks to 1-2 months annually during the dormant season and early spring. Soil saturation of these sites is often extended for 2-3 months. Most intermediate BLH sites occur between the 2- and 5-year flood frequency zones in the Bayou Meto Basin and some higher sites may not flood every year. Intermediate BLH habitats are present mostly on backswamp and point bar areas and higher edges of abandoned courses. Flooding of intermediate BLH typically occurs in late winter and spring but may occur at any time of the year depending on occurrence of large flood events. Dominant vegetation in intermediate BLH sites includes sugarberry, American elm, Nuttall oak, willow oak, and sweetgum. Small depressions such as vernal pools that are interspersed in intermediate BLH usually contain overcup oak. Common privet, Japanese honeysuckle, greenbrier, and poison ivy are common understory plants (Table 4).

High BLH habitats occupy high elevation areas within the Bayou Meto Basin that, at least historically, were flooded for up to a few weeks during some years, usually during high flow events of the Arkansas River or major tributaries. High BLH habitats may go several years between flood events. However, soils usually are saturated for some periods annually. High BLH habitats commonly are called flats and they occur primarily on higher elevation point bar ridges and next to natural levees. Generally the dividing point between intermediate and high BLH is the 5-year flood frequency contour. Dominant plant species in high BLH habitats include water oak, willow oak, cherrybark oak, shagbark hickory, and sweetgum. Secondary trees include persimmon, hackberry, delta post oak, American elm, and green ash. Winged elm is common in recently disturbed sites. Understory plants occur and include poison ivy, climbing dogbane, and Virginia creeper (Table 4).

Riparian forest is present in narrow corridors in immediate floodplains of small streams. These streams often are in abandoned courses of the Arkansas River such as Indian, Bakers, and Wabbaseka bayous and in narrow prairie terrace valleys such Faras Run, Buck Creek, and Johnson Branch. In the Arkansas River Lowland, riparian forests are within the 5-year flood frequency zone and often are subjected to deep flooding and high velocity flows. Trees in riparian areas include a combination of species typically found in cypress/tupelo and low BLH habitats (Table 4). In narrow terrace stream floodplains, riparian forests represent a transition from slash-type vegetation at higher elevations to BLH types on low downstream sides. Here, riparian vegetation includes a mixture of water and willow oak, green ash, American elm, persimmon, and cherrybark oak.

Natural levees are present immediately adjacent to current and former drainage floodplains. Levees often are as much as 5' higher than surrounding lands and support a unique community of plants (Table 4). Old natural levees of former Arkansas River courses contain more cottonwood, box elder, and other softwoods while natural levees created or veneered by smaller streams typically are dominated by cow oak, cherrybark oak, and delta post oak. Both levee types may support wind-blown soft mast species that occur in openings following major disturbances. Common vines in natural levee sites include greenbrier, poison ivy, and Carolina moonseed. Giant cane is common on natural levees and relatively large (i.e., several acres) "canebrakes" historically were common in some areas. Generally the tops of natural levees are not inundated except during larger floods

All BLH habitats have nutrient cycling processes and associated food webs that are dominated by a rich detrital base. Biomass in BLH is high, and leaf fall creates significant accumulation of litter that is decomposed by a rich invertebrate community and aided by seasonal flooding and a temperate climate. Nutrient circulation in BLH habitats is relatively tight because an extensive network of roots and fungal filaments are present in top soil layers and mycorrihizal fungi exist in decomposing litter. These features efficiently capture and conserve nutrients. Flooding, especially periodic backwater flooding, imports nutrients to BLH systems and drops sediments and nutrients especially in areas where flows are reduced such as natural levees. Flooding occasionally scours BLH sites, especially riparian areas, and exports nutrients from the system if flows are severe and extended. However, dense contiguous stands of BLH trees slow flood flows and cause most suspended sediments to drop. Scouring and nutrient export is greatest in riparian sites and least in natural levees, and intermediate and high BLH areas.

The diverse and highly interspersed BLH communities are sustained by diverse topography and periodic flooding and drying events. If flooding regimes are altered (either wetter or drier) then the community will shift to either wetter or drier-type tree species composition. At extremes of wetness and dryness, BLH communities change to other types. When flooding is prolonged, BLH will tend to shift to cypress/tupelo habitats first and then to open water habitats that support few if any trees. Conversely, completely drying a site will shift vegetation to upland-type communities. Floodplains generally have dynamic short- and long-term geomorphology, consequently, periodic change in BLH distribution is normal. Resilience to landscape change and disturbance depends on the severity and extent of the disturbance and whether hydrology, in particular, can reestablish a dynamic balance following the disturbance.

A rich diversity of animals occur in BLH habitats (Tables 5-8). The dynamic nature of flooding and resource availability causes most species to be mobile, omnivorous or seasonally variable in diet, and often at least partly arboreal (Heitmeyer et al. 2002). Most species depend to some degree on the rich detrital biomass and seasonal flooding regimes.

Post oak flat.—High ridges in the Bayou Meto Basin are not flooded except during extreme Arkansas River floods. These areas include high elevation point-bar settings, areas adjacent to natural levees, and scattered locations on the edge of the Prairie and Deweyville terraces. These locations tend to be too dry to support BLH yet are too wet to support true upland forests that occur in the Interior Highlands and river bluff areas of eastern Arkansas. Soils of high flats are of fluvial origin and may be highly saturated, but not flooded, for significant periods of the year, especially in spring. The dominant tree in these ridges is delta post oak, with cherrybark, water, and willow oak also present (Table 4). Hickory and sweetgum occasionally occur in these areas. Trees sometimes are scattered in these habitats and have intermixed openings of grass and forb species that form a savanna-type habitat.

Ecological processes in post oak flats contain elements of both BLH and upland forest systems and apparently are significantly influenced by fire. The dry locations of these habitats tend to reduce decomposition rates and cause nutrient cycling to be slower than BLH habitats. These flats often lose nutrients during large rain and runoff events; general productivity is lower than BLH types. Replenishment of nutrients also is less frequent than in BLH types because sediment-laden backwater flooding is rare. Litter accumulates in these flats and slowly decays, creating substantial fuel that quickly ignites and burns over extensive areas when fires occur. This susceptibility to fire increases fire intervals and causes many areas to have an intermixed grass community with savanna-like characteristics.

Animals present in post oak flats often include many upland forest species and also have interesting mixes of species, especially birds, that inhabit open and grassland type habitats. Large herbivores historically used flats extensively, grazed on grasses, and browsed on shrubs and trees. Larger openings in these drier flats supported abundant small mammal populations, and large avian predators such as raptors and owls likely were common.

Riverfront forest.—Areas immediately adjacent to the Arkansas River and its currently active meander belt are highly dynamic regions affected by regular changes in river flow, sediment deposition, and scouring events. These "riverfront" landscapes include highly interspersed point bars, abandoned channels, natural levees of various sizes and distributions, and the active Arkansas River channel and connected chutes. Historically, sediments at any given site were highly dynamic, often scoured and moved, and included a predominance of sand. Flooding of at least part of the floodplain immediately adjacent to the river occurred annually. These ecological constraints limited the type and number of plant species that were capable of tolerating such conditions. Most plants in riverfront areas are pioneer species that have short life spans, rapid growth rates, high and rapid seed production, great dispersal capabilities (e.g., wind-blown seeds), and highly branched shallow root systems. Common trees in riverfront forests include sycamore, cottonwood, black and sandbar willow, and black river birch (Table 4). Buttonbush, some oaks, and baldcypress are common along deeper backwater sloughs and abandoned channels. Higher elevation areas and natural levees farther from the channel often resemble natural levee communities described above and have unique stands that include significant amounts of sweet pecan, sugarberry, box elder, and ash (Meanley 1972). The understory of riverfront habitats includes mulberry, redbud, giant cane, swamp privet, and deciduous holly. Vines are mostly peppervine, grape, Virginia creeper, and greenbrier. Canebrakes are common throughout ridges of riverfront areas.

Because of frequent disturbances, annual productivity of riverfront forests is relatively low and highly dynamic. Litter and detrital material are sparse and quickly moved from sites during floods. Soils and sediments in riverfront areas typically are coarser material than in other habitats and nutrient and organic content is low. Vegetation in riverfront areas is resilient to disturbance, and species such as willow and sycamore are adapted to frequent sediment disturbances. Many animals use riverfront habitats, but few inhabit these areas year round. Seasonal visitors, especially migrant birds, find some food and substantial corridors of cover along the river.

DISTRIBUTION OF PRESETTLEMENT HABITAT TYPES

Only a few maps, records, and naturalist accounts describe native habitats present in the Bayou Meto Basin in the mid-1800s. The best accounts of general habitat type and distribution are U.S. Government Land Office (GLO) survey maps prepared 1850-60. These maps describe major land features including streams and bayous and distinguish areas that were either forested (all types combined) or prairie grassland. GLO maps do not describe composition of forested areas, nor do they delineate small areas of trees (such as slash) or herbaceous wetlands within prairie grasslands. GLO surveys probably mapped savannas as forest, but this is unclear because some savanna areas contained large amounts (>50%) of grassland. Consequently, GLO survey maps are good for indicating total forested and grassland area, but not for distinguishing other specific habitat types.

The few published descriptions of native vegetation in the Bayou Meto Basin in the 1800s suggest Presettlement habitat composition was not much different than at present (e.g., Nuttall 1821, Grimmett 1989). We believe this premise is correct and is a basis for understanding distribution and amount of habitat present in the Bayou Meto Basin in the Presettlement period. To predict distribution and amount of Presettlement habitat types, we determined which contemporary habitats are present in different geomorphological, soil, topography, and flood frequency settings. We used geomorphology maps prepared by Saucier (1994), soil maps from current NRCS data files, U.S. Geological Survey quadrangle topographical maps, and flood frequency maps prepared by the USACE Vicksburg District. Flood frequency maps delineated areas that are flooded during 2- and 5-year flood events. Vegetation was sampled at over 100 sites within the Bayou Meto Basin by Klimas et al. (2002) that represented major geomorphological features (e.g., point bar, backswamp, natural levee, etc.), soils, and flood frequency zones. For example, 1 sampling site was backswamp deposits, with Perry soils, and within the 2-year flood frequency contour. Plant sampling followed methods used in current hydrogeomorphic (HGM) modeling projects (Klimas et al. 2002) and characterized the dominant tree and shrub species composition, size, and density.

Using the above vegetation sampling, Klimas et al. (2002) prepared a matrix model of HGM types present in the Bayou Meto Basin (Table 9). We subsequently cross-correlated habitats used in our study with their HGM matrix. For example, backswamp deposits with Perry soils, <180' elevation, and within the 2-year flood frequency contour were HGM riverine backwater type RB-1 in the HGM matrix and Low BLH habitats in our report. Typically flood frequency and elevation were closely aligned by area of the Bayou Meto Basin. Flood frequency was a better indicator of habitat type than was strictly elevation because the Bayou Meto Basin slopes (and elevation declines) from northwest to southeast, therefore a 2-year flood event in the north part of the Basin might be up to 195' amsl while the same flood event

Table 5. Selected common bird species present in bottomland hardwood forest (BLH) habitat types in the Bayou Meto Basin, Arkansas. Species were selected from range maps, habitat descriptions of several field guides, data in Wakeley and Roberts (1996), and personal communication with W. Barrow. Y= year-round resident, S = summer breeding species, W= winter resident, and E = extirpated. Birds that stop-over only during migration are not included.

		Habitat			
Species	Common name	Cypress/ tupelo	Low BLH	Intermediate BLH	High BLH
Botaurus lentiginosus	American bittern	W	W		
Ixobrychus exilis	Least bittern	S	S		
Nycticorax nycticorus	Black-crowned night-heron	S	S	S	
Nycticorax violacea	Yellow-crowned night-heron	S	S	S	
Butorides virescens	Green heron	S	S		
Egretta caerulea	Little blue heron	S	S		
Bulbulcus ibis	Cattle egret	S	S		
Egretta thula	Snowy egret	S	S		
Ardea alba	Great egret	S	S		
Ardea herodias	Great blue heron	S	S		
Ictinia mississippiensis	Mississippi kite	S	S	S	S
Haliaeetus leucocephalus	Bald eagle	Y	Y	Y	Y
Accipiter striatus	Sharp-shinned hawk	W	W	W	W
Accipiter cooperii	Cooper's hawk	Y	Y	Y	Y
Buteo lineatus	Red-shouldered hawk	Y	Y	Y	Y
Buteo jamaicensis	Red-tailed hawk	Y	Y	Y	Y
Falco sparverius	American kestrel	Y	Y	Y	Y
Meleagris gallopava	Wild turkey	Y	Y	Y	Y
Scolopax minor	American woodcock		W	W	Y
Coccyzus americanus	Yellow-billed cuckoo		S	S	S
Otus asio	Eastern screech owl	Y	Y	Y	Y
Bubo virginianus	Great horned owl	Y	Y	Y	Y
Strix varia	Barred owl	Y	Y	Y	Y
Chordeiles minor	Common nighthawk			S	S
Archilochus colubris	Ruby-throated hummingbird	S	S	S	S
Ceryle alcyon	Belted kingfisher	Y			
Melanerpes erythrocephalus	Red-headed woodpecker		Y	Y	Y
Melanerpes carolinus	Red-bellied woodpecker		Y	Y	Y
Sphyrapicus varius	Yellow-bellied sapsucker	W	W	W	W
Picoides pubescens	Downy woodpecker		Y	Y	Y
Picoides villosus	Hairy woodpecker		Y	Y	Y
Colaptes auratus	Northern flicker		Y	Y	Y
Dryocopus pileatus	Pileated woodpecker	Y	Y	Y	Y
Contopus virens	Eastern wood-pewee	S	S	S	S
Empidonax virescens	Acadian flycatcher	S	S	S	S
Sayornis phoebe	Eastern phoebe	Y	Y	Y	Y
Myiarchus crinitus	Great crested flycatcher	S	S	S	S
Tyrannus tyrannus	Eastern kingbird		S	S	S
Vireo griseus	White-eyed vireo		S	S	S
Vireo flavifrons	Yellow-throated vireo	S	S	S	S
Vireo olivaceous	Red-eyed vireo	S	S	S	S
Vireo bellii	Bell's vireo		S	S	
Vireo gilvus	Warbling vireo			S	S
Cyanocitta cristata	Blue jay	Y	Y	Y	Y
Corvus ossifragus	Fish crow	Y	Y	Y	Y
Stelgidopteryx serripennis	Northern rough-winged swallow	S			S
Baeolophus bicolor	Tufted titmouse	Y	Y	Y	Y
Poecile carolinesis	Carolina chickadee	Y	Y	Y	Y
Troglodytes troglodytes	Winter wren	W	W	W	W
Thryothorus ludovicianus	Carolina wren	Y	Y	Y	Y
Regulus satrapa	Golden-crowned kinglet	W	W	W	W
Regulus calendula	Ruby-crowned kinglet		W	W	W
Polioptila caerulea	Blue-gray gnatcatcher	S	S	S	S
Catharus guttatus	Hermit thrush		W	W	W
Parula americana	Northern parula	S	S	S	S
Dendroica pensylvanica	Chestnut-sided warbler	S	S	S	S
Dendroica coronada	Yellow-rumped warbler	W	W	W	W
Dendroica discolor	Prairie warbler		S		
Oporonis formosus	Kentucky warbler		S	S	S
Wilsonia citrina	Hooded warbler		S	S	S
Mniotilta varia	Black-and-white warbler	S	S	S	S
Dendroica petechia	Yellow warbler	S			
Limnothlypis swainsonii	Swainson's warbler			S	S
Seiurus motacilla	Louisiana waterthrush	S	S		
Geothlypis trichas	Common yellowthroat		S		
Icteria virens	Yellow-breasted chat		S		
Setophaga ruticella	American redstart	S	S	S	S
Piranga rubra	Summer tanager	S	S	S	S
Piranga olivacea	Scarlet tanager		S	S	S
Melospiza georgiana	Swamp sparrow			W	W
Zonotrichia albicollis	White-throated sparrow			W	W
Junco hyemalis	Dark-eyed junco		W	W	W
Guiraca caerulea	Blue grosbeak	S	S	S	S
Passerina cyanea	Indigo bunting			S	S
Passerina ciris	Painted bunting			S	S
Icterus spurius	Orchard oriole		S	S	S
Icterus galbula	Baltimore oriole		S	S	S
Carduelis tristis	American goldfinch		Y		

Table 6. Selected common native mammal species present in bottomland hardwood forest (BLH) habitat types in the Bayou Meto Basin, Arkansas. Species were selected from range maps and habitat descriptions in Lowery (1974), Sealander (1979), and Cochran (1999).

		Habitat			
Species	Common name	Cypress/ tupelo	Low BLH	Intermediate BLH	High BLH
Didelphis virginiana	Opossum		X	X	X
Blarina brevicauda	Short-tailed shrew	X	X	X	X
Myotis lucifugus	Little brown bat	X	X	X	X
Myotis austroriparius	Southeastern myotis	X	X	X	X
Lasionycteris noctivagans	Silver-haired bat		X	X	X
Pipistrellus subflavus	Eastern pipistrelle	X	X	X	X
Eptesicus fuscus	Big brown bat	X	X	X	X
Lasiurus borealis	Eastern red bat		X	X	X
Lasiurus seminolus	Seminole bat	X	X	X	X
Nycticeius humeralis	Evening bat	X	X	X	X
Corynorhinus rafinesquii	Rafinesque's big-eared bat	X	X	X	X
Dasypus novemcinctus	Nine-banded armadillo			X	X
Sylvilagus floridanus	Eastern cottontail				X
Sylvilagus aquaticus	Swamp rabbit	X	X	X	X
Sciurus carolinensis	Eastern gray squirrel	X	X	X	X
Sciurus niger	Eastern fox squirrel	X	X	X	X
Glaucomys volans	Southern flying squirrel	X	X	X	X
Castor canadensis	American beaver	X	X	X	X
Oryzomys palustris	Marsh rice rat	X	X	X	X
Peromyscus leucopus	White-footed mouse		X	X	X
Peromyscus gossypinus	Cotton mouse		X	X	X
Peromyscus nuttalli	Golden mouse		X	X	X
Microtus pinetorum	Woodland vole				X
Ondatra zibethicus	Muskrat	X			
Canis latrans	Coyote		X	X	X
Urocyon cinereoargenteus	Gray fox				X
Ursus americanus	Black bear	X	X	X	X
Procyon lotor	Racoon	X	X	X	X
Mustela frenata	Long-tailed weasel			X	X
Mustela vison	Mink	X	X		
Mephitus mephitus	Striped skunk	X	X	X	X
Lutra canadensis	River otter	X	X		
Lynx rufus	Bobcat		X	X	X
Odocoileus hemionus	White-tailed deer	X	X	X	X

Table 7. Selected common reptile and amphibian species present in bottomland hardwood forest (BLH) habitat types in the Bayou Meto Basin, Arkansas. Species were selected from range maps and habitat descriptions of several field guides.

		Habitat			
Species	Common name	Cypress/ tupelo	Low BLH	Intermediate BLH	High BLH
Chelydra serpentina	Common snapping turtle	X	X		
Macroclemys temminickii	Alligator snapping turtle	X	X		
Sternotherus carinatus	Razorback musk turtle	X			
Kinsosternon subrubrum	Mississippi mud turtle	X	X		
Graptemys kohnii	Mississippi map turtle	X			
Graptemys pseudogeographica	False map turtle	X			
Trachemys scripta elegans	Red-eared slider	X			
Pseudemys concinna	River cooter	X			
Chrysemys picta	Painted turtle	X			
Deirochelys reticularia	Chicken turtle	X			
Apalone mutica	Smooth softshell	X			
Apalone spinifera	Spiny softshell	X			
Cnemidophorus sexlineatus	Racerunner		X	X	X
Scinella lateralis	Ground skink		X	X	X
Eumeces laticeps	Five-lined skink			X	X
Nerodia cyclopion	Mississippi green water snake	X	X	X	X
Nerodia rhombifer	Diamond back water snake	X	X	X	X
Nerodia erythrogaster	Yellowbelly water snake	X	X	X	X
Nerodia fasciata	Broad-banded water snake	X	X	X	X
Regina grahamii	Graham's crayfish snake	X	X		
Thamnophis sirtalis	Eastern garter snake			X	X
Thamnophis proximus	Western ribbon snake				X
Heterodon platirhinos	Eastern hognose snake				X
Farancia abacura	Mud snake	X	X	X	X
Coluber constrictor	Black racer		X	X	X
Opheodrys aestivus	Rough green snake		X	X	X
Elaphe obsoleta	Rat snake		X	X	X
Lampropeltis getula	Speckled king snake		X	X	X
Agkistrodon controtix	Southern copperhead				X
Agkistrodon piscivorus	Western cottonmouth	X	X	X	X
Sistrurus miliarius	Western pygmy rattlesnake				X
Necturus maculosus	Mudpuppy	X			
Amphiuma tridactylum	Three-toed amphiuma	X			
Siren intermedia	Lesser siren	X			
Ambystoma opacum	Marbled salamander	X	X	X	X
Ambystoma texanum	Smallmouth salamander	X	X	X	X
Ambystoma maculatum	Spotted salamander	X	X	X	X
Notophthalmus viridescens	Eastern newt	X	X	X	X
Bufo americanus	American toad		X	X	X
Bufo woodhousii	Woodhouse's toad	X	X	X	X
Acris crepitans	Northern cricket frog	X	X	X	X
Hyla cinerea	Green treefrog	X	X	X	X
Hyla versicolor	Common gray treefrog	X	X	X	X
Hyla chrysolscelis	Cope's gray treefrog	X	X	X	X
Pseudacris crucifer	Spring peeper	X	X	X	X
Pseudacris triseriata	Upland chorus frog	X	X	X	X
Gastrophrine carolinensis	Eastern narrowmouth toad	X	X	X	X
Rana catesbiana	Bullfrog	X	X	X	X
Rana clamitans	Bronze frog	X	X	X	X
Rana utricularia	Southern leopard frog	X	X	X	X
Rana palustris	Pickeral frog	X	X	X	X

Table 8. Native fish species in the Arkansas River and bottomland hardwood forest (BLH) habitat types in the Bayou Meto Basin, Arkansas. Data are from Robison and Buchanan (1988) and Baker and Kilgore (1994).

Species	Common name	Habitat: Arkansas River	Habitat: Cypress/ tupelo	Habitat: Flooded BLH
Scaphirhynchus platorynchus	Shovelnose sturgeon	X	?	
Polyodon spathula	Paddlefish	X	?	
Atractosteus spatula	Alligator gar	X	X	?
Lepisosteus oculatus	Spotted gar	X	X	?
Lepisosteus osseus	Longnose gar	X	X	?
Lepisosteus platostomus	Shortnose gar	X	X	?
Amia calva	Bowfin	X	X	X
Anguilla rostrata	American eel	X	X	
Alosa chrysochloris	Skipjack herring	X	?	?
Dorosoma cepedianum	Gizzard shad	X	X	X
Dorosoma petenense	Threadfin shad	X	?	?
Esox americanus	Grass pickeral	X	X	X
Hybognathus hayi	Cypress minnow	X	X	?
Hybognathus nuchalis	Mississippi silvery minnow	X	X	?
Notemmigonus crysoleucas	Golden shiner	X	X	X
Notropis amnis	Pallid shiner	X	?	
Notropis atherinoides	Emerald shiner	X	X	X
Opsopoeodus emiliae	Pugnose minnow	X	X	X
Lythrurus fumeus	Ribbon shiner	X	X	X
Notropis maculatus	Taillight shiner	X	X	X
Cyprinella venusta	Blacktail shiner	X	X	X
Pimephales vigilax	Bullhead minnow	X	X	X
Carpiodes carpio	River carpsucker	X	X	X
Erimyzon sucetta	Lake chubsucker	X	?	?
Ictiobus bubalus	Smallmouth buffalo	X	X	?
Ictiobus cyprinellus	Bigmouth buffalo	X	X	?
Ictiobus niger	Black buffalo	X	X	?
Minytrema melanops	Spotted sucker	X	X	X
Ictaluras furcatus	Blue catfish	X	X	?
Ameiurus natalis	Yellow bullhead	X	X	X
Ictaluras punctatus	Channel catfish	X	X	X
Noturus gyrinus	Tadpole madtom	X	X	X
Pylodictis olivaris	Flathead catfish	X	X	X
Aphreadoderus sayanus	Pirate perch	X	X	X
Fundulus chrysotus	Golden topminnow	X	?	?
Fundulus dispar	Northern starhead minnow	X	?	?
Fundulus olivaceus	Blackspotted topminnow	X	X	X
Gambusia affinis	Mosquitofish	X	X	X
Morone mississippiensis	Yellow bass	X	?	?
Centrarchus macropterus	Flier	X	X	X
Lepomis cyanellus	Green sunfish	X	X	X
Lepomis gulosus	Warmouth	X	X	X
Lepomis humilis	Orangespotted sunfish	X	X	?
Lepomis macrochirus	Bluegill	X	X	X
Lepomis marginatus	Dollar sunfish	X	X	?
Lepomis megalotis	Longear sunfish	X	X	?
Lepomis microlophus	Redear sunfish	X	?	?
Lepomis punctatus	Spotted sunfish	X	X	?
Lepomis symmetricus	Bantam sunfish	X	X	X
Micropterus salmoides	Largemouth bass	X	X	X
Pomoxis annularis	White crappie	X	X	X
Pomoxis nigromaculatus	Black crappie	X	X	X
Elassoma zonatum	Banded pygmy sunfish	X	X	X
Etheostoma asprigene	Mud darter	X	X	X
Etheostoma chlorosomum	Bluntnose darter	X	X	X
Etheostoma gracile	Slough darter	X	X	X
Etheostoma proeliare	Cypress darter	X	X	X
Etheostoma stigmaeum	Speckled darter	X	X	X
Percina caprodes	Logperch	X	X	X
Percina shumardi	River darter	X	X	X
Aplodinotus grunniens	Freshwater drum	X	X	X

Table 9. Hydrogeomorphic (HGM) site characteristics for habitats in the Bayou Mèto Basin, Arkansas (from Klimas et al. 2002).

HGM subclass	Subtype map designation	Characteristic plant communities	Mapping criteria	Comments
Riverine overbank (RO)	Subtype RO-1 5-year floodplain within abandoned courses of the Arkansas River	Overcup oak, bitter pecan Baldcypress, water elm, buttonbush	Hydrology: within the 5-year floodplain, but dominated by deep, relatively high velocity flood flows rather than backwater flooding Geomorphic setting: primarily within abandoned Holocene courses of the Arkansas River Soils: Perry, Portland	Abandoned Holocene courses of the Arkansas River that are currently occupied by smaller streams have narrow floodplains confined within banks of the former, larger river. Wetlands on the floodplain and banks of the modern stream are subject to deep, prolonged overbank flows. Examples include Wabbaseka and Indian Bayous.
Riverine overbank	Subtype RO-2 Riverfront natural levee sites within the 5-year floodplain	Sycamore, sugarberry, sweetgum, American elm, sweet pecan on natural levees of Bayou Meto and tributaries Cottonwood, boxelder, sugarberry, sycamore on natural levees of the Arkansas River Overcup oak and bitter pecan in swales between natural levees	Hydrology: within 5-year floodplain on natural levees adjacent to or near active channels Geomorphic setting: natural levee and riverfront point bar Soils: Crevasse, Rilla, Oklared, Roxanna, Coushatta, Wabbaseka, Latania, Commerce	Vegetation composition and structure is related to proximity to the channel and associated high flows, light availability, and sedimentation. Most of these sites are on substantial natural-levee deposits, but point-bar deposits with little or no natural levee are included if they are directly adjacent to the channel. Deposits of Arkansas River origin characteristically are dominated by eastern cottonwood, which is replaced by sycamore on sediments deposited by smaller streams.
Riverine overbank	Subtype RO-3 Riparian areas on tributary streams	Water oak, willow oak, green ash, American elm, persimmon, cherrybark oak	Hydrology: within the 5-year floodplain on narrow-riparian areas; flooding typically frequent, but short-duration Geomorphic setting: usually mapped as Holocene (or recent) undifferentiated alluvium Soils: Tichnor, narrow areas of Calhoun and Oaklimeter	This subtype occupies narrow valleys draining the Grand Prairie. Streams are small, with narrow floodplains, and transition to slash on the upstream end, and into the backwater zone of larger streams on the downstream end. Sideslope areas above the floodplain are mapped as components of the upland forest type (subtype U-2).
Riverine backwater (RB)	Subtype RB-1 Lower backwater zone, within the 1-2 year floodplain.	Overcup oak dominant, Nuttall & willow oak common associates	Hydrology: mostly within the 1 or 2-year floodplain, and the dominant flood pattern is deep, long-duration, low velocity flows Geomorphic setting: primarily backswamp with local natural levee veneers, isolated point bar deposits Soils: Perry, Portland, Sharkey, Desha, Moreland, Bowdre	This subtype constitutes much of the Bayou Meto backwater area, where frequent flooding, runoff from higher ground, and sluggish internal drainage supports an extensive overcup oak forest with inclusions of minor rises dominated by other oak species and green ash. RB-1 is also mapped along some tributary stream valleys within the Grand Prairie, between the valley walls and the RO-3 overbank floodplain.
Riverine backwater	Subtype RB-2 Upper backwater zone, within the 5-year floodplain	Willow oak with overcup oak in vernal pools	Hydrology: within the 5-year floodplain, and the dominant flood pattern is relatively shallow; low velocity flows with extensive ponding after floods or extended rainy periods Geomorphic setting: primarily	This subtype is frequently flooded, but also is strongly influenced by ponding of flood and rainwater well into the growing season in vernal pools of varying sizes. RB-2 is also mapped in prairie terrace tributary headwater areas where water ponds or moves

(Table 9, cont'd.)

HGM subclass	Subtype map designation	Characteristic plant communities	Mapping criteria	Comments
			backswamp with local natural levee veneers, isolated point bar deposits Soils: Perry, Portland, Sharkey, Desha, Moreland, Bowdre	sluggishly. These latter areas may support the slash community type.
Flats (F)	Subtype F-1 Backswamp and point bar deposits of Bayou Meto outside the 5-year floodplain	Delta post oak, water oak, swamp chestnut oak, mockernut hickory Vernal pools dominated by willow oak, green ash, Nuttall oak	Hydrology: not within the 5-year floodplain. Geomorphic setting: backswamp with natural levee veneer and some point bar deposits. Bayou Meto and other small streams are the principal source of sediments supporting this type Soil: Herbert	This subtype contains species not commonly seen in riverine subtypes. The diversity and wetland character of the type is strongly influenced by vernal pools that pond precipitation and local runoff. Soils and hydrology (above the 5-year flood zone) together are the principal mapping criteria.
Flats	Subtype F-2 Bayou Meto and tributaries high natural levee	Swamp chestnut oak, cherrybark oak, sycamore, shagbark hickory, sweetgum, some white oak	Hydrology: not within the 5-year floodplain; precipitation is the principal water source Geomorphic setting: natural levee adjacent to old channels (high levees, not thin veneer) Soils: Rilla 1-3 % slope	Diverse forest type usually found adjacent to oxbow lakes and large depressions. Precipitation is stored in small depressions, but larger vernal pools do not commonly occur.
Flats	Subtype F-3 Arkansas River high natural levee on abandoned courses	Water oak, sweet pecan, cherrybark oak, sycamore	Hydrology: not within the 5-year floodplain; precipitation is the principal water source Geomorphic setting: high natural levees adjacent to abandoned courses of Arkansas River Soils: Rilla, small areas of Keo in the upper NW corner of the basin	These are usually very high features of marginal wetland character, but high diversity. They may have substantial slope but are classified as flats because the principal source of water is precipitation. Depressions may be common, but larger vernal pools do not occur in this subtype.
Flats	Subtype F-4 Point bar Arkansas River	Water oak, cherrybark oak, cedar elm, sugarberry, sweet pecan, shagbark hickory on ridges and backslopes, Nuttall oak and ash in vernal pools Occasional components include delta post oak, bur oak and southern red oak Vernal pools may be extensive in large swales	Hydrology: not within the 5-year floodplain. Precipitation is the principal water source. Geomorphic Setting: point bar, point-bar swales, sometimes with a natural levee veneer. Soils: Rilla, Hebert, Keo, Caspiana, Roxana, Coushatta, Wabbaseka, Latanier, McGhee, Perry in swales	Extensive areas of this subtype have been cleared, and often leveled, for agriculture. High species diversity is related to subtle microrelief and ponding of precipitation in vernal pools and small depressions.

(Table 9, cont'd.)

HGM subclass	Subtype map designation	Characteristic plant communities	Mapping criteria	Comments
Flats	Subtype F-5 Deweyville flats	Delta post oak, post oak willow oak, Nuttall oak, green ash in vernal pools	Hydrology: not within the 5-year floodplain. Precipitation is the principal water source. Geomorphic Setting: Deweyville terrace Soils: Calhoun, Calloway, Perry, Portland	Soils do not distinguish this setting from adjacent surfaces, but geomorphic origin was distinctly different and produced very large vernal pools and depressions that may have functioned differently from those elsewhere in the basin. Evidence regarding species composition is largely inferential from other similar sites outside the Bayou Meto basin and small disturbed fragments within, since all Deweyville in the basin is currently in agriculture.
Flats	Subtype F-6 Prairie terrace -hardwood flats	Willow oak, post oak among pimple mounds Willow oak, green ash, American elm in vernal pools Post oak, cherrybark oak, southern red oak on mounds	Hydrology: not within the 5-year floodplain. Precipitation is the principal water source. Geomorphic Setting: prairie terrace Soils: Stuttgart, Dewitt, Calhoun , Calloway, Midland	These forests are characterized by a high degree of interspersion among micro-habitats, including upland species on mounds, post oak or mixed hardwood flats between mounds, and large, shallow vernal pools which are typically ringed by mosses. Similar sites with very shallow fragipans are likely to support wet prairie or savanna.
Flats	Subtype F-7 Prairie terrace -wet prairie and slash	Wet prairie habitats: prairie cordgrass-eastern gamma grass Slash habitats: sugarberry, green ash, green hawthorn, stiff dogwood, deciduous holly, American elm	Hydrology: not within the 5-year floodplain. Precipitation and local runoff are the principal water source. Geomorphic Setting: prairie terrace in swales and other poorly drained sites (wet prairie), or in the head of drainages (slash) Soils: Tichnor, Calhoun (now Ethel)	Wet prairie typically was restricted to fairly small areas where soil conditions, the presence of relic depressional features (e.g. old Arkansas River channels and swales) and the size of the local drainage source area all promoted development of wet inclusions within larger dry prairies. Slash habitats occur in the heads of drainage systems, and boundaries between the typical slash vegetation and adjacent prairie or forest was influenced by varying moisture levels and fire frequencies
Connected depression	Subtype D-1 Connected Depressions	Baldcypress, tupelo, buttonbush, swamp privet, water elm Perimeter zones and some shallow depressions may be dominated by overcup oak and bitter pecan.	Hydrology: within the 5-year floodplain. Stream flooding, groundwater and local runoff are the principal water sources. Geomorphic Setting: within Holocene alluvium in abandoned channels or large point-bar and backswamp swales. Soils: Yorktown, Perry	Most connected depressions are cypress-dominated sites where surface water is no longer present by late summer. During floods (< 5-year frequency) these sites are directly connected to stream systems.
Isolated depression	Subtype D-2 Isolated Depressions	Baldcypress, tupelo, buttonbush, swamp privet dominate most depressions. Perimeter zones and some shallow depressions may be dominated by overcup oak and bitter pecan. Swamp	Hydrology: not within the 5-year floodplain. Groundwater and local runoff are the principal water sources. Geomorphic Setting: abandoned channels and point-bar and backswamp swales in Holocene Deweyville prairie terrace	Isolated depressions are similar to connected depressions in most respects, but lack connections to stream systems during flooding events.

(Table 9, cont'd.)

HGM subclass	Subtype map designation	Characteristic plant communities	Mapping criteria	Comments
		cottonwood may have occurred within isolated depressions on the Deweyville terrace.	alluvium. Soils: Yorktown, Perry	
Connected lacustrine fringe	Subtype LF-1 Connected Fringe Wetlands	Baldcypress, tupelo, buttonbush, water elm Emergent vegetation	Hydrology: within the 5-year floodplain. Stream flooding, groundwater and local runoff are the principal water sources. Geomorphic Setting: abandoned channels in Holocene alluvium Soils: Yorktown	Natural connected fringe wetlands in the basin are forested and emergent communities within oxbow lakes and beaver ponds with significant open-water area that are inundated by river water during 5-year flood events. For mapping purposes, this category also includes numerous man-made ponds that may support fringe wetlands of willows, buttonbush, or other native species, but are often maintained with grassed banks.
Isolated lacustrine fringe	Subtype LF-2 Isolated Fringe Wetlands	baldcypress, tupelo, buttonbush, water elm emergent vegetation	Hydrology: not within the 5-year floodplain. Groundwater and local runoff are the principal water sources. Geomorphic Setting: abandoned channels in Holocene and Pleistocene alluvium. Soils: Yorktown	Natural isolated fringe wetlands in the basin are forested and emergent communities within oxbow lakes and beaver ponds with significant open-water area, that are not inundated by river water during 5-year flood events. For mapping purposes, this category also includes numerous man-made ponds that may support fringe wetlands of willows, buttonbush, or other native species, but are often maintained with grassed banks.
Upland	Subtype U-1 Prairie terrace -dry prairie	Big bluestem, little bluestem, Indian grass, switch grass, associated forbs	Hydrology: N/A Geomorphic Setting: prairie terrace Soils: Stuttgart (0 to 1%), Dewitt (0 to 1%) (formerly Crowley), Loring (1 to 3%), Immanuel (0 to 1%)	This is a non-wetland subtype. Historic distribution and soils are the principal tools used to identify potential dry prairie areas.
Upland	Subtype U-2 Prairie terrace - Upland Forest or Savanna	Southern red oak/post oak woodland or post oak savanna on surfaces of the prairie terrace Post oak savanna along rim and upper side slopes of prairie terrace, transitioning to delta post oak on lower slopes and Holocene and Deweyville surfaces. Riparian sideslopes include mixed species, including white oak, swamp chestnut oak, persimmon, red maple, post oak	Hydrology Geomorphic Setting: prairie terrace Soils: Loring 3 to 8% and 8 to 20%), Immanuel (3 to 8%, and 15 to 25%)(formerly Grenada), Stuttgart 1 to 3% slope, Dewitt (formerly Crowley)	This upland subtype includes a range of community types that reflect differing soil and drainage conditions, as well as changes in fire patterns that have tended to reduce the former extent of savanna areas.

only came up to 180' amsl in the southern part of the basin.

A map of habitat distribution and area we believe existed prior to significant degradation in the Bayou Meto Basin was prepared by Pagan et al. (2002) using geographic information system (GIS) data layers of soils, flood frequency, and geomorphology (Appendix A, Table 10). Prairie grassland was present in the northeast part of the Bayou Meto Basin, mostly in the former Long Prairie patch (Fig. 11). These grasslands are upland subtype U-1 in the HGM classification (Klimas et al. 2002) and were on the top of the Prairie and Deweyville terraces, had Stuttgart/DeWitt soils, and are outside of flood zones in the basin. Seven separated patches of prairie were present in the mid-1800s and covered about 21,000 acres.

Slash habitats were present in the Bayou Meto Basin along the small drainages that entered historic prairie grassland patches, especially along Faras and Little Faras Runs, Buck Creek, Johnson Branch, Melon Branch, Mitchell Branch, Short Creek, and Burns Branch. Slash habitats include a part of HGM flat subtype F-7 and typically occur on Tichnor and Calhoun soils (Klimas et al. 2002). We estimate slash covered about 600-700 acres in the Prairie and Deweyville terraces.

Small depressions within prairie grasslands historically contained seasonal herbaceous wetlands/wet prairie. These wetlands include part of HGM flat subtype F-7 (Klimas et al. 2002). The amount of seasonal herbaceous wetland in the Bayou Meto Basin is unknown but probably was similar to the estimated 1-2% of grassland area present in the Grand Prairie region (Heitmeyer et al. 2000). If this estimate is correct, then seasonal herbaceous wetland covered only 200-400 acres in the Bayou Meto Basin.

Savanna was present along edges of the prairie grasslands and probably covered 2000-4000 acres in the Bayou Meto Basin during the Presettlement period. Savanna is the HGM upland subtype U-2 (Klimas et al. 2002). Savannas were in Calloway, Calhoun, Loring, Stuttgart, and Immanuel soils with 1-3% slopes downward from the tops of prairie terraces. Savanna was not flooded except during extremely high flood events of the Arkansas River.

Cypress/tupelo habitats were present in the lowest elevations and wettest areas in the Bayou Meto Basin. These habitats represent HGM isolated and connected depression subtypes D-1 and D-2 and isolated and connected lacustrine fringe subtypes LF-1 and LF-2 (Klimas et al. 2002). Distribution of cypress/tupelo was scattered primarily along edges of active streams, in abandoned channels and courses, and in low depressions that had poor drainage. Soils in cypress/tupelo habitats are almost exclusively Yorktown and Perry clays, and all sites were within the 2-year flood frequency zone. Total area in cypress/tupelo at Presettlement is estimated at about 10,000 acres.

Low BLH habitats were present in low elevations within the 2-year flood frequency zone of

Table 10. Acreage composition of habitats present in the Bayou Meto Improvement Project Area, Arkansas during Presettlement [a] and current periods.

Habitat type	Presettlement	Current	Percentage loss
Prairie grassland	21,000	200	99.1
Seasonal herbaceous wetland	400	50	87.5
Slash	700	300	57.1
Savanna	4,000	500	87.5
Cypress/tupelo	7,000	5,000	28.6
Low BLH [b]	208,000	54,000	74.0
Intermediate BLH	262,000	36,500	86.1
High BLH	220,000	11,000	95.0
Post oak flat	14,000	954	93.2
Riparian	3,000	1,500	50.0
Natural levee	10,000	2,000	80.0
Riverfront	27,000	4,600	83.0
Total native habitats	777,100	116,604	85.0
Agricultural land	2,009	419,934	
Reservoirs	-	7,350	
Fish ponds	-	22,942	
Lakes, streams, ditches	-	12,566	
Other	-	199,713	
Total	779,109	779,109	

[a] Presettlement is defined as the mid-1800s.
[b] BLH = Bottomland hardwood forest.

the Bayou Meto Basin. These habitats are HGM riverine backwater subtype RB-1 (Klimas et al. 2002). Most low BLH habitats were in backswamp areas, in swales in point-bar areas, and along edges (but not on natural levees) of abandoned courses and channels. Low BLH habitats have Perry-Portland, Desha, and Sharkey soils. This habitat covered about 217,000 acres of the Bayou Meto Basin during the Presettlement period.

Intermediate BLH habitats are present between the 2- and 5-year flood frequency zones within the Bayou Meto Basin and are HGM riverine backwater subtype RB-2 (Klimas et al. 2002). These areas include higher backswamp areas (often with local natural levee veneers) and isolated point- bar deposits. Soils in intermediate BLH areas include several types mostly in the Perry-Portland series but also Desha, Sharkey, Moreland, and Bowdre soils. Intermediate BLH covered about 250,000 acres in the mid-1800s.

High BLH flats occupied higher elevations within the Bayou Meto Basin that were above the 5-year flood frequency zone yet within elevations flooded during high Arkansas River and tributary flood events. High BLH habitats are HGM flat subtypes F-1 and F-4 (Klimas et al. 2002) and were present on high elevation backswamp deposits, point-bar deposits of the Arkansas River, and high natural levees adjacent to abandoned courses. These habitats occur mostly on Rilla soils but high BLH near the Arkansas River have several soil types including Herbert, Keo, Caspiana, Roxana, Coushatta, Wabbaseka, Latanier, and McGhee soils. High BLH habitat covered about 220,000 acres in the Presettlement period.

Post oak flats were on the very high ridges of the Arkansas River Lowlands and higher well-drained areas on the edges of the Prairie and Deweyville terraces. Most post oak flats are HGM flat subtypes F-5 and F-6 (Klimas et al. 2002). Soils in post oak flats are mostly Calhoun-Calloway types but also include some Perry-Portland series in lower areas and Stuttgart-DeWitt in higher terraces. These sites were not flooded except during extremely high flood events of the Arkansas River (such as in 1927 and 1937). Area in post oak flat during the Presettlement period is estimated at about 14,000 acres.

Riparian forests were present in narrow bands along abandoned courses in the Arkansas River Lowland and small streams that drained prairie terraces. These unique forest assemblages were bounded by natural levee habitats on the higher portions of most abandoned courses and either open water or cypress/tupelo along the fringes of streams. These forests are HGM riverine overbank subtypes RO-1 and RO-3 (Klimas et al. 2002) and covered about 3000 acres. Soils in the abandoned courses are Perry-Portland types and mostly Tichnor in the terrace floodplains.

Natural levees historically occurred on about 10,000 acres in the Bayou Meto Basin and have Rilla soils except for a small area of Keo soils in the northwest corner of the basin. Natural levees are HGM flat subtypes F-2 and F-3 (Klimas et al. 2002). They are classified as flats because the main source of water to these sites is on-site precipitation. Natural levees are outside the 5-year floodplain.

Riverfront habitats covered about 28,000 acres along the Arkansas River and have a diversity of soils ranging from Bruno-Crevasse and Desha-Wabbaseka-Latanier associations in the northwest to Roxana-Coushatta association in the southeast. Riverfront habitats are HGM riverine overbank subtype RO-2 (Klimas et al. 2002) and flooded regularly during the Presettlement period; sometimes several times in a single year.

By the 1850s, small areas of the Bayou Meto Basin had been cleared for farming (McNeilly 2000). Most of these areas were on higher elevations on old natural levees near the modern Arkansas River. The extent of these clearings is not known, but probably was not more than 1000-2000 acres. To balance the total sum of land area in the Bayou Meto Improvement Project Area, this cleared land is estimated at 2009 acres.

CHANGES IN THE BAYOU METO ECOSYSTEM FROM PRESETTLEMENT TO PRESENT

NATIVE VEGETATION COMMUNITIES

About 85% of native vegetation communities within the Bayou Meto Improvement Project Area was destroyed between Presettlement and current periods (Table 10). The percentage loss is greatest (>95%) for prairie grassland, seasonal herbaceous wetland, savanna, and high BLH habitat types and least (<50%) for cypress/tupelo and riparian habitats. The highest elevations and best drained parts of the basin were cleared earlier, and to a greater extent, than lower elevations that were (and continue to be) regularly flooded.

The majority (419,934 of 774,100 acres) of native habitats have been converted to agricultural land uses, mostly irrigated cropland. About 30,000 acres were converted to reservoirs and fish ponds and nearly 200,000 acres are in roads, urban areas, commercial and industrial areas, and other human uses. Changes in flood frequency and duration in the basin also have shifted BLH communities in some poorly drained low depressions and areas semi-impounded by roads and levees to either dead timber or cypress/tupelo and low BLH types. The extent of these changes in BLH composition throughout the Bayou Meto Basin is unknown, but at least 400 acres of dead timber now exist on Bayou Meto WMA and tree species composition is shifting from high and intermediate BLH dominated by willow and water oak to low BLH dominated by overcup oak, ash, and elm on as much as ½ of the WMA (Roger Milligan, personal communication).

Remnant BLH in the basin are present primarily in 2 regions along the lower ½ of the Bayou Meto floodplain. The largest remaining tract of BLH is in the southern part of the basin centered around the Bayou Meto WMA. Over 95% of the 33,700-acre Bayou Meto WMA remains in BLH with relatively equal amounts of low and intermediate BLH and scattered patches of cypress/tupelo. The second large area of BLH is north of the WMA along Bayou Meto and includes mostly private hunting clubs. The 455-acre Smoke Hole Natural Area along Bayou Two Prairie is the largest remnant cypress/tupelo habitat; the balance of cypress/tupelo habitats occur along abandoned channels and oxbows, low riparian stream channels, and in low sumps along Bayou Meto, Little Bayou Meto, and Wabbaseka Bayou. Remnant high BLH is in scattered, usually very isolated, patches in the southwestern part of the basin. Most high BLH patches are <50 acres.

Riparian corridors are reduced by about 50% throughout the basin with the exception of the 2 areas along Bayou Meto and some stretches of Bayou Two Prairie. Riparian corridors along Indian, Bakers, Salt, and the northern 2/3 of Wabbaseka bayous are narrow and in some areas streambanks are completely denuded. Natural-levee forests are restricted to corridors along existing streams; old natural levees of former Arkansas River courses are almost entirely converted to agricultural uses. Remnant riverfront habitats are confined to batture lands immediately adjacent to the Arkansas River, mostly in the lower ½ of the basin.

Most terrace-type habitats have been destroyed on both the Prairie and Deweyville terraces. The largest remnant habitats are isolated patches of post oak flats, mostly in the northwestern part of the basin along streams and more highly dissected land. Only a few remnant patches of savanna with highly altered understory vegetation remain; these are usually near towns, rural churches, cemeteries, and schools or in pastures. Narrow bands of slash remain in some drainages that cut into the terraces. Only a few very small patches of prairie grassland remain in or on the edges of Grand Prairie and seasonal herbaceous wetlands are restricted to a few small periodically farmed depressions in pastures and unleveled croplands.

Destruction of native habitats in the Bayou Meto Basin began as early as the mid-1800s when larger numbers of European settlers moved to the Arkansas River Lowland to begin plantations and farming operations (Hubbell and Lunon 1990, McNeilly 2000). Initial clearing of BLH in the Arkansas River Lowland was restricted to the highest elevations along natural levees and point-bar ridges where forests were thinner and soils were better drained and contained primarily silty loams. Most of these areas were in high BLH and post oak flats. Large areas of BLH probably were not cleared until the 1880s when certain large plantations had human and livestock resources to do so (McNeilly 2000). Intense timber harvest occurred in the Bayou Meto Basin during 1900-20 (Holder 1970, Gandy 2000) when large tracts of forests were purchased by lumber companies that established numerous sawmills to process the timber. During the early 1900s, many drainage projects and levee and drainage districts were organized and construction of levees and ditches effectively drained some lands and allowed timber harvest in many low, wet locations. Rice production accelerated in the terrace portions of the basin in the early 1900s and led to conversion of almost all prairie grassland to cropland by the 1930s. Expansion of rice production into the Arkansas River Lowland occurred during the 1920s and 1930s and led to additional clearing of lower elevation lands formerly occupied by intermediate and low BLH.

By 1920 most of the large Presettlement trees, especially those in high and intermediate BLH areas in the basin had been cut. We suspect that much of the high BLH and post oak flats were cleared by 1920. Historic aerial photographs of select areas in the basin in 1937 show that most higher elevation forests had been cleared and converted to agriculture; remnant forest was primarily along stream corridors. It is noteworthy, however, that in 1921 about 85-90% of forest land on the low Perry clay soils was still forested (Knobel 1921); this was mostly cypress/tupelo and low BLH habitat type.

The next large period of timber cutting and clearing land for agriculture in the Bayou Meto Basin occurred from the mid-1950s to about 1975 (Holder 1970, MacDonald et al. 1979). Arkansas State Act 153 passed in 1955 and increased taxation on forested areas compared to cropland. By 1959 these taxes tripled and caused landowners to clear many forested lands, especially if they received no income from the forests. Further drainage projects facilitated forest clearing in the basin and large losses of intermediate and low BLH probably occurred then. In the early 1970s, commodity prices for soybeans, in particular, increased greatly and caused some landowners to further clear large blocks of forest lands, including those in highly flood prone areas. As an example of the time line of forest clearing, forest area in Lonoke County declined from 150,000 acres in 1950 to 50,000 acres in 1975 and forest area in Jefferson County declined from 130,000 acres in 1950 to 45,000 acres in 1975 (Holder 1970). Almost 160,000 acres of wetland (almost entirely forested) was destroyed from 1950-90 (Fig. 13).

Loss of native habitats on the Prairie and Deweyville terraces was similar to that in the Arkansas River Lowland except that almost all of the Preset-

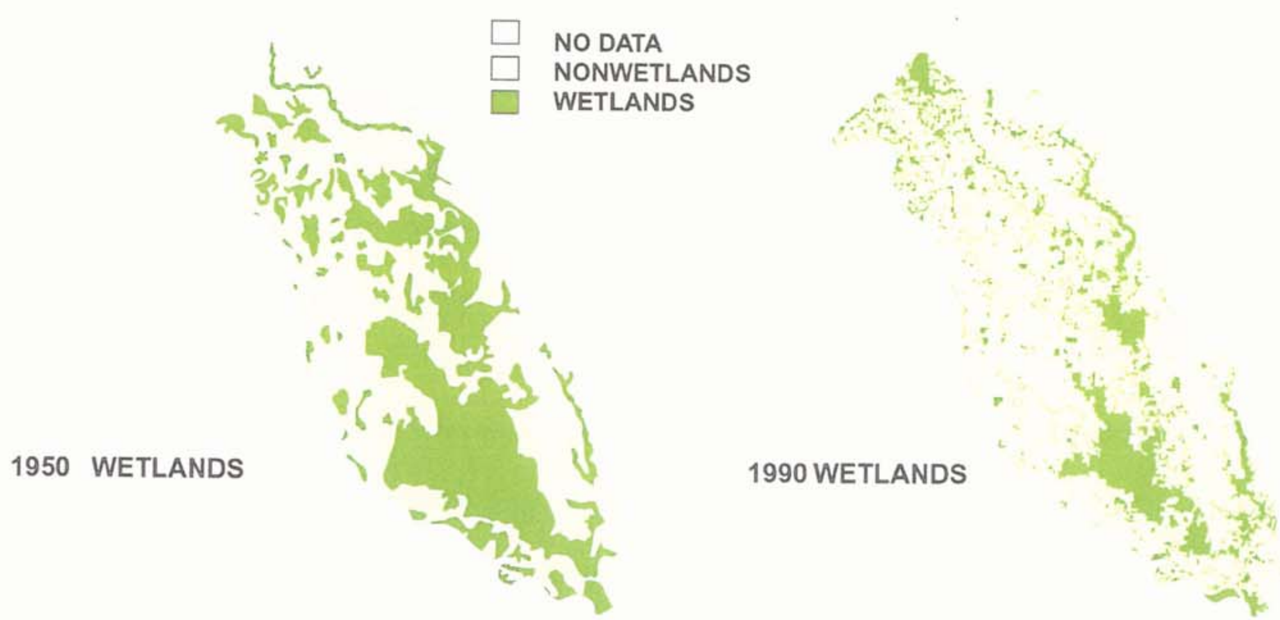


Figure 13. Wetland losses in the Bayou Meto Basin, Arkansas from the 1950s to the 1990s. (from Gandy et al. 2000)

tlement prairie grassland was lost by 1930 (Heitmeyer et al. 2000). Prairie grassland, including interspersed seasonal herbaceous wetlands, was converted almost entirely to rice fields from 1910 to 1930. Additionally, savanna and post oak flats adjacent to the prairie were cleared in the early 1900s and converted to cropland. Slash was gradually eliminated in the prairie terraces but persisted longer, into the mid-1900s, because of its location along streams and more highly dissected lands. BLH habitats on the higher elevations of the terraces were mostly cleared by 1920 and only lower BLH habitats along streams, such as Bayou Two Prairie, persisted and remain to the present. Clearing of forest land probably occurred somewhat earlier and more completely in the Prairie Terrace than in the Deweyville Terrace because of its slightly higher elevation, better drainage, less susceptibility to flooding, and proximity to major rice mills and storage and processing facilities.

HYDROLOGY

Groundwater dynamics.—Significant changes have occurred in the Mississippi Alluvial Aquifer that underlies the Bayou Meto Basin. Historically, this aquifer was present about 25-50' below the surface and was 70-100' thick (Joseph 1999). Average elevation of the top of groundwater was 164 amsl; regional groundwater flow was southward toward the Arkansas River. Large extractions of water from this aquifer began in the early 1900s, primarily pumping of well water for rice production in the Grand Prairie region. Today, hundreds of agricultural wells pump this groundwater throughout the Bayou Meto Basin.

Pumping groundwater has exceeded recharge capabilities in the Mississippi Alluvial Aquifer since the mid-1900s. Groundwater levels have declined substantially and a cone-of-depression exists northeast of the Bayou Meto Basin. Groundwater flow in the basin now is mostly northeast into this cone-of-depression rather than the historic southward flow toward the Arkansas River. Declines of over 50 feet (and up to 50% reduction in aquifer thickness) in the aquifer occur between Lonoke and Carlisle. The thickness of the aquifer now is mostly 40-60' and a small area near Lonoke has a thickness of only 40'. An area near Slovak, just east of the Basin has a saturated thickness of groundwater of only 20'. Average declines in the aquifer in the Bayou Meto Basin range from 1-2' per year. Pumping depths range from 120' near Lonoke to 20' near the Arkansas River.

Currently, about 800,000 acre-feet of groundwater is pumped from the Mississippi Alluvial Aquifer in the Bayou Meto Basin each year. The safe yield level, where recharge equals withdrawal is about 280,000 acre-feet per year. Consequently, current withdrawals exceed recharge by 65% annually on average. Saturated thickness of the aquifer is the least in areas farthest from recharge zones and near the center of the cone-of-depression in the Grand Prairie region and thickest near the southern part of the basin near the Arkansas River. Use of groundwater throughout eastern Arkansas has increased from about 800 million gallons/day in 1960 to over 2500 million gallons/day by 1995 (Arkansas Soil and Water Conservation Commission (ASWCC)1988).

Surface water dynamics.—Many factors have significantly changed surface water dynamics in the Bayou Meto Basin including clearing of forests; altered topography and land leveling; construction of roads, ditches, railroad beds, and urban areas; construction of storage reservoirs and fish ponds; pumping water from streams and abandoned channels for agricultural irrigation; and on-farm tailwater recovery and conservation systems. Primary water problems within the basin are: 1) shortage of surface water available for human and fish and wildlife needs, particularly during the agricultural irrigation season; 2) extensive flooding and poor drainage in the southern part of the basin; and 3) degraded water quality caused by soil erosion, high nutrient concentrations, and pesticide residues (e.g., dioxin contamination) (ASWCC 1988).

Stream flows throughout the basin generally are reduced from, and more irregular than, historic periods. Bakers Bayou, Crooked Creek, and Indian Bayou are reduced to intermittent status during summer and occasionally dry completely. Many weirs are present in streams within the basin; these weirs hold water within pools that are pumped during summer for agricultural irrigation. Over 20 weirs exist in the current Bayou Meto channel alone. Streamflow in Bayou Meto is highly variable and mean annual discharge has been very low (< 200 cfs) in some years (Fig. 14). In-stream flow requirements for water quality and fish and wildlife needs are 0.2 and 185 cfs respectively; as of 1988 available streamflow is only 109 cfs (ASWCC 1988). Even though streamflow in Bayou Meto has exceeded seasonal minimum over 80% of the time in recent years, daily discharge is usually below seasonal minimums during July-October (Fig. 15).

Hundreds of miles of ditches occur in the Bayou Meto Basin. Major ditches redirect water flows around and in Indian, Salt, and Wabbaseka bayous. Major man-made canals include Salt Bayou Ditch, Buffalo Ditch, Big Ditch, and Indian Bayou Ditch and they carry significant amounts of water through the basin watershed to the Arkansas River. These ditches accelerate water flow through the basin and effectively drain much of the northern 2/3 of the basin while increasing water volume and flood potential in the southern 1/3. Surface water runoff tends to "pond" for extended periods in the low elevation sump of the lower part of the Basin that contains the Bayou Meto WMA. Water also is extracted and diverted from abandoned channels and some now only have seasonal water. In many areas where "cross bayous" formerly connected bayous and streams, these connections are severed or diverted thus reducing and isolating flows of local watersheds. Sheetflow of surface water is almost absent in the Bayou Meto Basin now because of interceptions of surface water by ditches, roads, levees, and tail-water recovery systems. Reservoirs, fish ponds, and lakes cover over 35,000 acres and include the 2388-acre Lumsden Reservoir/Jacobs Lake Complex near Mill Bayou, Pickthorn Lake in Lonoke County, and Hallowell Reservoir in the Bayou Meto WMA.

Frequency of flooding in the Bayou Meto Basin is greatly altered from historic periods. Frequency, duration, and extent of flooding from overbank flows of regional streams in the upper 2/3 of the basin is reduced from historic periods, while similar flooding in the lower 1/3 has increased. A major change in flooding of the Bayou Meto Basin occurred following construction of the McClellan-Kerr Arkansas River Navigation System. This system constructed 17 locks and dams on a 445-mile section of the Arkansas River from the mouth upstream. Four locks and dams were built on the Arkansas River in the Bayou Meto Basin: Emmett Sanders Lock at mile 66, built in 1969; Lock and Dam No. 5 at mile 86.3, built in 1968; David D. Terry Lock and Dam at mile 108.1, built in 1958; and Murray Lock and Dam at mile 125.4, built in 1969. These locks and dams reduced seasonal and annual variation in Arkansas River flows. Upstream flood control dams on the Arkansas River have further altered flood events. The Arkansas River stage at Pine Bluff exceeded 40' 10 times from 1950 to 1958 (average of 1.1 times/year) but only 23 times from 1959 to 2001 (0.5 times/year; unpublished USACE records). Further reductions in flows of the Arkansas River have occurred when Oklahoma has exercised its right to develop and use up to 60% of the annual yield of the Arkansas River sub-basin

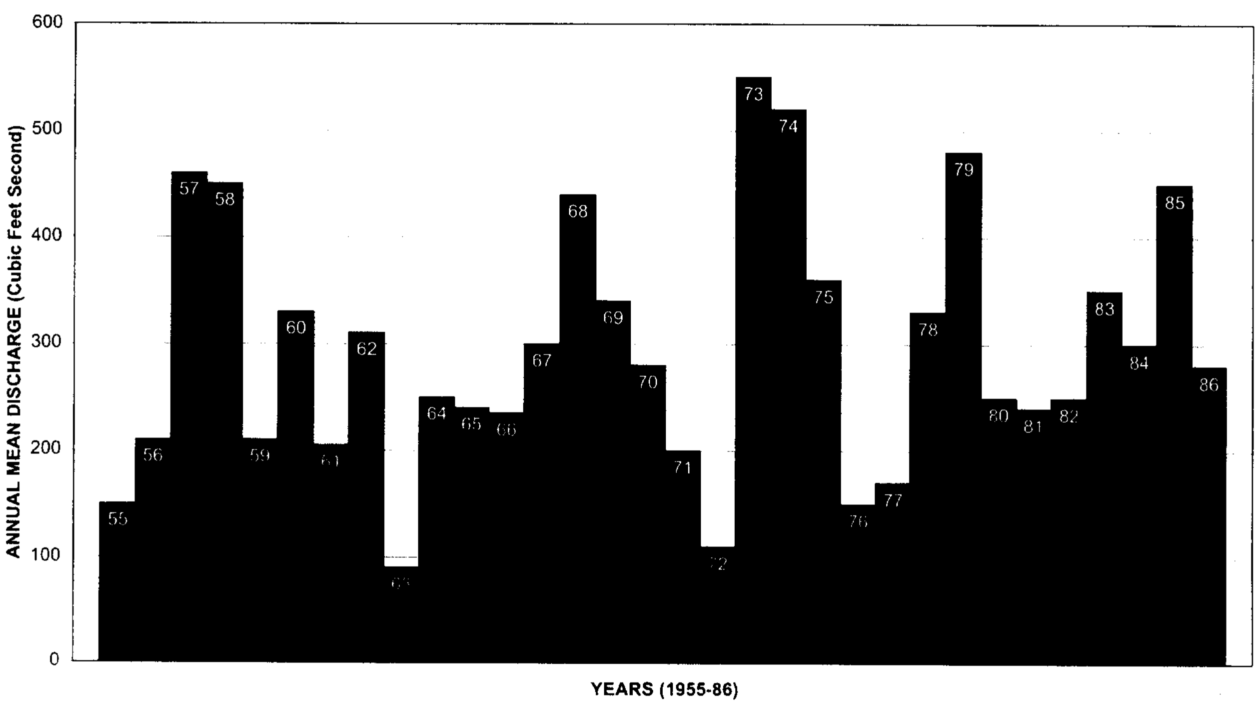


Figure 14. Annual mean discharge for Bayou Meto near Lonoke, Arkansas (from Arkansas Soil and Water Conservation Commission, 1988).

according to the Arkansas River Compact. This problem is compounded in dry years when Oklahoma uses a greater amount of their apportionment, thus further reducing flows downstream. Because of changes on the Arkansas River, major flooding of the Arkansas River that inundates much of the Bayou Meto Basin now is rare.

In 1913, the Farelly Lake Levee and Drainage District was formed in Arkansas and Jefferson counties and included 99,852 acres within the Bayou Meto Basin. The district imposed taxes on landowners in the district and constructed a levee at the confluence of Bayou Meto and the Arkansas River with the intention of reducing and preventing backwater flooding from the Arkansas River into the Bayou Meto Basin. Later, mainstem levees were built along the Arkansas River and they further limited Arkansas River flooding of the basin. Ironically, these levees, while preventing Arkansas River backwater flooding into the basin, simultaneously slowed drainage of water out of the Bayou Meto Basin into the Arkansas River, and subsequently increased flooding in the lower reaches of Bayou Meto and Little Bayou Meto. This increased flooding depth, duration and extent have impacted hydroperiods and vegetation communities in the Bayou Meto WMA and surrounding lowlands. This flooding problem was exacerbated further by construction of hundreds of miles of small levees on farms for flood protection and rice production, and within Bayou Meto WMA for impounding water for waterfowl hunting.

In addition to changes in seasonal and annual water quantity, water quality also has been degraded throughout the Bayou Meto Basin (ASWCC 1988). For example, turbidity concentrations of as high as 2700 NTU exist in Bayou Meto; the standard recommended by the Arkansas Department of Pollution Control and Ecology is 75 NTU. Approximately ½ of the dissolved oxygen measurements at Bayou Meto are less than state standards. Nitrogen and phosphorus concen-

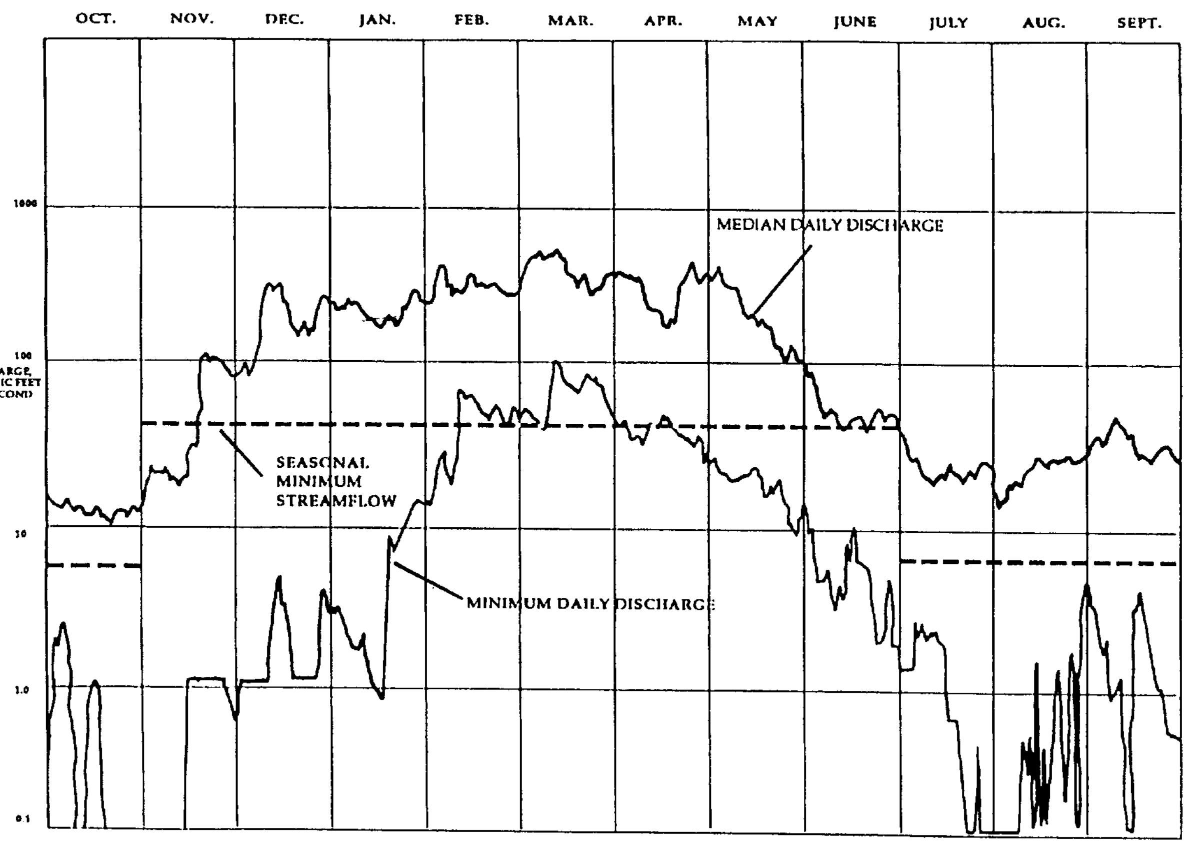


Figure 15. Comparison of seasonal minimum streamflow with minimum and median daily discharges of Bayou Meto near Lonoke, Arkansas, 1955-86 (from Arkansas Soil and Water Conservation Commission 1988).

trations in streamflows throughout the basin often are high. Concentrations of cadmium, copper, and selenium have occasionally exceeded recommended limits, and iron and manganese concentrations have exceeded standards at all recording stations. In the 1970s, Bayou Meto was contaminated with dioxin from Vertac Chemical, Inc., near Jacksonville after metal drums buried on site began to leak. Dioxin concentrations in Bayou Meto have gradually diminished since initial contamination in 1979, but residues in some fishes remain high. Production of dioxin at the Vertac plant has been discontinued, but a ban on fishing remains in effect in parts of Bayou Meto because of the persistence of the chemical. Toxaphene concentrations in Bayou Meto also occasionally exceed acute toxicity levels. Over 300 sites of potentially hazardous, toxic, and radioactive wastes currently exist in the basin (Gulf Engineers and Consultants 2000).

TOPOGRAPHY

The topography of the Bayou Meto Basin has been altered during the last 150 years by many activities including: 1) construction of roads, levees, railroad beds, and ditches; 2) siltation and purposeful filling of depressions, abandoned channels, and abandoned courses; 3) construction of fish ponds, reservoirs, and GTRs on duck clubs and Bayou Meto WMA; 4) leveling agricultural lands; and 5) urban construction projects.

Hundreds of miles of roads, railroad beds, levees, and ditches now exist in the Bayou Meto Basin. Major construction of roads occurred when forest lands were cleared for agricultural production in the early 1900s. Roads are present along boundaries of most sections of land and completely enclose many sections on higher elevation terraces and flats. These roads, and the ditches graded on road sides, restrict overland sheetflow of water and essentially create numerous small artificial watersheds at a section level. Farm and county roads further dissect lands and watersheds. Small levees exist throughout crop fields, especially where rice is produced. About 103,000 acres of rice is grown annually in the Bayou Meto Basin and is rotated biannually, usually with soybeans. Consequently about 200,000-250,000 acres of cropland are used biannually for rice production, and within this area there are extensive networks of levees to accommodate rice production and irrigation. In total, about 370,000 acres of cropland are irrigated annually and over 90% of agricultural fields have at least some levees and ditches used for irrigation and drainage.

In general, roads are least extensive in the lower 1/3 of the Bayou Meto Basin and along riparian areas, especially the Arkansas River riverfront lands. Levees and roads have impacted prairie terrace habitats, high BLH, post oak flat, and intermediate BLH areas more than other habitats. Over 20 miles of levees were constructed along the Arkansas River as early as 1856. By the 1930s, the Arkansas River had a mainstem levee along the entire reach of its floodplain. This levee subsequently was raised to near its present height in the mid-1900s. Other man-made flood control levees exist along considerable lengths of Bayou Meto, Salt Bayou Ditch, and Little Bayou Meto.

In addition to small ditches present throughout the Bayou Meto Basin, many large drainage ditches also exist. Many of these large ditches were initially constructed in the 1930s and 1940s, but some new ditches have been constructed as recently as the 1990s. These ditches significantly divert water flows. Maintenance of large ditches occurs periodically and involves removing sediments from the bottom of ditches and placing dredged material on old spoil banks or in new areas.

Soil erosion rates in the basin are high, especially in dissected terrace areas and near riparian watersheds in the Arkansas River Lowland. Soil loss tolerance values (T-values) generally range from 1 to 5 tons per acre per year and about 1/3 of the cropland in the basin (especially on prairie terraces) is eroding above tolerable levels. This erosion has caused considerable siltation in many streams and depressions in the basin and sedimentation rates reach 2-3 cm per year in some areas of the Bayou Meto WMA. This sedimentation is exacerbated by active filling of some depressions (including certain abandoned channels) for road construction, agricultural purposes, and disposal of dredged material.

As previously noted, 7350 acres of water storage reservoirs and 22,942 acres of fish ponds are present in the Bayou Meto Basin. Many farm ponds and small lakes also exist. Each of these water impoundments has dams and levees that surround the area and capture and redirect surface water flows. Area currently in GTRs is unknown but may exceed 40,000 acres (Roger Milligan, Rob Holbrook, Martin Blaney, personal communication). About 17,000 acres of GTRs exist in Bayou Meto WMA alone. Each GTR has levees that impound water and some have extensive exterior and interior levees with accompanying water-control structures. Most GTRs are in the Bayou Meto floodplain and much of the 2 large remaining tracts of BLH in the basin are heavily impacted by GTRs. These GTRs have significantly modified local and regional hydrology and tree species composition and health (see Fredrickson and Batema 1992).

The amount of agricultural land that has been leveled in the Bayou Meto Basin also is unknown because leveling is not regulated nor are records kept of this activity. NRCS personnel grossly estimate that at least 50,000 (13-14%) acres of the 370,000 acres of irrigated cropland in the Bayou Meto Basin is now leveled; most laser-leveled at a tenth-fall grade (Tom Fortner, personal communication). Up to 5000 acres are zero-graded meaning that the leveled field has a constant elevation throughout the field. Most leveling has occurred in the Arkansas River Lowland in Perry/Portland soils. Only about 10% of irrigated cropland on the Prairie and Deweyville terraces has been laser-leveled. Perry/Portland soils are relatively deep heavy clay deposits and leveling these soils does not run the risk of exposing less fertile lower horizons of soil that may have high concentrations of minerals such as zinc, selenium, and manganese that can potentially be toxic to certain agricultural crops. In contrast, leveling thinner soils on older Pleistocene terraces occasionally exposes lower soil horizons and high mineral concentrations that impede crop growth.

Agricultural land continues to be leveled in the basin at about 3000-5000 acres per year. Modern laser technology and large equipment makes leveling relatively easy, quick, and inexpensive. Changes in farm policy have reduced idle land and periods when crops are not grown. Consequently most leveling occurs in winter and early spring prior to planting; this typically is a wet period of the year and limits times when leveling can be done. Despite these changes in farm policies, we believe leveling will continue in the basin until about 25-30% of the total irrigated acreage is leveled within the next 10 years.

Nearly 200,000 acres of the Bayou Meto Basin now are in urban, commercial (non-fish pond or agricultural related), and industrial uses. North Little Rock, Jacksonville, Lonoke, England, Carlisle, and Stuttgart are major cities in or near the basin and population projections estimate that populations in Lonoke, Pulaski, and Jefferson counties will increase by 25-45% in the next decade. Urban expansion is occurring in all major communities and causes further clearing of forest and non-agricultural land, paving and leveling lands, construction of urban infrastructure including ditches, storm drainages canals and channels, and roads.

FISH AND WILDLIFE POPULATIONS

The abundance and diversity of fish and wildlife populations in the Bayou Meto Basin prior to European settlement is unknown (AGFC 1998). Early explorers reported abundant wildlife throughout the region, but most accounts were of game animals such as turkey, quail, prairie chicken, and waterfowl or of large predators such as black bear, mountain lion, and red wolf (e.g., Gerstaecker 1856, Audubon 1894). Undoubtedly, both the prairie and BLH parts of the Bayou Meto Basin contained complete complements of species endemic to these habitats during the Presettlement period, but relative population sizes and species composition are uncertain. Basic surveys of wildlife populations in Arkansas were not initiated until the early 1950s (Holder 1951) and systematic sampling of species and populations over time and location has been restricted to a few species.

The diversity of fish species in the Bayou Meto Basin has changed over the past few decades. Early surveys of fish conducted by resource agencies in the 1960s found 79 species of fish in the Bayou Meto watershed, but only 64 species were present by 1992 (Ryckeley 2000). Loss of riparian habitat and BLH corridors near streams has increased turbidity and temperatures in existing streams and affected certain fish species such as top minnows, sunfish, bass, and crappie that generally need relatively clear, cool water. In-stream flows are greatly reduced in many streams especially during summer because of extractions of irrigation water. Channelization and pollution also have degraded productivity of these habitats. Intermittent flows have eliminated riffle habitats and left only stagnant pools that concentrate prey and reduce species that need flowing water for protection and cover. Predominant fish species now found in small streams and bayous in the basin include mosquito fish, carp, buffalo, gar, bowfin, and some white crappie and largemouth bass (Table 8). Gizzard shad and shiners are common forage fish for larger predators. Fisheries in the Arkansas River seem less degraded than small streams, but populations are variable depending on location and in relation to locks and dams. Principal species include largemouth bass, crappie, bluegill, several species of catfish, striped bass, paddlefish, carp, and gar.

Little is known about population trends for other aquatic animal species such as amphibians, reptiles, mussels, and invertebrates in the Bayou Meto Basin. Some sampling of mussels recently has been conducted and no mussels remained in Crooked Creek, Bayou Two Prairie, or Wabbaseka Bayou, and limited numbers were present in Salt Bayou and Indian Bayou (Miller and Payne 2002). The exotic zebra mussel is very abundant in the Arkansas River and probably already is present in some streams in the basin (Gregg 1993).

Many species of birds and mammals now are extirpated from the Bayou Meto Basin. Early accounts of naturalists and explorers in the region suggest abundant populations of bison, mountain lion, prairie chicken, red wolf, Carolina parakeet, and passenger pigeon — all of which now are absent in the basin (AGFC 1998). Only a few black bears now are present in the southern end of the basin where large blocks of BLH habitat remain, but apparently they were quite abundant throughout the Basin in the late-1800s. Other early accounts (Gerstaecker 1856, (AGFC 1998) speak of large numbers of furbearers trapped and sold (mainly at Arkansas Post) for fur trade in the region, but little is known about changes since that time. Likely, numbers of larger furbearers such as otter, beaver, and bobcats have declined significantly since that time (Sealander and Heidt 1990). New mammal species that have moved into the Bayou Meto Basin since Presettlement times include the armadillo, ringtail, and nutria (Sealander and Heidt 1990).

Wildlife population trends in the Prairie and Deweyville terraces probably are similar to that of the entire Grand Prairie region (Heitmeyer et al. 2000). Because only a few small remnant areas of prairie grassland and seasonal herbaceous wetland remain, animals associated with these habitats are either absent or greatly reduced. Only small areas of slash and savanna remain on prairie terraces, and populations of species that use these habitats also are greatly reduced. Although all types of BLH still are present in the basin, the higher elevation and less flood-prone areas are over 90% destroyed and populations of bird and mammals that are highly associated with these types of BLH are reduced. Examples of species in decline are black vulture and Swainson's warbler which nested in cane interspersed in higher elevations and on natural levees. Also, many forest birds, especially those requiring large blocks of BLH habitat such as cerulean warbler and Mississippi kites have reduced populations (Mueller et al. 1999).

Waterbird numbers in the Bayou Meto Basin likely are significantly reduced from historic levels because of large losses of wetland, stream, and riparian habitats (Fredrickson and Heitmeyer 1988, Heitmeyer 2001). Species of special concern include yellow-crowned night heron, interior least tern, and American bald eagle. While numbers of waterfowl and some marsh birds such as king rail, American bittern, and short-billed marsh wren may have increased in the Grand Prairie when rice production increased greatly in the early 1900s their population numbers have since declined (Heitmeyer et al. 2000:53-56). Midwinter inventories of ducks in the basin have decreased from over 100,000 through much of the 1960s and 1970s to less than 50,000 in the 1990s (AGFC, unpublished records). Peak numbers of ducks in the Bayou Meto Basin in 1999-2000 were 34,427 counted in November 1999 (midwinter January numbers were only 14,735 ducks).

Our assessment of options for restoring habitat components of the Bayou Meto Basin is based on the fundamental process of understanding historical characteristics of the Presettlement ecosystem, ecological processes that control and maintain system elements, and contemporary changes to historic landscapes. This information can then be used to make decisions about where, or if, habitat restorations are possible and can be sustained.

ECOSYSTEM RESTORATION OPTIONS

SUMMARY OF ECOSYSTEM DEGRADATIONS

Native vegetation communities, regional hydrology, and local topography in the Bayou Meto Basin have been altered greatly since the Presettlement period. These changes create many challenges to restoring parts of the historic Bayou Meto ecosystem and constrain certain locations to the point where it is probably impossible to restore habitats. These degradations can be summarized as:

1. About 85% of native habitats have been lost to agriculture and urban developments.

2. Over 90% of prairie grassland, seasonal herbaceous wetland, slash, savanna, post oak flat, and high BLH have been destroyed.

3. Riparian corridors are narrow through much of the basin with the exception of large patches of BLH along the lower portion of Bayou Meto and along Bayou Two Prairie. Corridors are completely denuded along sections of Bakers, Indian, and Wabbaseka bayous and other small streams and abandoned courses.

4. The Mississippi Alluvial Aquifer that underlies the basin has declined by up to 50% in thickness and average declines in water tables are 1-2' per year at present pumping rates.

5. Stream flows (excepting the Arkansas River) are greatly reduced from historic levels and several streams are reduced to intermittent flows during summer because of reduced flows upstream, weirs in streams (especially in Bayou Meto and Crooked Creek), and pumping irrigation water from streams.

6. Hundreds of miles of ditches are present in the basin and major diversions of water occur via major ditches on Indian, Salt, and Wabbaseka bayous.

7. Historic labyrinths of bayous and streams now are disconnected because of ditching and filling of cross-bayous.

8. Over 35,000 acres of above-ground storage reservoirs, fish ponds, and small lakes have been constructed.

9. Flood frequency is altered throughout the basin. In the northern 2/3, flood frequency and duration is reduced because of improved drainage. In the lower 1/3, surface water is present for extended periods, often into the growing season, and drainage is poor and prolonged because of levee and water-control structure closures to Bayou Meto and Little Bayou Meto outlets to the Arkansas River.

10. Four locks and dams have been constructed on the Arkansas River from mile 86 to mile 125 along the southern edge of the basin.

11. Flood flows on the Arkansas River at the Pine Bluff gage station (an indicator of flooding in the Bayou Meto Basin) are reduced by up to 50% from pre-lock and dam periods.

12. Water quality is degraded in most streams and bayous from increased sedimentation and erosion, heavy metals, and pesticide contamination.

13. Thousands of miles of roads, levees, railroad beds, and small agricultural ditches have been constructed in the basin.

14.Sedimentation and active filling of depressions have occurred in agricultural fields (formerly in BLH) and in certain abandoned channels and courses.

15. Perhaps as much as 40,000 acres of BLH have been partly impounded in GTRs. Changes in tree species composition in GTRs are shifting BLH communities toward low BLH, cypress/tupelo, and even dead timber habitats.

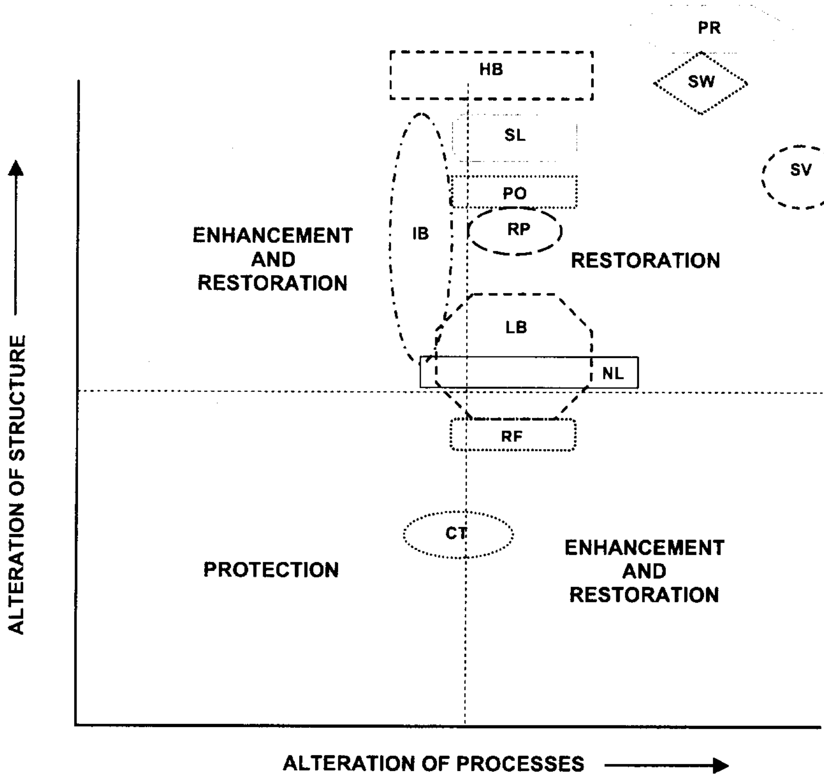


Figure 16. Model of the conservation actions most appropriate on sites of varying amounts of alteration of Presettlement structure and ecological processes in the Bayou Meto Basin, Arkansas. PR (prairie grasslands), SL (slash), SV (savanna), SW (seasonal herbaceous wetland), CT (cypress/tupelo), LB (low bottomland hardwood), IB (intermediate bottomland hardwood), HB (high bottomland hardwood), PO (post oak flats), RP (riparian), NL (natural levee), RF (riverfront habitat).

16. An estimated 50,000 acres of agricultural land has been laser-leveled.

17. Nearly 200,000 acres of the Bayou Meto Basin has been converted to urban, commercial (excluding fish ponds and aquaculture operations), and industrial uses. Human populations are expected to increase 25-45% in the next decade.

18. Fish species diversity, and probably population levels, have been reduced in many streams.

19. Mussel populations are reduced throughout the basin including the apparent absence of mussels in Crooked Creek, Bayou Two Prairie, and Wabbaseka Bayou. Exotic zebra mussels now are present in large numbers in the Arkansas River and may occur in some tributaries.

20. Populations of many wildlife species are decreased, including extirpation of bison, mountain lion, red wolf, and prairie chicken and extinction of Carolina parakeet and passenger pigeon.

21. Midwinter duck numbers have declined by ca. 50% from the 1960s and 1970s to the present.

GUIDING PRINCIPLES

Despite significant alterations to Bayou Meto Basin ecosystems, many opportunities exist to restore functional areas of all habitat types. The success of restoring habitats will depend on matching potential restoration sites with the defining ecological characteristics of each habitat type. Previously, we developed a set of principles for guiding ecosystem restoration activities in the Grand Prairie region of Arkansas (Heitmeyer et al. 2000). These principles also are applicable to the Bayou Meto Basin.

What is the appropriate conservation objective.—The degree and type of alteration to the structure and ecological processes of habitats determines what type of conservation action is appropriate for a given site. If structure and processes are not badly degraded, then protection of the site is needed. In contrast, if aspects of either structure or processes are significantly degraded then a combination of enhancement and restoration of the degraded feature(s) are needed to restore the integrity and functions of the habitat and site. For many sites, degradations are so significant that both structure and process must be restored, if this is possible at all (Fig. 16).

The amount of degradation is not equal among the habitats in the Bayou Meto Basin (Table 11) and examples of all appropriate conservation strategies exist (Fig. 16). In general, lower elevation habitat types, such as cypress/tupelo and low and intermediate BLH have the least degraded ecological processes and structure. Protection of relatively unaltered habitats is needed, especially along the lower ½ of the Bayou Meto floodplain and along Little Bayo Meto. A few locations also have relatively intact riparian, natural levee, and riverfront habitats. Few, if any, remnant sites of other habitat types remain functional.

Table 11. Major structural elements and primary ecological processes that sustain habitats in the Bayou Meto Basin, Arkansas, and changes from Presettlement time to the present.

Habitat type	Structural elements	Change from Presettlement	Primary process	Change from Presettlement
Prairie grassland	- Grass/forb dominated vegetation - Large contiguous patches - Terrace elevation position - 18 – 24" fragipan soils - Gently undulating topography	- >95% cleared - Small remnant patches - Land leveling of some sites	- Fire - Herbivory - Droughty non-flood environment (To deter invasion of woody vegetation and rapidly process nutrients and biomass)	- Fire largely absent - Reduced large herbivores - Altered small mammal community
Seasonal herbaceous wetland	- Small depressions and isolated watersheds in prairies - Annual/perennial herbaceous vegetation	- Depressions drained and leveled - Watersheds eliminated and reduced - >85% converted to agriculture	- Seasonal flooding 1-2 months annually - Sheetflow of surface water into basins - Occasional fire and extended droughts (To deter invasion of woody vegetation and germinate moist-soil plants)	- Remaining depressions <1 month flooding - Sheetflow absent - No fire
Slash	- Small streams incised into prairie terraces - Pioneer tree and shrub vegetation, with multiple vertical layers	- >95% cleared - Streams ditched	- Local surface water runoff and intermittent seasonal flow in streams - Active headcutting of streams - Occasional fire (To sustain active headcutting and increase drainage into prairie terrace)	- Reduced flows, absence of surface sheetflow - Reduced headcutting - Fire rarely occurs
Cypress/tupelo	- Water tolerant Cypress/tupelo trees, usual shrub/scrub vegetation on edges - Low depressions, abandoned channels and courses - Water retentive clay-type soils	- >35% cleared or converted to open water - Siltation of depressions, some filling of channels	- Extended flooding usually 3-6 months annually, soil saturation year round - Occasional drought (To sustain trees and shrubs and occasionally allow germination)	- Flood extent and frequency reduced in upper 2/3 but increased in lower 1/3 of basin
Low bottomland hardwood forest (BLH)	- Relatively water tolerant trees dominated by overcup oak - Sparse understory - Backswamp soils and position - Water retentive soils	- >70% cleared and converted to agriculture - Little change, but extended flood zone into higher elevations and lower 1/3 of basin	- Annual backwater flooding 1-3 months on average mostly in dormant season - Complete drying and low soil saturation for at least some months annually - Wind throw of large trees (To sustain trees and allow germination/regeneration)	- Reduced flooding in upper 2/3, increased flooding in lower 1/3 of basin
Intermediate BLH	- Semi-water tolerant trees dominated by nuttall and willow oak - Gently undulating topography	- >85% cleared and converted to agriculture	- Annual backwater and headwater flooding up to 1-2 months on average, soil saturation 2-3 months usually in dormant season - Occasional drought - Absence of flooding in some years - Wind throws of trees (To sustain trees and allow germination/regeneration)	- Reduced flooding away from streams and in upper 2/3, increased flooding in lower 1/3 of basin - No change except in lower 1/3 of basin

(Table 11 Cont'd)

Habitat type	Structural elements	Change from Presettlement	Primary process	Change from Presettlement
High BLH	- Marginally water tolerant trees dominated by water willow and cherrybark oak, hickory, and sweetgum - Dense understory vegetation - High point bars, ridges and edges of floodplains	- >95% clearing and conversion to agriculture - Land leveling on many farmed high BLH sites with many ditches and roads present	- Headwater, on-site and rarely backwater flooding a few weeks in some years during dormant season - Extended drought and low soil moisture - Occasional fire - Wind throw of trees (To sustain trees and allow germination/regeneration)	- Reduced flooding throughout the basin - Fire rare
Post oak flat	- Water intolerant trees - Sparse understory - Higher ridges and edges of floodplain and terrace - Well drained soils	- >80% cleared - Small remnant patches - Land leveling on some sites, many roads	- Soil saturation up to 1 month annually, flooding restricted to extreme high flood events - Occasional fire - Herbivory on forbs and saplings (To sustain trees and allow more open stands of trees)	- Fire rare - Reduced large herbivores
Natural levee	- Alluvial deposits in berms (up to 5' higher) adjacent to streams and abandoned courses - Marginally water tolerant pioneer and Intermediate BLH tree species - Interspersed cane brakes	- Over 80% of berms denuded and reduced in height; roads on many sites - Few cane brakes present	- Occasional flooding over berms for short durations - Deposition and additions of sediments on berms (To sustain deposition activity and sustain trees)	- Reduced flows and overbank flooding of small streams - Reduced deposition on berms - Some land leveling
Riverfront	- Sandy point bar deposits in active meander belt of Arkansas River - Significant variation in local topography - Pioneer-type trees	- Many high sites away from channel cleared, farmed, and semi-leveled - >80% cleared remnants isolated and near channel	- Regular high flows and flood events on Arkansas River meander belt - Active deposition of sand and scouring of channels/sloughs	- Reduced flows and flooding of Arkansas River - Reduced sediment deposition and scouring

Many sites with cypress/tupelo; low, intermediate, and high BLH; riparian forest; natural levee; and riverfront habitats need enhancement of their ecological processes and certain structural elements. The primary process that has become degraded for these habitats is the hydrological regime. Ironically, past clearing, drainage, and agricultural activities in the basin have reduced depth, duration and extent of flooding throughout much of the upper 2/3 of the basin while increasing the same features in the lower 1/3 of the basin. In the upper basin overland sheetflow of water is disrupted and in-stream flows are significantly reduced. Here, flooding now occurs primarily during large local rain events that causes mainly flashy, often deep high velocity but short duration, headwater flooding of streams; backwater flooding of abandoned courses is less common. Most abandoned channels are disconnected hydraulically from the Arkansas River and tributaries except in high flood events. This disconnection among streams and bayous is most significant in the middle portion of the basin which formerly had a labyrinth of cross bayous and interconnected sloughs and drainages.

In the lower 1/3 of the basin, drainage water and flows of streams are increased and impounded for longer periods than during the Presettlement period because of accelerated flows into the area from ditched upper portions of the basin and by levees and water control structures at the juncture of Bayou Meto and Little Bayou Meto with the Arkansas River. Flooding of this area now is longer and deeper than in the past and has greatly impacted health and species composition of BLH. Natural levee and riverfront habitats generally have reduced flows and flooding throughout the basin. Furthermore, ecological processes of sediment deposition and movement are diminished.

A few remnant slash and post oak flat habitats remain in the Bayou Meto Basin and these sites retain at least some residual structural features including presence of overstory trees and shrubs. In contrast, very little prairie grassland, seasonal herbaceous wetland, and savanna remains and the few sites that exist are badly damaged, perhaps to the point of imminent collapse. Active restoration is needed for all of these habitat types.

Structure and function.—Planners for ecosystem restoration must understand the degree of degradations to structure and ecological process of various habitat types and landscape complexes and seek to restore both the structure and function of the habitat and site (e.g., King and Keeland 1999, King 2000, Heitmeyer et al. 2000). Functions (see Table 1) of specific habitats and regional ecosystems are created and maintained by both the structure and ecological processes of the site. Restoring only structure or process without the other will not replicate natural ecosystem functions and values and will require greater management intensity to maintain the site. Furthermore, restoration of structure (e.g., replanting BLH trees) without restoring processes (e.g., seasonal overbank flooding regimes) will create only a temporary shift of plant communities and likely will fail to attract and sustain endemic animal populations or restore community functions.

We recognize that it is not possible to completely restore all structure and processes to every restoration site. Any return to historic structure or process typically is better than the currently degraded site and usually is more valuable. Many ecosystem functions transcend temporal, geographical, and taxonomic scales. We believe a multi-scaled evaluation of sites is needed to maximize ecosystem benefits and minimize restoration costs. This evaluation should include not only economic and ecological benefits and costs of restoring particular sites, but also potential broad-scale ecosystem benefits such as increased connectivity and improved hydrological function. An honest assessment of restoration options and potentials at a specific site is critical to determine if partly restoring values is sufficient to meet various land use objectives, resource needs, or if other sites are better candidates for restoration projects given limited resources.

Like-for-like.—True restoration of ecosystems involves reestablishing vegetation communities and processes that previously were present on a site. We used the mid-1800s as the baseline for determining types, distribution, and abundance of habitat types historically present in the Bayou Meto Basin and as a model for restoration. Modeling historic distribution of habitats in the basin in relation to soils, geomorphology, topography, and flood frequency (Appendix A) provides the base first-level criteria for deciding what habitat type(s) should be restored at specific locations. If at all possible, this type of like-for-like restoration should be pursued in the Bayou Meto Basin.

It may be possible to create a slightly different habitat type at a location than what was historically present. This creation does not emulate historic landscape mosaics, however, and created sites likely will require more intensive and costly manipulations and management to maintain functional habitats. Creation of habitats is more likely to succeed if the new type is relatively similar to historic conditions. For example, it may be possible to plant high BLH on former intermediate BLH sites, but subtle differences in soils and hydrology ultimately may compromise the site. The distribution of BLH habitat types is highly heterogeneous in the Bayou Meto Basin. Slight elevation differences can cause site-specific conditions to be different and support different tree species even within small areas. Inclusions of either wetter or drier type trees often occur within larger areas of a habitat type. For example, low depressions and swales are common in intermediate BLH areas and these low areas often have overcup oak and sometimes baldcypress present. Likewise, mounds and ridges in low and intermediate BLH areas usually support less water-tolerant species such as water oak, cherrybark oak, hickory, and sweetgum.

The geological and hydrological history of the Bayou Meto Basin have been highly dynamic, especially in the recent Holocene Arkansas River Lowland. Changes in the meander belts of the Arkansas River over the past 14,000 years have been common, and frequent flood events have regularly changed topography due to deposition and scouring. These changes have created a highly interspersed landscape mosaic in the basin and also subjected it to periodic (sometimes regular such as for Riverfront habitats) changes in distribution and amounts of habitats. The hydrology of the Arkansas River has been highly altered, however, and flood events have been reduced and will be less likely to change topography of the Bayou Meto Basin in the future unless they are near record levels. Nonetheless, some depositions and scouring may occur at some future time and change site conditions suitable for certain habitats. Furthermore, some anthropogenic changes (such as locks and dams on the Arkansas River, impoundments, etc.) alter characteristics of a site to the degree that former processes cannot be restored. Where irreversible changes in hydrology occurs, restoration projects should encourage habitat types that will be suited to current and foreseeable future conditions at the site.

The edges of habitat areas often were in dynamic flux as climate and disturbance changed over time and space. This was especially true in upland terrace locations where the balance between prairie grassland and surrounding savanna, slash, and forest was controlled by periodicity of fire, herbivory, and incision of streams into the terrace tops. At these terrace edges, it often is possible to restore more than 1 habitat type (e.g., either grassland or savanna) depending on the type and intensity of manipulations (e.g. fire return intervals) intended for the site. Sites that represent this potential in the Bayou Meto Basin are the edges of former prairie grassland.

Landscape ecology.—The objectives of different interest groups will dictate: 1) priority habitats for restoration, 2) size and configuration of the area to be restored, 3) location of the restoration site, and 4) ownership and management of the site. Coordination of restoration projects conducted by various interests can maximize benefits and ecological functions for the entire area. With that in mind, certain basic principles about landscape configuration should be considered when restoring habitats.

First, habitats within the Bayou Meto Basin were highly interspersed, heterogenous, and different among the 3 major geomorphological regions. The mosaic of habitat types in each region represented diverse topography and dynamic hydrological regimes and is a goal for future interspersion of restored habitats (see Appendix A). Historic habitat types varied in patch size, connectivity, and location. Seasonal herbaceous wetlands, savanna, post oak flat, slash, and cypress/tupelo habitats generally occurred in small disjunct patches. Consequently, restoration of these habitats can be more opportunistic, smaller, and less connected. In contrast, prairie grassland and BLH habitats occurred in larger patches that were highly connected. In particular, BLH habitats occupied entire floodplains of Bayou Meto streams and backswamp deposits. Riparian, natural levee, and riverfront habitats historically were not large or wide (except for some riverfront areas along the current Arkansas River) but were connected in long corridors along streams. Today, prairie, BLH, and riparian habitat patches are highly fragmented, with the exception of 2 large BLH areas along Bayou Meto.

Given the basic ecological processes that operated in the Bayou Meto ecosystem, we generally accept the notion that overall ecological integrity of the basin will be improved if: 1) patch sizes of all habitats can be enlarged, 2) remnant patches of BLH, prairie, and riparian habitats can be connected, 3) hydrological regimes and interconnections of bayous and streams can be restored, 4) complexes of habitats can be restored in historic contexts. We also acknowledge that some restoration efforts may target specific species of concern and will attempt to meet species-specific needs for habitat types, resources, and area. As an example, the Partners-in-Flight conservation plan for forest habitats in the MAV seeks contiguous blocks of BLH of at least 100,000 acres to support breeding swallow-tailed kites (also the estimated size to support viable populations of black bears), 20,000 acres to support cerulean warblers, and at least 10,000 acres to support Swainson's warblers and all other less area-dependent Neotropical bird species (Mueller et al. 1999). It generally is assumed that if the needs of the more area-dependent species are met, then needs of less area-dependent species also will be met. Exceptions exist from this assumption, but if it is mostly true then it further emphasizes the thought of maximizing patch size for at least BLH habitats.

Practicality.—Evaluation of restoration opportunities in the Bayou Meto Basin must understand the relative "costs" and constraints of restoring a site by assessing the degree of ecosystem degradations. In some locations, the degraded feature for a habitat may be a reversible local disruption such as clearing a patch of BLH that still retains seasonal flooding. In these sites, restoring the degraded feature may be relatively easy, such as replanting BLH trees. Other restoration actions also can immediately restore some functions such as removing a weir in a stream to restore hydrology of a riparian corridor. In contrast, many locations in the Bayou Meto Basin are highly altered and restoration simply is not feasible. In these areas, the degraded feature usually is an ecological process operating at a large geographic scale such as altered flows of the Arkansas River following construction of locks and dams. Other examples of non-restorable areas include: 1) sites in most urban settings; 2) irrigation reservoirs and fish ponds; 3) highly ditched and drained high elevation prairie terraces, bottomland flats, and some lower floodplain edges; 4) some laser-leveled fields, especially those surrounded by roads and ditches. Political and societal factors also will limit restoration efforts in some locations, and economic costs of restoring basic ecological processes, such as returning flows on the Arkansas River to historic levels simply are not feasible. Habitats that have the greatest extent of non-restorable former locations include prairie grassland, savanna, seasonal herbaceous wetland, post oak flat, natural levee, and high BLH.

Management intensity.—Because many areas of the Bayou Meto Basin are badly degraded, most restored habitats will require at least modest amounts of future management to sustain the restored habitat. The level of management intensity required to sustain restored sites is directly proportional to the degree of alteration, especially to the ecological processes (Fig. 16). Generally, management intensity also is inversely related to patch size and complexity. This is especially true for very small patches of habitat located within a matrix of surrounding agricultural lands, e.g., prairie patches within large expanses of rice fields. Furthermore, those habitats that required frequent disturbances from fire or herbivory (prairie grassland, slash, savanna, post oak flat), overbank flooding (natural levee, riverfront, some BLH sites), drought (seasonal herbaceous wetland, higher BLH types), and riverine sediment deposition and scouring (natural levee, riverfront) will require the most intensive and extensive manipulations if they are possible at all. Costs and frequency of management must be considered when restoring a location and some provision for long-term management must be secured.

Limits and threats.—Understanding impending threats to specific habitats and locations is important to establish priorities for restoration actions and to evaluate future impacts on restored sites (Heitmeyer et al. 2000:59-60). It also is important to understand the key resources of each habitat (such as foods, nest sites, etc.) and how reductions in these resources may "limit" populations of certain species. Often the factors that limit restoration opportunities also control functions of the site (e.g., overbank dormant season flooding and large patch sizes of BLH) and limit presence of animal species (e.g., wintering mallards, breeding warblers). In these cases, restoration of key processes will help alleviate gaps and limitations for multiple species and objectives. Generally, we accept the notion that priority should be given to restoration sites that:

- work in areas with the most important regional ecological values and processes; e.g., periodically flooded floodplains
- work in areas that had complexes of habitats and high diversity of species of concern
- work in areas that have been the most severely destroyed and degraded, especially those that require larger patch sizes and total amounts of habitat area to support system elements; e.g., prairie grassland, higher elevation BLH types.
- do not harm threatened or endangered species

In other situations, knowing imminent threats to not only existing remnant habitats, but also to potential restoration sites, may help prioritize sites, especially if many competing opportunities exist. Generally, those sites that might be further degraded or destroyed beyond repair unless a restoration action occurs have a higher short-term priority for restoration. In contrast, if a major landscape change seems inevitable (e.g., urban development, further water diversion) then targeting a site for restoration that has an impending change to surrounding lands will only create difficulty in maintaining the restored site in the future with increased costs and relatively artificial management needed. In all cases, limited resources require that restoration actions seek to provide maximum benefits and values for the long term.

RESTORATION DECISIONS

This document does not attempt to prioritize habitat restoration opportunities or identify specific sites that can (should) be restored. As previously stated, these decisions depend on the objectives of the interested party. We do, however, identify landscape and ecological characteristics that are needed at a site to successfully restore specific habitats. This process is useful in several contexts especially if: 1) sites are sought to restore a specific habitat type such as for mitigation or 2) a site is available or offered for restoration and the type of habitat(s) best suited for that site is uncertain. Below, we identify characteristics of sites that are needed to successfully restore the 12 native habitat types in the Bayou Meto Basin and also characteristics needed in restoring water flow and channels of abandoned courses and channels. In our judgement, the key to restoring the overall ecological integrity, diversity, functions, values, and communities throughout Bayou Meto Basin is in recreating a mosaic of all habitats in natural distribution patterns and in restoring some semblance of natural hydrology and water flows. The latter will require modifications to existing drainage and stream systems.

Prairie grassland.—Restoration of prairie grassland in the Bayou Meto Basin should target those areas of the Prairie and Deweyville terraces that formerly supported prairie grassland. The best sites for prairie restoration are at high elevations along the tops of terraces with <1% slopes. Principles for restoring prairie are similar to those previously outlined for the Grand Prairie (Heitmeyer et al. 2000). The best restoration sites are those that:

- are on Stuttgart and DeWitt (formerly Crowley) soils above 200'
- are at least 100 acres and preferably at least 1/4 mile wide (Helzer and Jelinski 1999)
- restore multiple prairie patches within 2-3 miles of each other
- are not on laser-leveled fields
- can be actively managed with fire, plantings, and grazing
- are not heavily ditched or, if so, are in areas where ditches can be filled or moved to the edges of the restored patch
- are not immediately adjacent to a forest edge unless management can control woody invasion

The area best suited for prairie restoration is >99% converted to agricultural production, especially rice. Consequently, opportunities for obtaining large or multiple blocks of land for restoration will be difficult. Nonetheless, we believe at least some prairie restoration is important to restore native plant and animal communities to the overall ecosystem. If restorations in the basin are coordinated with those desired for the entire Grand Prairie region, then regional values can be enhanced and incremental ecological gains achieved beyond the individual patch.

Seasonal herbaceous wetland/wet prairie.—While never very abundant in the Bayou Meto Basin, seasonal herbaceous wetlands were an integral part of the prairie terrace ecosystem and contributed important diversity and overall values. If possible, restoration of shallow depressions should be integrated in prairie grassland restorations. We encourage restoration of seasonal herbaceous wetland in:

- remnant depressions in prairie terraces
- relatively intact small watersheds where sheetflow of surface water occurs (these are areas that have limited ditches, roads, levees, and other diversions of surface water)
- fields that have not been laser-leveled
- sites that are distant from forest patches (to deter woody invasion)
- former meander scars of historic Arkansas River channels in the prairie terrace region
- Tichnor, Ethel, and Calhoun soils
- locations where several small basins can be restored within a 2-3 mile radius area

Seasonal herbaceous wetlands were interspersed throughout prairie grasslands and restoring many small wetlands in existing or restored prairie is preferable to restoring only a few large, isolated sites. The larger the basin, the more likely woody vegetation will invade the site and out compete emergent plants. Also, animal species that depend on these wetlands, benefit from multiple basins that have diverse settings and adjacent grasslands for part of their life-cycles (e.g., breeding frogs). This diversity and complex of basins buffers disturbances and hydrological dynamics in basins and increases viability of animal populations.

Where topography has been altered or depressions do not exist in a potential restoration site, it may be possible to restore, or create, shallow basins by carefully excavating areas and creating depressions and adjacent mounds. The soils of such areas must be carefully analyzed prior to excavation to avoid cuts that run into non-hydric soils or soil types that will not hold water. Generally, former wetland depressions have slightly different soils than surrounding grassland and represent inclusions of Calhoun and sometimes Tichnor soils in broader areas of Stuttgart and DeWitt soils. This is especially true where former channels of the Arkansas River cut through the terraces.

Slash.—Sites that are most suitable for restoring slash habitats are the upper ends of small streams incised into prairie terraces. These small streams should have at least some intermittent flows. Slash habitats support pioneer plant species and the location of a slash historically moved as drainages further incised the terrace. We specifically encourage restoration of slash in:

- upper ends of small drainages that extend into the former prairie terrace (see above discussion of where the terraces were)
- Tichnor and Calhoun soils with at least 2% slopes

- non-leveled lands bordering drainages, including man-made drainages
- at least partly intact local watersheds and overland sheetflow of surface water

Restoration of slash will be most successful if it can be conducted in connection with restoration of prairie grasslands. If possible, small complexes of habitats that have prairie on top of a terrace coupled with some interspersed depressional wetlands and slash entering into the site would be most desirable. In other areas, slash probably can be restored in isolation of other habitats, but these restored patches will be continually subject to pressures and disturbances from surrounding lands. Furthermore, isolated slash may not support endemic species, especially certain breeding birds, amphibians, and reptiles.

Savanna.—Savannas historically were restricted to the edges of prairie terraces and along higher ridges in the Bayou Meto Basin. A combination of fire, herbivory, soil type and drainage, and temporal changes in climate created savanna. Savanna patches probably were not large and their total area in the Bayou Meto Basin was relatively small compared to the more extensive Grand Prairie region.

Restoration of savanna will be complex because of the tremendous loss of prairie grassland in the region and because the controlling processes of fire and herbivory have been greatly reduced. Sites best suited for savanna restoration include:

- the ecotone of former prairie grassland
- pasture and haylands on the edges of the former Prairie terrace
- Loring, Immanuel (formerly Grenada), and Stuttgart soils with 1-3% slopes
- edges of towns, farmsteads, cemeteries, and rural churches
- sites that can be regularly disturbed with fire, grazing, and mowing

The few remnant patches of savanna (or sites that have at least some savanna-like characteristics) are mostly near active or abandoned farmsteads, in the edges of towns, and adjacent to or in cemetery and church lots. Most of these areas are relatively small, but could be expanded especially where pasture or idle land surrounds the remnant patch. Communities and churches help maintain the grass/tree mix by regular mowing, while pasture and hay lands maintain grasses from a combination of grazing and mowing. Any restored savanna will require regular and intensive disturbance to maintain the mixed grass/tree composition.

Cypress/tupelo.—Cypress/tupelo habitat historically occurred in many low elevation areas in the Bayou Meto Basin. These sites included sites that were both connected and non-connected to streams during 5-year flood events and also on fringes of abandoned channels and courses. In low areas that have been drained and/or cleared, restoration of cypress/tupelo habitats is appropriate and probably can be accomplished fairly easily. We specifically think restoration is possible:

- wherever fringes of abandoned channels (oxbows, cutoffs, chutes) and abandoned courses (major bayous and streams in the basin) have been cleared or drained
- in low sumps, depressions, and water-logged regions some of which may be created by man
- within the 1-year floodplain where surface water stands 3-9 months of the year on average, especially in backswamp deposits, and has the capability of being periodically drained
- on Yorktown and Perry soils

Restoration of cypress/tupelo will require reestablishment of dominant trees and restoring semi-permanent water regimes to a site. In some locations simply planting seedlings may be sufficient to reestablish trees. In sites that have been partly drained, regular flooding that persists at least 3 months of the year must be restored. Conversely, some former cypress/tupelo sites have been converted to open water habitats because water is present year round and soils are never dry. In these wet areas periodic drawdowns that expose soils and allow germination of baldcypress and water tupelo seedlings will be needed to maintain existing, and regenerate new, cypress/tupelo habitats.

Low bottomland hardwood forest.—Although low BLH comprises the largest remaining area of native habitats in the Bayou Meto Basin, over 70% of this habitat type has been destroyed. Over 120,000 acres of former low BLH lands have been cleared for agriculture in the 2-year floodplain of the Bayou Meto Basin. This area typically is highly flood prone and offers excellent opportunity for reforestation. Low BLH occupies over ½ of the 2 largest remaining blocks of BLH in the basin. Restoring low and intermediate BLH between these patches would reestablish the BLH corridor along Bayou Meto and also connect many other small fragmented patches. Reforestation of cleared lands in the 2-year floodplains of regional streams would reestablish important corridors throughout the basin and replicate mosaics of interspersed BLH habitats. Because low BLH is still present in relatively large amounts and is not as important for certain key animal species such as waterfowl and warblers, this habitat may not be the highest priority for restoration in the basin. However, opportunities for restoration of low BLH probably are greater and restoration is more likely to be successful than for most other habitats. We believe excellent restoration opportunities exist in sites:

- that have been cleared in the 2-year flood frequency zone
- that are inundated for an average of 1-3 months annually
- in flood prone agricultural land in and along all major streams
- wherever it is possible to connect fragmented patches, enlarge existing patches, and reconnect denuded floodplain corridors
- with backswamp deposits with Perry, Portland, Sharkey, Desha, Moreland, and Bowdre soils

In many areas, restoration of low BLH habitats will require only reforestation of appropriate tree species. These sites include most low elevation flood-prone agricultural lands. At both very low and very high elevation edges of the 2-year floodplain, some restoration of hydrology may be needed (in addition to reforestation) so that water is drained from the site for at least 9 months of the year including all of the growing season. These sites also need to be flooded on average 1-3 months with extended soil saturation for up to 5 months on average. Stagnant and repeated-year flooding should be avoided and periodic changes in depth, duration, and timing of annual flooding should occur. Occasional dry periods, even for an entire year, are recommended in low BLH sites to emulate natural droughts.

If possible, restoration of hydrology in BLH habitats should be made with the least amount of structural modifications. Limited structural modifications might include reconnecting bayous, sloughs, and other small drainage systems; filling of ditches and canals: removing levees and roads in low areas; and restoring drains to major outlets in the lower part of the basin. Wherever additional levees, ditches, and water control structures are needed they must be designed carefully so that they do not further fragment forest patches and further disrupt sheet and flood flows in the basin. Additional levees and water control structures have the potential to create pockets of standing water for extended periods that cannot be drained easily, thus further degrading BLH composition and functions. We are especially concerned that new ditches, roads, and levees may further fragment existing patches of BLH and create entry corridors for exotic species, predators, and cowbirds that can impact local populations of plants and animals.

Intermediate bottomland hardwood forest.—Intermediate BLH historically occupied large areas of the Bayou Meto Basin and represented the transition area from low wet areas to higher dry sites. This habitat provided a buffer to, and corridors connecting, adjacent habitat types and was critical to sustaining the high diversity of animal species in the region. Over 85% of this habitat type has been destroyed and some remaining sites are in jeopardy of being converted to low BLH, cypress/tupelo, or even dead timber because they are flooded for extended periods caused by poor drainage and excessive drain water inputs. Many areas of the basin offer excellent opportunities for restoring intermediate BLH habitats:

- between the 2- and 5-year flood frequency zones
- in cleared areas that can enlarge or reconnect existing BLH patches
- in backswamp with local natural levee veneers and swales in isolated point bar deposits
- that have Perry, Portland, Sharkey, Desha soils
- in non laser-leveled fields

Ideally, restoration of intermediate BLH should be done in concert with restoration of complexes of all BLH types. The best restoration sites may be cleared lands adjacent to existing low BLH along stream corridors. In some locations, restoration of intermediate BLH will only require reforesting a site, but some sites may require changes in hydrology, especially to drain areas that now are flooded for extended periods because roads, levees, or water-control structures restrict surface water drainage. As with restoration of hydrology in low BLH sites, structural modifications should be carefully designed so that further degradations to water supply and drainage do not occur.

High bottomland hardwood forest.—Most (>95%) high BLH has been destroyed in the Bayou Meto Basin. High BLH was among the first native habitats in the basin to be cleared and converted to agriculture in the early- to mid-1900s. This early conversion degraded former high BLH sites with extensive networks of roads, levees, railroad beds, ditches, and land leveling. Restoration of some former high BLH sites is not feasible and in many locations restoration will be costly, if possible at all. Restoration of hydrology will be the greatest challenge for high BLH sites because these habitats are at higher elevations above the 5-year floodplain and drainage has been extensive. Remaining high BLH habitats are mostly small and highly fragmented and few opportunities exist to reconnect patches and reestablish corridors of this habitat type. Despite these challenges, restoration of high BLH habitats is very important to restore vegetation and wildlife species diversity and recreate a landscape complex of native BLH habitats. Sites that are most suited for restoration of high BLH include:

- lands above the 5-year floodplain but below the 10-year floodplain
- areas that still are capable of periodic flooding from high flood events of the Arkansas River and local on-site runoff and flooding for up to 1-4 weeks annually
- point bar deposits, some with high natural levee veneers adjacent to abandoned courses of the Arkansas River
- Hebert and Rilla soils
- cleared lands that are adjacent to existing patches of BLH, especially other high BLH patches
- areas that are not highly ditched or leveed and that retain at least some surface sheetflow of water from local watersheds
- non laser-leveled fields

Restoration of high BLH sites will require reforestation and probably some replenishment of flooding capability. In these sites, structural modifications to restore (create) hydrology probably will be needed and may include levees, pumps, and water-control structures similar to GTRs. Where built, however, these structures should not compromise local runoff and flooding if at all possible, and good drainage facilities must be included so that areas can be completely drained, including drying soils completely. Additionally, careful management of water regimes in high BLH sites is critical and must engage dynamic flooding and draining schedules among years. Tree species typical of high BLH are the least water tolerant of BLH types and over-flooding must be avoided.

Post oak flat.—As with high BLH habitats, post oak flats formerly were present on the highest elevations (excepting natural levees) within the Arkansas River Lowland and are greatly destroyed. Post oak flats also occurred along the edges of the Deweyville Terrace, especially the transition zone from prairie grassland to lower BLH habitats. Post oak flats often contain considerable components of high BLH tree types and the "zone" of post oak area often is narrow and disjunct. Inclusions of intermediate BLH-type trees are common in depressions (vernal pools) in post oak flats and the topography of these areas is naturally undulating. Pimple mounds were common in post oak flats and created additional diversity and interspersion of micro habitats. Reestablishment of post oak flats seems possible in many small locations in the Bayou Meto Basin, especially sites that are:

- high elevations above the 10-year floodplain
- point-bar ridges and on the edges of prairie terraces
- composed of Rilla and Herbert soils in the Arkansas River Lowland and Calhoun, Calloway, Stuttgart, Midland, and Perry/ Portland soils on terraces
- adjacent to high BLH habitats
- non-leveled fields

Generally, restoration of post oak flats will require reforestation with appropriate tree species and integration of some periodic disturbances such as fire or grazing. Most former post oak flats were not flooded (except during very large Arkansas River floods) so restoring hydrology usually is not needed. In some sites, restoring diversity in topography is needed because old pimple mounds have been leveled or degraded and vernal pools have been filled. Post oak flats do not need to be large, but connecting them with existing (or restored) high BLH sites is desirable to enlarge forest patches and buffer both habitats from exterior disturbance and degradations such as ag-chemical drift, dust rain, cowbird parasitism, etc.

Riparian forest.—Riparian forest did not occupy large areas in the Bayou Meto Basin, but it provided important corridors along abandoned courses and small terrace streams. These habitats occurred in both the Arkansas River Lowland and in mid elevation sections of streams in the Deweyville and Prairie terraces. About ½ of these forests have been cleared and many sections of stream now are completely denuded. Restoring riparian forest to former widths along all sections of streams is desirable to restore these unique habitats and help buffer streams from sedimentation and pollution. Data from recent geomorphological investigations on Bakers Bayou (Dunbar 2001) are useful in understanding features of riparian corridors in the Arkansas River Lowland and help guide recommendations for both the channel portions of abandoned courses (see below) and riparian vegetation. Sites for restoration of riparian forest should be:

- abandoned courses of the Arkansas River in the Arkansas River Lowland
- mid-sections of small streams in the Deweyville and Prairie terraces
- at least 100' wide bands on both sides of streams (preferable combined width of 300')
- Perry and Portland soils in the Arkansas River Lowland and Tichnor and Oaklimeter soils in terraces
- where at least seasonal flows are present in streams and occasional deep flooding from overbank flooding occurs

The potential for restoring riparian forests along streams in the basin depends on the degree of modification of the stream corridor and surrounding land uses/ownership. While it is desirable to have at least 100' bands of forest on both sides of the stream, this width is not possible in some locations because roads, houses or farm dwellings, ditches, levees (including natural levees), or other irreversible topographic modifications are immediately adjacent to the stream. The width of most abandoned courses was 200-300' during the 1800s (Dunbar 2001) and this width of riparian forest should be reestablished where possible. Reforestation of many riparian sites is needed to achieve desired widths, and restoring hydrology and natural configuration to streams also is critical to sustain riparian forest over time. Restoring adequate flows to streams and providing for at least periodic flooding of the stream will be needed. Conversely, dams and weirs that impound and deepen water in streams for extended periods will tend to convert riparian forest to cypress/tupelo, dead timber, and open water habitats.

Natural levee forest.—Natural levees occurred adjacent to abandoned courses and channels of the Arkansas River and its tributaries. These levees were several feet higher than streambeds and usually were adjacent to riparian forest on the stream side and BLH habitats on the back side. Large areas of old high natural levees have been cleared and the height of some levees has been reduced from years of farming operations, road construction, land leveling, and other developments. The sites that seem most amenable for restoration of natural-levee habitats include:

- former high elevation natural levees outside the 5-year floodplain
- along existing streams and bayous and abandoned channels where at least some natural-levee topography and vegetation remains
- non leveled sites
- Rilla soils with 1-3% slopes

Forests in natural levee sites are diverse and heterogeneous and include mixtures of species commonly found in several BLH habitats. Restoring sites will require reforestation with a mixture of appropriate tree species and in some cases rebuilding the natural levee berm so that topographic features and variation are present and sites are above 5-year flood frequency elevations. If possible, these habitats should be restored next to existing or restored riparian forests to enlarge corridors and buffer interior portions of the forest from outside disturbance and contaminants.

Riverfront forest.—Riverfront habitats occur on both natural levees and point bars of the active Arkansas River meander belt. Most remnant riverfront habitat is within batture lands of the current Arkansas River and is subject to periodic fluctuations and flows of the river. Much historic riverfront habitat has been cleared for agriculture. Construction of mainstem levees next to the current Arkansas River floodplain has eliminated river scouring and depositional dynamics behind the levee. Construction of locks and dams has further impacted these habitats in many irreversible ways. Restoration of riverfront habitats will be possible only to the degree that some active Arkansas River fluctuations and high flows can occur in a site that creates regular scouring, deposition, and channel migrations. Riverfront vegetation is adapted to these regular disturbances, and if absent, the forest types will shift from riverfront to other BLH types. In most cases, the best restoration that can be expected is simply to abandon cleared sites within the batture lands or to supplement natural regeneration with select tree species plantings that can withstand river dynamics.

Sites that are best suited for restoration of riverfront forest include:

- batture lands along the Arkansas River
- cleared agricultural land that has significant diversity of topography including recently created swales, chutes, and cutoffs
- Crevasse, Roxana, Coushatta, and Latania sandy soils

Abandoned courses.—Abandoned courses in the Arkansas River Lowland of the Bayou Meto Basin are relatively wide, shallow corridors without pronounced or deep channels. Streams within abandoned courses migrated across the boundaries of the former course and often formed braided patterns of water flow. Restoration of abandoned courses should not attempt to create deep single channels into the course, but rather should reintroduce adequate seasonal water flows to reflood and create flows throughout the course. Specific items that are important in restoring the overall plant and animal communities in these courses include:

- reestablishing seasonal-water flows
- reconnecting cross-bayous and other networks of inter-bayou flows
- restoring, or maintaining, hydraulic connections to the floodplain
- restoring and widening riparian-forest corridors in the course, BLH habitats in wider floodplains, and natural-levee forests on adjacent natural levees
- restoring meanders of straightened sections of streams

Abandoned channels.—Many abandoned channels historically occurred in the Bayou Meto Basin. Although many abandoned channels still retain topographic integrity, several have been filled or silted in and most have altered hydrology. Remnant abandoned channels often are islands within wide expanses of agricultural lands and recently in urban fringes. In many cases, edges of the abandoned channel are highly developed and inputs of nutrients, chemicals, sediments, and sewage into the abandoned channel have significantly degraded productivity and water quality. Restoration of water regimes, water quality, and fringe vegetation of some areas of the channels probably is not possible. However, restoration of many features of the abandoned channels is desirable and should include:

- identifying opportunities to restore some hydraulic connection with bayous, streams, and the Arkansas River
- reducing sediment, nutrient, and contaminant inputs and rates into channels
- removing ditches that drain the abandoned channel
- reshaping bottoms of filled depressions
- restoring local surface sheetwater flows into channels
- restoring fringe vegetation communities such as cypress/tupelo and natural levee types and providing forest buffers >100' wide around the channel where possible
- reducing further developments along the edges of channels

SPECIFIC CONSIDERATIONS ASSOCIATED WITH THE BAYOU METO IMPROVEMENT PROJECT

On-farm conservation and improvements.—Many conservation measures are proposed to improve storage and use of surface water on farms in the Bayou Meto Irrigation District including construction of: 1) 738 miles of underground pipeline, 2) 312 miles of tailwater recovery canals, 3) 768 water-control structures mostly as parts of tailwater recovery systems, 4) 10,539 acres of new above-ground reservoirs, and 5) 1212 pumping stations to move water (NRCS 2000). In all of the above items, attempts would be made to avoid impacts to native habitats (e.g., reservoirs would be constructed in existing cropland).

As with other Improvement Project proposals, additional conservation of surface and groundwater in the Bayou Meto Basin is desirable because of impacts of continued depletion of the Mississippi Alluvial Aquifer that underlies the basin. Further depletion of this aquifer ultimately will greatly alter groundwater flows of water and recharges to area streams, wetlands, and floodplains. Continued depletion would further degrade remnant habitats and make restoration of habitats, especially BLH types, even more difficult. On-farm measures must be carefully designed so that they help water conservation objectives but do not coincidentally further jeopardize existing habitats or compromise restoration efforts.

Generally on-farm conservation developments do not directly promote restoration of habitats. Degrading impacts of some developments can be minimized by placing pipelines underground and by placing tailwater recovery canals and water-control structures in locations that minimize impacts to local watersheds and sheetflow of surface water into existing streams and abandoned channels. Any mitigation of impacts of on-farm measures should attempt to restore habitats similar to those destroyed. There may be opportunities to create small areas of wetland habitat in corners and low areas adjacent to some canals and reservoirs especially cypress/tupelo habitats in the Arkansas River Lowland and seasonal herbaceous wetlands in prairie terraces. Furthermore, reservoirs could supply water to adjacent restored BLH sites in winter when irrigation needs are reduced. Some restored high and intermediate BLH habitats adjacent to reservoirs could be developed and managed as GTRs. Water could subsequently be drained and recovered from GTR's in early spring and pumped back into reservoirs. Construction of new GTRs on restored sites must be carefully designed to avoid long-term problems with artificial hydrological regimes, tree health, and nutrient cycling (King and Fredrickson 1998). Detailed site-specific evaluations are needed prior to development of GTRs and long-term monitoring also is required.

Imported water.—Proposed on-farm conservation and improvement measures described above will help provide water needed to sustain current levels of agricultural production in the Bayou Meto Basin, but will not be sufficient to meet all needs. Additional surface water needs would be supplied by a proposed diversion of water from the Arkansas River just north of the David D. Terry Lock and Dam at mile 109. Water would be pumped from the river into 81 miles of canals, 270 miles of pipeline, and 383 miles of existing streams. Three major pump stations with adjoining storage reservoirs would lift water to various elevations in the basin.

Importing water into the basin could provide several opportunities to restore habitats including: 1) planting prairie grassland vegetation on canal and ditch rights-of-way, 2) purchasing wide easements next to canals for restoration of slash and some BLH habitats, and 3) restoring flows in streams. Opportunities in the Prairie and Deweyville terraces of the Bayou Meto Basin seem similar to those associated with the proposed Grand Prairie Demonstration Project (Heitmeyer et al. 2000). Planting prairie vegetation on canal rights-of-way will require regular disturbance to control woody invasions and will work best where prairie previously was present. Widening rights-of-way and purchasing easements would provide opportunities for interspersing slash habitats with grassland and also potentially include sites that were formerly savanna, post oak flat, and BLH types. Actual benefits of planting prairie grassland vegetation on canal banks may be low, but can provide habitat connectivity.

Using existing streams for water conveyance has both positive and negative aspects for restoring stream flows and associated vegetation. Natural stream flows in the basin are greatest in late winter and spring and lowest in summer and early fall. Irrigation needs, in contrast, are greatest in late spring and summer, and increased water flow and depth in riparian corridors during summer could convert habitats to more water tolerant communities such as cypress/tupelo or even kill trees and leave mainly scrub/shrub communities. Furthermore, weirs and dams in streams would impound water for extended periods in spring and summer and cause streams and associated riparian communities to be flooded longer and deeper and change vegetation composition. Conversely, most streams in the Bayou Meto Basin now have reduced yearly flows and riparian corridors have shifted toward drier-type vegetation. Overbank flooding from abandoned courses is reduced in the upper 2/3 of the basin. Importing water to streams and increasing flows especially during winter and spring could potentially restore some natural hydrology to these corridors and help restore native fish and wildlife communities.

Generally, bayous that were abandoned courses of the Arkansas River do not have deep silt deposits nor do they need excavation of channels (see previous discussion about abandoned courses). Instead, abandoned channels need additional water inputs and extended flows (especially during late winter and early spring), and restoration of wider riparian forest corridors along the course. If more water can be routed to these streams, and riparian corridors can be widened, then multiple benefits will accrue to the basin and many habitat areas can be restored. The greatest benefits to regional hydrology would be to reconnect bayous and streams where former cross bayous and shallow braided channels existed.

Flood control.—Much of the lower 1/3 of the Bayou Meto Basin is flooded for extended periods, especially when flows in the Arkansas River are high and the water-control structure located at the confluence of Bayou Meto is closed to prevent backwater flooding into the basin. Ironically, while this structure prevents backwater flooding, it simultaneously prevents drainage of tributaries that flow into Bayou Meto and causes flooding in the lower basin. These flood conditions cause a large area to flood for extended periods during spring and early summer. Where this spring and summer flooding occurs, water regimes in BLH habitats become wetter and causes shifts in tree species composition toward more water-tolerant types such as cypress/tupelo and low BLH and can even cause death of BLH trees. This situation is exacerbated by blocked and silted ditches and bayous, levees and roads across floodplains, and certain water-control structures.

Efforts to improve drainage and reduce flood damage are proposed for the lower part of the Bayou Meto Basin and include: 1) channel improvements and diversions, e.g., cleaning, enlarging, and straightening part of Crooked Creek; 2) new water-control structures, e.g., on Indian and Dry Bayou; 3) a pump station on Little Bayou Meto to move water into the Arkansas River when the Bayou Meto Water Control Structure is closed during high flows of the Arkansas River; 4) measures to reduce sedimentation in streams and ditches such as "greenway" riparian corridors, buffers, and drop structures; and 5) reforestation of certain low elevation flood prone agricultural lands. These proposed projects have several positive attributes for helping to restore habitats. They also have potentials to further degrade existing habitats and water regimes if not properly designed and managed.

Efforts to facilitate drainage of the lower Bayou Meto Basin during late spring, summer, and fall will help restore natural drainage patterns and prevent excessive flooding in floodplains that ultimately will degrade BLH habitats and prevent restoration of sites to historic communities. Conversely, if flood-control actions reduce flooding during winter and early spring, then floodplains will become drier and maintenance of historic BLH communities and the seasonal resources provided to fish and wildlife will be compromised. Drier floodplains in winter and spring also will prevent reestablishment and restoration of BLH habitats in these areas.

The flood-control proposals that seem most conducive to BLH restoration are: 1) the pump station at the confluence of Little Bayou Meto and the Arkansas River, 2) greenways and drop structures that reduce sedimentation in streams, and 3) reforestation of low elevation agricultural lands. If a pump station was built on Little Bayou Meto and only used to remove drainage water during late spring, summer, and fall then hydrology of BLH habitats (including potential restoration sites) would more closely resemble historic patterns. This restoration of hydrology may be most critical within the Bayou Meto WMA (see below) because an increasing amount of BLH in the WMA is subject to wetter flooding regimes and death and conversion of BLH trees is occurring. Widening riparian and BLH corridors, and restoring natural levee and riverfront forest next to streams and the Arkansas River would greatly reduce sedimentation of these drainages and moderate discharges during high flow events. These factors assist flood control efforts and also restore considerable areas of valuable habitat. Additional reforestation, coupled with at least partly restored hydrology, in the 1- and 2-year floodplains of the basin would accomplish many desired results including reducing flood damage of agricultural crops, moderating drainage discharges, reducing sedimentation rates in streams, and restoring critical corridors of BLH habitat. Reforestation should not be limited to just the 1- or 2-year floodplains, however, and should include key corridors along drainages that extend into higher elevations. Reforesting higher areas would help buffer discharges and water quality problems in lower elevations and also provide appropriate sites for restoring intermediate and high BLH and post oak flat communities.

Improvements to Bayou Meto Wildlife Management Area.—Several projects are being considered by the AGFC to improve drainage, flooding, and dewatering capabilities of GTRs and to increase foraging habitat for waterfowl. Certain of these projects might be incorporated into the USACE flood control projects (see above). These projects have the potential to restore natural hydrology to this area and also protect and restore BLH communities to historic distribution patterns. Specific projects being considered include: 1) new water control structures on Salt Ditch, Dry Bayou Ditch, and Hurricane Slough; 2) ditch clean outs at the Tipton Access, around Hallowell Reservoir, in Little Bayou Meto, on Dry Bayou Ditch, and in Long Pond Slough; 3) new GTRs next to the Bear Bayou Impoundment and on the west side of the area; 4) new levees or repairs to existing levees on the south end of Government Cypress and along the west side of the Upper Impoundment; and 5) further compartmentalization of GTRs.

These projects will be helpful to the maintenance and management of habitats in Bayou Meto WMA if they can: 1) help emulate natural water regimes and reduce prolonged and deep flooding, 2) supply dependable and adequate seasonal flood water during winter and early spring, and 3) efficiently and independently discharge water from impoundments. Furthermore, developments should attempt to avoid further fragmentation of existing patches with additional roads and levees. In some cases it may be possible to actually remove unnecessary roads and levees and fill ditches that impede or divert sheetflow of water. Each of the first 3 items listed above has at least some positive potential for restoration and management of BLH habitats. However, constructing new GTRs and additional compartmentalization of existing GTRs may be damaging.

Each of the water-control structures described above appears to be helpful in providing additional water to the area during winter and in diverting water away from the area, thus reducing excessive and prolonged flooding, during high-water periods.

Ditch clean outs that facilitate drainage of the area during spring and summer are badly needed to restore natural dynamics of flooding and drying of the basin and restoring appropriate BLH communities to specific elevations. This is especially true for intermediate BLH sites on the WMA because they have been increasingly flooded and compromised in recent years. Dredging and enlarging ditches should be kept minimal to avoid further fragmentation and disruption of existing forest patches.

Construction of new GTRs will require additional levees, water-control structures, and ditches. If these levees significantly impede flow of water across the WMA and impound water for extended periods into growing seasons, then they should not be built. The same is true for other proposed new levees or repair of old less functional levees on the WMA. In contrast, if levees will help provide additional shallow water in BLH sites that have been effectively drained by outside agricultural and ditch/drainage activities, then they help restore hydrology especially to higher elevation BLH communities.

Generally, more compartmentalization of GTRs is not desirable because it: 1) disrupts overland flow of water and nutrients; 2) fragments larger patches of forest; 3) increases levees, roads, water-control structures, and ditches that can become plugged by siltation, beavers, and debris; 4) increases disturbance of patches; and 5) increases management costs. Much of the BLH habitats in the Bayou Meto Basin already are heavily fragmented and laced with ditches, levees, and roads. The Bayou Meto WMA provides the largest tract of manageable BLH in the basin and should be restored to the largest undissected patches possible.

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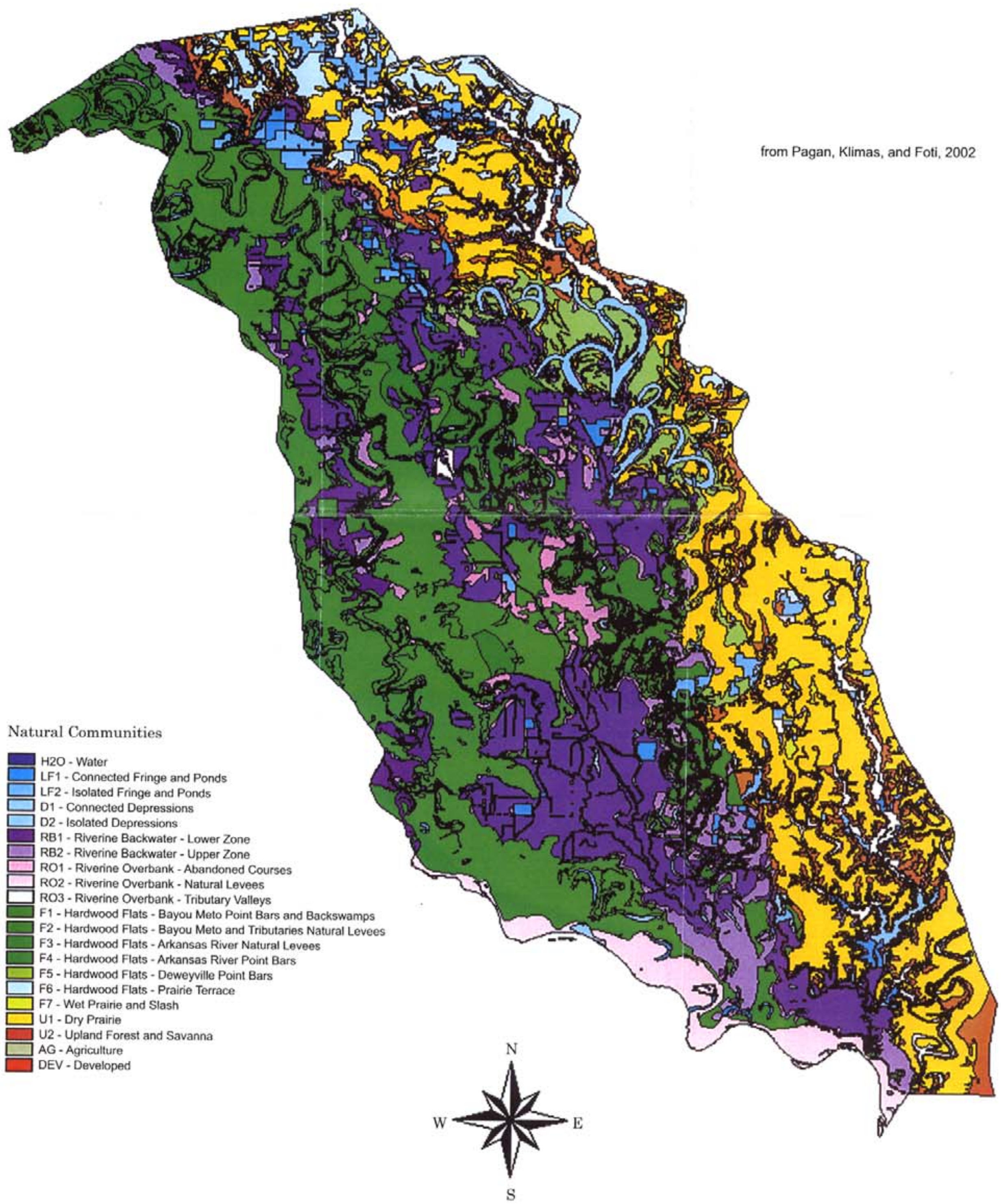
APPENDIX A

BAYOU METO
POTENTIAL NATURAL COMMUNITIES



SECTION IV

SITE-SPECIFIC RESTORATION OPPORTUNITIES

Environmental Restoration Opportunities in the Bayou Meto Project Area

Thomas Foti, Arkansas Natural Heritage Commission

The Bayou Meto Project of the US Army Corps of Engineers is being designed to meet several needs: irrigation, flood control and environmental restoration. Several studies have been undertaken to provide a basis for the restoration component. The USACE Waterways Experiment Station, led by subcontractor Charles Klimas, has produced a hydrogeomorphic analysis of the study area, and Joe B. Pagan of the Natural Resources Conservation Service has produced a map of "potential natural vegetation" of the study area to help guide restoration efforts. Mickey Heitmeyer and Leigh Fredrickson of the University of Missouri, along with Sammy King of the University of Tennessee have done a study of the landscape-scale restoration opportunities in the study area. These three projects complement each other to provide a comprehensive perspective for restoration.

The Heitmeyer approach is qualitative and historical in nature, although it depends heavily on present conditions as well. It begins with a description of the natural systems of the study area prior to massive alteration. The base time period is the mid-19th century. Heitmeyer uses a variety of historical sources to describe the plant communities and dominant natural processes at that time. Ecological inference from present vegetation is also used to build this understanding. He then develops an understanding of the ways we have changed each of these communities and processes, and the total losses of each. Finally, based on this understanding, he develops criteria for assessing the practicality of restoring each of the communities.

The hydrogeomorphic approach used by Klimas is quantitative, concentrates on wetlands, not uplands, and is based on existing vegetation. This approach classifies wetlands according to the source of water and the behavior of water within the wetland, primarily as predicted by geomorphic characteristics of the site. There are five hydrogeomorphic classes such as riparian wetlands and slope wetlands. In turn, these are divided into subclasses such as riparian backwater and riparian overbank. Klimas has been developing a wetland classification for Arkansas for several years, funded by the EPA and the Arkansas Multi-Agency Wetland Planning Team (MAWPT). Because of needs of the MAWPT, Klimas has further divided subclasses into communities based on finer geomorphic distinctions and dominant vegetation. Thus the riparian backwater subclass is divided into those areas that are flooded more frequently than every two years (Overcup Oak) and those flooded at a frequency of 2-5 years (Willow Oak). The classification is based on field sampling. After wetlands have been classified, their functions (water quality, water storage, etc.) are characterized and modeled using data derived by sampling wetlands of a given type in a variety of conditions resulting from varying intensity of disturbance and recovery period since disturbance. These models may then be used to predict the amount of recovery of wetland functions of a disturbed area over a period of time. This approach therefore provides a wetland classification that is useful in Heitmeyer's analysis, allows the creation of a map of potential classes, subclasses and communities based on geomorphology and flood frequency (even if the area is presently cleared and drained), and allows prediction of recovery of specific wetland functions resulting from restoration of specific wetlands.

Pagan builds on the hydrogeomorphic classification by further dividing subclasses and communities to define finer community types in some cases by using soil map units. His types also recognize that two or more plant communities may occur on the same site based on disturbance history or natural variation.

In the Bayou Meto study area, Pagan did much of the field sampling of sites to document the hydrogeomorphic site/vegetation and soil/vegetation relationships as well as variation in vegetation based on past disturbance.

These three approaches provide complementary understanding of restoration potentials in a project area. The Klimas approach provides a classification and functional assessment based on a scientifically-rigorous methodology that has been developed and tested nationwide. The maps are useful for understanding "potential" community distribution across the watershed as well as providing restoration goals for specific sites and predicted recovery of restored wetland areas. Pagan's soil-based mapping adds detail that is useful in understanding site-specific variation and in developing restoration plans for specific sites, as well as a better understanding of landscape-level plant community diversity. Heitmeyer provides a historical perspective on community-specific distriution, processes and loss, and provides a scientific rationale for most practical and effective restoration, as well as evaluation of specific alternative proposals produced during project development.

During the course of this project, specific restoration proposals have surfaced in a variety of ways. The multi-agency environmental review team has suggested several restoration options, the USACE has identified restoration possibilities, and Heitmeyer and his collaborators have suggested some alternatives.

The primary restoration opportunities that have emerged are shown in Map 1. Each has specific characteristics and values that will be described here. Two basic types of restoration have been proposed: restoration of riparian corridors and of broader landscape areas. The former approach primarily benefits aquatic and streamside communities. The landscape areas provide habitat for area-sensitive species and can encompass a natural mosaic of communities and species. These two approaches are not mutually exclusive, as will be demonstrated here: riparian corridors can serve as a part of a landscape area or can connect two landscape areas, making them effectively larger and more representative.

Although this report points out a variety of restoration opportunities, it does not necessarily propose that all of these can be accomplished by the Bayou Meto Project. Rather, those opportunities that gather support may be accomplished by a variety of means, whether federal, state and private. There are a number of programs appropriate to the study area conducted by such agencies and organizations as the US Department of Agriculture, the US Fish and Wildlife Service, the Arkansas Game and Fish Commission and Ducks Unlimited. As an example, the USDA, with match money and time provided by a variety of state agencies, has implemented the Bayou Meto Conservation Reserve Enhancement Program, which provided over $8,000,000 to restore riparian corridors in the watershed.

Bayou Meto WMA/Big Ditch Corridor (Landscape)

The US Fish and Wildlife Service has designated existing or potentially forested areas of at least 10,000 acres within the Lower Mississippi Valley as Priority Conservation Areas for migratory bird conservation. Such areas offer expanses of forest interior habitat for a viable population of certain key species. One such area within the study area encompasses the Bayou Meto Wildlife Management Area, along with privately-owned forested areas adjacent to the WMA and adjacent restorable croplands. Approximately 10 miles upstream from the WMA is another large forested Priority Conservation Area that the FWS designated the Big Ditch area. This area is privately owned, primarily by duck hunting clubs. Connecting these two areas would increase the value of these PCAs for area-sensitive species. A corridor 2-3 miles wide would function not simply as a connection between the two forested areas, but would effectively combine them into one area. This area would require about 22,000 acres.

Much of the area that would comprise the corridor is not within the two-year floodplain and has been extensively cleared. Only about 5,000 acres are within the 2-yr. floodplain and about 8,000 remains in native vegetation. However, the high bottomland forest communities that could be restored are in some cases more heavily cleared than wetter lands. Including higher sites also will add to the diversity of the eventual forest. For example, of the land to be restored in the proposed corridor that is within the 2-yr floodplain, nearly half is lower higher bottomland forest, while an additional 30% of those community types remain forested today. In this frequently flooded zone, drier point bars and backswamps make up 10% of the area and high natural levees 5%. In the full corridor, however, a similar 30% of the total area is forested, primarily with lower and upper bottomland forests, but of the area to be restored, 22% is such bottomland forests, 25% is point bars and backswamps and 10% is natural levees. It should be pointed out that in order to maintain the width of this corridor it will be necessary to add about 1300 acres of terrace that was formerly occupied by prairie and related forest and savanna. However, these areas should not be restored to prairie (better opportunities exist elsewhere), but rather to appropriate forest or woodland communities; the emphasis of this area should be to attain the largest continuous area of forest interior habitat possible, connecting the two existing forested areas.

In its delineation of boundaries of the Big Ditch migratory bird conservation area, the USFWS included area to the north of the existing forested area and extending up Bayou Two Prairie. A portion of this area lies on the Deweyville Terrace (see Klimas et al. and Heitmeyer, et al.). This terrace has been almost totally cleared, so that modern remnants of native vegetation to use as models do not appear to exist. Therefore, detailed analyses of first land survey data may provide the best perspective on possible restoration goals. Restoration of Deweyville Terrace forest will not only restore a decimated ecosystem, but will add to the habitat value of an existing forested block.

Restoration goals for the Deweyville Terrace forests and wetlands are not critical. As long as the restoration blocks are near or adjacent to existing forest of the Big Ditch area, any restoration will be effective. However, one of the key features of this area is the massive abandoned channels of the Arkansas River, which have been drained and are farmed. Therefore, the minimum restoration goal for this area should be restoration of one of the abandoned channels along with its surrounding natural levees, flats and backswamps. This should be located near existing Big Ditch forest.

Bayou Two Prairie is incised deeply into the prairie terrace on each side. Since it does not flood large areas, it has not been ditched or extensively cleared. However, some clearing has occurred and reservoirs have been built in the floodplain. Therefore it is primarily a target for protection, but some restoration is needed. Reservoirs have been built in the floodplain and in some cases weirs or low dams have been erected entirely across the bottoms.

Long Prairie/Grand Prairie (Landscape)/Bayou Two Prairie (Riparian)

Long Prairie was the name given locally to one of the several discrete patches of prairie that made up the complex called the Grand Prairie. The largest unit of prairie was also called Grand Prairie. Long Prairie was west and south of Bayou Two Prairie, Grand Prairie to the east and north. No remnants of native prairie remain within the Long Prairie area area. Over 180,000 acres of prairie existed in the Bayou Meto Project area in the early 19th Century. The largest unit of Long Prairie covered about 30,000 acres.

The primary goal of prairie restoration should be a large block of prairie of at least 1000 acres as recommended by the Lower Mississippi Valley Partners in Flight program, to provide habitat for viable populations of target grassland bird species. Ideally, an even larger area would be restored with both prairie grasslands and the related woodland, savanna, and forest types that occurred in the landscape. A long-range goal might be to restore sufficient habitat to eventually restore prairie chickens, once a popular game species of the Grand Prairie but which was extirpated due to loss of habitat and over-hunting. An appropriate habitat goal for this purpose would be restoration of a 2,000 acre block of prairie as a core, along with a total of 2,000 more acres of prairie in smaller blocks scattered within the surrounding 8,000 acres.

There may be potentials within the project area to restore two such areas. One would be centered on the Stuttgart Airport, which is on the eastern boundary of the project area. This is public land that occupies approximately 2,500 acres. Much of the area is leased for agriculture. It is possible that this farmland could be restored to prairie vegetation if the city were paid an amount equivalent to the current agricultural lease. The payment should not be in the form of a short-term lease, though, but rather a one-time payment for a long-term (preferably perpetual) easement. Another possible area is in the former Long Prairie south of Lonoke. There has been a willingness expressed by landowners in this area to consider large-scale prairie restoration. Restoration of two prairie chicken populations would greatly increase the long-term viability of the introduction.

Indian Bayou (Riparian)

Indian Bayou Ditch roughly follows the original course of Indian Bayou, carrying the bulk of the water that once flowed down the bayou. In some cases the former bayou has just been enlarged into a ditch but at one point a large curve approximately XX miles long was abandoned as the ditch was dug straight across. Little water flows through the natural course now, primarily during floods. Restoring flow to this stream segment would provide aquatic habitat benefits. It would require removal of some blockages caused by beaver and humans. Some riparian habitat restoration would also be required at places where the banks have been cleared or at places where blockages in flow have excessive vegetation to grow in the former channel. As with Baker's Bayou, widening the existing riparian corridor would allow restoration of a different habitat on the adjacent natural levee, comprised of higher-ground vegetation on the natural levee. As well, there may be opportunities to restore even wider belts to provide more landscape restoration benefits.

Wabbaseka Bayou (Riparian)/Wabbaseka Scatters (Landscape)

Wabbaseka Bayou is the extension of Indian Bayou below Tucker State Penitentiary. It extends from there to eventually join Little Bayou Meto. Like other streams of the study area it is on high ground and bounded by high natural levees. It is incised more deeply that most of the streams however. In many places there is a "shelf" of lowland between the channel of the bayou and the natural levee. This character may give it greater water-carrying capacity and thus have contributed to its never having been channelized. As a result of these factors it has a fairly intact riparian corridor and channel. It is among the most natural streams in the study area. For this reason it should be a protection priority. If there is a need to increase its water-carrying ability, work should be done sensitively, using such approaches as those outlined in the Stream Obstruction Removal Guidelines (SORG). Areas along it that have been cleared or otherwise altered should be a priority for restoration.

A large part of the area outlined as the Wabbaseka Scatters Landscape Area is within the two-year floodplain today, and preliminary analysis of post-project flooding indicated that this may have continued to be the case in the future. Therefore, contingent on future flooding conditions, this area was proposed restoration of forests and other wetlands. Doing so will increase the habitat value of the bottomland forest habitat of Bayou Meto WMA and will help achieve other project purposes by reducing flood losses. This will also increase the habitat values of the reach of Wabbaseka Bayou within and near the restored forest areas. Further analysis has shown that flooding may be substantially reduced by project flood control features. Of the original approximately 20,000 acres included in this area, only about half will remain in the 2-yr. floodplain. This area should certainly be restored as a project feature. However, restoration of the entire area will add diversity of habitats, as well as cover when high water drives terrestrial animals from lower areas. Within the 2-yr. floodplain, almost all of the area is low bottomland hardwood forest sites with relatively small areas of high bottomland hardwoods and hardwood flats. The portion of the area above the 2-yr. floodplain includes relatively dry Arkansas River point bars with small areas of even higher natural levees.

SECTION V

BAKERS BAYOU GEOMORPHIC INVESTIGATION

7/19/01

Engineer Research and Development Center
US Army Corps of Engineers Waterways Experiment Station

Geomorphic Investigation of Bakers Bayou, Stop 6, Near Lonoke, Arkansas

By

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PREPARED FOR:

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167 North Main Street
Memphis, Tennessee

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Preface

The following study by the Engineer Research Development Center, Waterways Experiment Station (ERDC-WES) was authorized by U.S. Army Corps of Engineers, Memphis District (CEMVM), by reimbursable funding document W38XGR10362431. The project manager at CEMVM for this study was Mr. Mark Smith (CEMVM-PM-E).

The principal investigator for the geomorphic study at Bakers Bayou, Site 6, was Mr. Joseph B. Dunbar, Engineering Geology Branch (GG-Y), Geotechnical and Structures Laboratory (GSL), ERDC-WES. Fieldwork in support of this study consisted of a one-day visit to the study site to locate soil borings and to perform a reconnaissance conductivity survey. This study was performed under the general supervision of Dr. Lillian Wakeley, Chief, ERDC-WES-GG-Y, and Dr. Mike O'Connor, Chief, GSL.

At the time of publication of this report, Dr. James R. Houston was Director of ERDC, and COL John W. Morris III, EN, was Commander and Executive Director.

1 Introduction

Background

A field trip was conducted on 9 January 2001 by personnel from various Federal and State agencies to examine a segment of Bakers Bayou, Arkansas, for coordinating agricultural water supply and ecosystem restoration requirements among the various Government agencies involved in project permitting and construction. The reach of Bakers Bayou under consideration is an abandoned Arkansas River course that will transport water pumped from the Arkansas River into Bakers Bayou for agricultural water needs in order to reduce aquifer pumping.

Various stops were made along the course of Bakers Bayou during the 9 Janpuary 2001 field trip as shown by Figure 1. The purpose for these stops was to examine the present condition of Bakers Bayou and compare it to site descriptions made during the 1854 Government Land Office (GLO) survey of this region. Stop 6 along the field trip route was considered to represent an ideal standard for the ecosystem restoration efforts to be incorporated in the agricultural water supply channel design. This location was recommended for further background study and is the subject of the present geomorphic investigation. Additional details of the January 2001 field trip are contained in a trip report by Dunbar (2001).

Purpose and Scope

The purpose of this study was to determine the historic limits of the channel fill, the boundaries of the abandoned Arkansas River channel at Site 6, and reconstruct to the extent possible, the nature and character of the relict river or stream channel at this location at around 1850. This study involves an integrated approach to the historic and prehistoric reconstruction at Site 6 and incorporates historic data, geomorphology, soils, stratigraphy, and radiometric dating methods. Activities performed during the course of this study include a focused literature review of historic data (i.e., surveys, maps, and photographs), interpretation of aerial photography and digital imagery, examination and description of soil cores, radiometric dating of selected soil samples, and preparation of the following report.

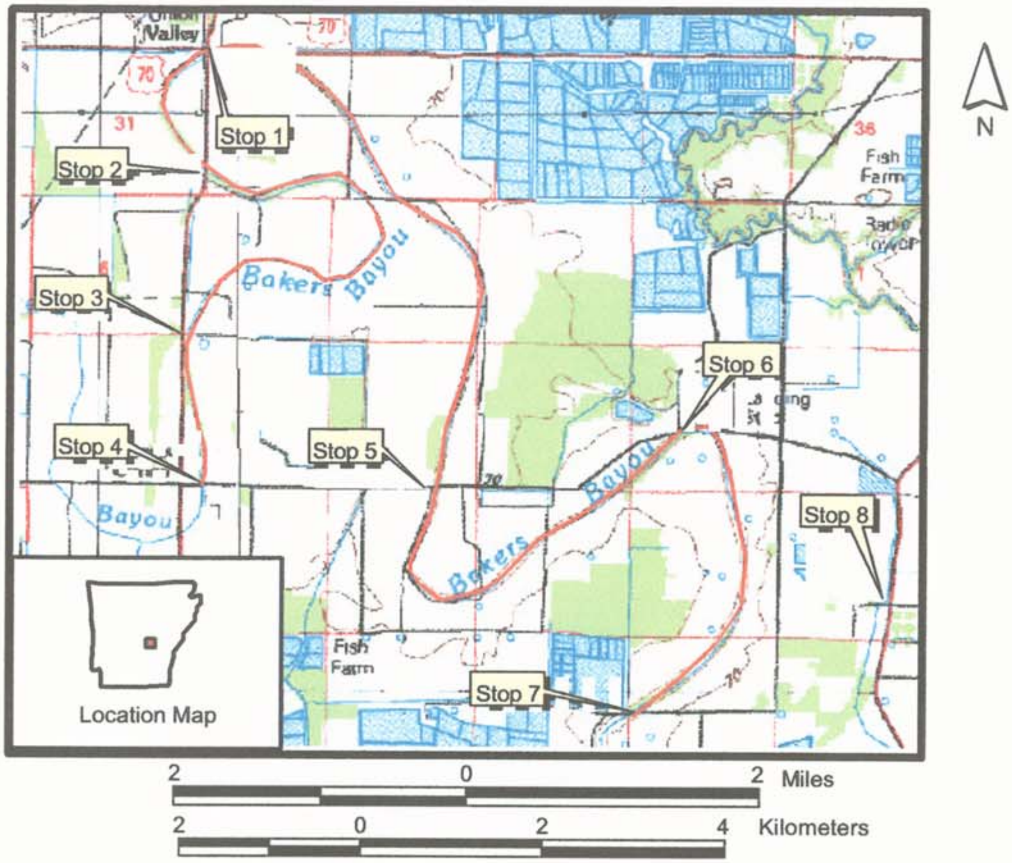


Figure 1. Location map of Bakers Bayou showing 14 January 2001 field trip stops. Stop 6 is the focus of the current geomorphic study

Study Area

Bakers Bayou is located approximately 16 miles (27 km) due east of Little Rock, Arkansas, and 6 miles (10 km) due south of Interstate 40 in Lonoke County. Bakers Bayou is an abandoned Arkansas River course that was active approximately 6,000 to 8,000 years before present (Saucier 1994). The abandoned course has been subsequently filled with sediment and presently serves as a local drainage. Bakers Bayou is a prominent topographic feature on the landscape and is part of the Holocene (less than 10,000 years) floodplain of the Arkansas River.

The area of interest is identified as Stop 6 on Figure 1 and is located on the Pettus, U.S. Geological Survey (USGS) 7-1/2 min. topographic quadrangle. Bakers Bayou at Site 6 is a 300 ft (100 m) wide forested corridor that is situated within the banks of the old Arkansas River channel. Standing water is currently present within the center of the old river channel where surface drainage collects (Figure 2). The old river channel is not evident at Site 6. Rather, this channel has been completely filled and all that remains is a poorly drained forested area,

Figure 2. View across Bakers Bayou at Stop 6. Trees in the middle of the photograph correspond to the approximate center of the old Arkansas River course at this location

occupying the approximate center of the old river channel. Along a significant part of the Bakers Bayou reach shown in Figure 1, the forests have been clear-cut to permit farming adjacent to the old channel, and also to provide water storage for livestock and/or irrigation needs (Figure 3).

Figure 3. View across Bakers Bayou at Stop 3 (see Figure 1 for photo location)

2 Methods

Historic Data

Historic data were collected to better understand past land use changes that have occurred in the study area. Relevant surveys, maps, aerial photographs, and digital images were obtained to compare land use changes and determine the limits of the abandoned course. Historic data collected for this study includes the following coverages:

a. Surveys and U.S. Geological Survey (USGS) Maps.

(1) 1855 Government Land Office Survey. Presents surveyors description of Bakers Bayou along the Township and Range Section lines. Index map from this survey shows earliest mapped location of Bakers Bayou course.

(2) 1891 Little Rock Topographic Quadrangle, Camp Pike. Scale 1:125,000, Map shows location of Bakers Bayou West of Site 6, beginning at 92• West Longitude.

(3) 1937 England USGS Topographic Quadrangle. Scale 1:48,000.

(4) 1943 England USGS Topographic Quadrangle. Scale 1:62,500.

(5) 1982 Pettus USGS Topographic Quadrangle. Scale 1:24,000.

(6) 1982 Pettus USGS Digital Raster Graphics (DRG). Scale 1:24,000.

b. Aerial Photography and Imagery.

(1) 1937 Black and White Aerial Photography. Scale 1:20,000, Flown for U.S. Department of Agriculture (USDA) by Bowman Park Aero Co., Louisville, Kentucky. This coverage is the earliest known aerial photographic coverage for this area.

(2) 1949 Black and White Aerial Photography. Scale 1:20,000, Flown for USDA by Tobin International, San Antonio, Texas.

(3) 1994 Black and White Digital Ortho Quarter Quads (DOQQ). Scale: 1 m pixel resolution

Aerial Photo Interpretation

Historic maps and aerial photography obtained for the study area were carefully examined to determine channel boundaries and the presence of inset stream channels. Selected photographs were digitally scanned, rectified to a digital base map, and then overlaid onto each other using ArcView, a Geographic Information System (GIS) software from Environmental System Research Institute (ESRI). Digitally rectified photographs and imagery permit close and spatially accurate examination of the geomorphic and man-made features. Land use changes, channel boundaries, and other important landform characteristics were evaluated and the geomorphic features mapped onto the USGS DRG for the England quadrangle in ArcView to produce the generalized geomorphic map in Figure 4 and the topographic based geomorphic map in Plate 1.

Drilling and Sampling

Six stratigraphic soil borings were drilled within the Bakers Bayou channel at locations identified in Figure 5. Boring locations were selected with two cores on the inside margins of the old channel and the remaining four cores located at the center of the old channel. The purpose for the soil sampling was to obtain detailed stratigraphic and lithologic information on channel filling. Stratigraphic and lithologic data are necessary to distinguish between the prehistoric and the historic limits of channel fill. For purposes of this study, the historic-prehistoric boundary has been set by CEMVM at about 1850.

Soil sampling was conducted with a CEMVM Failing 1500 drill rig and crew (Figure 6). Both disturbed and undisturbed soil samples were taken for later laboratory study. Boring advance between samples was performed with a bucket-type soil auger. Disturbed or general type samples were obtained with a standard split spoon. Undisturbed soil samples were obtained with a 3-in. (7.62 cm) Shelby or open-tube type sampler and hydraulically pushed to refusal or to the desired sample depth. Split spoon samples were taken where hydraulic push type techniques were not effective (boring BB-1) or where near surface samples were lost because of saturated soil conditions (boring BB-3). Complete information regarding sampling techniques for disturbed and undisturbed methods is contained in reference EM-1110-1-1906 (U.S. Army Corps of Engineers 1996).

The maximum sample depth was set at the base of the topstratum or the vertical accretion portion of the channel fill sequence. The maximum sample depth was based on an existing cone-penetrometer boring from Bakers Bayou (Figure 5 and previous subsurface mapping (Saucier 1967). These data indicate a fine-grained topstratum between 15 and 20 ft (4.6 to 6.1 m) thick, underlain by coarse-grained lateral accretion deposits greater than 40 ft (10 m) thick. The

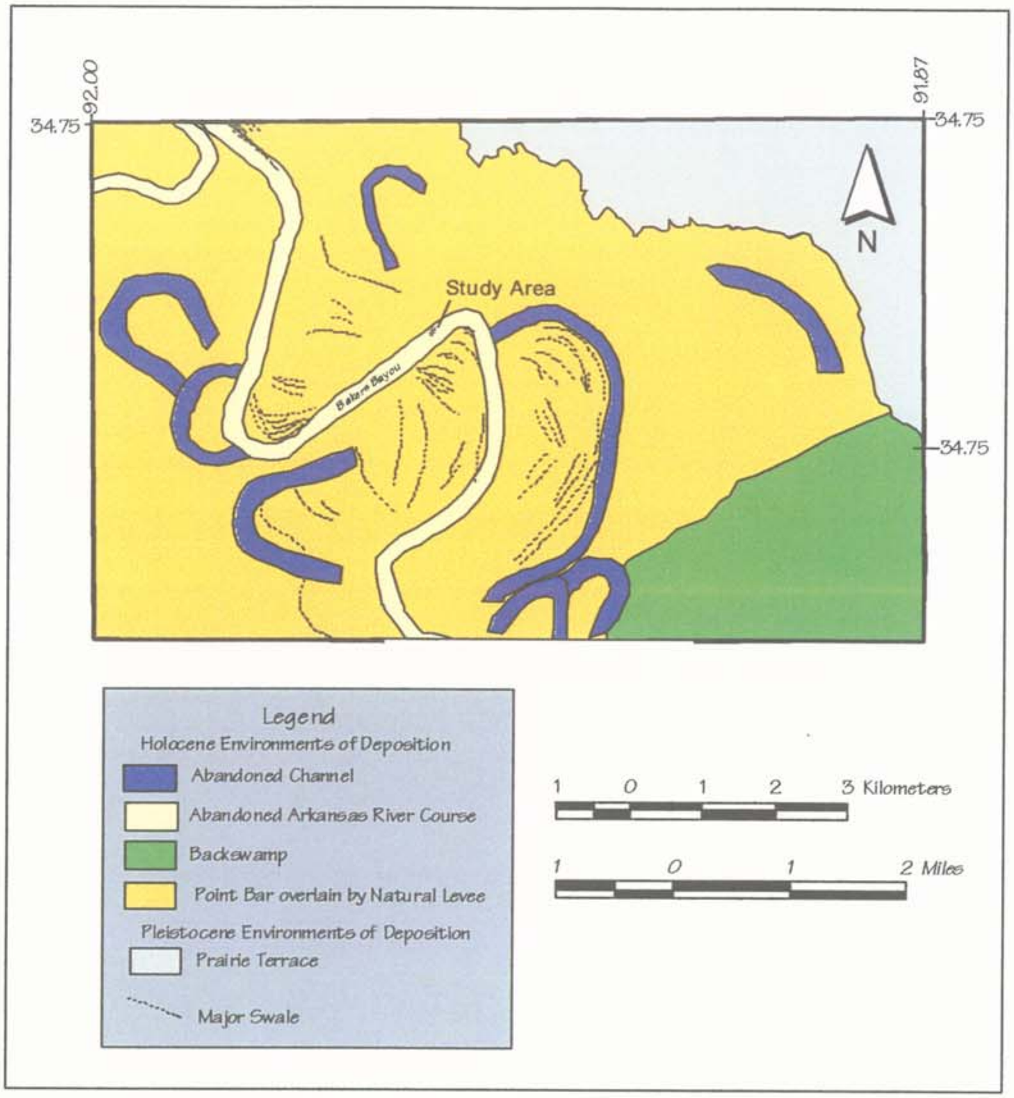


Figure 4. Geomorphic map of the Bakers Bayou study area showing major fluvial landforms

thickness of the topstratum at Site 6 varies between 12 and 16 ft (3.6 to 4.8 m) based on the borings drilled for this study. The vertical accretion or fine-grained component of the channel fill is important for understanding the filling history as the upper stratigraphy can provide important clues on the filling mechanism.

Soil Cores

Soil cores from the Bakers Bayou drilling were transported to the Engineer Research Development Center, Waterways Experiment Station (ERDC-WES) for laboratory evaluation. Samples were extruded from the Shelby tube using

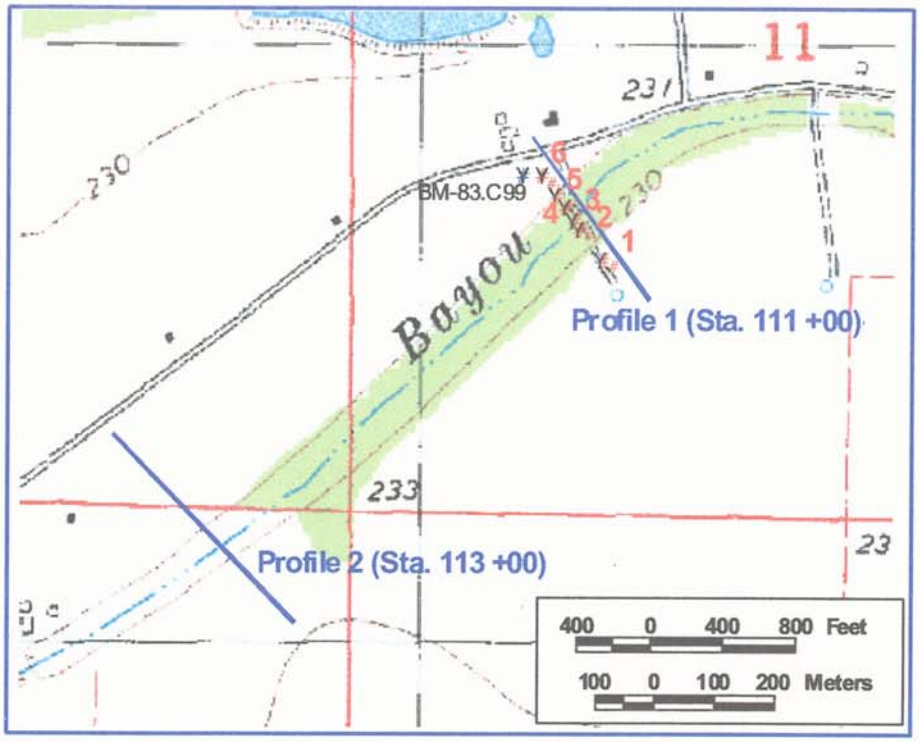


Figure 5. Location of borings drilled as part of this study (red circles), topographic profiles (blue line), referenced cone penetrometer boring (blue circle), and conductivity survey (same as profile locations, blue line)

either a hydraulic ram or simply cutting the Shelby tube longitudinally on either side with an electric circular saw and metal cutting blade. In both of the extruding techniques, soil samples were split in half to permit description of the lithology and stratigraphy.

Soil boring logs are presented in Appendix A. Each boring log in Appendix A contains the drilling inspectors sample description sheet, and a description of the soil samples by a geologist on ERDC-WES Form 819, Field Data Boring Log. Description of the soil on Form 819 in Appendix A contains lithology according to the Unified Soil Classification System (USCS). Included with the classification are Munsell color, soil consistency, moisture content, presence and character of mottles, type of bedding or laminations that are visible, character and content of organic matter, and other features that relate to the stratigraphy or mineralogy of the sediments. These data are discussed in more detail in a subsequent section of this report.

Figure 6. Drilling equipment used to sample at Bakers Bayou, Stop 6. Drill rig is set up within the old channel of the abandoned Arkansas River Course. Tree line in background corresponds to the present day bayou

Radiometric Dating of Soil Samples

Radiometric dating techniques were used in this study to calibrate the chronology of the stratigraphy and estimate sedimentation rates for channel filling. Radiometric dating is based on the radioactive decay of specific isotopes in sediments. Isotopes of interest to this study include Cesium-137, Lead-210, and Carbon-14. These three radiometric dating techniques were employed on soil samples from core BB-4 (Figure 5). This core is located within the active part of the present "channel." No sample loss was reported for this core on the sample boring sheet that was submitted by the CEMVM field inspector.

Radiometric dating techniques are based on the known half-life of specific isotopes and the ability to count the decay or activity rate of these isotopes with highly sensitive laboratory instruments. Cesium-137 has a half-life of 30.3 years and is a byproduct of atmospheric testing of thermonuclear weapons. This isotope was first introduced in 1952 and peaked during 1963 and 1964. Its presence in the soil and the characteristics of these peak signatures allows for the dating of soils and determining sedimentation rates for ecological studies.

Similarly, Lead-210 has a half-life of 22.3 years and is a byproduct of the Uranium 238 decay series. Lead-210 forms by the decay of Radon-222 in the atmosphere. Precipitation removes this isotope from the atmosphere and the Lead-210 isotope is rapidly absorbed by sediment. Dates of sediment deposition by this technique are calculated by determining the decrease in Lead-210 activity as a function of time.

Carbon-14 is produced in the earth's atmosphere by the interaction of cosmic radiation with nitrogen and to a lesser extent with oxygen, and carbon. Carbon-14 is rapidly assimilated into the carbon cycle and is incorporated into the tissue of all living organisms. Upon the death of the host organism, the Carbon-14 isotope decays at a fixed rate according to its half-life of 5,730 years. It is assumed that no new carbon is introduced into the closed system. The effective range of applicability of Carbon-14 dating is between 100 to 50,000 years.

Sediment dating by Cesium-137 and Lead-210 was performed by the USGS, Center for Coastal Geology, St. Petersburg, FL. Dr. Chuck Holmes, a USGS Geologist, sampled the upper 6 ft (~2 m) of core from BB-4 at the ERDC-WES. Additionally, one sample was selected for Carbon-14 (C-14) dating that was below the Cesium-137 and Lead-210 samples. The C-14 sample was submitted to Beta Analytical, Coral Gables, FL, for Accelerated Mass Spectrometry (AMS) C-14 dating. AMS techniques were required since the quantity of carbon was insufficient to date the sample by conventional C-14 methods. Detailed information about these different techniques is presented on the USGS website at http://sofia.usgs.gov/publications/fs/73-98/. Results of the radiometric dating from these various techniques are presented in Appendix B (Cesium and Lead-210 Results) and C (Carbon-14 Results).

Topographic Profiles

Two elevation profiles were surveyed by CEMVM across Bakers Bayou to define the surface topography across the abandoned course. Profiles were made at Site 6 and across an open field about 2,400 ft (732 m) southwest of this location (Figure 5). Profiles were made at these two locations to provide topographic evidence of the channel boundaries. Topographic profiles are presented in Appendix D. Topographic profiles are identified as section 111 + 00 (corresponds to profile 1 in Figure 5). The profile southwest of Site 6 is identified as section 113 + 00 in Appendix D (corresponds to profile 2 in Figure 5).

Conductivity Survey

A reconnaissance level geophysical survey was made across Bakers Bayou at two locations identified in Figure 5. The survey was performed by walking across the old channel and recording the conductivity values at 5 m (16 ft) intervals. The purpose for the geophysical survey was to delineate the boundaries of the old channel from the electrical properties of the underlying soils.

A Geonics, EM-31 instrument was used to survey across the old channel (Figure 7). The Geonics, EM-31 is an electromagnetic (EM), fixed frequency (9,400 Hz), transmitter and receiver that measures electrical conductivity. The sample frequency for the transmitter and receiver was twice per second. An analog display on the EM-31 console shows conductivity values in real-time and instantly identifies changes in bulk conductivity values due to variations in the underlying geology.

The general principal behind the survey is that a change in the underlying depositional environment will produce differences in the electrical properties of the soil. Thick channel sands contained in the abandoned course should produce a difference in the electrical conductivity values as compared to areas outside the old channel. Areas that are adjacent to the abandoned course correspond to natural levees, point bars, or backswamps (Figure 4). Results of the EM-31 survey indicate the area within the channel has a lower conductivity (high resistivity), while the area outside of the channel (i.e., natural levees), the conductivity is higher (low resistivity) because of the increased clay content. Results of the conductivity survey at Site 6 compare favorably with other evidence collected to determine the location of the channel boundaries.

Figure 7. Conductivity survey by geologist at Stop 6. Upper photograph is view looking southeast, near edge of old abandoned course. Lower photograph is view looking north at Bakers Bayou in background. At this location, there is no well-defined channel

3 Geologic Setting

Arkansas River Courses and Meander Belts

Major Arkansas River courses that were active during the Holocene are identified in Figure 8. Bakers Bayou is identified as course 4a in Figure 8. This course is estimated to be 6,000 to 8,000 years old and corresponds to course 4 in Figure 9. The chronology of the Arkansas River courses is based on over 30 years of engineering geology mapping by ERDC-WES in the Lower Mississippi Valley (USAE Waterways Experiment Station 1951, Saucier 1964, Saucier 1967) and numerous site-specific studies, including chronostratigraphic data (Saucier 1994).

Associated with each Arkansas River course identified in Figure 8 are specific environments of deposition. The major depositional environments are an abandoned course and associated abandoned channels, point bars, and backswamp deposits. Together, these environments have formed a meander belt complex (Figure 10).

Bakers Bayou Study Area

Pleistocene floodplain

The part of Bakers Bayou meander belt complex under study is bordered by the Pleistocene Grand Prairie to the east, and Holocene floodplain deposits to the west (Figure 10). The Grand Prairie is a Sangamon age (75,000 to 125,000 years old) floodplain of the Arkansas River that was created during the previous interglacial cycle. This older floodplain surface is approximately 5 to 9 ft (1.5 to 2.7 m) higher in elevation than the present day floodplain of the Arkansas River. Depositional environments forming this older surface are similar to those active on the modern floodplain.

In addition to the Grand Prairie, a second, younger Pleistocene surface is present southeast of the Bakers Bayou study reach (Figure 10). This surface represents a late Pleistocene flood plain that is characterized by oversized meander loops due to higher precipitation and increased runoff rates than currently exist today. The exact chronology for this surface is tentative, but has been estimated to range between 12,000 to 20,000 years before present (Saucier 1994).

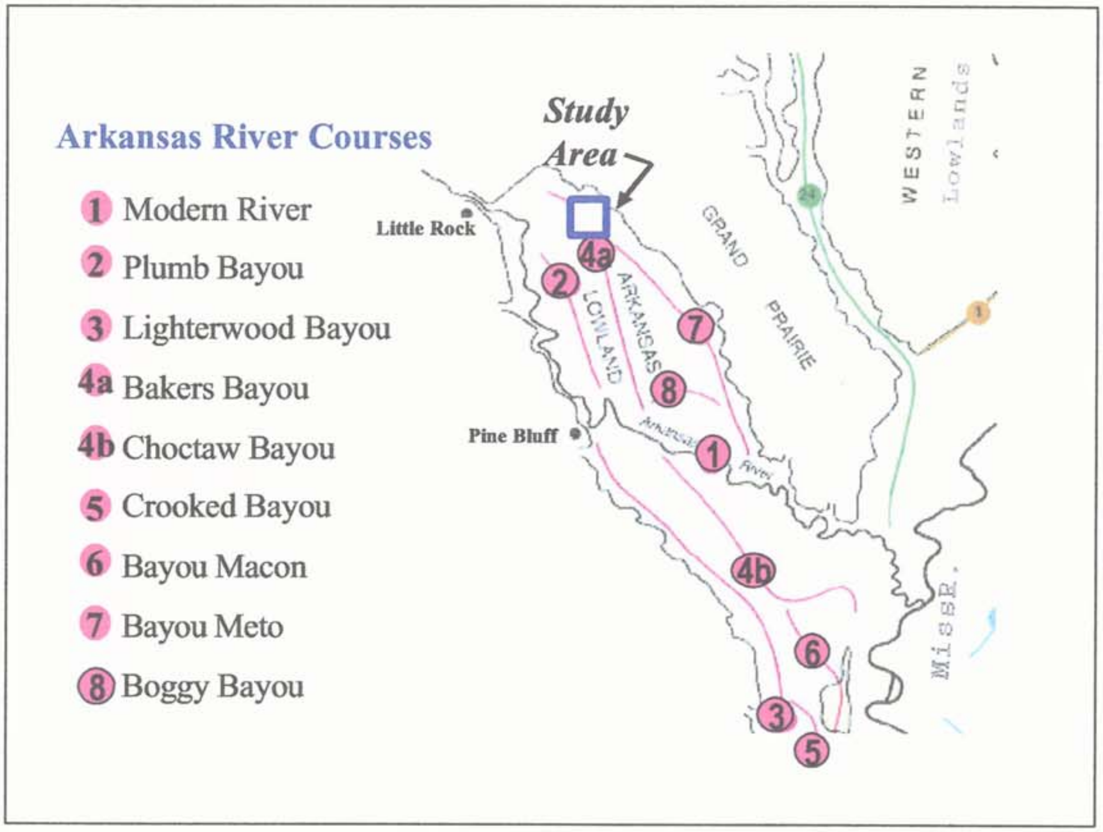


Figure 8. Major Arkansas River courses active during the Holocene (after Saucier 1994)

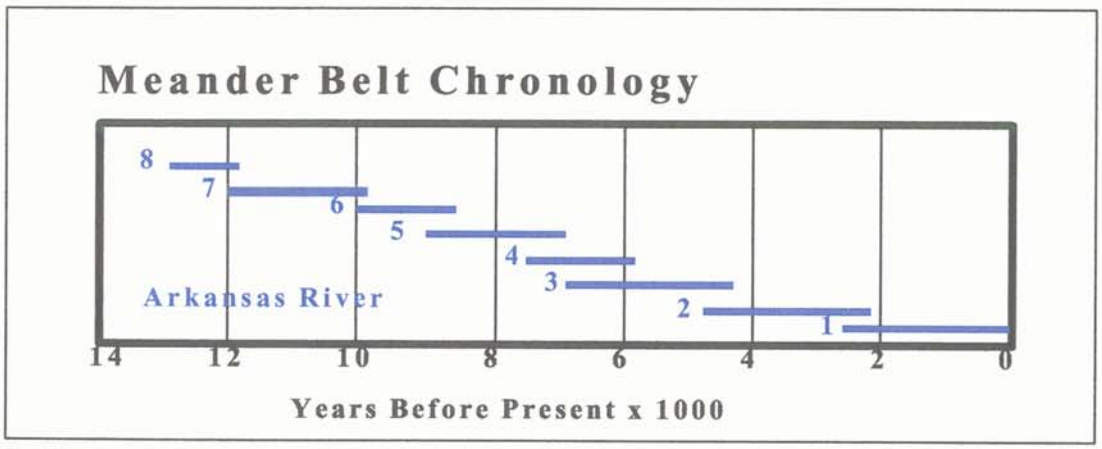


Figure 9. Estimated chronology of the major Arkansas River courses (Saucier 1994)

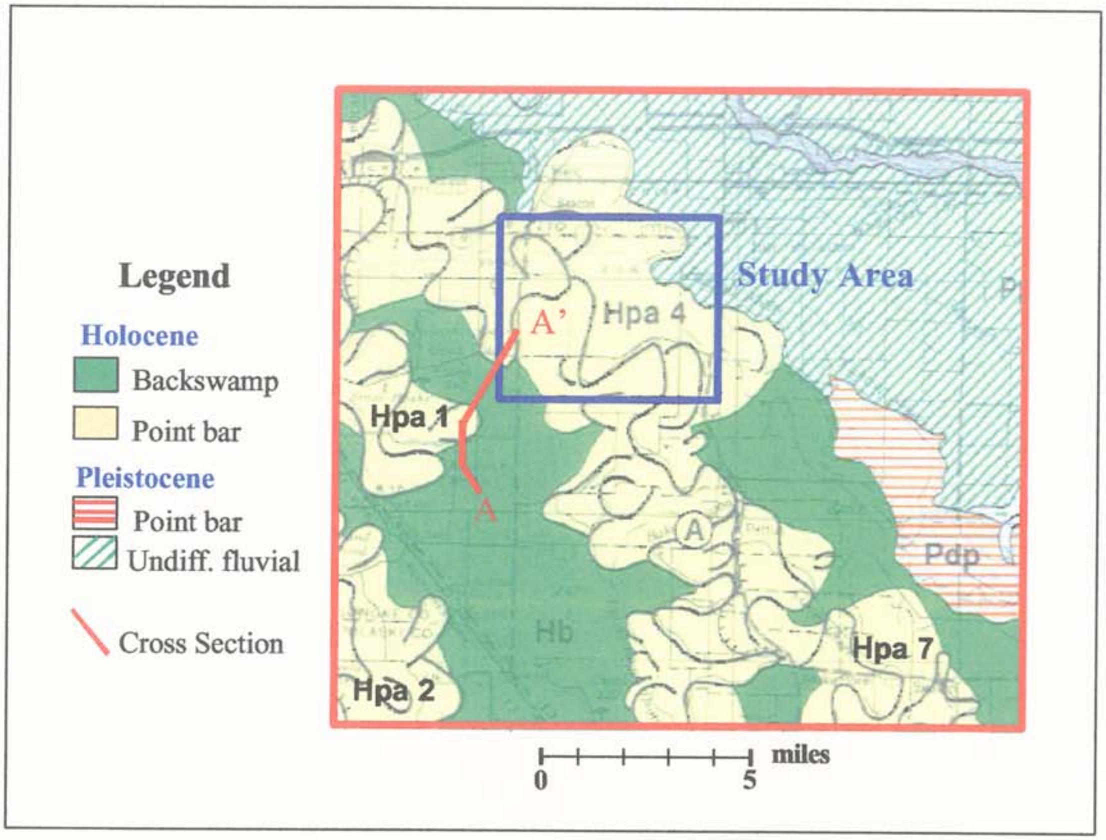


Figure 10. Bakers Bayou study area (box in blue) showing the general limits of the different Holocene (H) Arkansas River (a) meander belts. Meander belts consist of an abandoned course and associated abandoned channels, and point bar (p) deposits (after Saucier 1994). Cross section A-A' is presented as Figure 11

Holocene floodplain

Meander belt deposits associated with Bakers Bayou are approximately 5 miles wide at Stop 6 (Figure 10). Environments of deposition that formed the study area include the Bakers Bayou abandoned course, abandoned channels, natural levees, point bars, and nearby backswamp (Figure 5 and Plate 1). A summary of each environment is presented below to provide a general geologic framework for a closer study of Stop 6.

Abandoned course. An abandoned course is a river channel that is abandoned in favor of a more hydraulically efficient course. An abandoned course contains a minimum of two meander loops and forms when the river's flow path is diverted to a new position on the river's floodplain. The method by which a river abandons one course in favor of another course is a gradual process. It generally begins by a break or a crevasse in the river's natural levee during flood stage. The crevasse forms a temporary channel that over time may develop into a permanent channel. A change in the river's course is due to a more hydraulically efficient route across the flood plain, whereby the gradient of the new river channel is steepened by a reduction in the course length. As shown by Figures 8 through 10, the Arkansas River has experienced numerous course shifts during the Holocene.

The Bakers Bayou abandoned course is estimated to have been active between 6,000 and 8,000 years before present (Saucier 1994) and the channel has since been sediment filled. Channel filling is dominated by coarse-grained sediments, consisting of sand and silty sand at the base of the channel, overlain by silt and clay at the surface. Engineering geology mapping by Saucier (1967) indicates the Bakers Bayou course is approximately 50 ft (15 m) deep (Figure 11). Channel filling involves two different types of sediments and distinct fluvial processes. The base of the abandoned course consists of coarse-grained substratum sands, which are formed by lateral accretion (i.e., channel migration). In contrast, the upper part of the channel fill consists of a fine-grained topstratum, which forms by vertical accretion or over bank deposition.

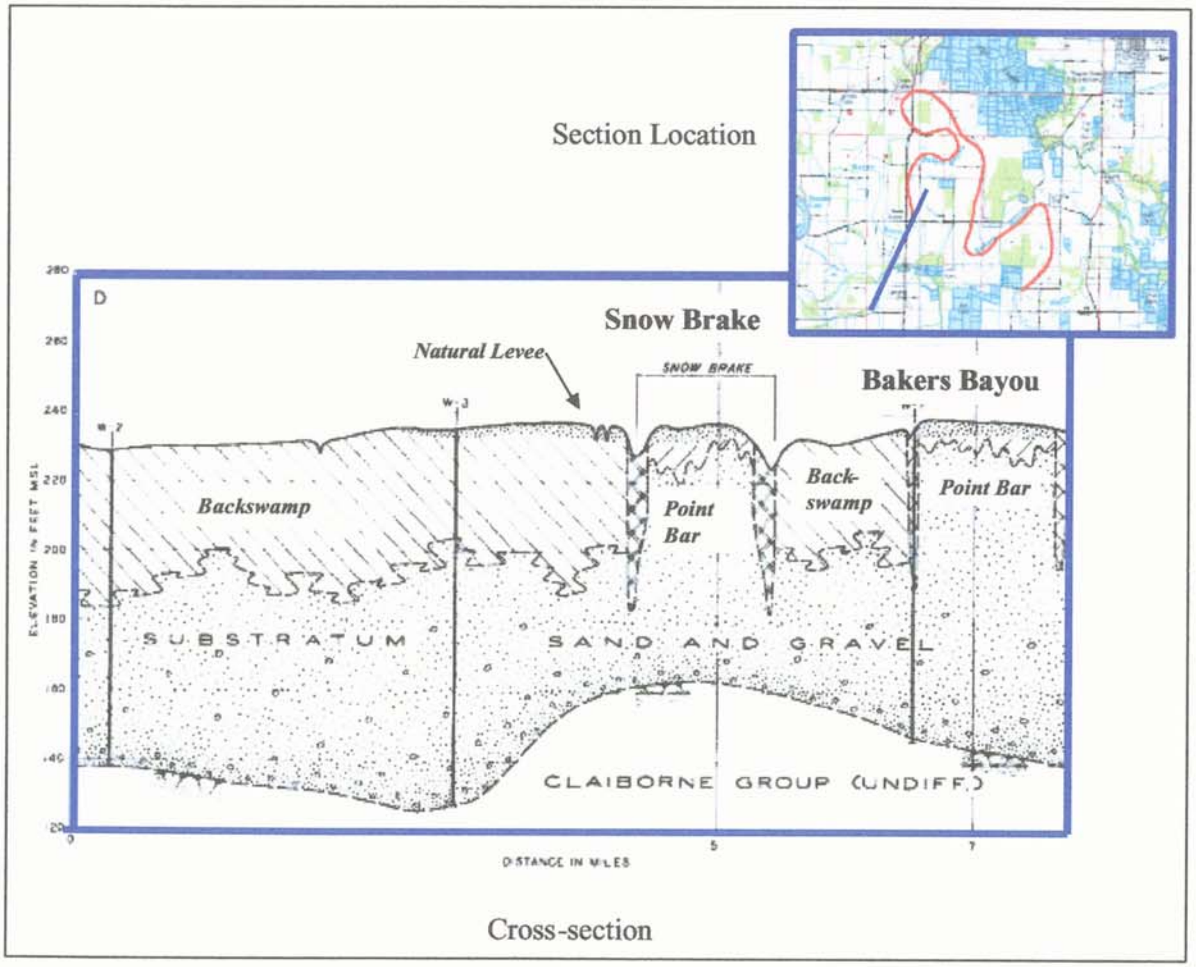


Figure 11. Geologic cross section across Snow Bayou (Arkansas Meander Belt 1) and Bakers Bayou (Arkansas Meander Belt 4), (from Saucier 1967)

At Stop 6, cone-penetrometer boring BM-83-C99 (Figure 5) was drilled to a depth of 50.5 ft (15.39 m). Textural data identifies a sandy substratum (silty sand and sand) below 22 ft (6.7 m). Above this interval, the channel is filled with a fining upward sequence, grading from silt to clay and then back again to silt at the surface. The upper surface silt sequence corresponds to overbank, natural levee deposits inset within the old course. A similar filling sequence is identified in other cone-penetrometer borings from the Bakers Bayou course.

Abandoned channel. An abandoned channel forms when a river migrates across its point bar and cuts off a loop segment to form an oxbow lake. The process by which the river abandons the loop occurs either gradually, or during a single flood event. For a cutoff to form gradually, river migration permits the upper and lower ends of the channel to come together, and then separate from the main course during a high flow event. A rapid cutoff during a single flood event is possible by a chute or high water channel developing across the point bar neck and flood flow creating a permanent channel across the point bar. Both neck and chute cutoffs are present in the Bakers Bayou reach shown in Figure 4. An excellent example of a cutoff that is in the process of forming is the northern most loop of Bakers Bayou in Figure 1 where the two arms of the course are touching.

Abandoned channels help define the boundaries of a meander belt complex. The ends of the abandoned channels are usually orientated toward the trunk course. Generally, abandoned channels and courses have different physical properties. Abandoned courses are much coarser grained as a whole than an abandoned channel. Abandoned channels typically contain finer-grained deposits, because they are usually separated from the trunk channel, and receive only sediments by overbank deposition during flood flow. An abandoned course will maintain a hydraulic connection to the floodplain over an extended period of time and will carry low stage channel flow.

Backswamp. Backswamp deposits are vertical accretion deposits that receive sediment during times of high water flow. Deposition occurs when the natural levees are crested, and suspended sediment in the floodwaters is carried to the distal parts of the floodplain. Backswamp deposits are confined to the southeastern part of the Bakers Bayou reach (Figure 4).

Primary geomorphic process active within this environment are vertical accretion of new sediment from annual flooding (presently not possible with construction of levees), pedogensis (soil formation), and bioturbation (churning and stirring of the underlying sediment by vegetation and organisms). Saucier (1967) identifies backswamp deposits in the study area as being from 40 to 50 ft (9 to 12 m) thick (Figure 11).

Natural levee. Natural levee deposits are not mapped as a separate environment on the geomorphic map (Figure 4 and Plate 1). This environment is present throughout the study area to some extent and mapping the limits would detract from the basic map information. Natural levee was mapped in combination with the point bar environment, but is described as a separate environment because of its importance to the study area.

Natural levees are vertical accretion deposits formed when the river overtops its banks during flood stage and sediment suspended in the flood flow is deposited adjacent to the channel. The resulting landform is a low, wedge shaped ridge, decreasing in thickness with distance from the levee crest. Natural levee deposits eventually merge with other floodplain deposits. Within the study area, natural levee deposits merge with backswamp and point bar sediments.

Silt and fine-grained sand are the dominant grain size in natural levee deposits. Within the old course at Stop 6, silt is the primary soil texture for the surface sediments. These deposits generally contain little organic material because of oxidation. Soil color ranges from tan to orange brown (see boring logs, Appendix A).

Natural levee topography at Stop 6 is defined by profile 1 (see Figure 5 for location and Appendix D, profile labeled station 111 + 00). This profile shows the slight rise in elevation along either side of the old course. At this location, the peak elevation is at survey distance 160 ft (approximate roadway) and 920 ft (open field) from the origin of the profile. The second profile doesn't extend completely across the old channel, but the right (south) bank levee is evident by the increase in elevation at survey distance 700 ft from the profile origin (Appendix D).

Point bar: The dominant depositional environment in the Bakers Bayou reach is point bar (Figure 4 and Plate 1). Point bar deposits are formed as a river migrates across its floodplain. River channels migrate by eroding the outside or concave bank, and depositing a sandbar on the inside or convex ban. With time the convex bank grows in size as the river migrates laterally, and the point bar is developed. Associated with the point bar are a series of arcuate rides and swales, or low-lying depressions, between the accreted sand bars. Swales are locations were fine-grained sediment accumulates by vertical accretion or overbank deposition. Point bars are easily recognized on aerial photography and topographic maps by the characteristic ridge and swale topography, and by the presence of numerous abandoned channels on the floodplain.

Point bar deposits are as thick as the total depth of the river channel in which they form. Point bar deposits at Stop 6 are approximately 50 ft (15 m) thick. These deposits fine upward from the maximum size of the river's bedload (coarse sand and/or gravel, Figure 11) to fine-grained soils at the surface (silt and clay). The basal portion of the point bar sequence, the substratum, forms by lateral accretion, while the fine-grained or upper portion, the topstratum, forms by vertical accretion. These two processes are fundamentally different mechanisms for sediment transport and deposition by a fluvial system.

4 Discussion of Site Data

Width of Abandoned Course at Stop 6

The lateral limits of the abandoned course in the Bakers Bayou reach were determined from historic aerial photography, topographic information (Appendix D), and site conductivity data at Stop 6. These data indicate a channel that is between 600 and 900 ft (182 and 274 m) wide when the course was active between 6,000 and 8,000 before present.

The maximum channel width at Stop 6 is between 700 to 830 ft (213 to 253 m). Aerial photography from 1937 indicates the channel at Stop 6 is about 700 ft (213 m) wide. The limits of the channel from topographic data (Appendix D) indicate the channel is about 710 ft (216 m) wide, while conductivity data would suggest a maximum width of about 830 ft (253 m). Channel width based on conductivity data represents a maximum value and probably reflects a significant increase in the fine-grained soils associated with the adjacent natural levee deposits. In summary, these different data types are in general agreement with each other about the width of the active middle Holocene channel.

Historic Limits Based on Site Surveys and Maps

Careful study of old photography, maps, and survey data is required to establish the historic channel limits. Historic map and survey data examined during this study have been previously identified in Chapter 2 of this report.

Topographic map data examined for this study indicates no significant changes in course location. All printed maps identify a course that has remained constant and stable during historic time as would be expected from a system that was abandoned approximately 6,000 years ago. The resolution or scale (i.e., 1:24,000 to 1:62,500) of these topographic maps does not permit for detailed reconstruction of channel dimensions.

A source of historic data that permits detailed examination of channel dimensions is the land survey of 1854 by John W. Garretson, D.S. The survey was performed under a 15 May 1854 contract to the Treasurer of the United States, and was commissioned to correct an error in the original survey of December 1815 for Township 1 North of the base line and Range 9 West of the 5th Principal Meridian

(T1N, R9W). The survey was conducted to establish the section lines within this township and range. The original 1815 survey was made to establish the boundaries for the lands acquired by President Jefferson in the Louisiana Purchase of 1803.

A portion of the 1855 plat map for T1N, R9W is presented as Figure 12 with Stop 6 identified and those locations where a description of the Bakers Bayou channel was noted during the survey. Survey locations identified in Figure 12 are at the intersection of Bakers Bayou with the section lines. The relevant surveyor's descriptions are summarized in Table 1 by their numbered location in Figure 12. The numbering convention in Figure 12 is based on previous work by Mr. Tom Foti, Arkansas Natural Heritage Commission.

Table 1
Bakers Bayou Surveyor's Descriptions of Channel Dimensions and General Character (from Surveyor's Notes Made Sept. and Oct 1854, T1N, R9W)

Location	Survey Width[1]	Width (ft)	Descriptive Remarks
1	150 links	99	flat, shallow
2	150 links	99	flat, shallow
3	620 chains (?)	40,920 (?)	flat, shallow
4	200 links	132	–
5	3.5 chains	231	–
6	200 links	132	–
11	250 links	165	–
13	200 links	132	–
14	–		–
15	100 links	66	slough brs NE & SW
16	200 links	132	–
17	200 links	132	–
19	–		–
20	–		–

[1] Note: 1 chain = 66 ft, 1 link = 0.66 ft.

Examination of Table 1 shows the channel dimensions in September and October of 1854 as ranging between 66 and 231 ft (20 and 70 m). An erroneous value for channel width is believed reported for location 3. This high value may represent a transcription error when the survey was typed and/or possibly a missing decimal point. The average value for channel width excluding location 3 is 132 ft (40 m). Channel depth is reported at three locations as being flat and shallow.

Historic Limits Based on Photos And Imagery

Historic photography examined for this study includes the 1937 and 1949 USDA, black and white prints at a 1:20,000 scale and DOQQ imagery from 1994. A comparison of the channel conditions was made between the three time periods using georeferenced images in ArcView. A close up view of Stop 6 for these three time periods is presented in Figures 13 through 15.

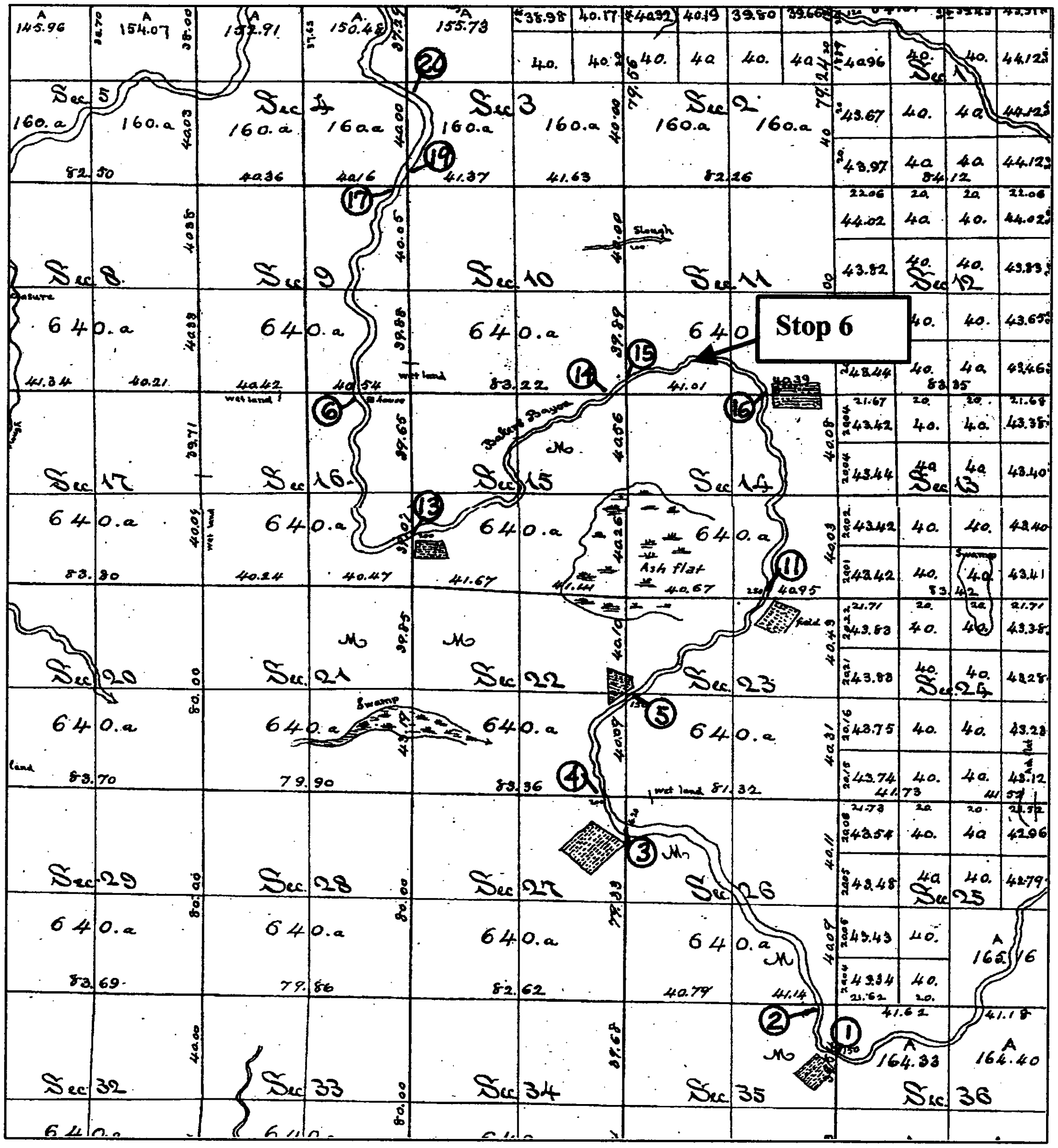


Figure 12. Locations where a description of the Bakers Bayou channel was noted during the 1854 land survey of T1N, R9W. See Table 1 for summary description of channel width and character

Figure 13. Close up view of Bakers Bayou Stop 6 in 1937 (from photo EL-6-53, flown 10 February 1937)

Figure 14. Close up view of Bakers Bayou Stop 6 in 1949 (from photo EL-2f-118, flown 7 February 1949)

Figure 15. Close up view of Bakers Bayou Stop 6 in 1994 (from DOQQ 03409117.nws, image dated 10 March 1949)

Comparison of these different time periods identifies the vegetation corridor bordering the relic river course at Stop 6 as being relatively constant in width during the time interval covered by the photography. However, further upstream and downstream from Stop 6, much of the channel area has been clear-cut for farm use (i.e., Figure 3).

Figure 13 highlights a modern day mystery from a geomorphic perspective. North and south of Bakers Bayou are several hundred or more rounded, circular, or elliptical shaped hills, between 2 and 3 ft (61 to 91 cm) high, and about 30 to 60 ft (9 to 18 m) in diameter. These low relief hills are known as pimple mounds, prairie mounds, or incorrectly as mima mounds. The geomorphic mystery surrounding these mounds involves their origin. As yet, no clear-cut and universally accepted explanation for their origin has been accepted. Saucier (1994) suggests that pimple mounds are the result of either ant or termite colonies. More than 20 different theories of origin have been proposed.

Noteworthy to this study from a chronological perspective is that no pimple mound formation by whatever cause has occurred more recently than about 5,000 years before the present (Saucier 1994). The occurrence of pimple mounds along either side of Bakers Bayou supports the age estimate for Bakers Bayou (Figures 8 and 9). The presence of the mounds on the 1937 photography helps to mark the limits of the abandoned course. Historic land use changes in the vicinity of Stop 6 are further illustrated by the slow disappearance due to human disturbance of these pimple mounds in the 1994 imagery (Figure 15).

A closer examination of Figures 13 through 15 indicates variable channel conditions between time periods. Figure 13 identifies high water conditions, as the trees are flooded in 1937. Attention is drawn to the water level in the southwest corner of the photograph and the location marked by the arrow (i.e., location 15, see Figure 12, note channel width in Table 1). At this location, the flooded zone is approximately 206 ft (62.8 m) wide. A well-defined channel is not present anywhere on the 1937 photograph in Figure 13. Attention is also drawn to a portion of Bakers Bayou between the two houses in the northeast corner of the photograph. At this location, a well-defined channel is not present in 1937.

Examination of these two locations in the 1949 photo identifies several noteworthy changes. First, the water level is much lower in the 1949 photograph as compared to the 1937 time period previously examined. Second, a channel has been dug in Bakers Bayou in the northeast corner of Figure 14, between the area of the two houses. And, third, a well-defined channel is not present along Bakers Bayou except in the area between Stop 6 and the canal. East of the dirt trail that crosses Bakers Bayou at Stop 6, the channel is between 40 and 70 ft (12 to 21 m) wide.

Figure 15 presents the most recent imagery of Bakers Bayou examined during this study. In this black and white satellite image, the water level is low, the tree canopy is less developed than the preceding time intervals, and a well-defined channel is noticeable for the first time along the north edge of the bayou. This channel was probably dug to pass water efficiently through this reach. Also noteworthy are the absence of pimple mounds, which were abundant in the 1937 photograph.

Selected 1854 GLO Survey Locations

A final comparison of historic survey data and photography is made for representative 1854 GLO survey locations. Figures 16 through 18 presents high-resolution close-ups for locations 15, 16, and 11, respectively (see Figure 12 for survey locations). The close-ups are intended to see whether the survey data can be matched with the channel conditions on either the 1937 and 1949 photographs, before wide scale disturbance occurred.

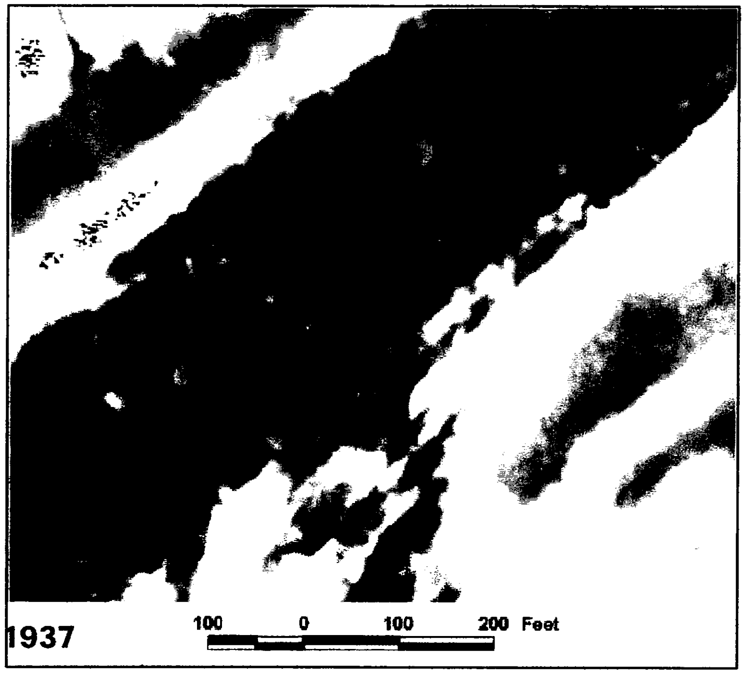
Figure 16 compares the survey data with the historic photography for GLO survey location 15. The center of the photographs in Figure 16 corresponds to the section line intersection with Bakers Bayou. The survey reports a stream width of 100 links or 66 ft (see Table 1). Examination of the 1937 photograph in Figure 16 shows interconnected open water ponds (darker areas) that are linked together by narrow stream segments. A well-defined channel is not present at this location as previously described. An open pond 66 ft across would best represent channel conditions at this location. Similarly, the channel is poorly defined nearly 100 years after the survey was made on the 1949 photograph.

Figure 17 compares the survey data with the historic photography for GLO survey location 16. At this location, the road crossing the 1937 photograph corresponds to the survey line intersection with Bakers Bayou. The 1854 survey reports a width of 200 links or 132 ft at this location. Here again, the channel area probably corresponds to open ponds, separated by interconnecting, narrow stream segments. The largest open water area immediately south of the road (section line) would correspond to a width of about 132 ft for comparison purposes with the survey report. In the 1949 photograph, the channel area is much less as shown.

Figure 18 compares the survey data with the historic photography for GLO survey location 11. A similar situation occurs at this location. The channel width reported at the time of the survey was 250 links or 132 ft. This width corresponds to the flooded area shown in the 1937 photograph.

Soils Data

Soils and boring data are an essential part of this study to establish the vertical limits of the historic channel fill. Published USDA (1981) soils data identifies unique soil series associated with the old Bakers Bayou course and with the natural levees bordering the old channel. Within the old channel are the Keo silt loan and Perry silt clay, and associated with the natural levees are the Herbert silt loam and Rila silt loam. Typical profiles for these different soil series are presented in Appendix E.



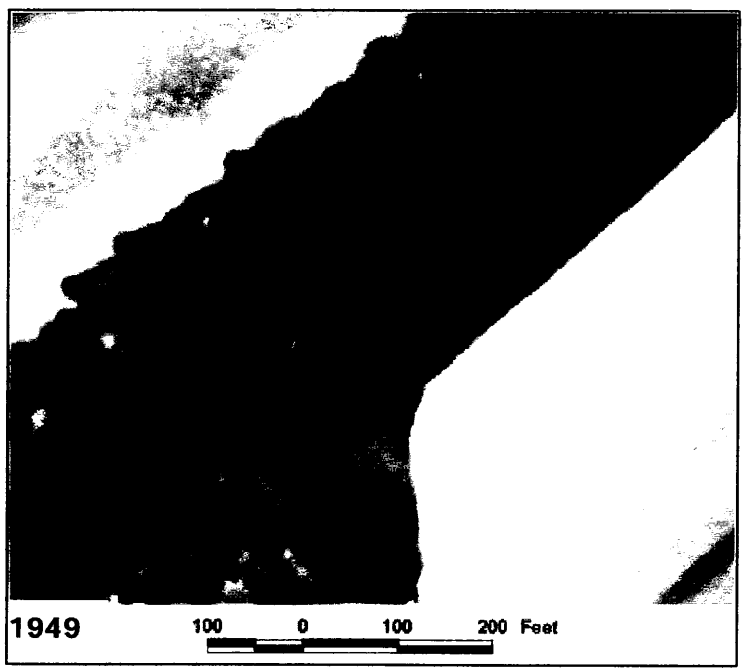


Figure 16. Location 15 from GLO 1854 survey (see Figure 12 and Table 1). Channel width at time of survey was 100 links or 66 ft. Center of photo marks section line intersection with Bakers Bayou

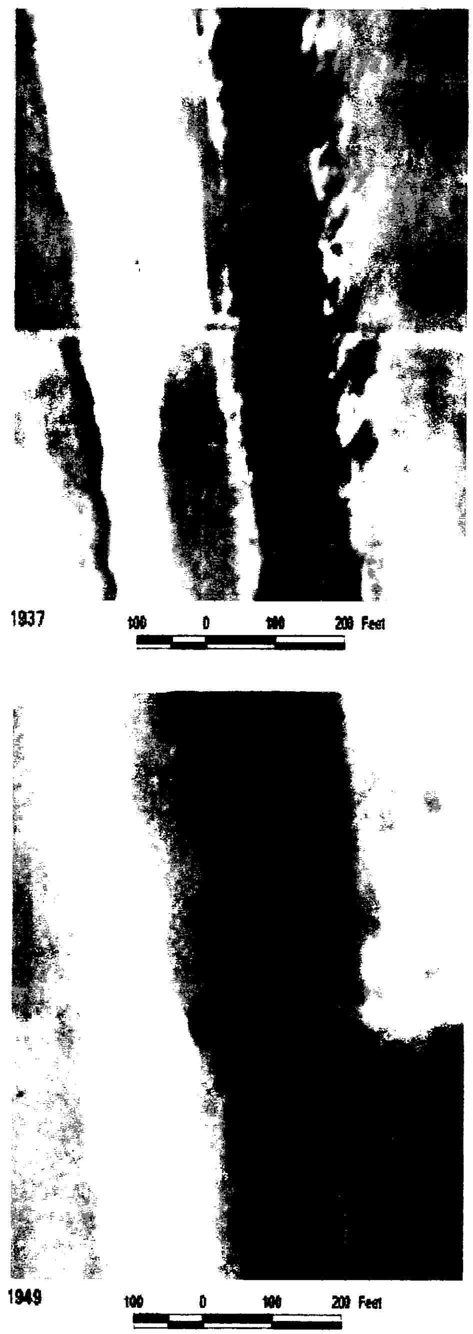


Figure 17. Location 16 from GLO 1854 survey (see Figure 12 and Table 1). Channel width at time of survey was 200 links or 132 ft. Road across Bakers Bayou in 1937 photo approximate intersection of bayou with section line. Width of bayou at road in 1937 about corresponds to survey width

Figure 18. Location 11 from GLO 1854 survey (see Figure 12 and Table 1). Channel width at time of survey was 250 links or 132 ft. Center of the photo approximate section line intersection with Bakers Bayou. Width of flooded channel in 1937 photo about corresponds to width of 1854 channel

Soils data in Appendix E identifies the edges of the old channel as being composed of Keo silt loam (USCS equivalent to CL - ML). In contrast, the soils along the lower elevations of the old channel, which corresponds to the location of the present bayou, are generally composed of Perry silty clay (USCS equivalent to CH). Both soil series include a buried soil horizon, which contains small carbonate concretions. Mottling is abundant in the Perry silty clay, and nearly absent in the Keo silt loam.

Natural levee soils are composed of the Herbert silt loam and the Rilla silt loam. These soil series correspond to a ML-CL in the USCS. Motteling is common. No buried soil horizons are associated with these soil series. However, both of these soils contain a well-developed argillic (t) B horizon (Appendix E). An argillic horizon corresponds to a B horizon with greater amounts of clay relative to the A or C horizon. The significance of an argillic horizon from a geomorphic perspective is that the clay has been illuviated or transported from the A horizon to the B horizon in solution. The increase in the clay content implies a stable horizon that through time has developed an argillic (Bt) horizon.

Soil characteristics are an important diagnostic tool to this study. A key question to this study is the significance of the buried soil horizon within the Keo and Perry soils. Does this buried soil contact mark the transition between natural conditions (i.e., prehistoric) and the onset of agriculture activities by European man in the region? If this theory is correct, then the cause for the buried horizon is associated with regional deforestation, increased surface runoff, and increased sediment transport to the drainage network. Alternatively, the buried soil horizon may represent a boundary caused by climatic changes; or a major course shift in the Arkansas River, whereby increased flooding and sediment are associated with closer proximity to the active river.

Boring Data

Six borings were drilled at Stop 6 for this study to examine the soils and the stratigraphic characteristics of the upper channel fill (see Appendix A for boring logs and Figure 5 for boring locations). The lithology of the upper channel fill consists mostly of silt (ML) and clay (CL). Soil color is highly variable, ranging from grey to tan, brown, yellow brown, and orange brown. Iron and manganese mottles are present throughout most of the core samples examined. Mottles range from few (<2 percent surface area) to many (>20 percent surface area). Also present are a few, small iron and carbonate concretions. Bedding typically ranges from thin beds to fine lamina, with both horizontal and cross bedding forms present. Bedding is present in about half of the core examined and is generally associated with the lower half of the borings where sedimentation rates were much higher. Bioturbation has generally destroyed most of the shallow primary sedimentary structures. Organic materials have typically been oxidized or reduced and are present as fine lamina (i.e., <1/16-in., ~1.6-mm) and/or disseminated organics. No significant occurrence of wood fragments, peat layers, or highly organic zones were present within the upper, fine-grained channel fill at Stop 6.

The absence of large wood fragments and/or thick occurrences of interbedded organic materials within the upper part of the abandoned course fill are due to oxidation and reduction of these sediments. Both of these processes generally consume most of the organics that are within the soil. The presence of mottles or redoximorphic features reflects the complex interplay between seasonal soil saturation, oxidation, reduction, and bacteria decomposing organic matter under anaerobic and aerobic conditions. The chemical process whereby mottles are produced and form iron masses, nodules, and concretions, or iron depletions and grey zones within the soil profile are described in detail by Vepraskas (1999). Redoximorphic features are most abundant in the cores from the center of the abandoned Bayou Bakers course, and become less pronounced along the margins of the old channel.

A detailed geologic cross section from the Bakers Bayou borings is presented in Figure 19 and identifies the major subdivision of the old channel from stratigraphic information. The boring logs in Appendix A identify laminated intervals and zones where bedding is absent because of bioturbation by organic activity. Laminated bedding corresponds to pulses of new sediment deposition during annual flooding. During the latter stages of filling of the Bakers Bayou abandoned course, accumulation of new sediment was probably restricted to major floods (i.e., 25-, 50-, 100-year events), when flood waters were able to extend into and partially fill the old course and transport new sediment. In between these major events, pedogenic activity would have altered or destroyed primary depositional structures depending on the time interval between flood events.

Available boring data from the center of the channel indicates a possible buried soil horizon between 1.0 to 1.5 ft (30 to 45 cm). A piece of glass was present in BB-5 at 1.2 ft (37 cm) and a possible buried Ao horizon was present in BB-2 at 1.5 ft (45 cm).

Sedimentation Rates

Radiometric dating was utilized in BB-4 to establish a chronology to calibrate the stratigraphy and soils data. Table 2 summarizes the results of the different methods used to age date sediments from boring BB-4.

Table 2
Summary of Radiometric Dating of Samples from BB-4

Depth, cm (in.)	Dating Method	ReportedAge	Calculated Sed Rate
0–2 cm (0-0.78 in.)	Cs-137	<1950	0.04 cm/yr
14 cm (5.5 in.)	Pb-210	151 yrs	0.09 cm/yr
167–208 cm (66–82.2 in.)	C-14	1540 yrs	0.11–0.14 cm/yr

Included in Table 2 are sedimentation rates based on various age dating methods. A bulk soil sample was necessary for the C-14 dating due to the absence of wood fragments and organic rich soil horizons. The bulk sample was

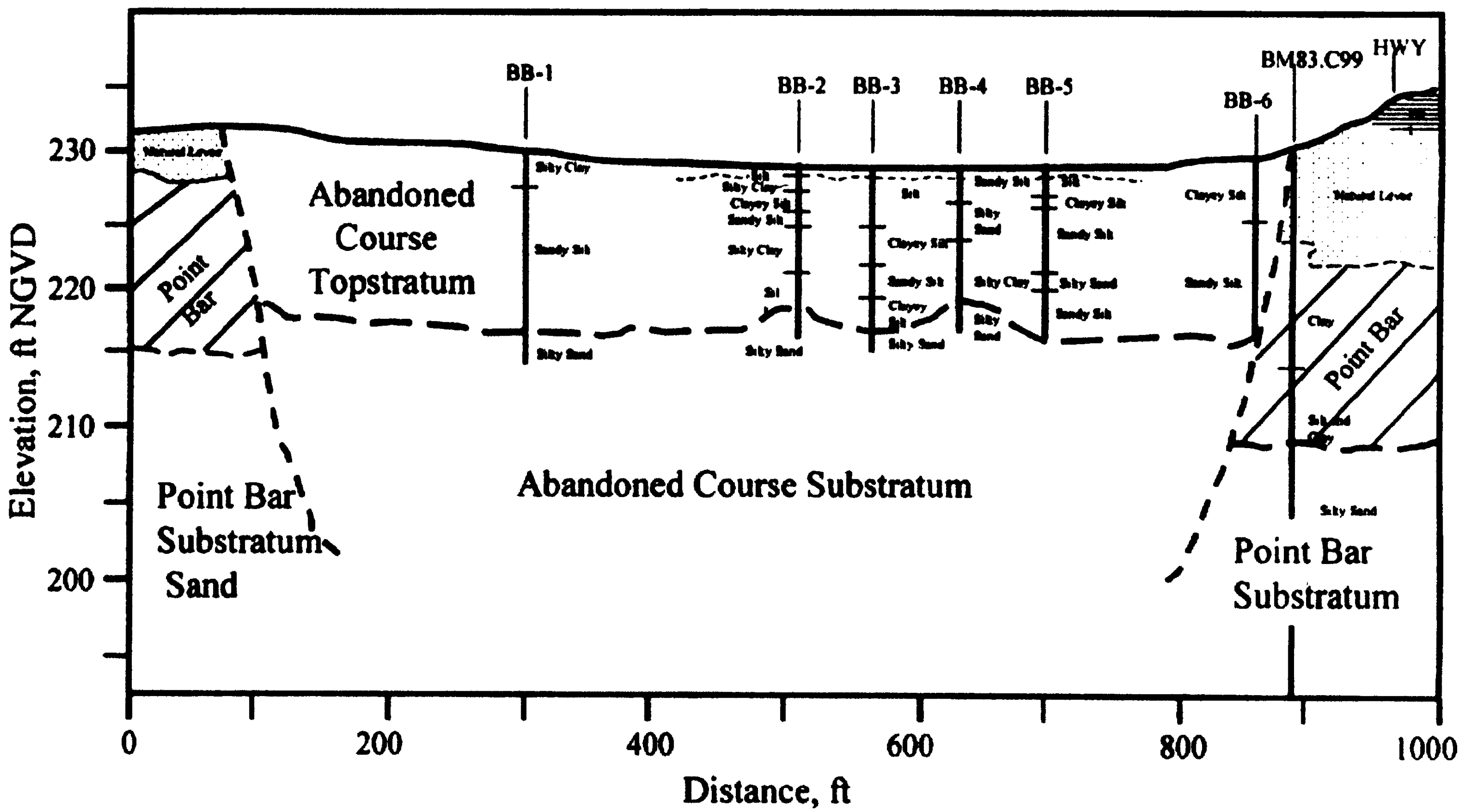


Figure 19. Cross section across Bakers Bayou (see Figure 5 for boring locations)

dated using AMS techniques. The C-14 based sedimentation rate is between 0.11 and 0.14 cm/year, and represents the rate of filling between the depth interval 14 and 167 cm and 14 and 208 cm, respectively. An average value representing the midpoint for this interval corresponds to a rate of 0.125 cm/yr. The C-14 and Pb-210 methods provide similar results and compare favorably. Both the short term (~150 years) and long term (~1,500 years) rates are in agreement. The presence of a glass fragment at 1.2 ft (37 cm) in core BB-5 provides a maximum sedimentation rate of 0.25, 0.37, or 0.74 cm/year based on the glass being 150, 100, or 50 years old respectively.

Buried Keo and Perry Soils as Historic Marker Horizons

In an earlier section of this chapter, it was reported that buried soils are associated with the Keo and Perry soil series (Appendix E) and that these soils were characteristic of the abandoned Arkansas River course known as Bakers Bayou. A major question raised was whether there is a relationship between historic land use changes and the burial of these soil surfaces. Based on the average long term sedimentation rate determined from this study, it is possible to test whether buried soil horizons identified for Keo and Perry soils are related to historic land use changes.

The typical range in depth reported for buried soils associated with the Bakers Bayou course are generally more than 36 in. (92 cm) as shown by the profiles in Appendix E. The estimated time required to bury a soil to a depth of 36 in. (92 cm) using the average sedimentation rate of 0.125 cm/year is 736 years. This estimate would indicate that these buried soils are not related to historic land use changes.

Additional conformation is provided by Mr. Tom Fortner (personal communication). Mr. Fortner was for many years the Lonoke County District Conservationist, Natural Resource Conservation Service, Lonoke, Arkansas. He considered the buried soils in Bakers Bayou to be much older and consequently, not associated with or related to historic land use changes. Furthermore, he indicated that the Perry soils were incorrectly mapped in Bakers Bayou. These soils should have been assigned a new soil series. Instead, they were assigned to the Perry series because of their high clay content.

5 Conclusions and Recommendations

Various types of data were examined during the course of this study to determine the prehistoric channel limits along Bakers Bayou at Stop 6. The time frame of particular interest to this study is 1850 and what the general conditions of the bayou or channel were at this location. From the various data examined during this study, the following conclusions are presented.

a. Bakers Bayou is an abandoned Arkansas River Course that was active between 6,000 and 8,000 years before the present.

b. Maximum channel width along Bakers Bayou during the Middle Holocene was between 600 to 900 ft. Maximum channel width at Stop 6 is about 710 ft (216 m).

c. Historic survey data identifies an 1850 channel along Bakers Bayou as ranging from 66 to 231 ft (20 to 70 m) wide. Maximum channel width at Stop 6 is estimated to range from 60 to 120 ft (18 to 37 m) based on 1937 photography. Available data examined for this study indicates the typical channel through the Bakers Bayou reach was probably not a single main channel, but rather a series of open to forested ponds separated by short and narrow channel segments.

d. Radiometric dating of sediment samples from boring BB-4 indicates general agreement between short term (~150 years) and longterm (~1,500 years) sedimentation rates. The range in rates varies between 0.04 to 0.14 cm/year. An average sedimentation rate of 0.125 cm/year is considered representative of long-term, prehistoric conditions. A piece of glass in boring BB-2 at 1.2 ft (37 cm) indicates the historic rates may be as high at 0.74 cm/year, assuming a glass age of 50 years.

e. An estimate of historic "channel" depth for Bakers Bayou at Stop 6 is less than 1 ft (<30 cm) deep based on analysis of existing data. A probable maximum depth would be estimated at no more than 3 ft (<1 m).

The following recommendation is suggested:

Perform additional shallow sampling and dating to verify the estimate of sedimentation rates in both disturbed and non-disturbed areas along Bakers Bayou. From the results of this study, the recommended sample depth would be no more than 5 ft (1.5 m). Sampling should be performed at four other locations to establish the sedimentation rates and historic filling for the entire reach of the project area.

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Appendix A
Soil Boring Logs

BORING LOG
FIELD DATA

Project: Bakers Bayou Ecosystem Restoration (BBER) Site: Site No. 6 Date: 3-13-01

Location: 31°43' 23.24" N Lat; 91° 56' 53.32" W. Long Job No: ____

Drill Rig: CE41690 Inspector: Combs/Dunbar Operator: ____ Surface El: ____ Boring No: BB-1

SAMPLE NUMBER	2001 DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Blow Count	Jar	CLASSIFICATION AND REMARKS
1	2-28	0.0		0.0	1.5	0.0	1.5	STANDARD SPLIT SPOON	—	1	Silty Clay (CL): brown (7.5YR 4/3) rootlets, damp, subangular blocky, soft, slightly plastic
2	2-28		3.0	1.5	3.0	1.5	3.0	"	—	2	Sandy Silt (ML): brown (7.5YR 4/3), rootlets, damp, [illegible], granular soft
3	2-28	3.0		3.0	4.5	3.0	4.5	"	4	3	Sandy Silt (ML) yellow red (5 [illegible])
									7		granular, dry.
									8		
4	2-28			4.5	6.0	4.5	6.0		3	4	Sandy Silt (ML): brown (7 [illegible])
									6		granular, more sand, [illegible]
									5		[illegible] than previous

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Sheet 1 of 3 Sheets

BORING LOG
FIELD DATA

Project BBER Site No. 6 Date 3-13-01
Location Job No
Drill Rig Inspector Operator Surface El Boring No. BB-1

SAMPLE NUMBER	2001 DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Blow Count	Jar	CLASSIFICATION AND REMARKS
5	2-28			6.0	7.5	6.0	7.5	STANDARD SPLIT SPOON	3	5	Sandy Silt (ML): brown (7.5YR5/6)
									3		~10% f. sand, dry, loose,
									4		uniform
6	2-28			7.5	9.0	7.5	9.0	"	3	6	Sandy Silt (ML) same
									3		
									5		
7	2-28			9.0	10.5	9.0	10.5	"	3	7	Clayey Silt (ML): darker brown
									4		(7.5YR4/6); dry, slight
									5		cohesion, uniform, light
											modeling (organics - 7.5YR3/2)
											3" clay seam on drill log —
											possible buried soil horiz?
8	2-28			10.5	12.0	10.5	12.0	"	3	8	Sandy Silt (ML): brown (7.5YR5/6)
									3		dry, loose - slight cohession,
									5		uniform

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Sheet 2 of 3 Sheets

BORING LOG
FIELD DATA

Project BBER Site No. 6 Date 3-13-01
Location
Job No
Drill Rig Inspector Operator Surface El Boring No. BB1

SAMPLE NUMBER	2001 DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Blow Count	Jar	CLASSIFICATION AND REMARKS
9	2-28		14.0	12.0	13.5	12.0	13.5	STANDARD SPLITSPOON	3	9	Sandy Silt (ML): same, uniform
									5		7.5YR5/8
									5		
10	2-28	14.0		13.5	15.0	13.5	15.0	"	3	9	Silty Sand (SM) light brown
									4		7.5YR6/4, uniform, v fine
									6		grained, loose
11	2-28			15.0	16.5	15.0	16.5	"	4	10	Silty Sand (SM) w. clay
									4		lenses, light brown (7.5YR6/4)
									5		

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Sheet 3 of 3 Sheets

General - SS

FIELD BORING LOG

HOLE NO. 1-BB-01

SHEET ____ OF ____

PROJECT Bakers Bayou LOCATION ____

DRILL RIG [illegible] INSPECTOR [illegible] OPERATOR [illegible]

DEPTH OF WATER None DATE - TABLE None DATE ____

ELEVATION OF GROUND ____

MUD ____

Sample Number	Date	Sample From	Sample To	Stratum From	Stratum To	Classification — Remarks	Type	Sampler
1	2-20-[illegible]	0.0	1.5	0.0		BR [illegible] Clay		S/S
2	"	1.5	3.0	0.0	3.0	" " "		"
3	"	3.0	4.5	3.0		BR Sandy Silt dry	4-7-[illegible]	"
4	"	4.5	6.0			BR Sandy Silt	3-6-5	S/S
5	"	6.0	7.5			BR Sandy Silt	3-3-4	"
6	"	7.5	9.0			BR Sandy Silt	3-3-5	
7	"	9.0	10.5			BR Sandy Silt w/ thin sand [illegible]	3-4-5	
8	"	10.5	12.0			BR Sandy Silt	3-3-5	[illegible]
9	"	12.0	13.5		14.0	BR Sandy Silt	3-5-5	
10	"	13.5	15.0	14.0		BR Silty Sand	3-4-6	[illegible]
11	"	15.0	16.5		16.5	BR Silty Sand w/ some [illegible] Dry	4-4-5	

[illegible] called Joe Dunbar with Results. [illegible] and [illegible] not [illegible] any samples at this location.

Gary Wilkins [illegible]

CELMN 650
JUN 90 REV.

PROPONENT
ED-G

BORING LOG
FIELD DATA

Project Bakers Bayou Ecosystem Restoration Site No 6 Date 10 April 01
Location 34° 43' 24.87" N. LAT / 91° 56' 54.86" W Long. Job No
Drill Rig CE 41650 Inspector Combs/Dunbar Operator Surface El Boring No. BB-2

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
1	2-28-01	0.0	0.22	0.0	2.3	0.0	2.15	3" Shelby Tube		1	Organic horizon, silty clay
											(CL): dark grey (10YR 4/0)
		0.22	1.5								soft, dry.
											Silt (ML): tan-yellow
											brown (10YR 5/4), laminated
											to massive, few org.
											mottles, soft, dry.
		1.5									Silty Clay (CL): dark grey
											brown (10YR 4/2 - 3/2) w.
											few org mottles (10YR 2/0)
			2.15								Soft, damp; buried Ao
2	2-28-01	2.15	3.6	2.3	4.5	2.3		"		2	Clayey Silt (ML): grey
											brown (10YR 5/2 to 4/6),
											laminated with settling
											(Fe & Mng. 10YR 3/3 & 5/8).
											soft, uniform texture,
		3.6	4.1								Sandy Silt (ML): light grey

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 4 Sheets

BORING LOG
FIELD DATA

Project BBER Site ______ Date 10 April 01
Location ______ Job No ______
Drill Rig ______ Inspector ______ Operator ______ Surface El ______ Boring No. BB-2

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
											(2.5Y 6/2); many mottles (20%) (Fe, Mag; 10YR 5/8, 2/1); uniform, bioturbated (no bedding), abrupt to wavy boundary at top / inclined (45° ε changes at bottom.
		4.1									Sandy Silt (ML) grey (10YR 6/2) w few mottles, no bedding visible
3	2-28-01			4.5	6.5	4.5	6.5	3" Shelby Tube		3	Sandy Silt (ML): same, mottles increasing at 5.0 ft (≥35%) & color orange brown (10YR 5/8). Matrix color change 5.6 ft to dark brown (10YR 4/3) and again at 6.0 ft to

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 4 Sheets

BORING LOG
FIELD DATA

Project BBER Site ______ Date 10 April 01
Location ______ Job No ______
Drill Rig ______ Inspector ______ Operator ______ Surface El ______ Boring No. BB-2

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
											drk yel brown (10YR 3/6), contact is abrupt and
			6.2								inclined at 45°, soft
4	2-28-01	6.2	8.0	6.5	8.7	6.5	8.7	3" Shelby Tube		4	Silty clay (CL), variegated grey and brown (10YR 5/3, matrix 50% w/ 10YR 5/8, 5/6, 3/1, 5/1), bioturbated, soft, damp, plastic, conc, diss. orgs.
		8.0	9.2								Clayey Silt (ML) grey (10YR 5/2), soft, few mottles (Fe, org, Mng 10YR 5/8, 2/1), faint org. laminations; damp.
5	"	9.2		8.7	11.0			"		5	Oxidized Silt (ML): 50% grey & orange brown (10YR 5/1

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 3 of 4 Sheets

BORING LOG
FIELD DATA

Project BBER Site ______ Date 10 April 91
Location ______ Job No ______
Drill Rig ______ Inspector ______ Operator ______ Surface El ______ Boring No. BB-2

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											+ 10YR 6/8 – 5/8), bioturbated
											sand increasing w. depth, soft,
											few mottles (1/16 ~ 1/8"). From
											10-11 ft, vertical contact
											between gray clay + oxid
											orange sand, extends to 11.0 ft
											1/2" conc @ 11.5';
6	2.28			11.0	12.8	11.0	12.8			6	Silty Sand (SM): brown (10YR 5/6),
											laminated, v.f.g., horiz to
											inclined bedding, soft,
											loose, Qtz sand,

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Sheet 4 of 4 Sheets

Undisturbed #2

FIELD BORING LOG

HOLE NO. 2-Bau.

SHEET ____ OF ____

PROJECT Bakers Bayou LOCATION Site 6

DRILL RIG ____ INSPECTOR ____ OPERATOR ____

DEPTH OF WATER ____ DATE ____ TABLE 2.5 DATE 2-28-01

ELEVATION OF GROUND ____

MUD 4.5'

Sample Number	Date	Sample From	Sample To	Stratum From	Stratum To	Classification — Remarks	Type Sampler
1	2-28-01	0	2.3'			BR Clayey Silt trace organics	
2	"	2.3	4.5'			BR Clayey Silt with trace Roots	
3	"	4.5	6.5			BR Clayey Silt	
4	"	6.5	8.7'			GR Sandy Silt with roots	
5	"	8.7	11.0			GR Silty Sand with trace roots	
6	"	11.0	12.6			BR Fine Sand / Silty Sand — [illegible]	

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~~PROPONENT~~ ED-G

BORING LOG
FIELD DATA

Project Bakers Bayou Ecosystem Restoration (BBER) Site No 6 Date 26 March 01
Location 34° 43' 25.39" N Lat., 91° 56' 55.27" N Long Job No
Drill Rig CE46AO Inspector Combs/Dunbar Operator Surface El Boring No. BB-3

SAMPLE NUMBER	2001 DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Comp	Tube	CLASSIFICATION AND REMARKS
1	3-1-01	0.0		0.0	2.5			3" Shelby Tube		—	LOST SAMPLE } Note see Sheet 4 for
2	"			2.5	5.0			"		—	Lost Sample } Splitspoon [illegible]
3	"	5.0	5.2	5.0	7.8	5.0	7.8	"	—	3	Clayey Silt (ML): Lt grey (10YR 4/2) w. fine [illegible] (10YR 4/6, 10YR 7/2), spherical concretions fine-medium, bio-turbated w. occasional faint lamination
											Contact at 5.7 Sharp, wavy
		5.2	7.8								Clayey Silt (ML), variegated, 50% grey & brown, (10YR 6/1, -4/6, -5/4), bioturbated, fine disseminated organics, sph. concretions fine-med (<5%), damp, soft, core is highly oxidized and weathered, contains disseminated rootlets,

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Sheet 1 of 4 Sheets

BORING LOG
FIELD DATA

Project BBER Site No. 6 Date 26 March 01
Location Job No
Drill Rig Inspector Operator Surface El Boring No. BB-3

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Comp	Tube	CLASSIFICATION AND REMARKS
4	3-1-01			7.8	9.8	7.8	9.8	3" Shelby Tube	—	4	Clayey Silt (ML): Varigated
											lt grey & brown (60%) (10YR 6/1,
											4/6, 6/8), w. many mottles
			8.5								(10YR 4/6, 2/1, 2/6), oxidized
		8.5	9.0								& weathered, bioturbated
											Mottles absent past 8.5';
											becomes coarser grading to
											sandy Silt/Silty Sand (ML/SM),
											v.f.g., drk yellow brown (varies
			10.0								10YR 5/8 - 10YR 5/4); faint
											lamination/bedding present
5.0	3-1-01	10.0		9.8	11.8			" (ditto)	0.15	5	Sandy Silt (ML): tan-brown
											(10YR 4/4 & 4/6) w. few
											mottles (10YR 2/1 & 3/6),
											dissem. organics, oxidized, Fe+Mn
											conc (few), spherical, ~1/16"

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Sheet 2 of 4 Sheets

BORING LOG
FIELD DATA

Project BBER Site No 6 Date 26 March 01
Location Job No
Drill Rig Inspector Operator Surface El Boring No. BB-3

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Corp	Tube	CLASSIFICATION AND REMARKS
5	3/01/01	10.5	11.8	9.8	11.8			3" Shelby Tube		5	Root cast 10.5–10.8 filled w.
											grey (10YR 5/1) clay (CL), soft,
											slightly plastic.
		10.8									Silt (ML): Yellow brown (10YR 5/4),
											soft, slight cohesion, sandy [illegible]
											coarsening w. depth; few fine, dry
											mottles, uniform, faint
			11.8								occasional [illegible]
6		11.8	12.5	11.8	13.8			"	0.24	6	Clayey Silt (ML): grey brown &
											yellowish [illegible] (10YR 5/1 & 5/4)
											w. few mottles (10YR 3/1 – 4/6),
											fine – 1/8" diam, spherical,
											soft, blocky.
		12.5	—								Silty Sand (SM): yell. brown
											(10YR 5/[illegible]), uniform, v.f.g.,
											dense, faint laminated.

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Sheet 3 of 4 Sheets

BORING LOG
FIELD DATA

Project ______ Site ______ Date 26 March 01
Location ______ Job No ______
Drill Rig ______ Inspector ______ Operator ______ Surface El ______ Boring No. BB-3

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
								3" Shelby Tube		6	occ very fine mottles, lateral accretion channel fill
— DISTURBED SAMPLES								—		Jar	—
1	3/01/01	0.0		0.0	1.5	0.0	1.5	STANDARD SPLIT SPOON		1	Silt (ML): dk yellow brown (10YR4/4); with organics, roots, [illegible] mottles & [illegible] (10YR 2/2), damp, block,
2	"			1.5	3.0			"		2	Silt (ML): same, moist
3				3.0	4.5			"		3	Silt (ML): same, wet
				4.5	6.0					4	Silt (ML): Yellowish Brown (10YR5/4); lower organics, more [illegible] [illegible], occassional concretion (<1/8")

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Sheet 4 of 4 Sheets

Undisturbed

#3

FIELD BORING LOG

3-BBU-01

HOLE NO.____

SHEET____ OF____

PROJECT Bakers Bayou LOCATION____

DRILL RIG CE 17654 Failing INSPECTOR Combs OPERATOR [illegible]

DEPTH OF WATER____ DATE____ TABLE____ DATE____

ELEVATION OF GROUND____

MUD____

Sample Number	Date	Sample From	Sample To	Stratum From	Stratum To	Classification — Remarks	Type Sampler
1	3-1-01	0.0	2.5			Sample slipped from tube	3" Tube
2	"	2.5	5.0			" " " "	"
3	"	5.0	7.8			BK Silty clay w/ lens sand	"
4	"	7.8	9.8			BK - GR Sandy silt w/ lens clay	"
5	"	9.8	11.8			BK Silty sand	"
6	"	11.8	13.8			BK silty sand	"

Note: Missing 2 samples #1 & 2

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Core Sampled for C137, PbZ10, & C14, see page 4 for details

BORING LOG
FIELD DATA

Project Bakers Bayou Ecosystem Restoration Site No 6 Date 8 April 2001
Location 34° 43' 25.39" N LAT / 91° 56' 55.72" W Long Job No
Drill Rig CE41690 Inspector Combs / Dunbar Operator C Surface El Boring No BB-4

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
1	3-5-01	0.0	0.2	0.0	1.5	0.0	1.5	3" Shelby Tube		1	Organic Sandy Silt (ML)
											A horiz, drk grey brown
											(10YR 4/4); few mottles
		0.2	1.1								laminated sandy silt (ML)
											yellow brown (10YR 5/4 & 5/8),
											w. drk organic leaf horizs
											(1/16 ~ 1/64"), dry, soft, faint bars.
		1.1	1.35								Silty Clay (CL) drk brown
											(10YR 4/4, 5/6,)
2	"	1.35	3.0	1.5	3.0	2.0	3.0	"		2	Sandy Silt (ML) drk yell.
											brown (10YR 5/8, 6/8, 4/6),
											horiz-wavy lenses; few Fe/Mn
											nodules,
3	"	3.0	5.5	3.0	5.5	2.5	5.5	"		3	Silty Sand / [illegible]
											wet - moist, heavy mottling
											matrix is tan - brown
											(10YR 5/4, 5/3), uniform, some

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Sheet 1 of 4 Sheets

BORING LOG
FIELD DATA

Project BBEK Site No6 Date 8 April 2001
Location ______ Job No ______
Drill Rig ______ Inspector ______ Operator ______ Surface El ______ Boring No. BB-4

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											Mottles / organic, 10YR 2/1;
											slight bedding visible, few Fe
											concretions (5YR 4/6)
4	3-5-01	5.5	7.9	5.5	8.5	5.5	8.5	3" Shelby tube		4	Silty Clay (CL): tan (10YR 5/4
											& 5/6) with few [illegible] 1/16"
											[illegible] (10YR 3/1) to 6.3
											Heavy Mottlings concretions
											between 6.3 – 7.2, conc.
											are Iron/Manganese fragments,
											irreg shaped (1/16" – 1/8", few
											1/4" size). Between 7.2 –
											7.9 have gradual decrease
											in mottles.
		7.9	8.5								Silt (ML): dark brown
											(5YR 4/6), abrupt boundary,
											few fine lamin in uniform,
											bioturbated, matrix, N occ

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Sheet 2 of 4 Sheets

BORING LOG
FIELD DATA

Project BBER Site No. 6 Date 5 April 01
Location Job No
Drill Rig Inspector Operator Surface El Boring No. BB-4

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											mottling (org/Mng-1/8"-1/16")s
											occ Fe conc.
5	3-5-01	8.5	9.9	8.5	10.5	8.8	10.5	3" Shelby Tube		5	Clayey Silt (ML) dark brown
											(10YR4/6), damp, soft, w.
											fe(?) conc (1/8"), varigated
											w. grey & tan hypocoats
											throughout matrix.
6	"	9.9	—	10.5	12.2	10.0	12.2	"		6	Silty Sand (SM): v.f. grained,
											may border on silt, dark
											orange brown (10YR4/6),
											uniform, dense, thick
											bedded to massive, contains
											filled root/burrows with
											Fe concs at 10.7-13.4'
											Vertical root/burrows, faint-
											diffuse laminations visible

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Sheet 3 of 4 Sheets

BORING LOG
FIELD DATA

Project BBER Site No. 6 Date 8 April 01
Location Job No
Drill Rig Inspector Operator Surface El Boring No BB-4

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
											Note core sampled every 2cm in tubes no. 1&2 and every 5cm in tube no 3 by Dr. Chuck Holmes, USGS, for Cesium 137 and Lead 210 age dating. Sample taken at 5.5-6.85 ft for AMS dating of organic sediment

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#4

FIELD BORING LOG

HOLE NO. 4 BBU-01

SHEET ____ OF ____

PROJECT Bakers Bayou LOCATION ____

DRILL RIG ____ INSPECTOR Combs OPERATOR Mann

DEPTH OF WATER ____ DATE ____ TABLE ____ DATE ____

ELEVATION OF GROUND ____

MUD ____

Sample Number	Date	Sample From	Sample To	Stratum From	Stratum To	Classification — Remarks	Type	Sampler
1	3-50	0.0	1.5	0.0		BR silt w/clay moist		3" Tube
2	"	1.5	3.0	0.0	5.5	" " "		"
3	"	3.0	5.5	5.5	8.5	BR lean clay		"
4	"	5.5	8.5	8.5		BR sandy silt w/clay moist		"
5	"	8.5	10.5	8.5		" " " moist		"
6	"	10.5	12.2	8.5		" " " "		"

Note: No Label on Spl. Six 10.5-12.2:

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PROPONENT
ED-G

BORING LOG
FIELD DATA

Project Bakers Bayou Ecosystem Restoration (BBER) Site #6 Date 3-30-01
Location 34° 43' 26.52" N Lat. 91° 56' 56.14" W. Long Job No
Drill Rig CE 41690 Inspector Combs/Dunbar Operator Surface El Boring No. BB-5

SAMPLE NUMBER	2001 DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
1	3-6-01	0.0	0.5	0.0	2.5	0.0	2.5	3" Shelby Tube		1	Cla[illegible] (CH): dark grey (10YR 3/2),
											soft, plastic, few yellow
											brown mottles (10YR 4/6) &
											dissem. organics (<5%), no
											sed structure, bioturbated
		0.5	2.0							1	Silt (ML): laminated to thinly
											bedded, variable brown & tan
											(10YR 6/3, 6/6, 6/8, 4/4),
											Piece of glass @ 1.2 ft,
											occassional mottling (organics
		2.0	2.5								- 10YR 3/1), rootlets; grades
											to a mixed clay/silt/org
											laminated core @ 2.0 ft. slightly
											weathered, slightly bioturbated
2		2.5	3.25	2.5	5.0	2.5	4.85	3" Shelby Tube		2	Clayey Silt (ML) dark-lt. grey

2b

glass
b

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Sheet 1 of 4 Sheets

BORING LOG
FIELD DATA

Project BBER Site #6 Date 3-30-01
Location ______ Job No ______
Drill Rig ______ Inspector ______ Operator ______ Surface El ______ Boring No. BB5

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
								3" Shelby Tube		2	10YR 4/1 - 4/3) ± brown (10YR 5/4);
											dissem. organics (<5%), occasional
											lamina - massive (bioturbated),
											trace of filled (organic-rich silt) IIa
											roots (1/8 - 1/4" diam), soft
		3.25								2.0	Silt (ML): yellow-brown (10YR 4/4),
											uniform, soft, damp, w. IIb
											few mottles (10YR 6/8, 3/1),
											slight cohesion;
				5.0	7.5	5.0	7.6	3" Shelby Tube		3	Silt (ML): reddish brown (5YR
											4/4 - 4/6 matrix), few organic IIIa/b
											mottles, faint lamina, increased
			6.1								cohesion. (higher clay content)
											dense soft

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BORING LOG
FIELD DATA

Project BBER Site No 6 Date 3-30-01
Location ___ Job No ___
Drill Rig ___ Inspector ___ Operator ___ Surface El ___ Boring No. BB-5

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS	
		6.1						3" Shelby Tube		3	Sandy Silt (ML/SM): yellow brown,	
											(10YR 5/4), laminated, x-bedding,	IIIb
											trough fill, gradding to	
			6.9								a silty sand (SM/ML)	
		6.9									Silty Sand (SM): dk yellow	
											brown (10YR 4/6), faint lamina	
											to uniform, massive, slight	
											to little cohession, dissem.	
			8.0								organics & few 1/16" mottles	
		8.0	9.5	7.5	9.5	7.5	9.5	3" Shelby Tube		4	Sandy Silt (ML): dk yellow brown	IIb
											(7.5YR 4/6) grading to lt. yellow	
											brown (10YR 5/8) individual	
											lamina are visible ~1/16-1/8"	C
											horizonal, uniform in texture,	
											sandy, loose to slight cohession,	
											dk layers (clay organic) are 1/8-1/4"	

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BORING LOG
FIELD DATA

Project ______ Site ______ Date ______
Location ______ Job No ______
Drill Rig ______ Inspector ______ Operator ______ Surface El ______ Boring No. BB-5

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
				9.5	11.5	9.5	11.5	3" Shelby Tube		5	Silt (ML): Yellow Brown (10YR 5/6),
											wet, uniform, massive, slight
											mottling (org/mag), soft,
											little-no cohesion, no
			11.1								bedding or lamina. visible.
		11.1	—	11.0	12.5	11.0	12.5	"		6	Sandy Silt (ML): thin-thick
											(6-8") bedded, yellow
											brown (10YR 5/6, 6/8),
											uniform, soft, dense, damp

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

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#5

FIELD BORING LOG

5-BBU-1
HOLE NO.____
SHEET ____ OF ____

PROJECT Bakers Bayou LOCATION ____
DRILL RIG CE 41690 F1550 INSPECTOR Combs OPERATOR Mann
DEPTH OF WATER ____ DATE ____ TABLE ____ DATE ____
ELEVATION OF GROUND ____

Sample Number	Date	Sample From	Sample To	Stratum From	Stratum To	Classification — Remarks	MUD Type	Sampler
1	3-6-01	0.0	2.5	0.0		BR silt moist		3" Tube
2	"	2.5	5.0	5.0	7.5	" " sat		"
3	"	5.0	7.5	7.5		BR sandy silt moist		"
4	"	7.5	9.5	7.5		" " " "		"
5	"	9.5	11.0	7.5		" " " "		"
6	"	11.0	12.5	7.5		" " " "		"

Note No Table on Tube Power estimate

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PROPONENT
ED-C

BORING LOG
FIELD DATA

Project Bakers Bayou Ecosystem Restoration (BBR) Site No. 6 Date 2 April 01
Location 34°43'27.80"N Lat 91°56'57.25"W Long Job No
Drill Rig CE41690 Inspector Combs/Dunbar Operator Surface El Boring No. BB-6

SAMPLE NUMBER	2001 DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
1	3/6/01	0.0		0.0	2.0	0.0	1.9	3" Shelby Tube		1	Clayey Silt (ML): dk brown
											(10YR 3/3) with few, small
											(<1/16") organic mottles (10YR 3/3),
			1.1								no bedding visible, uniform,
											dry, dense, bioturbated
		1.1									Silty clay (CL): dk brown
											(7.5YR 4/4), plastic, soft
			2.0								dry, no bedding, bioturbated
2	3/6/01	2.0	2.2	2.0	4.7	2.0	4.7	"		2	Clayey Silt (ML): dk brown
											(10YR 3/3), abrupt boundary
											color change
		2.2									Clayey Silt (ML): dk reddish
											brown (5YR 4/4), dry, uniform
											soft, slight cohesion, dense
											[illegible] mottling [illegible]
											From 5.15-5.30 ft, [illegible]
				5.3							clay lenses (10YR 8/2), pos[illegible]

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Sheet 1 of 3 Sheets

BORING LOG
FIELD DATA

Project BBER Site No. 6 Date 2 April 01
Location Job No
Drill Rig Inspector Operator Surface El Boring No. BB-6

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Tube	CLASSIFICATION AND REMARKS
											organic horizon.
		5.3		4.7	6.7	4.7	6.46	3" Shelby Tube		3	Sandy Silt (ML): yellow brown
											(10YR 6/6, 6/8), laminated
											to thinly bedded, horiz - wavy
											beddings laminations, clay ball
											(3/4-1" diam) at 6.0 ft with dark
											brown color (10YR 3/4), majority
											of core in interval consists of
											fine lamina between 1/16 - 1/32"
											thick.
				6.7	9.0	6.7	8.9	"		4	Sandy Silt (ML): light yellow [illegible]
											to tan (10YR 6/8 - 7/4); massive,
											bioturbated to 7.4, clay
											ball/clast from 7.4 - 7.8 ft
											(10YR 4/6); below 7.8 [illegible] [illegible]
											horiz - wavy, thinly bedded -

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 3 Sheets

BORING LOG
FIELD DATA

Project ______ Site ______ Date 2 April 0[illegible]
Location ______ Job No ______
Drill Rig ______ Inspector ______ Operator ______ Surface El ______ Boring No. BB-6

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
								3" Shelby tube		4	laminated sandy silt, individual lamina range from tan to orange brown in color (10YR 7/4, 7/3, 7/2, & 5/8)
				9.0	11.5	9.5	10.5	"		5	Sandy Silt (ML): same as above; laminated, soft, slight cohesion, wavy to horiz with minor cross bedding at 10.5 ft. Approx 0.5 ft of fallin.
				11.0	12.8	11.0	12.8	"		6	Sandy Silt (ML) same, laminated to thinly bedded (<3"), horizontal, [illegible] dry, dense

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 3 of 3 Sheets

6

FIELD BORING LOG

6-BBU-01
HOLE NO. ____

SHEET ____ OF ____

PROJECT Bakers Bayou LOCATION ____
DRILL RIG E 41690 Failing INSPECTOR Combs OPERATOR Mann
DEPTH OF WATER ____ DATE ____ TABLE ____ DATE ____
ELEVATION OF GROUND ____

MUD ____

Sample Number	Date	Sample From	Sample To	Stratum From	Stratum To	Classification — Remarks	Type	Sampler
1	3-6-01	0.0	2.0	0.0	4.7	BK lean clay		3" Tube
2	"	2.0	4.7	4.7		BR Sandy Silt moist		"
3	"	4.7	6.7	4.7		" " " "		"
4	"	6.7	9.0	4.7		" " " "		"
5	"	9.0	11.5	4.7		" " " "		"
6	"	11.5	13.2	4.7		" " " "		"
						Refusal sample #6 11.5-13.2		
						1-BBU-01 34° 43' 23.24" N		
						91° 56' 53.32" W		
						2-BBU-01 34° 43' 24.87" N		
						91° 56' 54.86" W		
						3-BBU-01 34° 43' 25.39" N		
						91° 56' 55.27" W		
						4-BBU-01 34° 43' 25.95" N		
						91° 56' 55.72" W		
						5-BBU-01 34° 43' 26.52" N		
						91° 56' 56.14" W		
						6-BBU-01 34° 43' 27.80" N		
						91° 56' 57.25" W		

WCELMR 650
JUN 90 REV.

PROPONENT
ED-G

Appendix B
Cesium-137 and Lead-210 Dating Results

Dunbar, Joseph B ERDC-GSL-MS

From: Charles W Holmes [cholmes@usgs.gov]
Sent: Thursday, June 21, 2001 11:36 AM
To: Dunbar, Joseph B
Subject: Bakers bayou

holmes-bb.xls

Joe:

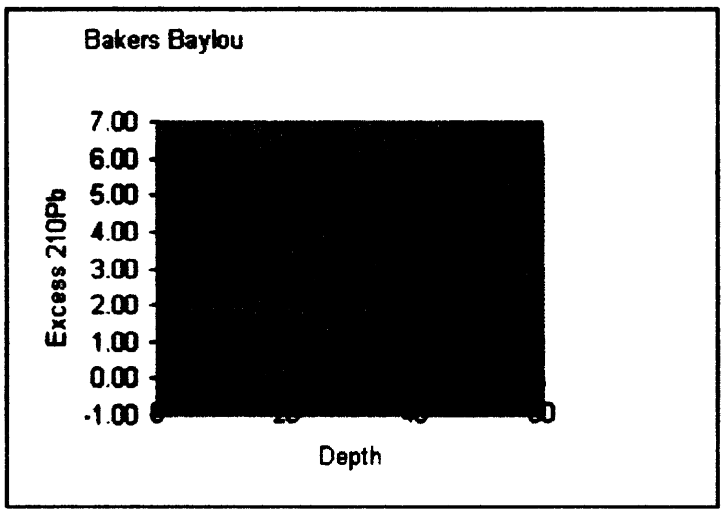
The calculated rate of accumulation is 0.09 cm/yr. This put the 14cm interval at about 151 years/pb. The core was very difficult because of the variation in sediment type. But I think we got a good handle on it by separating the coarse from the fined. This is why the sample intervals are different from those I took.

The Attached excel files contains the data and the curve. The Pb-210 is the raw number, the Ra226 is the radium which is used as the ambient 210Pb. As you can see the only Cs-137 that showed up was in the top sample. The top was duplicated.

Any questions call, I will be in and out for the next two weeks.

Chuck Holmes
600 4th Street South
St. Petersburg, Fl 33701
E-mail- cholmes@usgs.gov
Phone(voice) 727-803-8747 (ex 3056)
Fax 727-803-2032

Values in dpm/g	USACE		Excess dpm/g	210Pb dpm/g	226Ra dpm/g	137Cs dpm/g	
-	BB 0-2	1	5.80	6.86	1.06	0.26	The
	BB 0-2 (2)	1	5.39	6.58	1.19	0.22	
	BB 2-8	5	2.62	4.52	1.90	nd	
	BB 8-12	10	1.16	2.96	1.80	nd	
	BB12-16	14	0.05	1.95	1.90	nd	
	BB 18-20	19	-0.03	1.69	1.72	nd	
	BB 38-40	39	0.12	2.20	2.08		
	BB3 0-5			3.12	1.95	nd	
	BB2 0-3			1.59	1.33	nd	
	error (dpm/g)			0.25	0.20		



ppm	dpm/g	dpm/g	inaa/gamma
11.7	2.8314	2.98	0.9501342
11.9	2.8798	3.51	0.8204558
11.9	2.8798	3.28	0.8779878
12.8	3.0976	3.86	0.802487
12.4	3.0008	3.35	0.8957612
10.7	2.5894	3.12	0.8299359
11.6	2.8072	3.08	0.9114286
11.8	2.8556	3.16	0.9036709
11.9	2.8798	3.52	0.818125
12.9	3.1218	3.34	0.9346707
12.4	3.0008	3.41	0.88
10.9	2.6378	3.45	0.7645797
12.8	3.0976	3.29	0.9415198

Appendix C
Carbon-14 Dating Results

May 25, 2001

Mr. Joseph B. Dunbar
US Army Corps of Engineers
Waterways Experiment Station
CEWES-66Y
3909 Halls Ferry Road
Vicksburg, MS 39180
USA

RE: Radiocarbon Dating Result For Sample BB-4-C14-1@6.85'+6.5+5.5

Dear Mr. Dunbar:

Enclosed is the radiocarbon dating result for one sample recently sent to us. It provided plenty of carbon for an accurate measurement and the analysis went normally. The report sheet contains the method used, material type, applied pretreatments and, where applicable, the two sigma calendar calibration range.

As always, this report has been both mailed and sent electronically. All results (excluding some inappropriate material types) which are less than about 20,000 years BP and more than about ~250 BP include this calendar calibration page (also digitally available in Windows metafile (.wmf) format upon request). Calibration is calculated using the newest (1998) calibration database with references quoted on the bottom of the page. Multiple probability ranges may appear in some cases, due to short-term variations in the atmospheric 14C contents at certain time periods. Examining the calibration graph will help you understand this phenomenon. Don't hesitate to contact us if you have questions about calibration.

We analyzed this sample on a sole priority basis. No students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analysis. We analyzed it with the combined attention of our entire professional staff.

Information pages are also enclosed with the mailed copy of this report. If you have any specific questions about the analysis, please do not hesitate to contact us.

The cost of the analysis was charged to your VISA card. A receipt is enclosed. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

Mr. Joseph B. Dunbar

Report Date: 5/25/01

US Army Corps of Engineers

Material Received: 4/12/01

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta – 154710	1530 +/-40 BP	-24.4 o/oo	1540 +/-40 BP

SAMPLE: BB-4-C14-1@6.85•+6.5+5.5
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (organic sediment); acid washes
2 SIGMA CALIBRATION : Cal AD 420 to 620 (Cal BP 1530 to 1330)

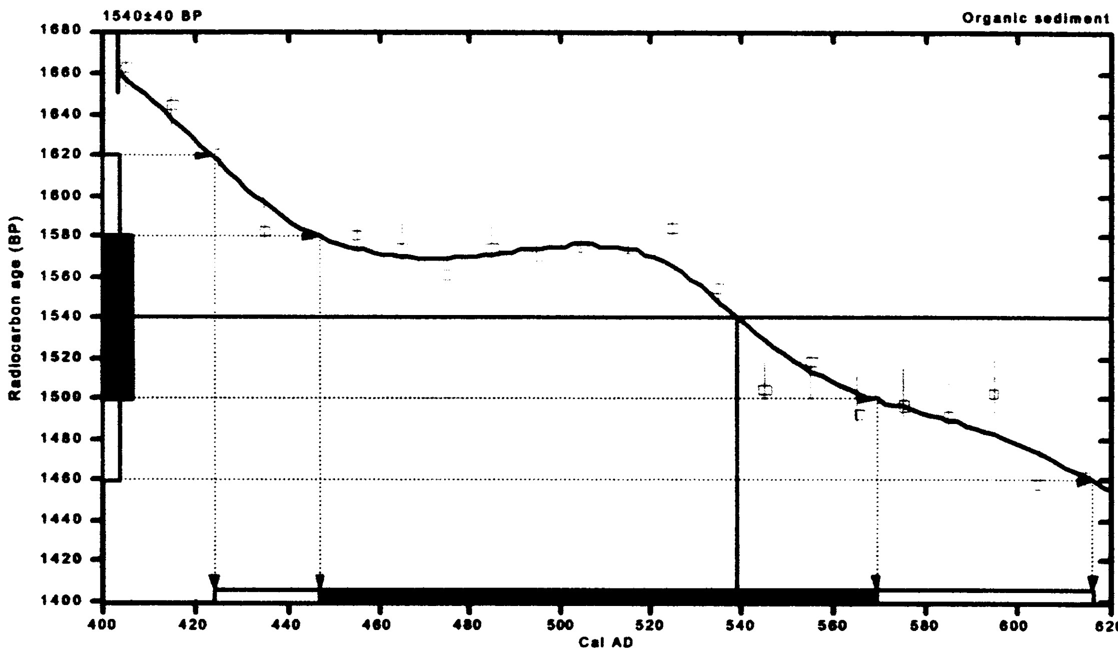
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4:lab. mult=1)

Laboratory number:	Beta-154710
Conventional radiocarbon age:	1540±40 BP
2 Sigma calibrated result: (95% probability)	Cal AD 420 to 620 (Cal BP 1530 to 1330)

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 540 (Cal BP 1410)
1 Sigma calibrated result: (68% probability)	Cal AD 450 to 570 (Cal BP 1500 to 1380)



References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxli-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Inc.

4985 SW 74 Court, Miami, Florida 33155 USA • Tel: (305) 667 5167 • Fax: (305) 663 0964 • E-Mail: beta@radiocarbon.com

Appendix D
Topographic Profiles Across Bakers Bayou

Appendix E
USDA Soil Profile Information

Typical pedon of Keo silt loam, 0 to 1 percent slopes, in a field in the NE1/4NE1/4SW1/4 sec. 21, T. 1 N., R. 10 W., Lonoke County:

Ap—0 to 6 inches; dark brown (7.5YR 4/4) silt loam; weak fine granular structure; very friable; common fine roots; slightly acid; abrupt smooth boundary.

B1—6 to 12 inches; dark brown (7.5YR 4/4) silt loam; weak medium subangular blocky structure; very friable; few fine roots; slightly acid; clear smooth boundary.

B2—12 to 30 inches; dark brown (7.5YR 4/4) silt loam; weak medium subangular blocky structure; friable; common fine pores; neutral; clear wavy boundary.

C1—30 to 48 inches; brown (7.5YR 4/4) very fine sandy loam; massive; very friable; neutral; clear smooth boundary.

IIAb—48 to 54 inches; dark brown (7.5YR 4/4) silt loam; few fine distinct strong brown mottles; weak medium subangular blocky structure; friable, few fine pores; few dark stains; few small concretions; mildly alkaline; clear smooth boundary.

IIIC2—54 to 72 inches; brown (7.5YR 5/4) very fine sandy loam; massive; very friable; mildly alkaline.

Typical pedon of Perry silty clay, 0 to 1 percent slopes, in a field in the NE1/4NE1/4SW1/4 sec. 24, T. 2 S., R. 8 W., Lonoke County:

Ap—0 to 4 inches; dark gray (10YR 4/1) silty clay; few fine distinct strong brown mottles; weak medium subangular blocky structure; firm; common fine roots; medium acid; abrupt smooth boundary.

B21g—4 to 23 inches; gray (10YR 5/1) clay; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very firm; few fine roots; few slickensides which do not intersect; few black stains; medium acid; clear smooth boundary.

B22g—23 to 34 inches; dark gray (10YR 4/1) clay; few fine distinct strong brown and reddish brown mottles; moderate medium subangular blocky structure; very firm; few fine roots; few slickensides which do not intersect; slightly acid; clear wavy boundary.

IIB3—34 to 54 inches; reddish brown (5YR 4/3) clay; common fine faint dark reddish gray mottles; moderate medium subangular blocky structure; very firm; few slickensides which do not intersect; common carbonate concretions; mildly alkaline; gradual wavy boundary.

IIC—54 to 72 inches; reddish brown (5YR 4/3) silty clay; common medium faint dark reddish gray (5YR 4/2) and distinct yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; very firm; common carbonate concretions; calcareous; moderately alkaline.

Typical pedon of Herbert silt loam, 0 to 1 percent slopes, in a field in the SW1/4SE1/4NW1/4 sec. 5, T. 2 S., R. 9 W., Lonoke County:

Ap—0 to 7 inches; brown (10YR 4/3) silt loam; weak medium granular structure; friable; common fine and medium roots; few fine pores; strongly acid; clear smooth boundary.

A2—7 to 14 inches; grayish brown (10YR 5/2) silt loam; common medium distinct brown (10YR 4/3) and strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine roots; common fine pores; few fine dark concretions; strongly acid; clear wavy boundary.

B21t—14 to 27 inches; reddish brown (5YR 4/4) silty clay loam; grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) silt coatings on peds; common medium distinct yellowish red (5YR 5/6) and reddish gray (5YR 5/2) mottles; moderate coarse prismatic parting to moderate medium subangular block structure; firm; thin patchy clay films on faces of peds and in pores; few fine roots; common fine pores; few fine dark concretions; very strongly acid; gradual wavy boundary.

B22t—27 to 36 inches; reddish brown (5YR 5/4) silt loam; grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) silt coatings on peds; common fine distinct yellowish red and reddish gray mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; thin patchy clay films on faces of peds and in pores; common fine pores; few fine soft dark brown concretions; very strongly acid; gradual wavy boundary.

B3—36 to 53 inches; brown (7.5YR 4/4) silt load; common fine distinct grayish brown and strong brown mottles; weak medium subangular blocky structure; friable; few line pores; few fine soft dark brown concretions; strongly acid; gradual wavy boundary.

C—53 to 72 inches; reddish brown (5YR 5/4) silt loam; few fine distinct grayish brown and strong brown mottles; massive; friable; few black stains; few fine soft dark brown concretions; slightly acid.

Typical pedon of Rilla silt loam, 0 to 1 percent slopes, in a field in the SE1/4SE1/4NE1/4 sec. 25, T. 1 S., R. 9 W., Lonoke County:

Ap—0 to 6 inches; dark brown (10YR 4/3) silt loam; weak medium granular structure; friable; common fine and medium roots; medium acid; abrupt smooth boundary.

A2—6 to 12 inches; brown (10YR 5/3) silt loam; few fine faint dark yellowish brown mottles; weak medium subangular blocky structure; friable; few fine roots; few fine pores; strongly acid; clear wavy boundary.

B2t—12 to 38 inches; reddish brown (5YR 4/4) silty clay loam; moderate medium and coarse subangular blocky structure; firm; thin pale brown (10YR 6/3) silt coatings on faces of peds; few thin patchy clay films on peds; common fine pores; very strongly acid; gradual wavy boundary.

B3—38 to 55 inches; yellowish red (5YR 4/6) silt loam; weak medium subangular blocky structure; friable; few thin patchy clay films; few fine pores; small pockets and streaks of pale brown loam; very strongly acid; gradual wavy boundary.

C—55 to 72 inches; yellowish red (5YR 4/6) loam; massive; very friable; common pale brown (10YR 6/3) fine sandy loam pockets and streaks; strongly acid.

SECTION VI

WATER QUALITY

Part A. Water Supply
Part B. Flood Control

Bayou Meto Area
Flood Control Project
Water Quality Summary

The State of Arkansas has designated the waters within the Bayou Meto project area as suitable for the propagation of fish and wildlife; primary and secondary contact recreation; and public, industrial, and agricultural water supplies. Although there is some concern for elevated bacteria and nutrients in Wabbaseka Bayou and high turbidity in the Arkansas River, all designated uses are being maintained in these waters. The upper reach of Bayou Meto is under a fish consumption advisory due to elevated concentrations of dioxin in fish tissue. The current advisory extends to the Highway 13 Bridge; but in future may be extended downstream of this site for certain fish species. Although the dioxin source, the Vertac, Inc. site, is considered 100 percent remediated, it has not been delisted from the National Priorities List (NPL).

Concentrations of chemical parameters exhibit patterns generally expected within historic agricultural regions. Streams in the more agricultural areas were characterized by higher turbidity, suspended and dissolved solids concentrations than portions of the stream in urban areas. Concentrations of dissolved solids, chloride, sulfate and conductivity peak in the late summer when conditions are dry and water levels are usually low. Nitrogen, phosphorus, fecal coliform and turbidity concentrations peak in the late winter and spring when rain is more plentiful and runoff occurs. Samples collected from the Arkansas River had mean concentrations for TDS higher than the other streams. Mean concentrations for conductivity, fecal coliform, sulfate, and chloride were higher in the Arkansas River than in other streams over the same period of record. Each parameter examined exceeded its State criterion at least once during the period of record; however, these occasions were temporal in nature and concentrations did not remain elevated long after the associated event ended.

In the Mississippi Embayment Study, the USGS reported that concentrations of pesticides showed distinct seasonal patterns that corresponded to the types of crop grown in the basin and the pesticide used on those crops. Water samples from Bayou Meto, Two Prairie Bayou, Wabbaseka Bayou and Indian Bayou had traces of pesticides in the low parts per billion range. While no DDT was detected in the water samples, all sediment samples collected by MVK had trace amounts of DDT or its derivatives.

SECTION VI

WATER QUALITY

Part A. Water Supply

Bayou Meto Basin, Arkansas
Water Quality Assessment
Water Supply

General. The Bayou Meto Basin, Arkansas Project area is located in east central Arkansas and includes portions of Lonoke, Jefferson, Prairie, Pulaski, and Arkansas counties. The project area encompasses 779,109 acres lying generally south of Interstate 40, between the Arkansas and White Rivers. Tributaries of the Arkansas River provide natural drainage to the project area. Major tributaries include Bayou Meto, Two Prairie Bayou, Indian Bayou, and Little Bayou Meto. Smaller tributary systems include Wabbaseka Bayou, Baker's Bayou, Salt Bayou Ditch, Big Ditch, and Crooked Creek. Some 396,874 acres of the project area are irrigated and 22,942 are in commercial fishponds. Primary crops include rice, soybeans, cotton, wheat, and baitfish. Currently, agriculture relies heavily on the Mississippi River Valley alluvial aquifer as the primary source of irrigation water. However, groundwater is being withdrawn at such a rate that the aquifer is in danger of being permanently damaged. Surface stream flows can become inadequate to support fish and wildlife during the summer months due to the lack of rainfall and withdrawals for crop irrigation. Agricultural flooding is a major problem at other times of the year. The Bayou Meto Basin Project is twofold. One goal is to provide flood control to the low-lying regions in the project area. The second goal is to relieve the strain on the aquifer by supplying irrigation water from the Arkansas River through a series of new canals, improved existing channels, and pipelines. Localized, supplemental storage will also be added through the development of on-farm reservoirs. This section of the report addresses the existing irrigation water quality within the project area and evaluates project impacts as a result of water supply improvements.

Project Description. Alternatives for the Bayou Meto Water Supply Study are described in detail in other sections of this document. They include plans to construct a pumping station to obtain water from the Arkansas River, construct new canals, selectively excavate existing streams to improve capacity, and construct pipelines to carry water to fields.

General Water Quality. The project area is located within three USGS Hydrologic Units (HU): the Lower Arkansas River (HUC 08020401) containing Wabbaseka Bayou; Bayou Meto and its tributaries (HUC 08020402); and the Lower Arkansas-Maumelle (HUC 11110207), the source water for the water supply project. These three Hydrologic Units lie within the Arkansas Delta Ecoregion. A review of the 2002 State of Arkansas Integrated Water Quality Monitoring and Assessment (305(b)) Report indicates that the Arkansas Department of Environmental Quality (ADEQ) has designated the waters within the project area as suitable for the propagation of fish and wildlife; primary and secondary contact recreation; and public, industrial, and agricultural water supplies. Although there is some concern for elevated bacteria and nutrients in Wabbaseka Bayou and high turbidity in the Arkansas River, all designated uses are being maintained in these waters. The upper reach (007) of Bayou Meto is under a fish consumption advisory due to the presence of dioxin in fish tissue. ADEQ states that the source, residue from Vertac, Inc. a Superfund site, has been removed and that contamination downstream is being addressed through natural attenuation.

The 2002 305(b) report also assesses the quality of groundwater within the State through the Arkansas Ambient Groundwater Monitoring Program. This program began in 1986 and currently consists of nine monitoring areas. These monitoring areas are used to gather water quality data from various aquifers in representative areas of the state in order to evaluate potential impacts from multiple land uses. The Lonoke Monitoring Area represents a rural, agricultural community that relies entirely on groundwater for all its water needs. The Lonoke Monitoring Area has one well in the Sparta aquifer and thirteen wells in the alluvial aquifer; ten, of which, are within the Bayou Meto Project Area. Groundwater in the Lonoke Monitoring Area is considered to be generally good. Iron and manganese were detected in all fourteen samples above their respective secondary maximum contaminant levels (SMCLs) – unenforceable federal guidelines regarding taste, odor, color and other non-aesthetic effects of drinking water. Three of the wells also had total dissolved solids above the recommended SMCL. In addition, the pesticide bentazone was detected at low levels in three wells. Pesticides are considered to be the primary potential groundwater contaminants in the Lonoke Monitoring Area.

To evaluate the water quality within the project area, water quality data were retrieved from the USGS NWIS Web Database, the ADEQ Surface Water Quality Monitoring Database, and the ADEQ Ambient Ground Water Monitoring Program. Data were evaluated from surface streams within the project area, ten wells within the Mississippi River Valley alluvial aquifer in the Lonoke Monitoring Area, and two stations located on the Arkansas River at Terry Lock and Dam just below the planned water supply intake. Table 1 lists the stations and periods of record for the resulting data set. In addition, the Vicksburg District Corps of Engineers (MVK) collected water samples from the Bayou Meto project area in August 2000 and January 2001. These stations are listed in Table 2. Station locations are also indicated on the project area map in Figure 1.

<u>Irrigation Water Quality</u>. For the purposes of this study, water quality was evaluated according to criteria that determine its ability to sustain irrigation; criteria that help protect soil and plant health. Four basic criteria are used to evaluate water quality with respect to irrigation: 1) the total soluble salt content (salinity hazard); 2) the relative proportion of sodium cations to other cations (sodium hazard); 3) excessive concentrations of elements that cause ionic imbalance in plants (toxicity); and 4) bicarbonate anion concentrations as related to calcium and magnesium cations.

Salinity hazard is the result of excess salt deposition in the soil. Excess salt increases the osmotic pressure of the soil solution and can result in a physiological drought condition. Even through the field appears to have plenty of moisture; plants wilt because the roots absorb insufficient water to replace transpiration loses. The total soluble salt content can be measured as electrical conductivity.

Sodium hazard is expressed as sodium adsorption ratio (SAR), the ratio of sodium to calcium plus magnesium. Although sodium contributes directly to total salinity and may be toxic to sensitive plants, the main problem is its effect on soil permeability and water infiltration. Continued use of water with a high SAR (>10) leads to a breakdown in the soil's physical structure. The sodium replaces calcium and magnesium sorbed on the clays and causes dispersion of soil particles. This results in the breakdown of soil aggregates causing the soil to become hard and compact when dry and increasingly impervious to water penetration when wet.

Some elements in irrigation water may be directly toxic to crops. Establishing toxicity limits in water is complicated by reactions that take place once the water is applied to the soil. When an element is added to the soil from irrigation, it may be inactivated by chemical reactions or it may build up in the soil until it reaches a toxic level. An element at a given concentration in water may be immediately toxic to a crop because of foliar effects if sprinkler irritation is used. If furrow irrigation is used, it may require a number of years for the element to accumulate to toxic levels, or it may be immobilized in the soil and never reach toxic levels. There is a long list of elements that can cause a toxic effect on crops including boron, chlorine, and selenium. In addition, waters high in chloride and / or sulfate ions have been found to reduce phosphorus availability to plants.

Waters high in bicarbonate will tend to precipitate calcium carbonate and magnesium carbonate when the soil solution concentrates through evapotranspiration. This means that the SAR value will increase as the relative proportion of sodium ions becomes greater. This, in turn, will increase the sodium hazard of the water to a level greater than indicated by the SAR value.

Past Studies. Two studies evaluating use of water from the Arkansas River to meet irrigation needs were reviewed for this report. In 1982, Peralta and Dutram evaluated Arkansas River water from Terry Lock and Dam for quality and quantity as potential irrigation water for the Bayou Meto Basin. The authors looked at conductivity, SAR, chloride, sulfate, bicarbonate, alkalinity, pH, and heavy metal content. These parameters were classified according to the now out of print USDA Handbook 60. The authors found the Arkansas River water to have a low SAR. Salinity usually fell in the medium range but increased during dry years. In addition, concentrations for chloride, sulfate, bicarbonate, alkalinity, pH, and heavy metals were general in the low range. The authors suggest that the water is suitable for irrigation, but cautioned against the possibility of salt damage. They recommend using river water to supplement irrigation needs only when the quality was deemed suitable by the criteria listed in Table 4 of that document. Thesegeneral use irrigation criteria are presented in Table 3 of this document along with their descriptors.Summary data from the 1982 report are presented in Table 4. Table 3 also includes criteria more specific to rice production. These criteria were obtained form the University of Arkansas Cooperative Extension Service Rice Production Handbook and through personal communication with Mr. Phil Tacker, University of Arkansas Extension Engineer.

Gilmour and Marx evaluated Arkansas River water from two sites, Van Buren and Gillett, between 1975 and 1985. The authors evaluated the water with respect to electrical conductivity, SAR and chloride. They found that mean yearly river water conductivities were within the range typical for irrigation water in Arkansas, mean yearly SARs were in the low range (<10), and chloride concentrations were higher than those in good quality subsurface water. The report concluded that the Arkansas River would be a good source of irrigation water for most crops especially rice, soybeans, cotton, grain sorghum and corn. Caution was advised, however, when irrigating salt-sensitive crops and those having a low chloride tolerance. Summary data from this report are also presented in Table 4.

<u>Historic and Current Irrigation Water Quality Data</u>. The data from the USGS and ADEQ are summarized in Table 5. This table reports the minimum, mean and maximum concentrations from each site compared to the criteria listed in Table 3. Data from each stream or water source were grouped to simplify analysis. The groups, indicated next to the station number in Table 1, are: 1) Bayou Meto (BM), 2) Bayou Meto – urban (BMU), 3) Two Prairie Bayou (TPB), 4) Crooked Creek (CC), 5) Wabbaseka Bayou (WAB), 6) Arkansas River (AR), and Lonoke Monitoring Area (Wells). The four stations in the Bayou Meto-U group are outside the project area but are included for comparison as source water to the basin. The ten samples from the Lonoke Monitoring Area wells represent the quality of the majority of water currently being drawn from the alluvial aquifer for irrigation.

Average conductivities for Bayou Meto, Two Prairie Bayou and Crooked Creek were low, less than 250 µmhos/cm; while average conductivities for the Arkansas River and the alluvial wells were in the medium range between 250 and 750 µmhos/cm. All groups had maxima that exceed 750 µmhos/cm, placing them occasionally in the high range for conductivity. Figure 2 is a graphic representation of the conductivities for each sampling station compared to the general use irrigation criteria. The samples from Bayou Meto and Two Prairie Bayou that exceeded the 750 µmhos/cm threshold were collected before 1985. Data were collected from the Arkansas River between 1969 and 2001. The majority of the data fell into the medium range between 250 and 750 µmhos/cm. The alluvial well samples from the Lonoke Monitoring Area were all collected in 2001. These samples fell in the medium to high conductivity range; and were very similar in magnitude to the data collected from the Arkansas River. In general, conductivities exhibited a cyclic pattern, peaking in the second half of the year. Arkansas River samples collected between July and December were extracted from the data set and averaged, producing a mean concentration of 660 µmhos/cm. This value is 130 units higher than the yearly average and is very similar to the alluvial well water (698 µmhos/cm) with respect to conductivity. The average for samples collected between May and August, the peak months for irrigation, was 573 µmhos/cm, only 40 units higher than the yearly average. Conductivities less than 750 µmhos/cm can be considered low salinity in rice production. The majority of the conductivity data evaluated for this reportfell in the low to medium range for rice production. Only three samples collected from Bayou Meto in the late 1970s were in the high range for salinity.

Calculated SARs were available for Arkansas River station 7263620 from the 1970s. The SARs for the other stations were calculated from existing sodium, magnesium, and calcium data by converting the ppm concentrations to milli-equivalents and using the equation:

$$SAR = \frac{NA}{\sqrt{\frac{Ca + Mg}{2}}}$$

Criteria for SARs were the same for general use irrigation and rice production. Sodium adsorption ratios for all stations were ≤ 6 %, placing the SAR in the low range. Figure 3 provides a clearer picture of the period of record for the SAR data. Waters from Two Prairie Bayou and Wabbaseka Bayou have SAR values similar that of the alluvial well water. The majority of samples from the Arkansas River, while still in the low range, have much higher SAR values than the well water currently used for irrigation.

In Table 5, the mean values for chloride are significantly below the 177 mg/l threshold for the general use irrigation low chloride range. Looking at the graphs in Figure 4, most of the samples above 177 mg/l chloride were collected before 1990. The most recent data for all groups was at or below 177 mg/l. In the last ten years, only one sample, collected in the late 1990s at Terry Lock and Dam in the Arkansas River, was higher than 177 mg/l chloride. All of the alluvial well samples from the Lonoke Monitoring Area were less than 65 mg/l chloride. Chloride also exhibited a cyclic nature with concentrations highest during the second half of the year. From May to August, during the period when irrigation is most likely to be needed, the seasonally adjusted mean for chloride in the Arkansas River increased from 72.9 to 87.9 mg/l. While still within the low range, waters from the Arkansas River were almost four times higher in chloride than the representative alluvial well water during this period. Overall, the waters evaluated by the general use irrigation criteria were within the low range for chloride. The rice specific criteria indicate that waters with chloride concentrations less than 70 mg/l can be considered low and waters with concentrations above 100 mg/l can be considered high. By these criteria, only the waters from Crooked Creek and the Lonoke Monitoring wells always fell into the low chloride range for all sampling events. Yearly means for all stations were in the low range, with the exception of the Arkansas River. In the last 10 years, from May to August, seasonally adjusted means fell into the low to medium range for chloride.

Similarly, all of the samples collected for sulfate were in the low range for general use irrigation. No sample exceeded 200 mg/l sulfate. The water from the monitoring wells had the highest average, 72.3 mg/l, but not the highest value. Figure 5 shows the range of sulfate data available for review. Sulfate criteria for rice production were significantly lower than the general use criteria. Waters from Bayou Meto, the Arkansas River, and the Lonoke Monitoring wells had maxima that exceeded the 100 mg/l high criterion. Mean values for the Arkansas River and the Lonoke Monitoring wells also exceeded the 30 mg/l low criterion for rice production. The yearly mean for the Arkansas River was approximately two-thirds the mean for the Lonoke wells.

Bicarbonate and alkalinity concentrations are shown in Figures 6 and 7. All of the data for Bayou Meto, Two Prairie Bayou and Crooked Creek were collected before 1980. Only a few of the samples from the Arkansas River were collected after 1980. The ten well water samples were collected in 2001. Because of the lack of recent data, the surface water may not be adequately represented for bicarbonate or alkalinity. The majority of the surface water samples were below 183 mg/l bicarbonate and below 150 mg/l alkalinity, which places them in the low range classification for both parameters. Mean values for the alluvial well water samples were higher than the maximum values for the surface water samples for both parameters. Figures 6 and 7 show that all but one of the well samples was higher than the general use irrigation thresholds for bicarbonate and alkalinity. Rice production irrigation criteria for both bicarbonate and alkalinity are significantly higher that the general use criteria. Water from the Arkansas River and other streams can be classified as low, while water from the alluvial wells is classified as high for both general use and rice production.

Mean concentrations for pH for all waters in the project area were less than 8.5 SU, although waters in Bayou Meto and the Arkansas River occasionally exceeded that number. The highest pH was 9.0 SU from the Arkansas River and highest value for well water from the Lonoke Monitoring Area was 7.6 SU. Overall, mean pHs fell within the low range for irrigation water. Heavy metals concentrations reported in Table 5 were the result of summing the metals available from each station. Mean values were well below the 10 mg/l criterion. Individual values for samples from Bayou Meto and Two Prairie Bayou did exceed 10 mg/l at 14.1 and 13.0 mg/l respectively. These were the result of high concentrations of iron and manganese. ADEQ analyzed boron and selenium as part of its surface water monitoring program. Mean concentrations for each group were less than 0.05 mg/l boron and less than 0.001 mg/l selenium. Generally, irrigation waters having less than 0.5 mg/l boron and less than 0.1 mg/l selenium are satisfactory for use on most crops with no plant toxicity anticipated. No heavy metals data were available for the Lonoke Monitoring Area wells.

Review of MVK Data. Data from samples collected by the MVK in August 2000 and January 2001 were also evaluated against the irrigation criteria in Table 3. These data are presented in Table 6. Sulfate concentrations were less than 480 mg/l for all samples, but exceeded 30 mg/l for WB-02, Indian Bayou-01, and Indian Bayou Ditch. Chloride concentrations were less than 177 mg/l for all samples, but exceeded 70 mg/l for WB-02 and Indian Bayou Ditch. The sum of the metals analyzed was less than 1 mg/l for all samples, well below the 10 mg/l general use criterion. Conductivity and pH data were available for samples collected in January 2001. Two of the samples, BM-10 and BM-12, were slightly above 250 μmhos/cm while the other three were less than 250 μmhos/cm. The pHs for all samples were less than 8.5 at the time of sampling. All stations sampled for sulfate, chloride, heavy metals, and pH can be classified in the low range for each parameter at the time of sampling. Conductivity or salinity hazard fell into the low to medium range depending upon the location.

Discussion and Summary. The Mississippi River Valley alluvial aquifer is the primary source for irrigation water in the Bayou Meto Basin. Supplemental water is also drawn from larger surface streams when available. For this project, historic and recent data were evaluated from seven potential water sources: 1) Lonoke Monitoring Area alluvial wells (Wells); 2) Arkansas River (AR); 3) Bayou Meto; 4) Bayou Meto-urban (BMU) – near Little Rock and Jacksonville; 5) Two Prairie Bayou; 6) Crooked Creek; and 7) Wabbaseka Bayou. In order to evaluate each water source more easily, the mean concentrations were ranked from lowest concentration to highest for each parameter considered to be a critical criterion for general use irrigation water quality. This ranking is presented in Table 7.

Salinity hazard is measured as water's electrical conductivity. Five groups had data for conductivity. Of these, Crooked Creek had the lowest mean concentration and the Lonoke Monitoring Area alluvial wells had the highest mean concentration. Waters from Crooked Creek, Two Prairie Bayou, and Bayou Meto fell into the low range for salinity hazard. Waters from the Arkansas River and the Lonoke Monitoring Area wells were higher in conductivity than the surface waters and fell into the medium range for salinity hazard. Gilmour (1987) stated that the mean yearly conductivities for the Arkansas River were within the range typical for general use irrigation water in Arkansas. The data evaluated in this report support that finding. Waters with conductivities in the medium range between 250 and 750 μmhos/cm can be used on soils if moderate amounts excess water are applied to provide some leaching. Plants with moderate salt tolerance can be grown without serious yield reduction when normal cropping practices are followed. The data suggest that water from the Arkansas River will not increase the salinity of soils appreciably if used for irrigation within the Bayou Meto Basin.

Sodium hazard is determined by calculating the SAR of the water using measured concentrations of sodium, magnesium and calcium. The SAR ranking from Table 7 shows that all water sources had mean SAR concentrations in the low range or less than 6%. Crooked Creek had the lowest mean concentration with the alluvial wells second lowest and water from the Arkansas River the highest. Low SARs indicate good water that can be used on most soils. No sodium problem is anticipated for either soils or crops in the Bayou Meto Basin through the use of Arkansas River water for irrigation.

Chloride, sulfate, heavy metals, and pH concentrations represent potential toxic effects to soil and plant heath. All water source groups within the project area were evaluated as low for all four parameters. For chloride, the Arkansas River had the highest mean concentration (72.6 mg/l), which was almost three times higher than the next highest, the Lonoke alluvial wells (23.6 mg/l). For sulfate the Lonoke alluvial wells had the highest concentration (72.3 mg/l) almost double the next highest, the Arkansas River (45.2 mg/l). No metals data were available for the Lonoke alluvial wells. Water from the Arkansas River had the lowest mean and maximum concentrations for combined metals of all the surface waters evaluated suggesting that there should be no problem with metals toxicity by using Arkansas River water for irrigation purposes. Sulfate, likewise, should pose no problem since concentrations in the Arkansas River are less than those found in the Lonoke alluvial well water. Although in the low range, the average chloride concentrations in the Arkansas River are higher than those found in the groundwater currently being used for irrigation. Gilmour (1987) also found that chloride concentrations in the river were higher than those in good quality subsurface water supplies in Arkansas. He also stated that while it was possible to have temporary chloride toxicity on sensitive crops when using river water, excessive accumulation was unlikely and was not found in previous studies of soils irrigated with Arkansas River water.

There were no recent bicarbonate or alkalinity data for the surface water groups. These parameters are not always part of a routine analytical suite. For the surface water data available, only two samples each exceeded the 183 mg/l threshold for bicarbonate and the 150 mg/l threshold for alkalinity. The Lonoke alluvial wells had the highest mean concentration for each parameter, placing them in the high range above their respective thresholds. Arkansas River water analyzed in the 1980s was substantially lower than the Lonoke alluvial well water. This data set, while small, suggests that there will be no problem from either alkalinity or bicarbonate by using the Arkansas River as an irrigation water source.

Overall, the data indicate that on average the Arkansas River has water that is as good as or better than the representative alluvial well water. Chloride concentrations in the Arkansas River are of the most concern. Yearly means suggest that Arkansas River water concentrations have three times the amount of chloride than the Lonoke alluvial well water and the other surface streams in the Bayou Meto Basin. During the irrigation season, concentrations increase to almost four times that of the alluvial well water. These data suggest that crops should be assessed and monitored against chloride buildup and or toxicity.

Another issue of importance to the Bayou Meto Basin is the existence of dioxin contamination within Bayou Meto itself. Sediment downstream of the Vertac Chemical Corporation was contaminated with dioxin due to historic chemical manufacturing processes. Bayou Meto throughout most of its length was impacted by this contamination. Minimal sediment data exists for dioxin in Bayou Meto; however, data from 1992 (Table 8) indicate that at the I-40 and HW 15 bridges, dioxin sediment concentrations were 39.7 and 46.0 ppt, respectively. Sediment concentrations decreased further downstream from the source to 4.2 ppt at HW 152 and 1.4 ppt at HW 11 below the Bayou Meto Wildlife Management Area. Elevated dioxin concentrations in fish caused the ADH to issue a fish consumption advisory in 1980. Today, the advisory extends to the HW 13 Bridge; but in future may be extended downstream of this site for certain fish species. Although the dioxin source, the Vertac site, is considered 100% remediated it has not been delisted from the NPL. Any project excavation on Bayou Meto should be planned to minimize the possibility of allowing contaminated sediment to migrate downstream or into other streams in the basin.

Water Quality Impacts. The purpose of this section is to discuss anticipated water quality impacts associated with the project.

Channel excavation, improvement of existing ditches, pipeline construction. Direct impacts would tend to be immediate, localized, and short term in duration. The physical process of channel and bank excavation would resuspend sediment, strip away existing aquatic habitat, and bury or kill invertebrates. Net effects of this activity would be to increase water turbidities and lower and shift fish and invertebrate species composition. The effects of increased turbidities may include decreased light penetration, increased water temperatures, and lowered DO concentrations. These impacts may be magnified if streams are stressed due to low water, late summer conditions when water temperatures and DO concentrations are extreme. However, these impacts are anticipated to be short term and will decrease once construction ceases and vegetation has been reestablished along the project areas.

Indirect impacts of channel and bank excavation can be longer term. They can include the loss of stream habitat and long term increases in turbidity due to loss of stream bank vegetative cover and the erosion protection it provides during rain and flood events. Increased solids in the system can mean a redistribution of pollutants throughout the system. The water supply plan calls for minimal excavation in each reach to reduce this impact. Once vegetation has reestablished the potential for erosion will be reduced. For the metals and organic pesticides evaluated in this study, the concentrations and spatial distributions are similar throughout the system. Any effects due to redistribution because of erosion should be minimal. For the dioxin contaminated sediments in upper Bayou Meto, the effects could be longer term. Any excavation in Bayou Meto should be done with care to minimize or prevent the movement of contaminated sediment downstream or into other parts of the basin. Excavated sediment should be treated as contaminated and placed in capped, upland disposal sites where it cannot be reintroduced into the system. Measures should be taken to protect the bank and streambed from erosion or head cutting above bank cuts in order to prevent contaminated sediment from moving downstream. Currently the ADH is considering extending the current fish consumption advisory beyond the HW 13 Bridge. Any repositioning of dioxin-contaminated sediment could have a long-term effect on the distribution of dioxin in the aquatic system.

Construction of Weirs. The immediate, short-term impacts from weir construction would be similar to those from channel excavation such as increased turbidities and species reduction. Long term, the construction of weirs will create a permanent pool of water during low flow conditions and that may provide incidental improvement of habitat for freshwater mussels, other freshwater invertebrates, and fish. However, basic water quality parameters such as DO and temperature could become impaired in the summer during hot, dry weather. Also, since these weirs have the potential to trap sediments moving through the system and the main contaminants of concern in the project area are associated with sediments, provisions should be made to monitor the depth of sediments trapped by the weirs and their anthropogenic chemical composition to ensure there are no long term impacts to biota within the immediate project area.

On Farm Reservoirs. On farm reservoirs are planned to increase irrigation water reliability during peak periods. Direct and immediate impact to water quality will depend on the location of these reservoirs. For maximum collection of rainfall and irrigation runoff, on farm reservoirs should be located down gradient at the lowest point of the property. Such a location could have the long-term effect of trapping eroded soil and preventing it from entering local streams. While such ponded water will have the incidental effect of attracting wildlife, it is understood that the reservoir may be drained during the growing season. Additionally, best management practices (BMPs) in place for reservoir upkeep may state that reservoir depth be maintained by removing sediment when necessary.

Construction of Pump Stations. The construction of pump stations on the Arkansas River, and at Bayou Meto and Two Prairie Bayou will likely have no direct impacts to the streams within the project area. Indirect impacts will be localized resulting from removal of vegetation and from construction practices. Erosion effects can be minimized through the development and proper implementation of the State required storm water plan. These impacts are anticipated to be short term and will decrease once vegetation has been reestablished along the effected area. Pump Station No. 2 will be located within the stretch of Bayou Meto under the dioxin fish consumption advisory. As stated previously, any excavation in Bayou Meto should be done with care to prevent or minimize movement of contaminated sediment downstream. Bank cuts should be protected to prevent erosion and sediment displacement.

Effects of water withdrawal on Pool No. 6 above Terry Lock and Dam. The Arkansas Soil and Water Conservation Commission has the authority to establish minimum stream flow in the Arkansas River under Act 1051 of 1985 and Act 469 of 1989. The minimum stream flow is defined in legislation as the quantity of water required to meet the largest of the following instream flow needs as determined on a case by case basis: 1) interstate compacts; 2) navigation; 3) fish and wildlife; 4) water quality; and 5) aquifer recharge. The only quantifiable flow rates in Pool No. 6 of the Arkansas River are 2000 cfs (navigation), 4645 cfs (fish and wildlife), and 684 cfs (water quality). The instream flow that meets the largest requirement stated by the legislation is 4645 cfs for fish and wildlife. Period of record data show that some years have had days when flows in the Arkansas River were insufficient to meet the minimum flow requirements, meaning no water would be available to meet additional irrigation demands. To increase reliability of the irrigation delivery system, the project includes on-farm reservoirs that will supplement the local water needs when sufficient water is not available from the Arkansas River. Because the water supply plans do not call for withdrawals from the Arkansas River when flows are below the 4645 cfs for fish and wildlife, there should be no impact to Pool No. 6 due to water withdrawal.

Long Term Use of Arkansas River Water for Irrigation. As discussed in the summary, the data, overall, indicate that the water from the Arkansas River is as good or better than the representative alluvial well water evaluated for this report. Researchers in the 1980s who evaluated the Arkansas River water came to similar conclusions. Chloride was the one parameter that was noticeably higher in the river water than the alluvial aquifer water. During the summer months of May through August, average chloride concentrations are almost four times higher than the well water. While water application studies did not show any buildup in the soil, the researchers suggested that chloride be monitored. Data for this report relied on databases from the USGS and the ADEQ. Some parameters important to irrigation water quality are not routine tests for these agencies. It is suggested that a monitoring program include these irrigation water quality parameters.

Sedimentation in irrigation reservoirs, canals, and ditches. There can be many sources of sedimentation associated with surface water irrigation systems. There can be sedimentation downstream from the irrigation stream diversion due to reduced ability to transport the source stream's sediment load. Along diversion canals, there can be both channel bottom scour and bank erosion, causing either offsite sedimentation or deposition in the canal because of decreased ability to transport the sediment load. In fields, there can be specific erosion patterns associated the irrigation method used. Frequently, a portion of this eroded sediment is deposited in the lower one-third of the irrigation run and in the tailwater recovery area. From the tailwater area there may be additional erosion and associated sedimentation along the return flow to the watercourse.

The water supply construction plan calls for the use of unlined ditches and canals to distribute irrigation water. During design three types of potential erosion scenarios were evaluated: general scour due to flow; wave induced erosion; and localized erosion due to sudden changes in canal configuration. Flow velocities were designed to be low enough to retard general scour. With long canals with significant fetch maintained at essentially a constant elevation, there is the potential for long term wave induced erosion similar to that occurring along lake shore lines. Wave induced erosion will be resisted somewhat by vegetation on the embankment; however, near the shore line the vegetation growth will be suppressed. It is possible that exposed locations in bends may require protection from direct wave attack. The most likely extent and rate of wave induced erosion is difficult to estimate, but it is expected to be low. During design for construction, isolated canal locations that are determined to require riprap protection for whatever reason will have riprap protection designed into the project at that time. Direct effects of erosion in the stream can be long term; displacing sediment, contaminants, and aquatic life as described above. While provision for the occasional repair of eroded embankments due to wave action will be part of the project operation and maintenance, the physical act of erosion will continue until detected, reported, and repaired. Provisions may also need to be made to manage sedimentation in the canals and reservoirs comprising the irrigation system. On-farm reservoirs would be best placed in the tailwater areas of the farms to serve a dual function of sediment and water retention.

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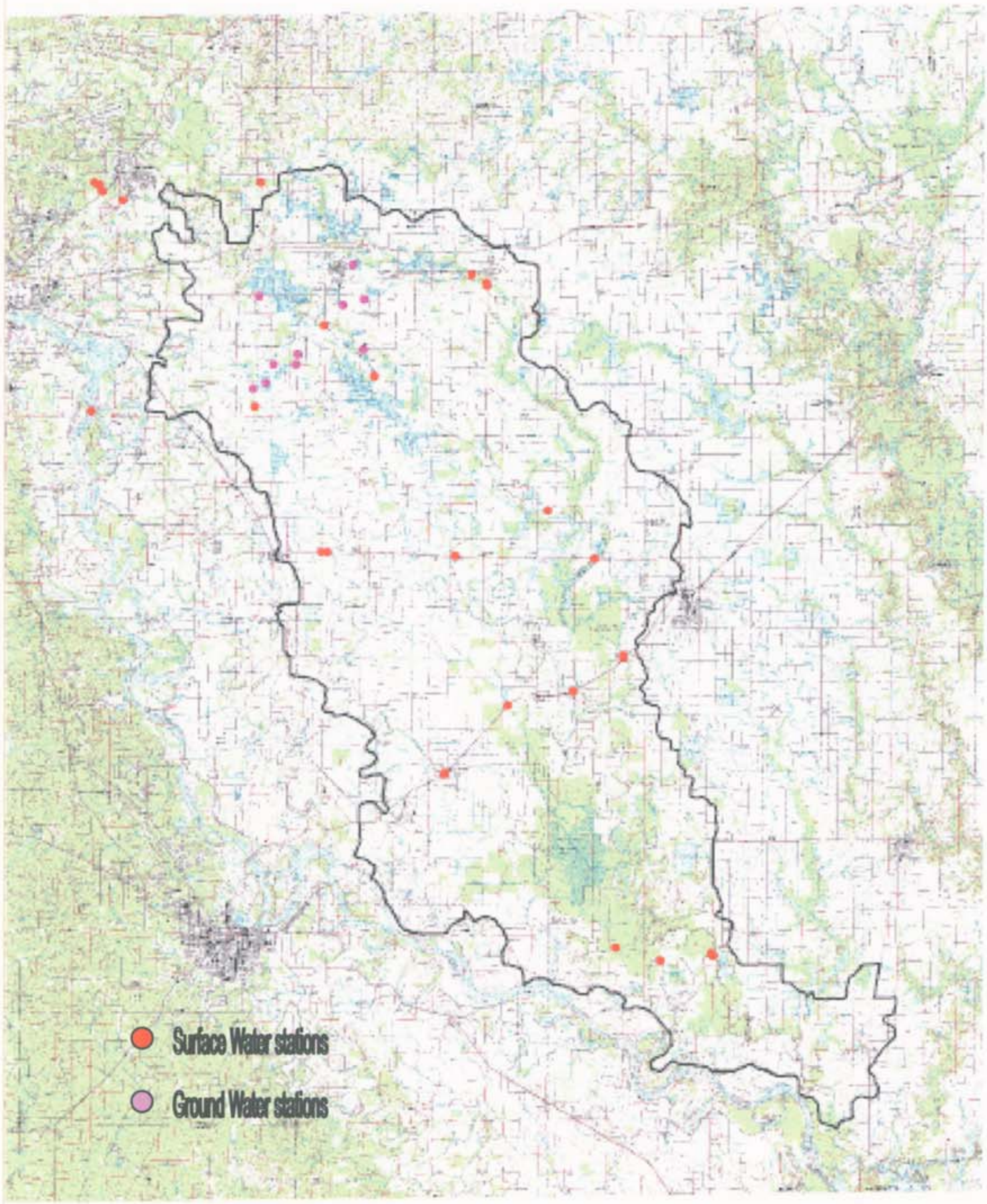

Figure 1. Sampling stations evaluated within the Bayou Meto Project Area.

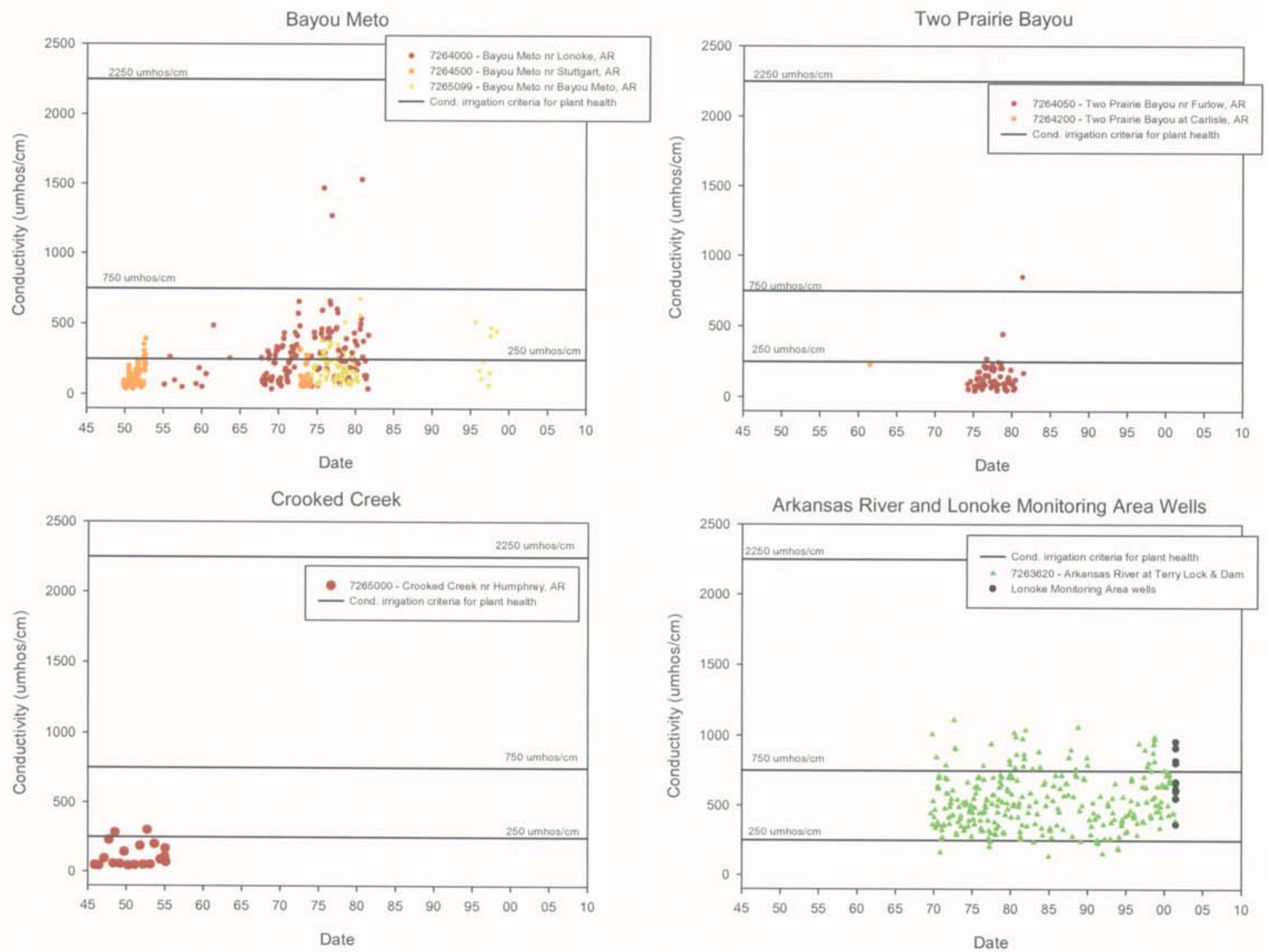

Figure 2. Electrical conductivities of waters within the Bayou Meto Water Supply project area.

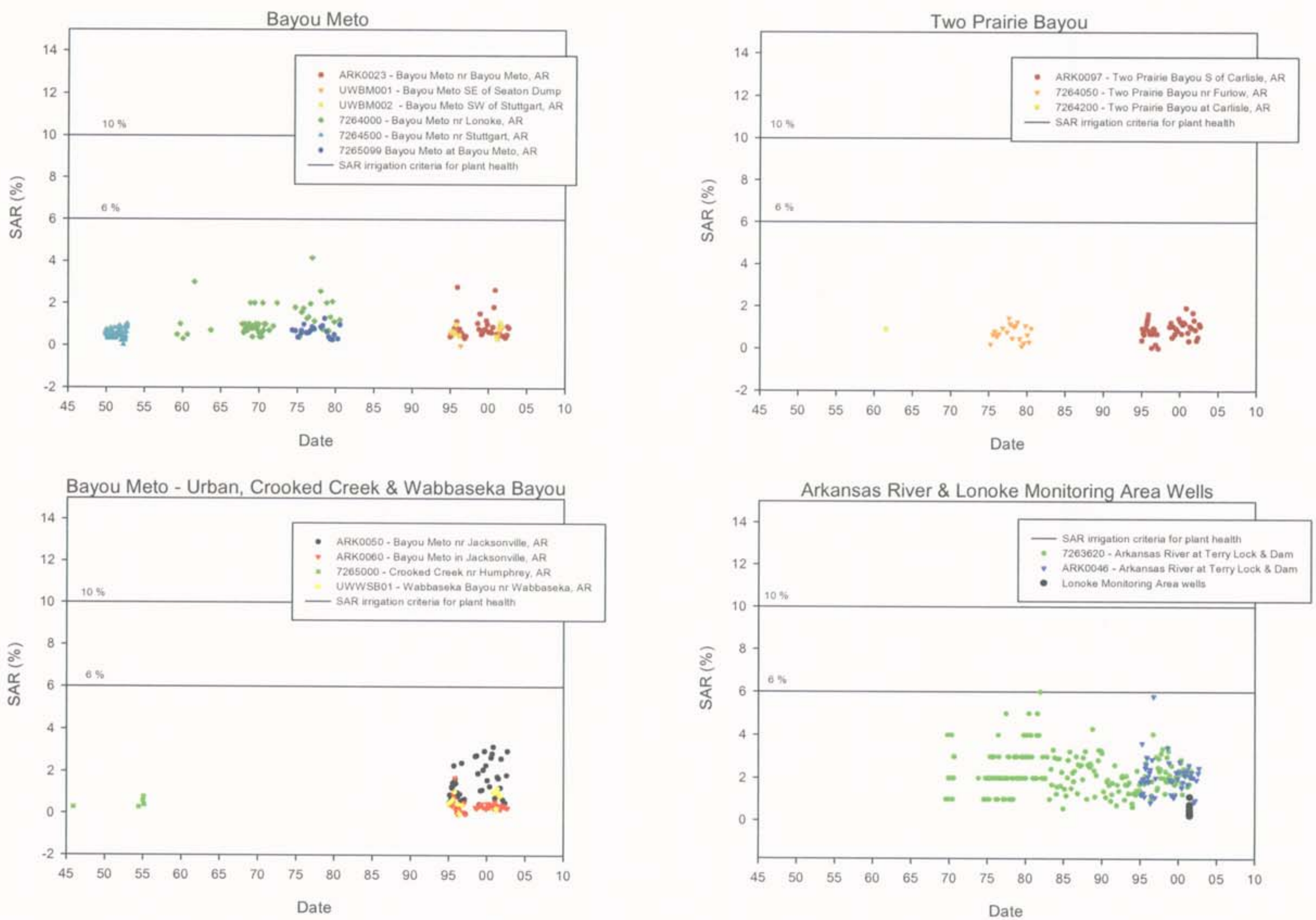

Figure 3. SARs of waters within the Bayou Meto Water Supply project area.

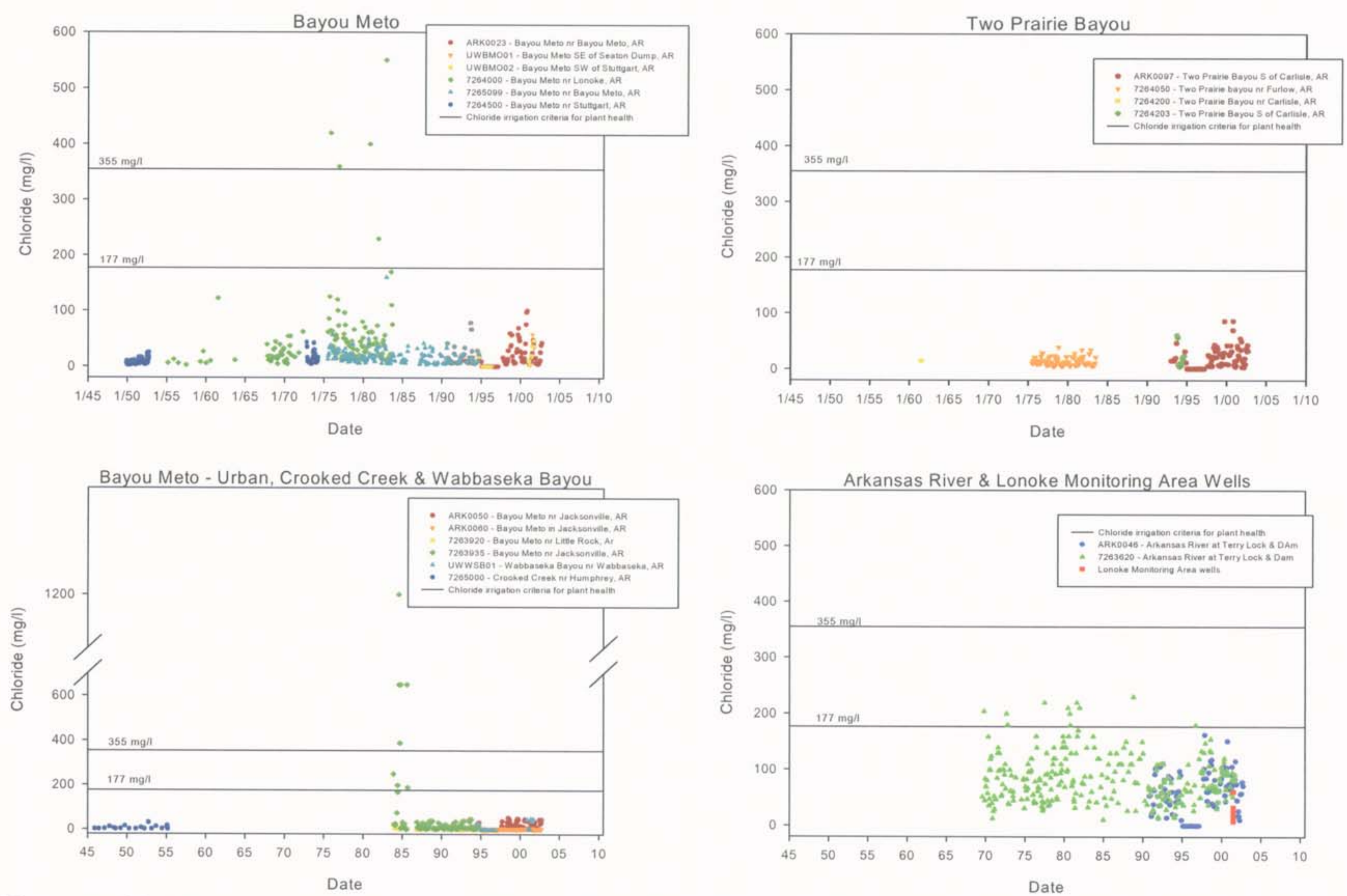

Figure 4. Chloride concentrations of waters within the Bayou Meto Water Supply project area.

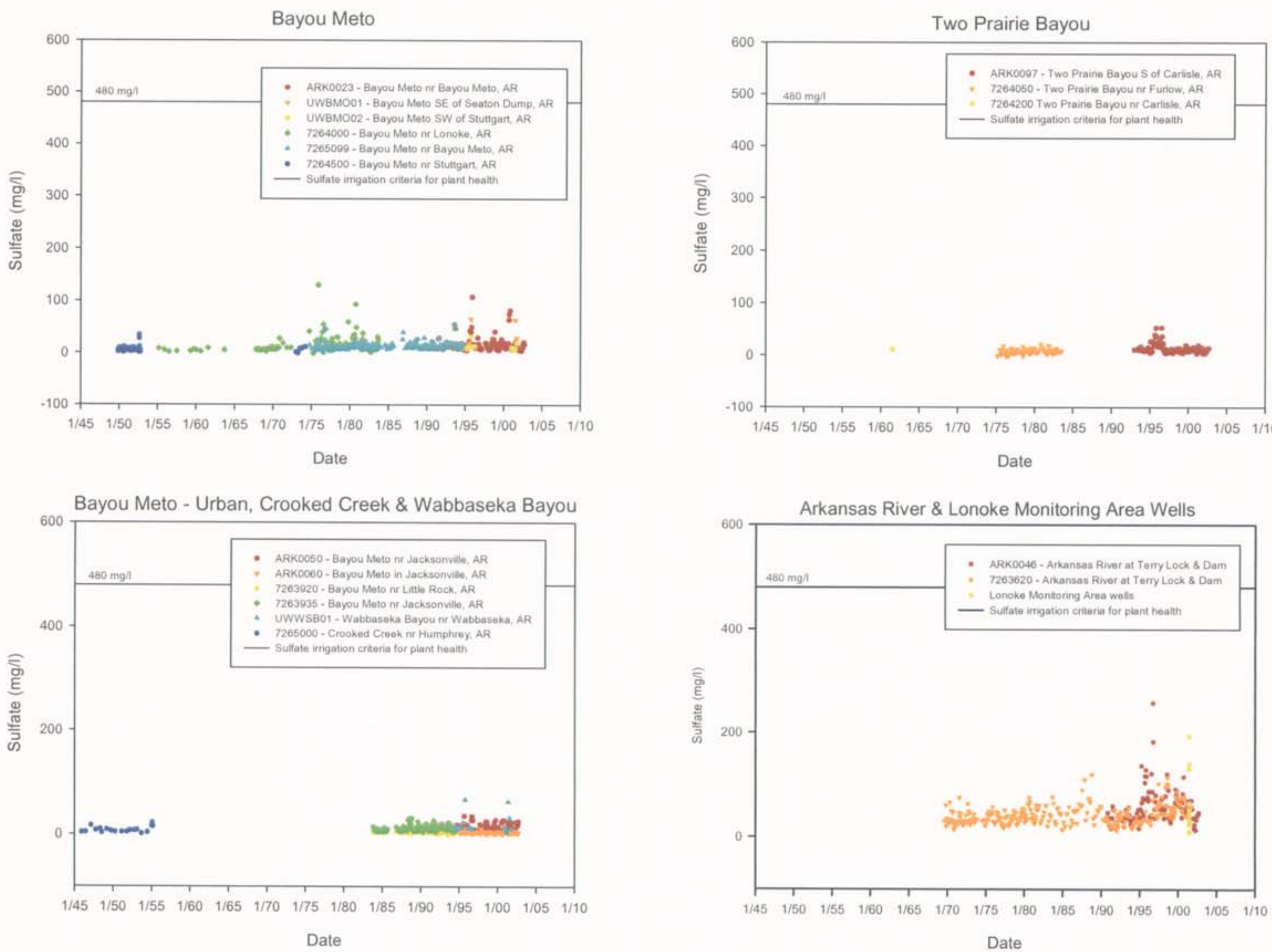

Figure 5. Sulfate concentrations of waters within the Bayou Meto Water Supply project area.

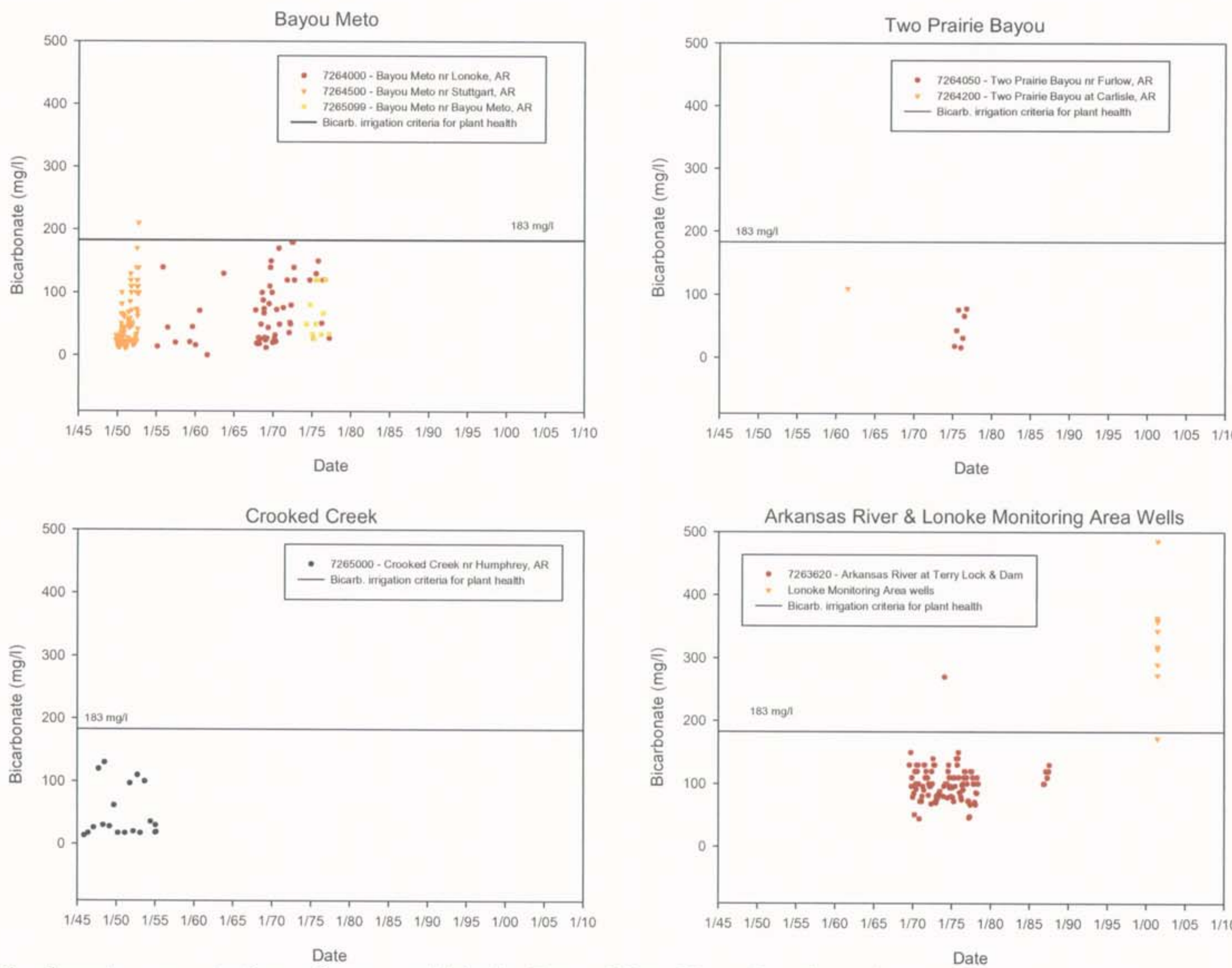

Figure 6. Bicarbonate concentrations of waters within the Bayou Meto Water Supply project area.

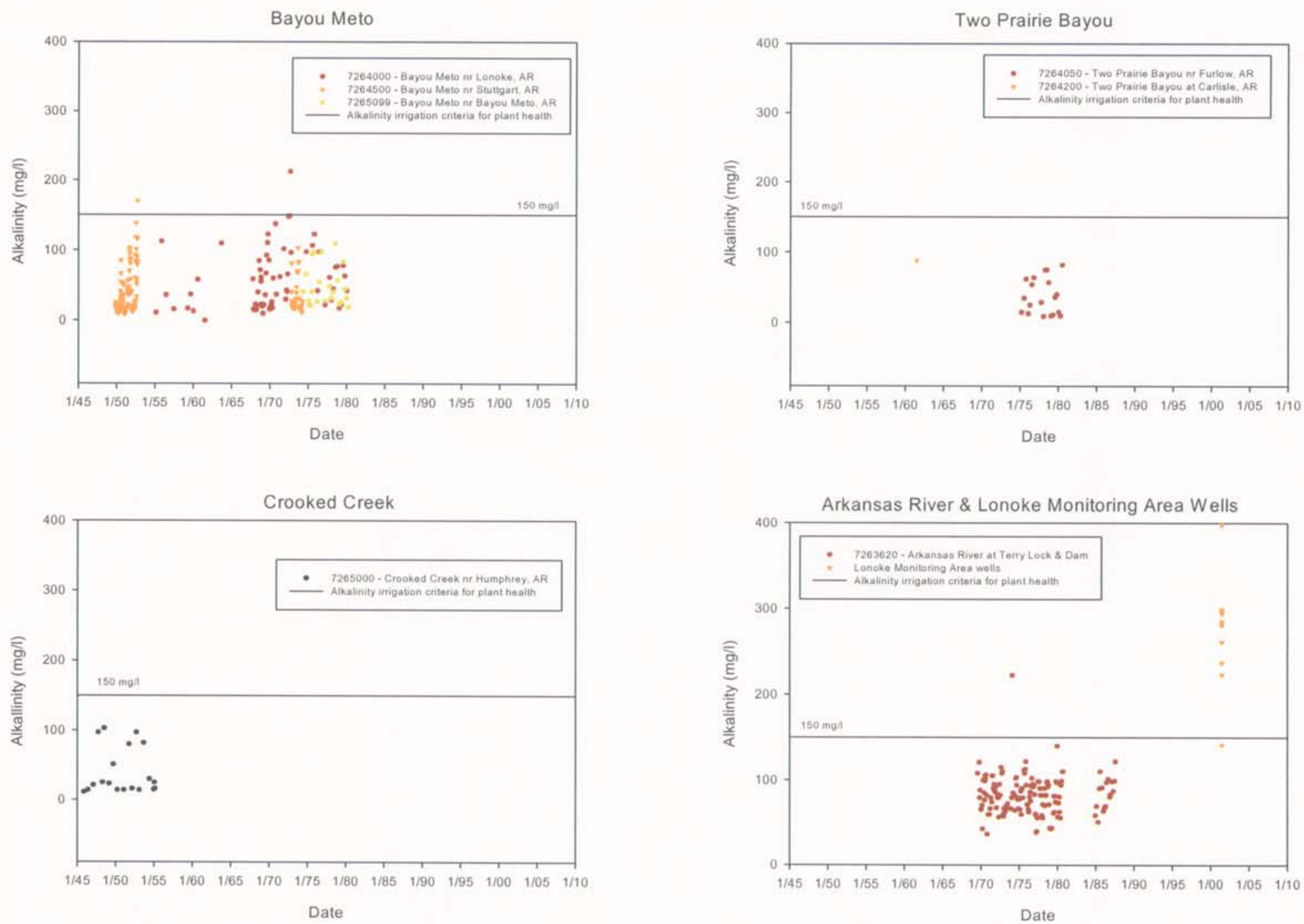

Figure 7. Alkalinity concentrations of waters within the Bayou Meto Water Supply project area.

Table 1. Sampling stations for USGS and ADEQ data used in this water quality evaluation.

STATION	LOCATION	PERIOD OF RECORD
Surface Water Bayou Meto HUC 08020402		
USGS 7263920 (BMU)	Bayou Meto nr N. Little Rock, AR -0920913: 345158 NAD27	11/01/83 – 9/06/94
USGS 7263935 (BMU)	Bayou Meto nr Jacksonville, AR -0920720: 345039 NAD 27	11/01/83 – 9/06/94
USGS 7264000 (BM)	Bayou Meto nr Lonoke, AR -0915458: 344413 NAD 27	2/21/55 – 10/04/83
USGS 7264050 (TPB)	Two Prairie Bayou nr Furlow, AR -0915848: 345132 NAD 27	4/03/74 – 7/12/83
USGS 7264200 (TPB)	Two Prairie Bayou @ Carlisle, AR -0914558: 344644 NAD 27	7/11/61 – 10/20/87
USGS 7264203 (TPB)	Two Prairie Bayou on HW 13 Br. S of Carlisle, AR -0914505: 344610 NAD 27	10/05/93 – 9/06/94
USGS 7264500 (BM)	Bayou Meto nr Stuttgart, AR -0913658: 342715	11/10/49 – 12/11/74
USGS 7265000 (CC)	Crooked Creek nr Humphrey, AR -0914004: 342535 NAD 27	11/14/45 – 2/22/55
USGS 7265099 (BM)	Bayou Meto nr Bayou Meto, AR -0913145: 341205 NAD 27	4/17/74 – 5/23/96
ADEQ ARK0023 (USGS 7265099) (BM)	Bayou Meto nr Bayou Meto, AR -91.5306: 34.2019	9/04/90 – 9/10/02
ADEQ ARK0050 (BMU)	Bayou Meto @ HW 161 nr Jacksonville, AR -92.1221: 34.8442	10/01/83 – 9/10/02
ADEQ ARK0060 (BMU)	Bayou Meto @ W Main St Br in Jacksonville, AR -92.1538: 34.8661	10/01/83 – 9/10/02
ADEQ ARK0097 (TPB)	Two Prairie Bayou @ HW 13 S of Carlisle, AR -91.7514: 34.7694	5/14/93 – 9/10/02
ADEQ UWBM001 (BM)	Bayou Meto @ county rd SE of Seaton Dump -91.6911: 34.5769	6/01/94 – 9/11/01
ADEQ UWBM002 (BM)	Bayou Meto @ HW 79, 2 mi SW of Stuttgart, AR -91.6164: 34.4536	6/01/94 – 9/11/01
Surface Water Lower Arkansas River HUC 08020401		
ADEQ UWWSB01 (USGS 07262528) (WAB)	Wabbaseka Bayou @ HW 79 @ Wabbaseka, AR -91.3164: 33.9717	6/01/94 – 9/10/01
Surface Water Lower Arkansas - Maumelle HUC 11110207		
USGS 07263620 (AR)	Arkansas River @ David D. Terry Lock & Dam 920918: 344007 NAD 27	7/24/69 – 9/13/01
ADEQ ARK0046 (USGS 07263620) (AR)	Arkansas River @ David D. Terry Lock & Dam -92.155: 34.6686	10/01/86 – 9/10/02
Ground Water Lonoke Monitoring Area - Mississippi River Valley Alluvial Aquifer (Bayou Meto HUC 08020402)		
ADEQ LON014	-91 53 29.7; 34 47 10.1	6/12/01
ADEQ LON016	-91 59 09.7; 34 45 49.1	6/19/01
ADEQ LON017	-91 52 43.5; 34 45 32.5	6/12/01
ADEQ LON017R	-91 53 46.4; 34 45 18.2	6/12/01
ADEQ LON020	-91 56 01.7; 34 42 40.2	6/12/01
ADEQ LON021	-91 59 21.2; 34 42 19.2	6/19/01
ADEQ LON024	-91 52 32.4; 34 42 56.4	6/12/01
ADEQ LON040	-91 58 37.0; 34 41 13.5	6/19/01
ADEQ LON041	-91 58 58.1; 34 41 14.8	6/19/01
ADEQ LON042	-91 58 02.1; 34 42 19.7	6/19/01

Table 2. Sampling stations for MVK water and sediment samples.

Station	Location	Sample Date
LBM-01	Little Bayou Meto	August 2000
TPB-01	Two Prairie Bayou	August 2000
Bayou Meto-1	Bayou Meto	August 2000
BM HW 11	Bayou Meto	August 2000
WB-01	Wabbaseka Bayou	August 2000
WB-02	Wabbaseka Bayou	August 2000
Indian Bayou-01	Indian Bayou	August 2000
Indian Bayou Ditch		August 2000
Crooked Creek	Crooked Creek	August 2000
BM-10	Little Bayou Meto 0630601: 3784809	January 2001
BM-11	Little Bayou Meto 0626444: 3786017	January 2001
BM-12	Salt Bayou Ditch 0616261: 3808691	January 2001
BM-13	Two Prairie Bayou 0614279: 3847993	January 2001
BM-14	Indian Bayou 0592729: 3836600	January 2001

Table 3. Water quality standards for irrigation water.

		General Use Criteria [1]		Criteria for Rice [2]
Parameter	Level	Range	Irrigation Use	Range
Conductivity (µmhos/cm)	Low salinity	< 250	Can be used for most crops on most soils	< 750
	Medium salinity	250 – 750	Can be used if a moderate amount of leaching occurs. Can be used for plants with moderate salt tolerance.	750 - 1200
	High salinity	750 – 2250	Cannot be used on soils with restricted drainage. Use on plants with high salt tolerance.	> 1200
	Very high salinity	> 2250	Not suitable for irrigation.	
SAR (%)	Low	< 6	Can be used on all soils and all non-sodium-sensitive crops.	< 6
	Medium	6 – 10		6 - 10
	High	10 – 18		> 10
	Very high	> 18	Not suitable for irrigation.	
Chloride (mg/l)	Low	<177	Excellent to good. Suitable for most plants and soils.	< 70
	Medium	177 – 355	Good to injurious under certain conditions.	70 – 100
	High	> 355	Injurious to unsatisfactory. Normally unsuitable.	> 100
Sulfate (mg/l)	Low	< 480	Excellent to good. Suitable for most plants and soils.	< 30
	Medium	480 – 961	Good to injurious under certain conditions.	30 – 100
	High	> 961	Injurious to unsatisfactory. Normally unsuitable.	> 100
Bicarbonate (mg/l)	Low	< 183		< 305
	High	> 183		≥ 305
Alkalinity (mg/l)	Low	< 150		< 225
	High	> 150		≥ 225
pH (SU)	Low	< 8.5		
	High	> 8.5		
Heavy metals (mg/l) [3]	Low	< 10	Satisfactory	
	High	> 10	Unsatisfactory	

[1] water quality standards from Table 4, Peralta and Dutram (1982)
[2] University of Arkansas Cooperative Extension Service Rice Production Handbook MP192
[3] Al + As + Ba + Cd + Cr + Cu + Fe + Pb + Li + Mn + Hg + Mo + Ag + Zn

Table 4. Data from earlier studies comparing Arkansas River water to irrigation water quality criteria.

Parameter	Statistic	Peralta & Dutram 1982 @ Terry L&D	Gilmour & Marx 1987 @ Van Buren	Gilmour & Marx 1987 @ Gillett	Criteria [1]
Conductivity (µmhos/cm)	Min	431	485	404	Low = <250
	Mean	525			Med = 250-750
	Max	678	806	634	High = 750 -2250
					Very High = > 2250
SAR (%)	Min	2.1	1.9	1.5	Low = <6
	Mean	2.6			Med = 6 – 10
	Max	3.7	3.8	3.3	High = 10 – 18
					Very High = >18
Chloride (mg/l)	Min	61	84	88	Low = <177
	Mean	88			Med = 177 – 355
	Max	134	162	121	High = >355
Sulfate (mg/l)	Min	31			Low = <480
	Mean	38	-	-	Med = 480 – 961
	Max	49			High = >961
Bicarbonates (mg/l)	Min	81			Low = <183
	Mean	98	-	-	
	Max	114			High = >183
Alkalinity (mg/l)	Min	67			Low = <150
	Mean	81	-	-	
	Max	91			High = >150
pH (SU)	Min	7.5			Low = < 8.5
	Mean	7.8	-	-	
	Max	7.9			High = >8.5
Heavy Metals (mg/l)	Min				Low = <10
	Mean	<2	-	-	
	Max				High = >10

[1] water quality standards from Table 4, Peralta and Dutram (1982)

Table 5. Irrigation water quality parameters for the Bayou Meto water supply project area.

Parameter	Statistic	Bayou Meto Urban	Bayou Meto	Two Prairie Bayou	Crooked Creek	Wabbaseka Bayou	Arkansas River Terry L&D	Lonoke Management Area wells	General Use Criteria [1]	Rice Criteria [2]
Conductivity (µmhos/cm)	Min		38.0	43.0	43.0		135	366	Low = <250	Low = < 750
	Mean	-	198	139	118	-	533	698	Med = 250-750	Med = 750 – 1200
	Max		1530	849	300		1110	959	High = 750 -2250 Very High = > 2250	High > 1200
SAR (%)	Min	ND	ND	ND	0.3	ND	0.6	0.2	Low = <6	Low = < 6
	Mean	0.9	0.7	0.9	0.5	0.7	2.1	0.5	Med = 6 – 10	Med = 6 – 10
	Max	3.2	4.2	1.9	0.8	1.2	6.0	1.1	High = 10 – 18 Very High = >18	High > 10
Chloride (mg/l)	Min	0.035	0.035	0.035	2.20	0.035	0.035	7.7	Low = <177	Low = < 70
	Mean	18.9	22.2	16.5	8.10	16.4	72.9	23.6	Med = 177 – 355	Med = 70 – 100
	Max	1200	550	85.7	32.0	49.7	230	60.6	High = >355	High = > 100
Sulfate (mg/l)	Min	1.17	0.500	0.500	1.00	3.63	13.0	10.0	Low = <480	Low = < 30
	Mean	8.95	12.3	10.9	7.98	20.4	45.2	72.3	Med = 480 – 961	Med = 30 – 100
	Max	35.1	130	52.6	22.0	66.4	257	193	High = >961	High = > 100
Bicarbonates (mg/l)	Min		ND	16.0	13.0		44.0	173	Low = <183	Low = < 305
	Mean	-	54.3	54.8	47.7	-	101.	329		
	Max		210.	110.	130.		270.	486	High = >183	High = ≥ 305
Alkalinity (mg/l)	Min		ND	9.0	11.0		36.0	142	Low = <150	Low = < 225
	Mean	-	44.3	40.3	39.4	-	80.5	272		
	Max		213.	89.0	103.		223.	398	High = >150	High = ≥ 225
pH (SU)	Min	5.9	4.4	5.3	6.3	6.0	5.9	6.8	Low = < 8.5	
	Mean	6.9	7.3	6.9	7.1	7.3	7.7	7.1		
	Max	7.3	8.8	8.0	8.4	8.2	9.0	7.6	High = >8.5	
Heavy Metals (mg/l)	Min	ND	ND	ND		ND	ND		Low = <10	
	Mean	0.071	0.124	0.149	-	0.044	0.016	-		
	Max	2.8	14.1	13.0		1.4	0.587		High = >10	

[1] water quality standards from Table 4, Peralta and Dutram (1982)
[2] University of Arkansas Cooperative Extension Service Rice Production Handbook MP192

Table 6. Water quality samples collected by MVK.

										BM-10	BM-11	BM-12	BM-13	BM-14		
Parameter	LBM-01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	Little Bayou Meto	Bayou Meto	Five Fork	Two Prairie Bayou	Indian Bayou	General Use Criteria[1]	Rice Criteria [2]
	August 2000									January 2001						
Sulfate (mg/l)	9.5 J	21	20 J	19 J	21	41	60	82	ND	19 J	15 J	22	14 J	16 J	L <480 M 480-961 H >961	L < 30 M 30-100 H >100
Chloride (mg/l)	28	27	49	43	55	77	64	81	34	16	8.5	20	17	11	L <177 M 177-355 H > 355	L <70 M 70-100 H >100
Metals (mg/l)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	L <10 H >10	
Conductivity	-	-	-	-	-	-	-	-	-	294	109	272	160	173	L<250 M250-750	L <750 M 750-1200
pH	-	-	-	-	-	-	-	-	-	6.6	6.7	7.4	7.2	7.7	L <8.5 H >8.5	

[1] water quality standards from Table 4, Peralta and Dutram (1982)
[2] University of Arkansas Cooperative Extension Service Rice Production Handbook MP192

Table 7. Ranking of mean concentrations of waters within the project area according to the general use irrigation criteria.

Rank[1]	Conductivity	SAR	Chloride	Sulfate	Bicarbonate	Alkalinity	pH	Heavy Metals
1	CC (low)	CC (low)	CC (low)	CC (low)	CC (low)	CC (low)	BMU (low)	AR (low)
2	TPB (low)	Wells (low)	WAB (low)	BMU (low)	BM (low)	TPB (low)	TPB (low)	WAB (low)
3	BM (low)	WAB (low)	TPB (low)	TPB (low)	TPB (low)	BM (low)	Wells (low)	BMU (low)
4	AR (medium)	BM (low)	BMU (low)	BM (low)	AR (low)	AR (low)	CC (low)	BM (low)
5	Wells (medium)	TPB (low)	BM (low)	WAB (low)	Wells (high)	Wells (high)	WAB (low)	TPB (low)
6	- (BMU)	BMU (low)	Wells (low)	AR (low)	- (BMU)	- (BMU)	BM (low)	- (CC)
7	- (WAB)	AR (low)	AR (low)	Wells (low)	- (WAB)	- (WAB)	AR (low)	- (Wells)

[1] Median concentrations of water groups from Table 4 are ranked from lowest to highest with 1 being the lowest and 7 being the highest.

Table 8. Dioxin in sediment (University of Arkansas 1992).

Station Number	Stream Location	2,3,7,8-TCDD (ppt)	UEL Guideline [1]
Bayou Macon			
1	Macon Bridge	0.260	8.8
2	New (Caddo) Bridge	0.490	
3	Highway 167	199.	
4	Reeds Bridge	276.	
6	Broken Bridge	197.	
7	I-40	39.7	
8	Highway 15	46.	
10	Culler	24.2	
13	Highway 79	4.2	
14	Highway 152	5.6	
15	Wildlife Mgt. Area	5.3	
16	Highway 11	1.4	
Wattensaw Bayou (background sample)			
19	Highway 11	0.420	8.8
20	Wildlife Mgt. Area	0.280	

[1] Upper effects threshold for *Hyalella azteca* bioassay in freshwater sediments (1999).

SECTION VI

WATER QUALITY

Part B. Flood Control

Bayou Meto Basin, Arkansas
Water Quality Assessment
Flood Control

General. The Bayou Meto Basin, Arkansas Project area is located in east central Arkansas and includes portions of Lonoke, Jefferson, Prairie, Pulaski, and Arkansas counties. The project area encompasses 779,109 acres lying generally south of Interstate 40, between the Arkansas and White Rivers. Tributaries of the Arkansas River provide natural drainage to the project area. Major tributaries include Bayou Meto, Two Prairie Bayou, Indian Bayou, and Little Bayou Meto. Smaller tributary systems include Wabbaseka Bayou, Baker's Bayou, Salt Bayou Ditch, Big Ditch, and Crooked Creek. Some 396,874 acres of the project area are irrigated and 22,942 are in commercial fishponds. Primary crops include rice, soybeans, cotton, wheat, and baitfish. Currently, agriculture relies heavily on the Mississippi River Valley alluvial aquifer as the primary source of irrigation water. However, groundwater is being withdrawn at such a rate that the aquifer is in danger of being permanently damaged. Surface stream flows can become inadequate to support fish and wildlife during the summer months due to the lack of rainfall and withdrawals for crop irrigation. Agricultural flooding is a major problem at other times of the year. The Bayou Meto Basin Project is twofold. One goal is to relieve the strain on the aquifer by supplying irrigation water from the Arkansas River through a series of new canals, improved existing channels, and pipelines. The second goal is to provide flood control to the low-lying regions in the project area. This section of the report addresses the existing water quality conditions within the project area and evaluates project impacts to water quality as a result of flood control improvements.

Project Description. Alternatives considered for the Bayou Meto Flood Control Study are described in detail in other sections of this document. They include plans to provide some flood relief for the most frequently flooded reaches while giving full consideration to environmental resources. Streams identified for work include: Indian Bayou, Indian Bayou Ditch, Wabbaseka Bayou, Boggy Slough, Little Bayou Meto, Salt Bayou, Crooked Creek Ditch, Crooked Creek, Two Prairie Bayou and, Big Bayou Meto. Work includes selective excavation of stream bottoms, selective clearing and snagging, selective cutting of stream banks, construction of levees, construction of low water weirs, and construction of pumping stations.

Historic and Existing Water Quality. The project area is located within three USGS Hydrologic Units (HU): the Lower Arkansas River (HUC 08020401) containing Wabbaseka Bayou; Bayou Meto and its tributaries (HUC 08020402); and the Lower Arkansas-Maumelle (HUC 11110207), the source water for the water supply project. These three Hydrologic Units lie within the Arkansas Delta Ecoregion. A review of the 2002 State of Arkansas Integrated Water Quality Monitoring and Assessment Report indicates that the Arkansas Department of Environmental Quality (ADEQ) has designated the waters within the project area as suitable for the propagation of fish and wildlife; primary and secondary contact recreation; and public, industrial, and agricultural water supplies. Although there is some concern for elevated bacteria and nutrients in Wabbaseka Bayou and high turbidity in the Arkansas River, all designated uses are being maintained in these waters. The upper reach (007) of Bayou Meto is under a fish consumption advisory due to the presence of dioxin in fish tissue. ADEQ states that the source, residue from Vertac, Inc. a Superfund site, has been removed and that contamination downstream is being addressed through natural attenuation.

To evaluate the water quality within the project area, water quality data were retrieved from the USGS NWIS Web Database and the ADEQ Surface Water Quality Monitoring Database. Surface water data from two stations located on the Arkansas River at Terry Lock and Dam just below the planned water supply intake and groundwater data from the ADEQ Lonoke Monitoring Area are also included in the analysis. Table 1 lists the stations and periods of record for the resulting data set. In addition, the Vicksburg District Corps of Engineers (MVK) collected water and sediment data from the Bayou Meto project area in August 2000 and January 2001. These sampling stations are listed in Table 2. Station locations are also indicated on the project area map in Figure 1.

USGS and ADEQ Water Quality Data. The data from the USGS and ADEQ are summarized in Tables 3 through 6. These tables report the number of samples analyzed from each site and the minimum, mean and maximum concentrations compared to state criteria. Data from each stream were grouped to simplify analysis. The groups, indicated next to the station number in Table 1, are: 1) Bayou Meto (BM), 2) Bayou Meto – urban (BMU), 3) Two Prairie Bayou (TPB), 4) Crooked Creek (CC), 5) Wabbaseka Bayou (WAB), and 6) Arkansas River (AR). The four stations in the Bayou Meto-U group are outside the project area but are included for comparison as source water to the basin.

Water quality and nutrient data are summarized in Table 3. In general, many of these parameters exhibit seasonal cycles. Mean water temperatures were similar, 17 to 19°C for all streams, although the maximum temperature criterion of 32°C was exceeded slightly in Bayou Meto and the Arkansas River at least once. Mean pH measurements were between 6.9 and 7.7 SU with maxima at or below the 9.0 SU criterion. Minimum values < 6.0 SU were reported in the Bayou Meto-U, Bayou Meto, Two Prairie Bayou and Arkansas River groups. All groups reported low values for dissolved oxygen (DO) during late summer at least once during the period of record. Mean DO values were 5.3 mg/l or lower with the exception of the Arkansas River stations. Of the three groups with similar number of measurements, Bayou Meto had the most variability in DO.

Mean turbidities for Bayou Meto-U, Two Prairie Bayou, and Arkansas River were less than 45 NTU, the criterion for the Delta Ecoregion least-altered streams. However, all streams exceeded the 100 NTU storm flow criterion of 100 NTU at least once during the period of record. Figure 2 shows the typical periodicity seen in the water quality data in the basin. Turbidity concentrations (Figure 2a) were typically higher in the first 6 months of the year when rain runoff was likely. The majority of TDS measurements exceeding the 390 mg/l Ecoregion criterion were collected before 1995. Samples collected outside the project area in the Bayou Meto-U and Arkansas River groups had the highest TDS. The Arkansas River group had the highest mean concentration. TDS also exhibited seasonal cycles (Figure 2b), with concentrations reaching their maxima during the late fall. Similarly, soluble salts also peaked at this time. While all groups except Crooked Creek had data greater than the 36 mg/l criterion for chloride, Arkansas River had the only mean exceeding 36 mg/l. The Arkansas River had the highest sulfate mean and maximum concentrations (both exceeding the 28 mg/l criterion). All groups except Crooked Creek had maxima exceeding 28 mg/l.

Nitrogen and phosphorus species are represented by nitrate/nitrite (NO3-N) and total phosphorus (TP) in Figure 2c. Peak concentrations for these nutrients occurred during the first six months of the year, probably moving into streams in rain runoff. Means for nitrogen and phosphorus species were generally highest in the Bayou Meto-U and Two Prairie Bayou groups. The Arkansas River group had the lowest mean for ammonia (0.071 mg/l), the lowest mean for TKN (0.713 mg/l), and the next lowest mean for nitrate/nitrite (0.327 mg/l). Bayou Meto-U and Two Prairie Bayou maximia exceeded the 1.6 mg/l chronic aquatic life criterion for ammonia at least once during the period of record. ADEQ recommends using 0.1 mg/l as a guideline for assessing TP data. The means for all groups exceeded this value. The minimum value for Wabbaseka Bayou also exceeded 0.1 mg/l TP. While orthophosphate does not have criteria, mean concentrations for all groups except Arkansas River were greater than 0.1 mg/l. The fecal coliform criterion for secondary contact waters is 1000 / 100 ml of water. None of the means exceeded that value; however, the maxima for all groups except Wabbaseka Bayou did exceed it. The fecal coliform maximum for Arkansas River was an order of magnitude greater than that of the other streams. Only Bayou Meto and Bayou Meto-U had fecal coliform means that did not exceed the 200 / 100 ml criterion for primary contact waters.

<u>USGS and ADEQ Metals Data</u>. Similarly, Table 4 summarizes the combined ADEQ and USGS metals data. Both acute and chronic exposure limits are utilized when evaluating aquatic life protection criteria for metals in water. Where required, criteria were calculated for a hardness of 50 mg/l and 100 mg/l. Data for Bayou Meto-U, Bayou Meto, and Two Prairie Bayou were compared to the 50 mg/l criteria. Data for Wabbaseka Bayou and the Arkansas River were compared to the 100 mg/l criteria. Bayou Meto had the highest mean values for aluminum, chromium, iron, mercury, and selenium. Two Prairie Bayou had the highest mean values for copper, manganese, and zinc. Wabbaseka Bayou had the highest mean values for arsenic, cadmium, and nickel. The Arkansas River had the highest mean value for silver. No stream exceeded any criteria for chromium, nickel and silver. All cadmium data from Wabbaseka Bayou exceeded the acute aquatic life criterion (CMC). Two Prairie Bayou had cadmium means exceeding the CMC. The Arkansas River cadmium means exceeded the chronic aquatic life criterion (CCC). Mean copper values exceeded the CCC for Bayou Meto-U and the CMC for Bayou Meto and Two Prairie Bayou. Bayou Meto-U, Bayou Meto, and Two Prairie Bayou lead means exceeded the CCC. Bayou Meto-U, Bayou Meto, Two Prairie Bayou and the Arkansas River mean mercury values all exceeded their CCC. No stream means exceeded any zinc or selenium criteria. Many of the metals, however, had maximum values exceeding their criteria briefly during the period of record.

USGS and ADEQ Pesticide Data. Pesticide and PCB data are summarized in Tables 5 and 6. The chlorinated pesticides listed in Table 5 are compared to their aquatic life criteria. Aldrin, DDE, DDT, dieldrin, endrin, and toxaphene were detected in only a few samples from Bayou Meto-urban and Two Prairie Bayou. DDD was detected in one sample from Bayou Meto-urban at a concentration of 0.005 µg/l. This value exceeded the CCC for DDD. The Bayou Meto-U means for dieldrin and endrin also exceeded their CCC values and the toxaphene, detected in both streams, exceeded its CMC. No chlorinated pesticides were detected in samples from Bayou Meto, Wabbaseka Bayou, or the Arkansas River. The agricultural herbicides detected in the project area streams are listed in Table 6. These compounds are commonly used for either broad-leaf weed control or grassy weed control throughout the Delta Ecoregion on a variety of crops. Unlike the chlorinated pesticides, many of these compounds have short half-lives in the environment and are generally non-toxic to aquatic organisms. Bayou Meto had the highest number of samples with herbicide detections in the project area. Two Prairie Bayou had the fewest. Samples from the Arkansas River contained only low levels of 4 herbicides.

Vicksburg District (MVK) Water Quality Data. Nutrient data collected by MVK personnel in August 2000 and January 2001 are listed in Table 7. Generally, most of the data fell within the minimum / maximum ranges developed from the combined USGS and ADEQ data. Total organic carbon (TOC), only collected in August 2000, was the exception with values at least doubled the maximum concentrations seen in the combined dataset. Ammonia concentrations in samples collected by the MVK did not exceed any aquatic life criteria. All but two of the TP samples did exceed the 0.1 assessment guideline. Seven of the nine samples collected in August 2000 exceeded the Delta ecoregion criterion for chloride and three exceeded the sulfate criterion.

Vicksburg District (MVK) Metals Data. Data for trace metals in water are listed in Table 8. Most of the values are non detect and are given as < the detection limit. Of the detected metals, only lead in BM-14 (Indian Bayou) exceeded its chronic aquatic life (CCC) value. Results reported for copper, lead, selenium and silver in August 2000 have detection limits above some of their criteria and could not be evaluated.

Historic Sediment Quality Data Review. No historic metals or pesticide sediment data were available from the ADEQ or USGS for the project study area.

Historic Dioxin Contamination in Bayou Meto Sediments. Historic sediment data were available for dioxin (2,3,7,8 TCDD) in Bayou Meto from samples in the early 1990s. The Vertac Chemical Corporation site, located on Rocky Branch Creek a tributary of Bayou Meto in Jacksonville, Arkansas, has a long history of herbicide production. In 1948, as Reasor Hill Company, the site began producing 2,4,5-T (dioxin is a by-product). In 1961, Hercules purchased the plant and produced Agent Orange. From 1971 to 1976, Transvall leased the plant and produced 2,4-D; 2,4,5-T; and 2,4,5-TP. Vertac organized in 1976 and in 1979 suspended production of 2,4,5-T and 2,4,5-TP. The site was placed on the NPL (Superfund) list in September 1983. All manufacturing operations at the site ceased in May 1986. In December 1986, the Potentially Responsible Party (PRP) began removal activities with EPA oversight; and all site remedial construction activities were declared complete in September 1998. The site is considered 100% remediated but has not been delisted.

The ADH has been monitoring dioxin in fish tissue since the late 1970s. In 1980, a fish consumption advisory was issued for Bayou Meto below Vertac. Sediment samples collected for the US Fish and Wildlife Service (USFW) in 1991 showed dioxin concentrations well above background samples throughout Bayou Meto as far south as the Bayou Meto Wildlife Management Area (Table 12). Background samples collected in other streams were below the detection limit.

There are no specific criteria to evaluate sediment data. At the time of the 1991 sampling, no screening guidelines existed for dioxin concentrations in sediment. More recently, sediment guidelines for organic compounds are being developed through the use of bioassays. The National Oceanic and Atmospheric Administration (NOAA) developed the upper effects threshold (UEL) presented in Table 12 from bioassays using *Hyalella azteca* and freshwater sediments. This guideline represents the concentration of dioxin above which adverse biological impacts would always be expected to *H. azteca* due to exposure to dioxin alone; although adverse impacts can occur below the UEL. In 1991, six of the twelve stations had sediment concentrations greater than the current UEL. Present day, in the 2002 Water Quality Inventory Report, ADEQ states that the source of the dioxin has been removed and that contamination downstream is being addressed through natural attenuation. As of October 2002, the fish consumption advisory is still in place for Bayou Meto reach number 08020402-007 extending approximately 48 miles downstream of the original source to the HW 13 Bridge. Based on new fish tissue data and recommendations from the US EPA, the ADH is considering extending the advisory downstream for some fish species.

Existing Sediment Quality Data Review. Sediment data from samples collected by the MVK in August 2000 and January 2001 were analyzed for metals, chlorinated pesticides, herbicides, PAHs, and TOC. These data are presented in Tables 13 through 16. While there are no specific criteria to evaluate sediment data, NOAA has developed benchmark levels that can be used to screen sediment concentrations for some of these parameters. Two of the NOAA benchmarks are the Environmental Response-Low (ERL) and the Environmental Response-Median (ERM). The ERL and the ERM represent the 10^{th} and 50^{th} percentiles of contaminant concentrations that have elicited adverse biological responses. The ERL represents the value at which toxicity may begin to be observed in sensitive species. The ERM is the median concentration of toxic samples evaluated in the NOAA study. These NOAA benchmarks are based on data collected from marine studies, which limits their usefulness. However in the absence of specific criteria, they still provide a reasonable guide to use in comparing sediment data.

Positive results were reported for all of the metals except silver (Table 13). Reported concentrations exceeded the ERLs for arsenic in WB-02 and Indian Bayou-01 from the August 2000 sampling and for nickel in BM-10 from the January 2001 sampling. Table 13 also contains the mean concentration of metals found in the soils in the Eastern US by the US Geological Survey. The three samples exceeding the NOAA ERLs were also slightly above the USGS Earth's Crust averages but were well within the observed ranges.

Table 14 contains chlorinated pesticide and PCB data from samples collected in August 2000. Positive results were found for the compounds beta-BHC, gamma-BHC, DDD, DDE, DDT, endosulfan sulfate, and endrin. All of the samples with positive results for DDT and its derivatives exceeded either its corresponding ERL or ERM. There are no guidelines for the herbicides listed in Table 15. The only samples with positive results not qualified as less than the detection limit (J) or blank contaminated (B) were BM-10 (2,4,5-TP) and BM-11 (Dinoseb), both at low ppb concentrations. For the PAHs listed in Table 16, only Bayou Meto-1 from August 2000 had 'J' concentrations for fluoranthene and pyrene. No concentrations exceeded any guidelines.

Summary. Concentrations of chemical parameters within the waters and sediments of the Bayou Meto project area exhibited patterns generally expected within historic agricultural regions. Within the Bayou Meto project area and excluding the Arkansas River, the urban areas, generally, had lower mean concentrations for turbidity, TDS, total suspended solids (TSS), chloride, and sulfate. The more agricultural portions of Bayou Meto and Wabbaseka Bayou had the highest means for turbidity, conductivity, chloride, sulfate, TDS, and TSS of the streams within the project area. Concentrations of dissolved solids represented by TDS, conductivity, sulfate, and chloride peaked in the late summer when conditions were dry and water levels were generally low. Nitrogen, phosphorus, fecal coliform and turbidity concentrations peaked in the late winter and spring, probably coinciding with rainfall events. Each of these parameters exceeded its criterion at least once during the period of record; however these occasions were of a temporal nature and concentrations probably did not remain elevated long after the associated event ended. Samples collected from the Arkansas River had mean concentrations for TDS higher than the other groups. Mean concentrations for conductivity, fecal coliform, and sulfate were at least 2 times higher than the other groups; and mean concentrations for chloride were at least 3 times higher over the period of record.

Metals in Bayou Meto and Two Prairie Bayou, the longest streams, had similar mean concentrations. No stream exceeded any criteria for chromium, nickel, and silver. Other dissolved metals with aquatic life criteria did exceed one of those values at least once during the period of record. Various streams within the project area had the highest means for all metals except silver, which was higher in the Arkansas River.

The ADEQ reported in its 2002 Water Quality Report that Bayou Meto had the highest number of pesticide detections per sampling event in the basin and that Wabbaseka Bayou at HW 79 had a high number as well. The insecticides aldrin, DDT and its derivatives, dieldrin, endrin, and toxaphene were reported by the ADEQ and USGS in water samples from Bayou Meto-urban, Bayou Meto, and Two Prairie Bayou. Water samples collected by the MVK also had traces of aldrin, BHC, and endrin aldehyde in Bayou Meto, Wabbaseka Bayou, and Indian Bayou. While no DDT or toxaphene was detected in the water, all sediment samples collected by MVK had DDT or its derivatives.

Two Prairie Bayou, Bayou Meto, Wabbaseka Bayou, Indian Bayou Ditch, and Crooked Creek sediment also had traces of endrin and BHC.

The ADEQ tested water samples from these streams for herbicides from 1995 to 2001. Herbicides detected include pre-emergent herbicides, and those associated with specific crops such as rice, cotton, and soybeans. In the Mississippi Embayment Study by the USGS, concentrations of these types of herbicides showed distinct seasonal patterns that corresponded to the type of crop grown in the basin and the pesticide used on those crops. Concentrations of the detected herbicides in the Bayou Meto project area were generally in the low ppb ranges and while not equally dispersed throughout the project area at the time of sampling, could certainly move and dilute within the steams of the basin after application. Water samples collected by the MVK from Two Prairie Bayou, Bayou Meto, Wabbaseka Bayou, Indian Bayou, and Indian Bayou Ditch also had traces of 2,4-D; 2,4,5-T; 2,4-DB; and Dinoseb. Sediment samples had traces of 2,4,5-TP and Dinoseb. These samples were not analyzed for all of the herbicides listed by ADEQ.

Sediment downstream of the Vertac Chemical Corporation was contaminated with dioxin due to historic chemical manufacturing processes. Bayou Meto throughout most of its length was impacted by this contamination. Minimal sediment data exists for dioxin in Bayou Meto; however, data from 1992 indicate that at the I-40 and HW 15 bridges, dioxin sediment concentrations were 39.7 and 46.0 ppt, respectively. Sediment concentrations decreased further downstream from the source to 4.2 ppt at HW 152 and 1.4 ppt at HW 11 below the Bayou Meto Wildlife Management Area. Elevated dioxin concentrations in fish caused the ADH to issue a fish consumption advisory in 1980. Today, the advisory extends to the HW 13 Bridge; but in future may be extended downstream of this site for certain fish species. Although the dioxin source, the Vertac site, is considered 100% remediated it has not been delisted from the NPL.

The US EPA requires ongoing monitoring at the Vertac site and in the affected streams beyond to ensure that the site is being maintained correctly and that the public is sufficiently protected from dioxin. The required Bayou Meto fish monitoring program involves yearly samplings of fish tissue from set collection sites within the affected streams. Two of the fish monitoring stations lie within the Bayou Meto Project Area. BM 5.5 extends approximately 1.5 miles upstream from the I-40 Bridge. Another site, BM6, is approximately 2.5 miles in length and centered in the bend at the HW 15 Bridge. The Bayou Meto bypass channel in the Reach 3 flood control alternative will cut into the stream in this portion of Bayou Meto.

<u>Water Quality Impacts</u>. The purpose of this section is to discuss anticipated water quality impacts associated with the project alternatives. Alternative 2 is broken out into construction activities for several reaches within the project area. Work consists mainly of selective clearing, excavation of streambeds, construction of low water weirs, construction of a bypass channel and bridge, and construction of a levee. Alternative 2A also includes an overlap between flood control and water supply in three reaches (Indian Bayou Ditch, Crooked Creek Ditch, and Crooked Creek). Alternatives 3A and 3B call for construction of pumping stations.

Levee Construction. No direct impacts to water quality will likely result from the construction or modification of levees since the actual work involved would not be directly connected to the water. Soil erosion is likely to increase in the vicinity of the construction area due to the removal of vegetation and the placement of fill material. Runoff from the project area will be highly turbid and contain high concentrations of suspended solids. Indirect impacts to water quality of any water body receiving this runoff include increased turbidity and suspended solids. The effects of increased turbidities may include decreased light penetration, increased water temperatures, and lowered DO. Erosion effects can be minimized through the development and proper implementation of the State required storm water plan. These impacts are anticipated to be short term and will decrease once vegetation has been reestablished along the affected area.

Channel excavation and selective clearing. Direct impacts would tend to be immediate, localized, and short term in duration. The physical process of channel and bank excavation would resuspend sediment, strip away existing aquatic habitat, and bury or kill invertebrates. Net effects of this activity would be to increase water turbidities and lower and shift fish and invertebrate species composition. The effects of increased turbidities may include decreased light penetration, increased water temperatures, and lowered DO concentrations. These impacts will be magnified if streams are stressed due to low water, late summer conditions. However, these impacts are anticipated to be short term and will decrease once construction ceases and vegetation has been reestablished along the project areas.

Indirect impacts of channel and bank excavation can be longer term. They can include the loss of stream habitat and long term increases in turbidity due to loss of stream bank vegetative cover and the erosion protection it provides during rain and flood events. Increased solids in the system can mean a redistribution of pollutants throughout the system. The flood control plan calls for minimal excavation in each reach to reduce this impact. Once vegetation has reestablished the potential for erosion will be reduced. For the metals and organic pesticides evaluated in this study, the concentrations and spatial distributions are similar throughout the system. Any effects due to redistribution because of erosion should be minimal. For the dioxin contaminated sediments in upper Bayou Meto, the effects could be longer term.

Channel excavation for Bayou Meto bypass channel in Reach 3. In Upper Bayou Meto, the bypass channel is the only work item in the recommended flood control alternative. In this plan the bypass channel is not excavated to the same depth as the thalwag of the original channel. This will have the result of keeping low flows in the old channel and will minimize sediment disturbance. During construction most of the material removed will be bank material and not bottom sediment. As discussed above in the Summary, the upper end of the bypass channel will be cut into an area that is one of the US EPA's dioxin fish monitoring sites and is known to have dioxin contamination in the sediment. Currently the ADH is considering extending the current fish consumption advisory beyond the HW 13 Bridge. Any repositioning of dioxin-contaminated sediment could have a long-term effect on the distribution of dioxin in the aquatic system. The recommended bypass channel design will minimize the disturbance and possible relocation of contaminated sediment downstream. Excavated material taken from the intersection of the bypass channel with Bayou Meto will be placed in capped, upland disposal sites or within the constructed levee where it cannot be reintroduced into the system. The two low water weirs intended for this bypass channel have the potential for collecting contaminated sediment over time and should also prevent this material from moving downstream. Measures will be taken to protect the bank and streambed from erosion or head cutting above the bypass channel in order to prevent contaminated sediment from moving downstream.

Construction of Low Water weirs. The immediate, short-term impacts from weir construction would be similar to those from channel excavation such as increased turbidities and species reduction. Long term, the construction of weirs will allow for a permanent pool of water during low flow conditions and could provide some improvement of habitat for freshwater mussels, other freshwater invertebrates, and fish. The potential exists, however, for basic water quality parameters such as DO and temperature to become impaired in the summer. Also, since weirs have the potential to trap sediments moving through the system and the main contaminants of concern in the project area are associated with sediments, provisions should be made to monitor the depth of sediments trapped by the weirs and their anthropogenic chemical composition to ensure there are no long term impacts to biota within the immediate project area.

Construction of Pumping Plants. The construction of pumping plants will likely have no direct impacts to the streams. Indirect impacts will be localized resulting from removal of vegetation and from construction practices. Erosion effects can be minimized through the development and proper implementation of the State required storm water plan. These impacts are anticipated to be short term and will decrease once vegetation has been reestablished along the effected area.

In operation the pumping plants may become point sources that introduce turbidity into the receiving waters. In Regulation 2, the State of Arkansas says that 'there shall be no distinctly visible increase in turbidity of receiving waters attributable to municipal, industrial, agricultural, other waste discharges or instream activities.' No discharge or instream activity should cause turbidity values to exceed 45 NTU for least-altered Delta Ecoregion streams or 75 NTU for channel-altered Delta Ecoregion streams. Suspended sediment that would normally settle during flood events would be pumped out of the basin, resulting in a pulse of high turbidity in the receiving water. The effects would be those of increased turbidities discussed above.

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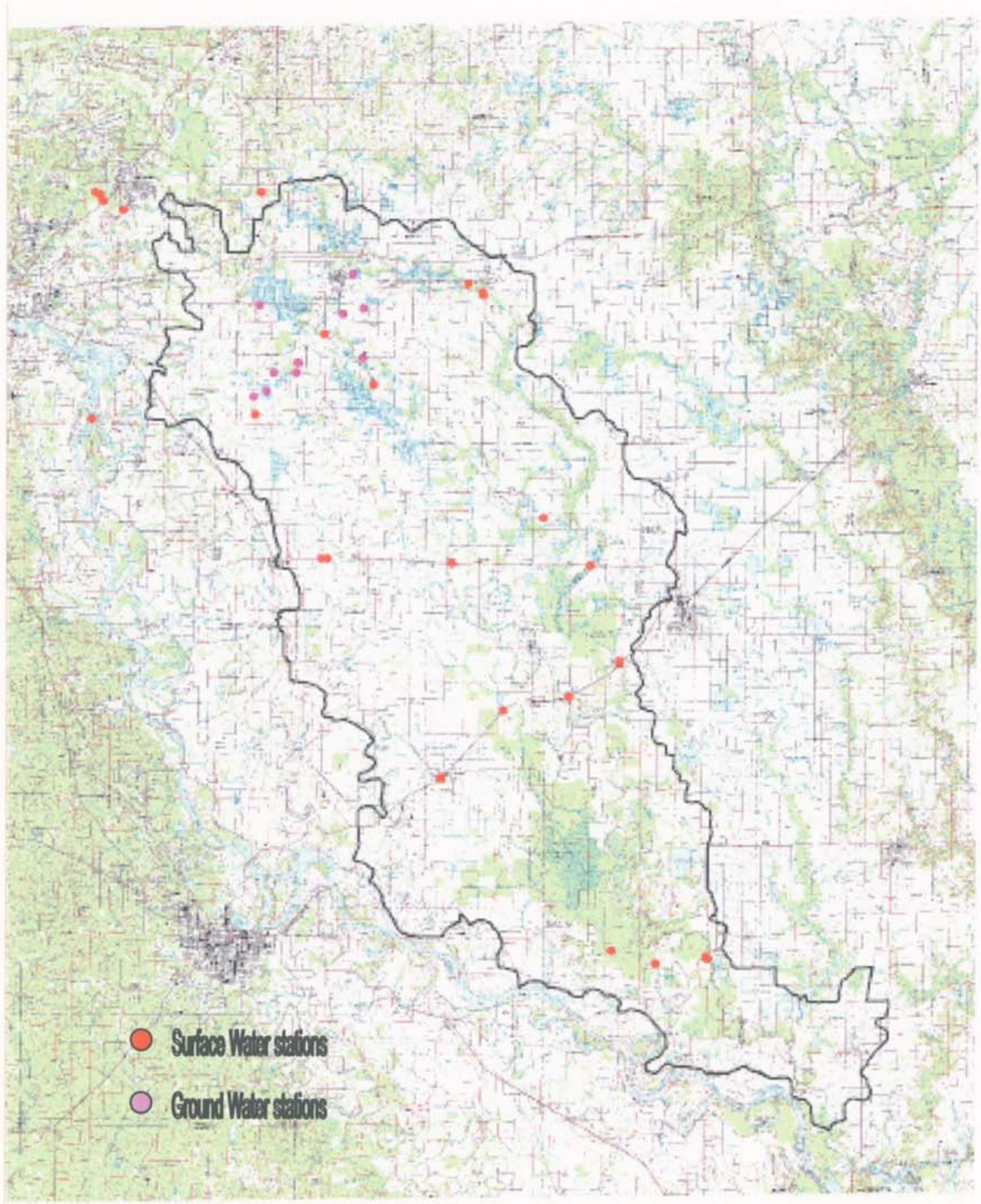


Figure 1. Sampling stations evaluated within the Bayou Meto Project Area.

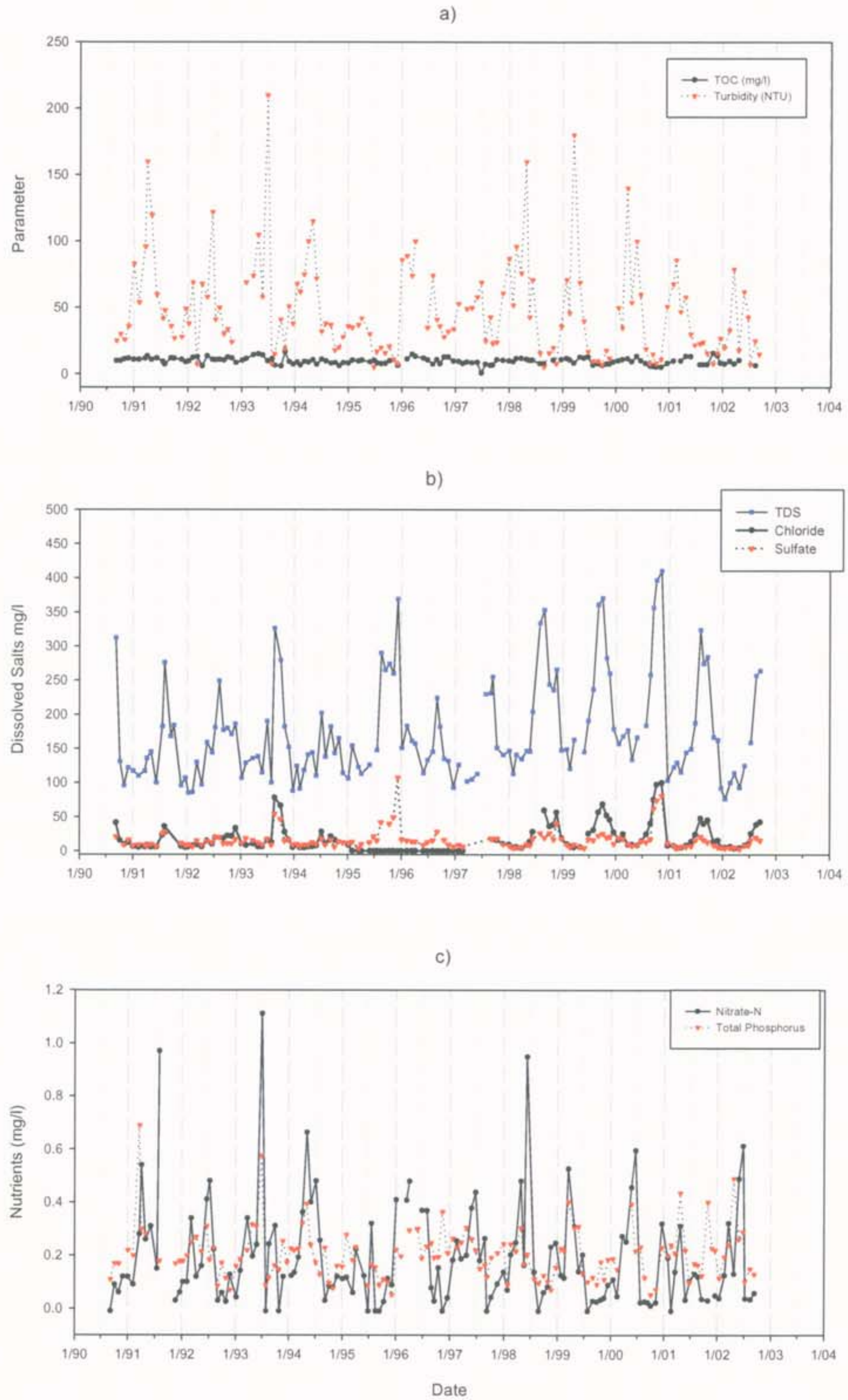


Figure 2. Example of water quality data periodicity in the project area (ARK023: Bayou Meto at Bayou Meto, Arkansas).

Table 1. Sampling stations for USGS and ADEQ data used in this water quality evaluation.		
STATION	LOCATION	PERIOD OF RECORD
Surface Water Bayou Meto HUC 08020402		
USGS 7263920 (BMU)	Bayou Meto nr N. Little Rock, AR -0920913: 345158 NAD27	11/01/83 – 9/06/94
USGS 7263935 (BMU)	Bayou Meto nr Jacksonville, AR -0920720: 345039 NAD 27	11/01/83 – 9/06/94
USGS 7264000 (BM)	Bayou Meto nr Lonoke, AR -0915458: 344413 NAD 27	2/21/55 – 10/04/83
USGS 7264050 (TPB)	Two Prairie Bayou nr Furlow, AR -0915848: 345132 NAD 27	4/03/74 – 7/12/83
USGS 7264200 (TPB)	Two Prairie Bayou @ Carlisle, AR -0914558: 344644 NAD 27	7/11/61 – 10/20/87
USGS 7264203 (TPB)	Two Prairie Bayou on HW 13 Br. S of Carlisle, AR -0914505: 344610 NAD 27	10/05/93 – 9/06/94
USGS 7264500 (BM)	Bayou Meto nr Stuttgart, AR -0913658: 342715	11/10/49 – 12/11/74
USGS 7265000 (CC)	Crooked Creek nr Humphrey, AR -0914004: 342535 NAD 27	11/14/45 – 2/22/55
USGS 7265099 (BM)	Bayou Meto nr Bayou Meto, AR -0913145: 341205 NAD 27	4/17/74 – 5/23/96
ADEQ ARK0023 (USGS 7265099) (BM)	Bayou Meto nr Bayou Meto, AR -91.5306: 34.2019	9/04/90 – 9/10/02
ADEQ ARK0050 (BMU)	Bayou Meto @ HW 161 nr Jacksonville, AR -92.1221: 34.8442	10/01/83 – 9/10/02
ADEQ ARK0060 (BMU)	Bayou Meto @ W Main St Br in Jacksonville, AR -92.1538: 34.8661	10/01/83 – 9/10/02
ADEQ ARK0097 (TPB)	Two Prairie Bayou @ HW 13 S of Carlisle, AR -91.7514: 34.7694	5/14/93 – 9/10/02
ADEQ UWBM001 (BM)	Bayou Meto @ county rd SE of Seaton Dump -91.6911: 34.5769	6/01/94 – 9/11/01
ADEQ UWBM002 (BM)	Bayou Meto @ HW 79, 2 mi SW of Stuttgart, AR -91.6164: 34.4536	6/01/94 – 9/11/01
Surface Water Lower Arkansas River HUC 08020401		
ADEQ UWWSB01 (USGS 07262528) (WAB)	Wabbaseka Bayou @ HW 79 @ Wabbaseka, AR -91.3164: 33.9717	6/01/94 – 9/10/01
Surface Water Lower Arkansas - Maumelle HUC 11110207		
USGS 07263620 (AR)	Arkansas River @ David D. Terry Lock & Dam 920918: 344007 NAD 27	7/24/69 – 9/13/01
ADEQ ARK0046 (USGS 07263620) (AR)	Arkansas River @ David D. Terry Lock & Dam -92.155: 34.6686	10/01/86 – 9/10/02
Ground Water Lonoke Monitoring Area - Mississippi River Valley Alluvial Aquifer (Bayou Meto HUC 08020402)		
ADEQ LON014	-91 53 29.7; 34 47 10.1	6/12/01
ADEQ LON016	-91 59 09.7; 34 45 49.1	6/19/01
ADEQ LON017	-91 52 43.5; 34 45 32.5	6/12/01
ADEQ LON017R	-91 53 46.4; 34 45 18.2	6/12/01
ADEQ LON020	-91 56 01.7; 34 42 40.2	6/12/01
ADEQ LON021	-91 59 21.2; 34 42 19.2	6/19/01
ADEQ LON024	-91 52 32.4; 34 42 56.4	6/12/01
ADEQ LON040	-91 58 37.0; 34 41 13.5	6/19/01
ADEQ LON041	-91 58 58.1; 34 41 14.8	6/19/01
ADEQ LON042	-91 58 02.1; 34 42 19.7	6/19/01

Table 2. Sampling stations for MVK water and sediment samples.

Station	Location	Sample Date
LBM-01	Little Bayou Meto	August 2000
TPB-01	Two Prairie Bayou	August 2000
Bayou Meto-1	Bayou Meto	August 2000
BM HW 11	Bayou Meto	August 2000
WB-01	Wabbaseka Bayou	August 2000
WB-02	Wabbaseka Bayou	August 2000
Indian Bayou-01	Indian Bayou	August 2000
Indian Bayou Ditch		August 2000
Crooked Creek	Crooked Creek	August 2000
BM-10	Little Bayou Meto 0630601: 3784809	January 2001
BM-11	Little Bayou Meto 0626444: 3786017	January 2001
BM-12	Salt Bayou Ditch 0616261: 3808691	January 2001
BM-13	Two Prairie Bayou 0614279: 3847993	January 2001
BM-14	Indian Bayou 0592729: 3836600	January 2001

Table 3. Water quality and nutrient data from streams in the project area (sources: USGS and ADEQ).

Parameter	#/Group	Statistic	Bayou Meto Urban	Bayou Meto	Two Prairie Bayou	Crooked Creek	Wabbaseka Bayou	Arkansas River Terry L&D	Criteria
Water	495/570	Min	1.0	0.0	0.5		4.0	0.0	30 [a]
Temperature	/220/0	Mean	17.6	18.2	17.0	-	19.3	18.7	32 [b]
(C)	/13/518	Max	32.0	35.0	32.0		30.0	33.0	
pH	499/689	Min	5.9	4.4	5.3	6.3	6.0	5.9	6.0 – 9.0
(SU)	/222/11	Mean	6.9	7.3	6.9	7.1	7.3	7.7	
	/13/567	Max	7.3	8.8	8.0	8.4	8.2	9.0	
Dissolved	542/778	Min	ND	ND	ND		ND	ND	5 [c]
Oxygen	/237/19	Mean	5.34	4.39	5.3	ND	3.2	7.8	2 [d]
(mg/l)	/23/592	Max	9.66	16.3	12.0		12.8	16.4	
Turbidity	466/404	Min	4.20	3.00	4.00		4.1	0.60	45 [a]
(NTU)	/176/0	Mean	21.3	56.8	37.3	-	66.5	22.0	75 [b]
	/16/441	Max	192	2000	290		240	660	100 [j]
Conductivity	0/374	Min		38.0	43.0	43.0		135	
(µhos/cm)	/65/19	Mean	-	198	139	118	-	533	
	/0/417	Max		1530	849	300		1110	
Chloride	477/640	Min	0.035	0.035	0.035	2.20	0.035	0.035	36 [e]
(mg/l)	/202/19	Mean	18.9	22.2	16.5	8.10	16.4	72.9	
	/15/526	Max	1200	550	85.7	32.0	49.7	230	
Sulfate	480/630	Min	1.17	0.500	0.500	1.00	3.63	13.0	28
(mg/l)	/207/19	Mean	8.95	12.3	10.9	7.98	20.4	45.2	
	/15/529	Max	35.1	130	52.6	22.0	66.4	257	
Ammonia	494/412	Min	0.002	0.002	0.002		0.002	0.002	19.9 [g]
(mg/l)	/190/0	Mean	0.266	0.100	0.514	-	0.081	0.071	1.6 [h]
	/15/260	Max	5.60	0.911	9.50		0.180	0.460	
Nitrate/Nitrite	469/472	Min	0.005	0.005	0.005		0.005	ND	
(mg/l)	/215/0	Mean	0.583	0.282	.333	-	0.415	0.327	
	/15/267	Max	12.0	1.41	4.94		1.12	0.855	
Ortho-	498/356	Min	0.002	0.002	0.018		0.106	0.002	
Phosphate	/149/0	Mean	0.441	0.127	0.476	-	0.220	0.063	
(mg/l)	/15/192	Max	6.10	0.880	7.33		0.592	0.370	
Total	482/501	Min	0.010	0.030	0.010		0.166	ND	0.1
Phosphorus	/217/0	Mean	0.576	0.238	0.655	-	0.358	0.109	
(mg/l)	/15/544	Max	7.50	0.390	7.90		0.838	0.933	
TKN	413/132	Min	0.050	0.050	0.692		0.620	0.080	
(mg/l)	/56/0	Mean	0.988	1.13	1.44	-	1.26	0.713	
	/6/476	Max	5.50	3.30	2.68		2.24	4.60	
TOC	393/222	Min	2.10	0.700	4.85		6.4	0.60	
(mg/l)	/110/0	Mean	7.24	9.76	10.4	-	8.69	5.71	
	/12/188	Max	20.0	16.4	17.5		10.4	11.0	
TSS	499/466	Min	0.50	0.50	2.00		6.00	0.50	
(mg/l)	/216/0	Mean	18.0	39.0	28.4	-	22.4	19.6	
	/13/162	Max	267	375	287		61.5	121	
TDS	488/612	Min	6.00	20.0	45.0	77.0	123	5.00	390 [e]
(mg/l)	/206/2	Mean	102	159	143	87.0	230	290	
	/15/513	Max	2510	1120	376	97.0	391	1480	
Fecal Coliform	259/610	Min	ND	ND	ND	ND	88	ND	1000 [f]
(# / 100 mls)	/131/19	Mean	131	159	288	ND	323	766	200 [i]
	/8/450	Max	4500	7400	4400	ND	820	51000	

[a] Delta Ecoregion, Least-Altered Streams
[b] Delta Ecoregion, Channel-Altered Streams
[c] Delta Ecoregion, Primary Season Value
[d] Delta Ecoregion, Lowest Critical Season Value
[e] Delta Ecoregion
[f] Secondary Contact Waters
[g] acute aquatic life (CMC)
[h] chronic aquatic life (CCC)
[i] Primary contact waters
[j] Storm runoff

Table 4. Metals data from streams in the project area (sources: USGS and ADEQ).									
Parameter µg/l	#/Group	Statistic	Bayou Meto Urban	Bayou Meto	Two Prairie Bayou	Crooked Creek	Wabbaseka Bayou	Arkansas River Terry L&D	Criteria (Reg 2, July 2001)
	98/65	Min	21.8	28.1	23.1		18.9	16.9	
Aluminum	/48/0	Mean	128	269	252	-	146	134	
	/11/48	Max	701	1806	1619		485	587	
	52/143	Min	0.500	0.500	0.500		1.43	ND	
Arsenic	/73/0	Mean	0.965	3.98	3.66	-	6.65	1.43	
	/5/149	Max	2.78	24.0	30.0		17.9	4.14	
	234/272	Min	ND	ND	0.070		7.10	0.02	1.7 [a,c]
Cadmium	/108/0	Mean	0.331	3.00	3.54	-	30.2	1.22	3.7 [a,d]
	/12/132	Max	1.30	10.0	10.0		62.7	78.0	0.6 [b,c]
									1.0 [b,d]
	227/217	Min	0.200	ND	0.200		0.200	ND	326 [a,c]
Chromium	/78/0	Mean	0.860	3.15	2.53	-	0.276	1.65	564 [a,d]
	/5/126	Max	11.0	50.0	16.0		0.580	20.0	111 [b,c]
									188 [b,d]
	280/347	Min	0.250	ND	0.250		0.25	ND	9 [a,c]
Copper	/149/0	Mean	7.23	13.1	13.6	-	1.43	4.12	17 [a,d]
	/12/163	Max	32.0	176	127		3.80	24.4	7 [b,c]
									12 [b,d]
	98/229	Min	42.1	ND	19.0		9.00	1.5	
Iron	/110/1	Mean	479	1579	1373	1300	133	44.7	
	/11/170	Max	2270	14100	4410		675	298	
	231/214	Min	0.200	ND	0.20			ND	30 [a,c]
Lead	/75/0	Mean	3.57	8.13	7.01	-	ND	1.19	65 [a,d]
	/5/130	Max	100	70.0	52.0			27.0	1.2 [b,c]
									2.5 [b,d]
	98/223	Min	23.3	ND	13.0		4.90	0.25	
Manganese	/112/0	Mean	480	225	757	-	262	7.24	
	/12/169	Max	2799	1500	13000		1400	80	
	6/17	Min	ND	ND	ND			ND	2.0 [a]
Mercury	/3/0	Mean	0.196	0.449	0.42	-	-	0.127	0.012 [b]
	/0/75	Max	0.250	1.60	0.50			0.700	
	98/78	Min	ND	ND			1.00	ND	780 [a,c]
Nickel	/48/0	Mean	1.51	2.81	ND	-	2.94	1.74	1400 [a,d]
	/11/148	Max	24.3	37.0			22.4	9.00	88 [b,c]
									157 [b,d]
	52/76	Min		ND	ND			ND	20 [a]
Selenium	/47/0	Mean	ND	2.31	2.30	-	ND	1.02	
	/5/59	Max		5.00	10.0			4.15	5 [b]
	0/5	Min		ND				ND	1.0 [a,c]
Silver	/0/0	Mean	-	0.200	-	-	-	0.48	3.4 [a,d]
	/0/100	Max		1.00				1.0	
	232/330	Min	ND	ND	ND		ND	ND	64 [a,c]
Zinc	/144/0	Mean	23.4	24.4	28.7	-	3.44	8.7	115 [a,d]
	/12/156	Max	500	320	390		9.40	110	58 [b,c]
									105 [b,d]
	322/661	Min	ND	ND	ND	14.0	28.0	45.0	
Hardness	/171/19	Mean	22.6	38.4	32.5	38.7	123	116	
	12/195	Max	260	250	168	120	260	208	

[a] acute aquatic life criteria (CMC)
[b] chronic aquatic life criteria (CCC)
[c] hardness dependent (50 mg/l)
[d] hardness dependent (100 mg/l)

Table 5. Combined pesticides and PCB data from project area streams (sources: USGS and ADEQ).									
Parameter (µg/l)	# Detected /Group	Statistic	Bayou Meto Urban	Bayou Meto	Two Prairie Bayou	Crooked Creek	Wabbaseka Bayou	Arkansas River Terry L & D	Criteria CMC [a] CCC [b]
Aldrin	6/0/3	Min	ND	ND	ND				3.0
		Max	0.001		0.001	-	-	-	-
A-BHC	0/0/0	Min	ND	ND	ND	-	-	-	
		Max							
B-BHC		Min	ND	ND	ND	-	-	-	
		Max							
G-BHC		Min	ND	ND	ND	-	-	-	
		Max							
D-BHC		Min	ND	ND	ND	-	-	-	
		Max							
pp-DDD	1/0/0	Min	0.005	ND	ND	-	-	-	1.1
		Max							0.0010
pp-DDE	10/0/3	Min	0.001	ND	0.001	-	-	-	1.1
		Max	0.001		0.001				0.0010
pp-DDT	6/0/1	Min	0.001	ND	0.001	-	-	-	1.1
		Max	0.001						0.0010
Heptachlor		Min	ND	ND	ND	-	-	-	0.52
		Max							0.0038
Dieldrin	18/0/2	Min	0.001	ND	0.001				2.5
		Max	0.010		0.001	-	-	-	0.0019
A-Endosulfan		Min	ND	ND	ND				
		Max				-	-	-	
B-Endosulfan		Min	ND	ND	ND				Sum =
		Max				-	-	-	0.22
Endosulfan Sulfate		Min	ND	ND	ND				
		Max				-	-	-	0.056
Endrin	19/0/2	Min	0.001	ND	0.001				0.18
		Max	0.068		0.001	-	-	-	0.0023
Endrin Aldehyde		Min	ND	ND	ND				
		Max				-	-	-	
Heptachlor Epoxide		Min	ND	ND	ND				
		Max				-	-	-	
Methoxychlor		Min	ND	ND	ND				
		Max				-	-	-	
Chlordane		Min	ND	ND	ND				2.4
		Max				-	-	-	0.0043
Toxaphene	2/0/1	Min	1	ND	5	-	-	-	0.73
		Max	5						0.0002
PCB		Min	ND	ND	ND	-	-	-	-
		Max							0.0140

[a] (CMC) - acute aquatic life criteria
[b] (CCC) - chronic aquatic life criteria

Table 6. Herbicide data from ADEQ for project area streams.

Parameter (µg/l)	# Detected /Group	Statistic	Bayou Meto Urban	Bayou Meto	Two Prairie Bayou	Crooked Creek	Wabbaseka Bayou	Arkansas River Terry L & D	Criteria
	2/8/1	Min	0.016	0.62	0.088		0.025	ND	
Molinate	0/4/0	Max	3.38	11.5		-	12.3		
	1/0/0	Min	0.007	ND	ND	-	ND	ND	
Trifluralin	0/0/0	Max							
	2/1/0	Min	0.023	0.011	ND	-	0.088	ND	
Prometon	0/2/0	Max	0.035				0.568		
	1/2/1	Min	0.047	0.011	0.118	-	ND	ND	
Simazine	0/0/0	Max							
	4/6/1	Min	0.008	0.031	0.472	-	0.034	0.368	
Atrazine	0/3/1	Max	0.293	0.202			0.085		
	2/0/0	Min	0.038	ND	ND	-	ND	ND	
Diazinon	0/0/0	Max	0.044						
	1/4/1	Min	0.082	0.016	0.012	-	0.074	0.010	
Metribuzin	0/1/1	Max		0.066					
	1/2/0	Min	0.056	0.045	ND	-	ND	0.024	
Alachlor	0/0/1	Max		0.056					
	0/1/0	Min	ND	0.006	ND	-	ND	ND	
Ametryn	0/0/0	Max							
	0/2/0	Min	ND	0.004	ND		0.017	ND	
Prometryn	0/3/0	Max		0.050		-	0.213		
	0/1/1	Min	0.060	ND	0.018		0.041	ND	
Terbutryn	0/3/1	Max				-	1.60		
	3/9/1	Min	0.008	0.013	0.594		0.029	0.159	
Metolachlor	0/4/0	Max	1.78	1.53		-	1.81		
	0/2/0	Min	0.083	ND	ND		0.860	ND	
Cyanazine	0/1/0	Max	0.717			-			
	1/1/0	Min	0.010	0.064	ND		ND	ND	
Pendimethalin	0/0/0	Max				-			

Table 7. Water quality samples collected by MVK for nutrients in water.

Parameter (mg/l)	LBM - 01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	BM-10 Little Bayou Meto	BM-11 Bayou Meto	BM-12 Five Fork	BM-13 Two Prairie Bayou	BM-14 Indian Bayou	Criteria
	August 2000									January 2001					
TKN	0.38	0.57	0.70	0.37	0.21	0.35	0.34	0.30	0.86	1.3	0.81	0.78	0.90	0.92	
TP	0.30	0.11	0.12	0.084	0.12	0.12	0.17	0.076	0.14	0.32	0.22	0.18	0.25	0.29	0.1
Sulfate	9.5 J	21	20 J	19 J	21	41	60	82	ND	19 J	15 J	22	14 J	16 J	28
Chloride	28	27	49	43	55	77	64	81	34	16	8.5	20	17	11	36
TSS	20.7	38	56	18	26	28	36	22	40	36.8	6.9	19.0	30.2	52.7	
Total Solids	390	290	376	298	460	528	540	658	273	234	118	220	147	191	
TOC	82	48	52	45	73	66	76	79	47	-	-	-	-	-	
Ammonia	0.094J	ND	ND	ND	ND	0.037J	ND	0.13	ND	-	-	-	-	-	19.9 [a] 1.6 [b]
NO2/NO3	0.10	0.035 J	0.065 J	0.027 J	0.053 J	0.24	0.088J	0.16	0.041J	-	-	-	-	-	

a acute aquatic life criteria (CMC)

b chronic aquatic life criteria (CCC)

Table 8. Water quality samples collected by MVK for trace metals in water.

										BM-10	BM-11	BM-12	BM-13	BM-14	
Parameter (µg/l)	LBM - 01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	Little Bayou Meto	Bayou Meto	Five Fork	Two Prairie Bayou	Indian Bayou	Criteria (Reg 2, July 2001)
	August 2000									January 2001					
Antimony	<20	<20	<20	<20	<20	<20	<20	<20	<20	< 3	< 3	< 3	< 3	< 3	
Arsenic	4.95	<15	3.5 J	<15	6.8 J	3.6 J	5.6 J	<15	<15	2	2	2	< 2	2	
Beryllium	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	< 1	< 1	< 1	< 1	< 1	
Cadmium	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1.7 [a] 0.6 [b]
Chromium	<10	2.1 J	<10	8.1 J	<10	<10	2.1 J	<10	<10	3	3	3	2	5	326 [a] 111 [b]
Copper	<10	<10	<10	<10	<10	<10	<10	<10	<10	3	3	2	2	4	9 [a] 7 [b]
Lead	<10	<10	<10	<10	<10	<10	<10	<10	<10	1	1	1	1	2	30 [a] 1.2 [b]
Mercury	.000007	.000003	.000006	.000003	.000002	.000004	.000003	.000002	.000004	0.008	0.010	0.005	0.008	0.010	2.0 [a] 0.012 [b]
Nickel	<10	<10	<10	5.9 J	<10	<10	<10	<10	<10	3	3	3	2	4	780 [a] 88 [b]
Selenium	<20	<20	<20	<20	<20	<20	<20	<20	<20	< 2	< 2	< 2	< 1	< 2	20 [a] 5 [b]
Silver	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	< 1	< 1	< 1	< 1	< 1	1.0 [a]
Thallium	<30	<30	<30	<30	<30	<30	<30	<30	<30	< 2	< 2	< 2	< 2	< 2	
Zinc	<10	3.0 J	7.2 J	3.1 J	4.4 J	4.7 J	6.2 J	<10	5.2 J	< 10	12	11	10	411	64 [a] 58 [b]

[a] acute aquatic life criteria (CMC)
[b] chronic aquatic life criteria (CCC)

Table 9. Water quality samples collected by MVK for pesticides and PCBs in water.

Parameter (µg/l)	LBM - 01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	Criteria CMC [a] CCC [b]
	August 2000									
Aldrin	<0.025	<0.025	0.032	<0.025	<0.025	0.029	0.031	<0.025	0.034	3.0 -
A-BHC	<0.025	0.015J	0.019J	<0.025	0.012J	<0.025	0.011J	<0.025	0.022J	
B-BHC	<0.025	<0.025	<0.025	0.030	0.024J	0.012J	0.028	<0.025	<0.025	
G-BHC	<0.025	<0.025	<0.025	<0.025	0.023J	<0.025	<0.025	<0.025	<0.025	
D-BHC	<0.025	<0.025	<0.025	0.034	<0.025	<0.025	<0.025	<0.025	<0.025	
pp-DDD	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	1.1 0.0010
pp-DDE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	1.1 0.0010
pp-DDT	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	1.1 0.0010
Heptachlor	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.52 0.0038
Dieldrin	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	2.5 0.0019
A-Endosulfan	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	Sum =
B-Endosulfan	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.22
Endosulfan Sulfate	<0.050	0.098	0.038J	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.056
Endrin	<0.050	<0.050	0.016J	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.18 0.0023
Endrin Aldehyde	<0.050	0.17	<0.050	0.17	<0.050	<0.050	<0.050	<0.050	<0.050	
Heptachlor Epoxide	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	
Methoxychlor	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	
Chlordane	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	2.4 0.0043
Toxaphene	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.73 0.0002
PCBs	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	- 0.0140

[a] acute aquatic life criteria (CMC)
[b] chronic aquatic life criteria (CCC)

Table 10. Water quality samples collected by MVK for herbicides in water.

										BM-10	BM-11	BM-12	BM-13	BM-14	
Parameter (µg/l)	LBM - 01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	Little Bayou Meto	Bayou Meto	Five Fork	Two Prairie Bayou	Indian Bayou	Criteria
	August 2000									January 2001					
2,4-D	<0.20	<0.19	0.66	0.14 J	<0.19	<0.19	<0.19	<0.19	<0.19	<0.20	<0.20	<0.20	<0.20	<0.20	
2,4-DP	<0.20	<0.19	<0.21	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.20	<0.20	<0.20	<0.20	<0.20	
2,4,5-T	<0.050	<0.047	<0.053	<0.047	<0.047	<0.048	<0.047	0.011 J	<0.048	<0.05	<0.05	<0.05	0.038 J	<0.05	
2,4,5-TP	<0.050	<0.047	<0.053	<0.047	<0.047	<0.048	<0.047	<0.048	<0.048	<0.05	<0.05	<0.05	<0.05	<0.05	
2,4-DB	<0.20	<0.19	<0.21	<0.19	<0.19	0.45	<0.19	<0.19	<0.19	<0.20	<0.20	<0.20	<0.20	0.20	
Dinoseb	<0.050	0.019 J	0.35	<0.047	<0.047	<0.048	<0.047	<0.048	<0.048	<0.05	<0.05	<0.05	0.120	<0.05	
MCPA	<20.0	<18.9	<21.3	<18.9	<18.9	<19.2	<18.9	<19.2	<19.2	<20	<20	<20	<20	<20	
MCPP	<20.0	<18.9	<21.3	<18.9	<18.9	<19.2	<18.9	<19.2	<19.2	<20	<20	<20	<20	<20	
Dalapon	<0.10	<0.094	<0.11	<0.094	<0.094	<0.096	<0.094	<0.096	<0.096	ND	<0.10	<0.10	<0.10	<0.10	
Dicamba	<0.10	<0.094	<0.11	<0.094	<0.094	<0.096	<0.094	<0.096	<0.096	ND	<0.10	<0.10	<0.10	<0.10	
DCAA % (surrogate)	125	122	117	144	126	119	124	109	111	125	130	99	175	131	

Table 11. Water quality samples collected by MVK for PAHs in water.

Parameter (µg/l)	LBM -01	TPB-01	Bayou Meto - 1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	Criteria CMC[1] CCC[2]
	August 2000									
Acenaphthene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	1700 520
Acenaphthylene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Anthracene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Benzo[k]fluoranthene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Benzo[a]pyrene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Benzo[b]fluoranthene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Benzo[ghi]perylene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Benzo[a]anthracene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Chrysene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Dibenz[a,h]anthracene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Fluoranthene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	3980
Fluorene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Indeno [1,2,3-cd]pyrene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
2-Methylnaphthalene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Napthalene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	2300 620
Phenanthrene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	
Pyrene	<9.6	<9.4	<9.8	<9.6	<9.6	<9.4	<9.6	<9.4	<9.4	

[1] CMC- acute - ambient water quality criteria – freshwater lowest observable effect level
[2] CCC- chronic - ambient water quality criteria – freshwater lowest observable effect level

Table 12. Dioxin in sediment (University of Arkansas 1992).

Station Number	Stream Location	2,3,7,8-TCDD (ppt)	UEL Guideline [1]
Bayou Macon			
1	Macon Bridge	0.260	8.8
2	New (Caddo) Bridge	0.490	
3	Highway 167	199.	
4	Reeds Bridge	276.	
6	Broken Bridge	197.	
7	I-40	39.7	
8	Highway 15	46.	
10	Culler	24.2	
13	Highway 79	4.2	
14	Highway 152	5.6	
15	Wildlife Mgt. Area	5.3	
16	Highway 11	1.4	
Wattensaw Bayou (background sample)			
19	Highway 11	0.420	8.8
20	Wildlife Mgt. Area	0.280	

[1] Upper effects threshold for *Hyalella azteca* bioassay in freshwater sediments (1999).

Table 13. Samples collected by MVK for metals in sediment.

Parameter (mg/kg)	LBM -01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	BM-10 Little Bayou Meto	BM-11 Bayou Meto	BM-12 Five Fork	BM-13 Two Prairie Bayou	BM-14 Indian Bayou	Guidelines ERL[1] ERM[2]	Guidelines Earth's Crust[3]
	August 2000									January 2001					NOAA	USGS
Antimony	-	0.66	0.74	-	0.69	1.61	1.03	0.98	0.85	0.70	0.67	0.75	0.79	0.57	-	-
Arsenic	-	2.8	2.77	-	5.43	8.39	9.28	5.13	8.05	5.99	4.40	5.70	5.30	2.80	8.2 70.	7.4
Beryllium	-	0.899	0.900	-	0.800	1.20	1.30	1.10	1.10	1.20	1.60	1.30	0.800	0.899	-	-
Cadmium	-	0.174	0.082	-	0.192	0.593	0.295	0.229	0.080	0.439	0.150	0.150	0.270	0.180	1.2 9.6	-
Chromium	-	19.7	24.1	-	21.6	31.9	30.4	28.8	29.1	28.4	28.4	18.5	15.2	12.3	81 370	52
Copper	-	9.29	7.40	-	10.5	24.0	17.0	14.9	10.5	19.9	13.9	14.8	12.2	10.6	34 270	22
Lead	-	18.4	17.6	-	15.2	38.2	19.7	21.0	19.7	19.1	15.7	16.4	40.4	10.1	46.7 218	17
Mercury	-	0.067	0.032	-	0.023	0.065	0.039	0.039	0.018	0.0447	0.0148	0.0203	0.1230	0.0143	0.15 0.71	0.12
Nickel	-	11.7	12.8	-	15.8	21.7	22.6	19.8	18.0	23.4	25.2	19.9	10.5	15.0	20.9 51.6	18
Selenium	-	0.75	0.71	-	0.57	0.91	1.07	0.81	0.68	0.599	0.500	0.400	0.600	0.400	-	0.45
Silver	-	0.29	<0.10	-	<0.10	0.11	<0.10	0.29	<0.10	<0.100	<0.100	<0.100	<0.100	<0.100	1 3.7	-
Thallium	-	0.36	0.39	-	0.25	0.37	0.38	0.32	0.30	0.200	0.300	0.200	<0.200	<0.200	-	-
Zinc	-	51.3	48.4	-	133	165	72.1	71.4	46.1	85.7	63.9	51.3	53.3	42.9	150 410	52
TOC	-	40000	16600	-	5890	31600	25500	23700	10600	39300	4700	4720	43200	7400	-	-

1 ERL Effects Range-Low
2 ERM Effects Range Median
3 Mean concentration of elements in soils in the Eastern United States.

Table 14. Samples collected by MVK for pesticides and PCBs in sediment.

Parameter (µg/kg)	LBM - 01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	Criteria ERL[1] ERM[2]
	August 2000									
Aldrin	-	<1.70	<1.27	-	<1.25	<1.35	<1.86	<1.34	<1.28	
A-BHC	-	<1.70	<1.27	-	<1.25	<1.35	<1.86	<1.34	<1.28	
B-BHC	-	2.90	<1.27	-	2.81	2.95	<1.86	5.08	1.29	
G-BHC	-	<1.70	<1.27	-	0.85 J	<1.35	<1.86	1.07 J	0.68 J	
D-BHC	-	<1.70	<1.27	-	<1.25	<1.35	<1.86	<1.34	<1.28	
pp-DDD	-	<3.40	5.06	-	51.9	75.2	37.3	145	4.49	2 20
pp-DDE	-	5.68	8.50	-	76.3	149	123	343	11.6	2.2 27
pp-DDT	-	<3.40	<2.55	-	13.0	15.1	35.4	61.2	3.51	1 7
Heptachlor	-	<1.70	<1.27	-	<1.25	<1.35	<1.86	<1.34	<1.28	
Dieldrin	-	<3.40	<2.55	-	<2.50	<2.70	<3.72	<2.68	<2.56	0.02 8
A-Endosulfan	-	<1.70	<1.27	-	<1.25	<1.35	<1.86	<1.34	<1.28	
B-Endosulfan	-	<3.40	<2.55	-	<2.50	<2.70	<3.72	<2.68	<2.56	
Endosulfan Sulfate	-	<3.40	<2.55	-	2.61	3.43	<3.72	<2.68	<2.56	
Endrin	-	5.58	1.68	-	3.66	<2.70	<3.72	14.1	1.44 J	
Endrin Aldehyde	-	2.23	<2.55	-	<2.50	<2.70	<3.72	11.5	<2.56	
Heptachlor Epoxide	-	<1.70	<1.27	-	<1.25	<1.35	<1.86	<1.34	<1.28	
Methoxychlor	-	<17.0	<12.7	-	<12.5	<13.5	<18.6	<13.4	<12.8	
Chlordane	-	<17.0	<12.7	-	<12.5	<13.5	<18.6	<13.4	<12.8	
Toxaphene	-	<17.0	<12.7	-	<12.5	<13.5	<18.6	<13.4	<12.8	
Total PCBs	-	<17.0	<12.7		<12.5	<13.5	<18.6	<13.4	<12.8	22.7 180

Table 15. Samples collected by MVK for herbicides in sediment.

Parameter (µg/kg)	LBM - 01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	BM-10 Little Bayou Meto	BM-11 Bayou Meto	BM-12 Five Fork	BM-13 Two Prairie Bayou	BM-14 Indian Bayou	Criteria
	August 2000									January 2001					
2,4-D	-	<13.6	<10.3	-	<10.1	<10.8	<14.8	<10.9	<10.2	<18.8	<9.48	<9.47	<14.5	<9.54	
2,4-DP	-	<13.6	<10.3	-	<10.1	<10.8	<14.8	<10.9	<10.2	<18.8	<9.48	<9.47	<14.5	<9.54	
2,4,5-T	-	<3.40	<2.56	-	<2.52	<2.70	<3.70	1.46 J	<2.54	<4.70	<2.37	<2.37	<3.62	<2.38	
2,4,5-TP	-	<3.40	<2.56	-	<2.52	<2.70	<3.70	<2.73	<2.54	7.32	<2.37	<2.37	<3.62	<2.38	
2,4-DB	-	<13.6	<10.3	-	<10.1	<10.8	<14.8	38.8 B	26.1B	<18.8	<9.48	<9.47	<14.5	<9.54	
Dinoseb	-	<3.40	<2.56	-	<2.52	<2.70	<3.70	<2.73	<2.54	<4.70	4.80	<2.37	<3.62	<2.38	
DCAA % (surrogate)	-	123	99.5	-	114	126	146	101	103	110	45.0	61.5	23.3	64.9	
MCPA	-	<1361	<1026	-	<1009	<1079	<1480	<1092	<1016	<1880	<948	23400B	2093B	10000B	
MCPP	-	3522	<1026	-	<1009	<1079	<1480	<1092	<1016	<1880	<948	<947	<1449	<954	
Dalapon	-	<6.81	<5.13	-	<5.05	<5.40	<7.40	<5.46	<5.08	<9.40	<4.74	<4.73	<7.25	<4.77	
Dicamba	-	<6.81	<5.13	-	<5.05	<5.40	<7.40	<5.46	<5.08	<9.40	<4.74	<4.73	<7.25	<4.77	

2,4-DB method blank for Aug 2000 = 31.3 µg/kg
MCPA method blank for Jan 2001 = 2193 µg/kg

Table 16. Samples collected by MVK for PAHs in sediment.

Parameter (µg/kg)	LBM - 01	TPB-01	Bayou Meto -1	BM HW 11	WB-01	WB-02	Indian Bayou-01	Indian Bayou Ditch	Crooked Creek	Guidelines ERL[1] ERM[2]
	August 2000									
Acenaphthene	-	<690	<510	-	<510	<530	<740	<550	<510	16 500
Acenaphthylene	-	<690	<510	-	<510	<530	<740	<550	<510	44 640
Anthracene	-	<690	<510	-	<510	<530	<740	<550	<510	85.3 1100
Benzo[k]fluoranthene	-	<690	<510	-	<510	<530	<740	<550	<510	
Benzo[a]pyrene	-	<690	<510	-	<510	<530	<740	<550	<510	430 1600
Benzo[b]fluoranthene	-	<690	<510	-	<510	<530	<740	<550	<510	
Benzo[ghi]perylene	-	<690	<510	-	<510	<530	<740	<550	<510	
Benzo[a]anthracene	-	<690	<510	-	<510	<530	<740	<550	<510	261 1600
Chrysene	-	<690	<510	-	<510	<530	<740	<550	<510	384 2800
Dibenz[a,h]anthracene	-	<690	<510	-	<510	<530	<740	<550	<510	63.4 260
Fluoranthene	-	<690	370 J	-	<510	<530	<740	<550	<510	600 5100
Fluorene	-	<690	<510	-	<510	<530	<740	<550	<510	19 540
Indeno [1,2,3-cd]pyrene	-	<690	<510	-	<510	<530	<740	<550	<510	
2-Methylnaphthalene	-	<690	<510	-	<510	<530	<740	<550	<510	70 670
Napthalene	-	<690	<510	-	<510	<530	<740	<550	<510	160 2100
Phenanthrene	-	<690	<510	-	<510	<530	<740	<550	<510	240 1500
Pyrene	-	<690	270 J	-	<510	<530	<740	<550	<510	665 2600

[1] ERL - Environmental Response Low
[2] ERM- Environmental Response Median

SECTION VII

404(b)(1) EVALUATION

SECTION VII

BAYOU METO BASIN, ARKANSAS PROJECT

SECTION 404 (b) (1) EVALUATION REPORT

I. PROJECT DESCRIPTION

a. Location. The Bayou Meto Basin project area is located in east central Arkansas and includes portions of Arkansas, Jefferson, Lonoke, Prairie, and Pulaski counties. The project area encompasses 765,745 acres located east and north of the Arkansas River. The project area is shown in Plate 1 of the General Reevaluation Report. Detailed maps are provided in Volume 7, Appendix B, Section X, Reference Maps. The area is comprised of various wetland types, traditional delta farmland, some post oak forest, and areas that were historically prairie.

b. General Description. The primary purposes of the project are to provide flood control, groundwater protection and conservation, supplemental agricultural water (irrigation), and waterfowl management. The project includes construction of a major pump station on the east bank of the Arkansas River near the David D. Terry lock and dam, and an elaborate water distribution system which utilizes existing channels and newly constructed canals, along with ditches and pipelines to provide transfer of surface water from the Arkansas River to the water-depleted project area. Fifty-six weirs would be built in existing channels, and numerous other hydraulic structures (e.g., check structures, inverted siphons, gate well structures) would be constructed in association with the water delivery and flood control systems. Descriptions and plate drawings of the various hydraulic structures are contained in Volume 3, Appendix B, Section I, Hydraulics & Hydrology. Water conservation measures, groundwater management strategies, retrofit of existing farm irrigation systems, and new on-farm storage reservoirs are also integral parts of this project. It is important to note that in order for a farmer to construct an on-farm project feature in a wetland, the farmer would have to apply for and obtain an individual Section 404 permit.

c. Authority and Purpose. Depletion of the alluvial aquifer in eastern Arkansas, due to extensive agricultural water use, prompted the U. S. House of Representatives, Committee on Public Works and Transportation, to adopt a resolution in September 1982, authorizing the U. S. Army Corps of Engineers to examine the feasibility of agricultural water supply and conservation improvements in the region. The Water Resources Development Act (WRDA) of 1996 reauthorized the Grand Prairie - Bayou Meto Project. The Grand Prairie - Bayou Meto Project was previously authorized by the Flood Control Act of 1950 and de-authorized in 1989 pursuant to Section 1001(b) of WRDA 1986.

d. General Description of Dredged and Fill Material. Earthen material would be excavated during existing channel improvements and new canal, pipeline, weir, inlet channel, reservoir, and pump station construction. Excavated material from canal construction would be deposited along both sides of many canal sections to form levees. Material excavated in preparation for pump station construction and from inlet channel construction would be placed adjacent to and surrounding the pump station. Material excavated from pipeline construction would be spread back over the pipelines and any excess would be utilized in levee construction. Minimal excavation would be performed at each weir site in order to smooth out humps and depressions in the channel; this excavation is necessary to provide a uniform thickness of riprap. Fill for the weirs, gate well structures, drop pipe structures, check structures, and road crossings would consist of limestone riprap and filter gravel brought in from quarries. In addition, semi-compacted earth fill and gravel would be deposited in order to construct an access road to the pump station; and limestone riprap would be placed at the mouth of the pump station inlet channel for scour protection.

There are five features associated with the waterfowl management plan:

*10,000 acres of herbaceous wetland complex restoration. Some grading and shaping may be required prior to planting.

*23,000 acres of bottomland hardwood reforestation utilizing seedlings. Some grading and shaping may be required prior to planting.

*levee system within Bayou Meto WMA will be degraded and the material (approximately 9,285 cubic yards) will be pushed into adjacent borrow ditch.

*2,643 acres of riparian buffer areas 100 feet wide will be reforested with bottomland hardwoods.

*240 acres of moist soil habitat will be established. Site selection and design are not known at this time.

More detailed information may be found in Volume 1, Main Report, Section III, Waterfowl Management Plan.

(1) Texture of Material. There are three distinct geologic regions in the Bayou Meto Basin. The Grand Prairie terrace, which consists of a layer of loess covering thick deposits of clays and silty clays. The Deweyville Complex, which has Stuttgart-Dewitt soils in the highest elevations, while the adjacent slopes consist of Calloway-Calhoun-Loring soils. Some Tichnor soils are present within the Bayou Two Prairie, and Perry soils are present near Bayou Meto in the southwest portion of this terrace. The third region makes up the majority of the Basin and is referred to as the Arkansas River Lowland, which was formed by historic Arkansas River meanders and course changes. The Arkansas River Lowland has elevations ranging from 170-190' average mean sea level (amsl) and consists of Claiborne, Jackson, and Wilcox Tertiary deposits underlying the surface Quaternary deposits from east to west. Abandoned channels and courses, point bars, backswamp deposits, and natural levees are all found in the Lowland, and have a relatively thin layer of silt overlaying the older deposits. The surfaces of the abandoned courses tend to be silt and clay overlying fill made up of sediments dominated by coarse and fine

sand. The soils associated with abandoned courses tend to be Perry and Keo clays with Rilla soils on the adjacent natural levees.

The excavated material would be comprised mainly of loam, silt and clay with clay being dominant in some areas. Limestone riprap and filter gravel would comprise the construction material for weirs, gate well structures, check structures, and inlet channel protection. Semi-compacted earth fill and gravel would constitute the materials deposited to construct the pump station access road.

(2) Quantity of Material. A breakdown of the fill quantities for various project items is presented in Table 1. The levees constructed adjacent to canals for flood control will utilize materials excavated from the channels and excess from installation of the pipelines. Reservoirs (totaling 91 acres) will be constructed at the pumping plants; one is a pit reservoir and will be excavated within the channel, and three will be above ground reservoirs.

Restoration features may require reshaping of localized terrain before reforestation and prairie restoration activities occur. Levee construction on moist soil units would also be required for the waterfowl management plan. Specific fill quantities for these features are not included in this table.

Table 1. Fill Quantities

PUMP STATION ACCESS ROAD, earth fill & gravel	28,553 cy
PUMPING STATION, reinforced concrete	2,580 cy
Backfill	23,170 cy
PUMP STATION INLET CHANNEL, riprap & filter material	8,126 tons
WEIRS (56), riprap	17,395 tons
Reinforced concrete	796 cy
GATE WELL STRUCTURES (14), riprap & filter gravel	1,663 cy
Reinforced concrete	556 cy
CHECK STRUCTURES (11), riprap & filter gravel	14,429 tons
Reinforced concrete	16,574 cy
ROAD CROSSINGS, riprap & filter gravel	28,944 tons
LANDOWNER TAKEOFFS, bedding	942 cy
Concrete	2,591 cy

PIPELINE, bedding	25,312 cy
LEVEES FOR FLOOD CONTROL	1,069,973 cy
LEVEES FOR RESERVOIRS	553,304 cy

It is estimated that approximately 19,944,700 cubic yards of earthen material would be excavated for the pumping station, the pumping station inlet channel, pipelines, canals, channel improvements, and borrow pit (27 acres in size). Excavated materials from installation of drop structures, check structures, pump structures, landowner takeoffs, siphons and pipelines will be used as backfill. Pipelines that are 27' or smaller in diameter will be installed with a trenching device (ditch witch) that digs, installs the pipe and backfills in one movement. Excavated material listed below for pipelines includes material that was displaced using an excavator or backhoe only. A breakdown of excavation quantities is shown in Table 2.

Table 2. Excavation Quantities

PUMPING STATION (4)	20,380 cy
PUMP STATION INLET CHANNEL	422,200 cy
NEW CANALS (NED)	10,017,600 cy
EXISTING DITCHES (NED)	2,727,451 cy
EXISTING CHANNEL IMPROVEMENTS (NED)	1,879,374 cy
EXISTING CHANNEL CLEANOUTS (WM)	2,247,673 cy
BORROW PIT	1,556,165 cy
PIPELINES	458,634 cy

(3) Source of Material. Earthen material would be excavated during canal, inlet channel, pump station, and pipeline construction. Riprap, gravel, and earth fill would be hauled in from nearby quarries and borrow pits.

e. Description of Proposed Discharge Sites.

(1) Location. Excavated material would be deposited along both sides of the newly constructed canals and graded and shaped into levees wherever topography and channel depth dictate a need for levees. Material excavated for pump station and inlet channel construction would be deposited in an area adjacent to and surrounding the pump station. Excess

material from pipeline construction would be placed as cover material then spread or landscaped. All materials excavated for pump structures, landowner takeoffs, and drop structures will be utilized in backfilling these features. Riprap and filter gravel would be placed in the bottom of channels and along banks at weirs, gate well structures, check structures, road crossings, drop pipe structures, and at the mouth of the pump station inlet channel. Earth fill and gravel would be placed in a farmed wetland in order to build an access road to the pump station.

(2) Size. The smallest areas practical would be utilized for deposition sites. Construction of the project would result in the loss of approximately 1,830 acres of wetlands. Reduction of hydrology (indirect impacts) would result in adverse impact to approximately 1,897 acres of wetlands.

(3) Type of Site. Riprap and filter gravel would be placed in channel bottoms and along the banks at weirs, various structures, road crossings, and the mouth of the pumping station inlet channel. Earthen material would be deposited on agricultural lands and naturally vegetated areas (e.g., bottomland hardwoods).

(4) Type of Habitat. Approximately 1,695 acres of bottomland hardwoods would be lost to project construction; approximately 1,497 acres of bottomland hardwoods would be adversely impacted as a result of reduction of hydrology. In addition, approximately 135 acres of farmed wetland would be lost to project construction; approximately 400 acres of farmed wetland would be adversely impacted as a result of reduction in hydrology.

(5) Timing and Duration of Discharge. Project construction is assumed to begin in 2007 and take about 7 years to complete. The canal and pipeline construction is assumed to take place from 2007 to 2014. The pumping plant would be built from 2007 to 2012.

f. Description of Disposal Method. Excavated material would be handled by dragline or excavator and augmented by conventional road construction equipment and deposited to form levees along the canals. Riprap would be deposited by dragline or excavator and dozer. Construction in "wet" areas, such as weir construction sites, may require the use of specialized equipment such as an amphibious excavator. Pipeline burial would be accomplished with a trenching device or ditch witch on pipes smaller than 30 inches in diameter. For larger pipelines, an open trench would be excavated, bedding material added and the trench backfilled.

II. FACTUAL DETERMINATIONS.

a. Physical Substrate Determinations.

(1) Substrate Elevation and Slope. The study area lies in the alluvial plain of the Mississippi River Embayment with elevations most of the wetland sites designated for use as disposal sites for excavated material being below elevation 200 feet amsl.

The discharge areas in the wetlands along the constructed canals would be altered with deposition. Canal levees would range in height from 2 feet to 18 feet above the existing ground surface. These levees would have 3H:1V side slopes. Once installed, the pipelines would be covered with the excavated material; any excess material would be utilized in canal levees where possible or spread over the immediate area in order to minimize impacts to existing topography. There should not be any changes in depth, current pattern, water fluctuations, or bottom contours and substrate elevations on any wetlands outside the disposal areas.

Material excavated during pump station and inlet channel construction would be used to raise the area adjacent to and surrounding the pump station to a general elevation of 190 feet amsl.

The placement of riprap at the inlet channel mouth, gate well structures, and drop pipe structures would not change the elevation or slope of any existing streams. Wetlands outside the deposition areas would not be altered by riprap in the channels and along the banks. Riprap weirs of varying heights and check structures would be constructed in existing channels.

In addition to the direct impacts, adverse impacts resulting from reduction in hydrology would affect approximately 1,497 acres of forested wetlands and 400 acres of farmed wetlands.

(2) Sediment Type. Sediment is comprised primarily of sand, silt, loess, and various clays.

(3) Dredged and Fill Material Movement. There would be no foreseeable movement of fill or excavated material. The embankments would be seeded; and riprap would be placed in order to protect the banks and channel bottoms at gate well structures, road crossings, check structures, and the inlet channel mouth. The "check structures" that would be placed in the new canals would help to prevent bottom and bank scour.

(4) Physical effects on Benthos. Where deposition of riprap takes place in existing channels, the physical destruction of the benthic macroinvertebrate community is expected. However, recolonization by some benthic organisms would be expected to occur over time.

(5) Other Effects. Slight increases in water table elevations could indirectly affect the substrate in the vicinity of new canals and receiving channels.

(6) Actions Taken to Minimize Impacts. No excavated material would be placed where it would disrupt the normal hydrologic regime. The first layers of excavated material would be covered with "cleaner" material from the deeper layers of excavation and would be planted with a grass cover to reduce erosion and possible leaching of contaminants from the excavated material. To compensate for direct impacts associated with construction, 2,313 acres of cleared land would be acquired in fee title and planted in bottomland hardwood trees. In addition 1,780 acres of cleared land would be acquired in fee title and planted in bottomland

hardwood trees to compensate for indirect impacts resulting from adverse hydrological impacts.

b. Water Circulation, Fluctuation, and Salinity Determination.

(1) Water Quality. Water quality in Bayou Meto Basin is currently designated as suitable for the propagation of fish and wildlife, primary and secondary contact recreation, and public, industrial, and agricultural water supplies. Although there is some concern for elevated bacteria and nutrients in Wabbaseka Bayou and high turbidity in the Arkansas River, all designated uses are being maintained in these waters. The upper reach of Bayou Meto is under a fish consumption advisory due to elevated concentrations of dioxin in fish tissue. The current advisory extends to the Highway 13 Bridge; but in future may be extended downstream of this site for certain fish species. Although the dioxin source, the Vertac, Inc. site, is considered 100 percent remediated, it has not been de-listed from the National Priorities List (NPL). With project implementation, there would be increased silt loads and turbidity, and a resuspension of pesticides with excavation and deposition activities. However, these levels should decrease markedly upon completion of work. Also, there should be an overall significant improvement in water quality in the channels and receiving streams because of the periodic introduction of "fresh" waters from the Arkansas River. In addition, the streams, newly constructed canals, and ditches would not be subjected to the typical rates of sediment inflows that result from tillage up to top bank because of the levees and riparian buffer strips. Further information is provided in Volume 10 Appendix D, Section VI, Water Quality. Section VI contains a water quality report, Bayou Meto Area Water Quality Report, prepared in 2002 by the Vicksburg District, Corps of Engineers. The following water quality data, assumptions, and conclusions are taken from the above report.

(a) Salinity. Excess salt can result in physical drought conditions. The total soluble salt content can be measured as the electrical conductivity in surface waters. Values < 250 µmhos/cm can be used for most crops on most soils, while values of 250-750 µmhos/cm can be used for plants with moderate salt tolerance. Most average values measured in streams within the study area were < 250 µmhos/cm while Arkansas River values measured were < 750 µmhos/cm. Excess conductivity values are not expected to be generated with any aspect of this project.

(b) Water Chemistry. The pH levels were generally acceptable with the average pH ranging from 6.9 to 7.7 Standard Units (SU). Therefore, pH falls with the 6.0 to 9.0 SU range for freshwater life as stated in U.S. Environmental Protection Agency *Quality Criteria for Water* (U.S. EPA 1986). The pH of these streams should not be significantly altered when surface water from the Arkansas River is introduced into the system. The deposition of excavated and riprap materials would not have any effects of pH levels wherever deposition occurs.

(i) Sodium Adsorption Ratio (SAR). The ratio of sodium to calcium plus magnesium can ultimately have a negative impact on soil permeability and water infiltration. Water with SAR values of < 6% are desirable and can be used on all soils and non-sodium sensitive crops. All values measured for this parameter were well below the 6% action level. Excess SAR values are not expected to be generated with any aspect of this project.

(ii) Chloride. Chloride is one of the major inorganic anions found in natural waters and high levels may harm growing plants. High levels of chloride has also been found to reduce phosphorus availability to plants. Values < 177 mg/l are excellent to good for irrigation, being suitable for most plants and soils. Average values of selected streams within the study area were slightly lower than Arkansas River waters, however, all were < 177 mg/l. Excessive chloride values are not expected to be generated with any aspect of this project.

(iii) Sulfate. Sulfates are widely distributed in natural waters and high levels have been found to reduce phosphorus availability to plants. Values < 480 mg/l are excellent to good for irrigation, being suitable for most plants and soils. Average values of selected streams within the study area were slightly lower than Arkansas River waters, however, all were < 480 mg/l. Excessive sulfate values are not expected to be generated with any aspect of this project.

(iv) Bicarbonates. Waters high in bicarbonate tend to precipitate calcium carbonate and magnesium carbonate which increases the SAR value. This can lead to a higher hazard than indicated by the SAR value. Values < 183 mg/l are considered to be low for this parameter. The trend of average values of selected streams within the study area being lower than the Arkansas River and all average values being lower than the action levels is continued. Excess bicarbonate values are not expected to be generated with any aspect of this project.

(v) Alkalinity. Alkalinity is significant to determining the suitability of water for irrigation. Values < 150 mg/l are considered to be low for this parameter. Selected streams within the study area and the Arkansas River samples all have averages < 150 mg/l. Excess alkalinity values are not expected to be generated with any aspect of this project.

(vi) Heavy Metals. The effects of metals in water range from beneficial through troublesome to dangerously toxic. Some metals are essential, others have adverse effects, and still others are either beneficial or toxic, depending on their concentration. Some elements may be directly toxic to crops, come elements may be inactivated by chemical reactions, and some elements may build up in the soil until it reaches a toxic level. The following metals were summed and their values used for comparisons: aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, molybdenum, silver, and zinc. Values < 10 mg/l were considered low and acceptable. All average heavy metal values were less than 0.2 mg/l.

(c) Clarity. Initial deposition of fill material would produce a relatively short term increase in turbidity which should return to average pre-construction levels of between 40 and 44 NTU. There are no published USEPA levels for turbidity, but these average levels do fall within the 75 NTU level stated in the Arkansas Water Quality Standards.

(d) Color. No expected change.

(e) Odor. No expected change.

(f) Taste. No expected change. The ditches and canals are not currently used as a municipal water supply, nor are they expected to be used as such.

(g) Dissolved Gas Levels. Dissolved oxygen (DO) levels were generally within an acceptable average range of 6.1 mg/l to 6.5 mg/l. These values are above the minimum acceptable level of 5.0 mg/l established by the EPA. Additionally, recorded levels were above the Arkansas established critical levels of 3.0 mg/l. DO levels of the system are expected to improve with the introduction of Arkansas River water. Furthermore, the presence of weirs and check dams and the pumping agitation provided would tend to oxygenate the water. Volume 10, Appendix D, Section VI, provides additional information.

(h) Nutrients. No concentration limits have been specified for surface waters by either EPA or state authorities, and nutrient levels were not monitored.

(i) Eutrophication. No expected change.

(j) Others as appropriate. Although the water temperature of the Arkansas River varies more than that of the receiving channels, temperatures would quickly equilibrate during passage through the upper distribution canals. The temperature of the diverted surface water should not exceed recommended EPA values. Water temperatures of the channels would not be affected by any type of discharge material. Moreover, water temperatures for the entire area are primarily affected by air temperature, solar radiation, and the degree of vegetative shading along the watercourses.

(2) Current Patterns and Circulation.

(a) Current Patterns and Flow. Deposition of excavated material in embankments along the new canals would not disrupt any water currents or flow in the area during normal or flood stage conditions. Operation of the pump station would have minimal effects on current patterns and stream flows at low and normal stages. Material deposited in the vicinity of the pump station would be contained within a specific area in order to prevent significant impacts to overbank flows and current patterns of the Arkansas River. Riprap would not alter flows or current patterns where it is deposited for erosion. There may be a localized reduction in flow and development of eddy currents along the riprap-water interface as the water flows over the riprap. These reductions would not have a noticeable effect on the main stream flow characteristics. Weirs would have a pooling effect on the receiving channels and create a riffle effect downstream of the weirs.

(b) Velocity. Operation of the pumping station would obviously create velocities within the new canals and receiving channels. However, overall velocities would be dissipated by the weirs and check structures. Velocity changes within the receiving channels would be within acceptable limits. Deposition of riprap and excavated material at other locations would not affect velocities of the associated channels.

(c) Stratification. No stratification would occur in the receiving channels beyond that which may normally take place under existing conditions.

(d) Hydrologic Regime. No change in overall hydrologic structure or disruption of flow patterns is anticipated beyond those previously discussed. However, a partial reduction in hydrology would adversely impact approximately 1,497 acres of forested wetlands and 400 acres of farmed wetlands.

(3) Normal Water Level Fluctuations. The receiving channels have been altered and, generally, flows are extremely low during the summer months. Additional water from the Arkansas River and the pooling effect of the weirs would provide minimum summer water levels that are substantially higher that existing summer levels. Rainfall would also affect water level fluctuations. Since the pump station would operate on an "as needed" basis for irrigation; the project would generally provide water level fluctuations between minimum pools and bank full.

(4) Salinity Gradients. Not applicable.

(5) Actions Taken to Minimize Impacts. The placement of excavated material and riprap at all locations would be done during low water periods to avoid disruption of periodic water inundation patterns and reduce the amounts of erosion back into the watercourse. To compensate for direct impacts associated with construction, 2,313 acres of cleared land would be acquired in fee title and planted in bottomland hardwood trees. In addition 1,780 acres of cleared land would be acquired in fee title and planted in bottomland hardwood trees to compensate for indirect impacts resulting from hydrological changes.

c. Suspended Particulate/Turbidity Determinations.

(1) Expected changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Sites. No significant increase in suspended particulate levels or extended periods of turbidity are expected with deposition of fill material. Discharge activities would increase turbidity at those sites but return to preconstruction levels of 40 to 44 NTUs. Suspended and dissolved solid levels are typical of streams in agricultural areas, ranging from 21.8 to 28.2 mg/l for suspended solids and from 182.9 to 210.2 mg/l for dissolved solids. These levels are not hazardous to aquatic organisms. Excavated material which is placed in embankments would be deposited during drier months to reduce suspended solids and turbidity levels in the streams and wetlands. Seeding of the embankments would significantly reduce particulate runoff once the grasses become established.

(2) Effects on Chemical and Physical Properties of the Water Column.

(a) Light Penetration. Deposition of excavated material and riprap would produce a relatively ephemeral increase in turbidity during construction. This should return to near existing levels after construction.

(b) Dissolved Oxygen. Deposition of fill and excavated material into the wetlands or the waterways would not adversely impact DO levels of streams. In fact, the accumulated effects of pumping activities and turbulence at the weir and check structure sites would tend to oxygenate the water.

(c) Toxic Metals and Organics. When sediment is disturbed during project construction, the possibility exists that some of the pesticide materials may be transferred to the water column (mobilization) either through resuspension of the sediment solids, disposal of the interstitial water, or desorption from the resuspended solids. Further information is presented in Appendix D, Section VI, Water Quality.

(d) Pathogens. No increase in pathogenic levels is foreseen with project implementation.

(e) Aesthetics. Increase turbidity during deposition would have minor, short-term impacts on the aesthetic value of existing channels. Overall, the project would increase the aesthetic value of most receiving channels by maintaining minimum pools year-round.

(3) Effects on Biota.

(a) Primary Production. Submerged vegetation is mainly confined to the shoreline. A minor setback in production would take place until revegetation transpires. In places where riprap is deposited, different species would invade the new niche but at a slower rate. Deposition of earthen material would bury plant communities resulting from levee or reservoir construction; primary production would be transformed to drier associations of plants at these deposition sites.

(b) Suspension/Filter Feeders. Mussel populations are extremely limited in the receiving channels. However, any mussels present would be eliminated at the deposition sites; these sites should slowly recolonize after construction.

(c) Sight Feeders. Fish would be temporarily displaced during construction within existing channels. However, fish would become reestablished in these areas following construction. Riprap would provide new habitat and slightly increase the fishery resource at those specific sites.

(4) Actions Taken to Minimize Impacts. Water current or circulation patterns would be slightly altered. Deposition of fill and excavated material would take place during periods of low flow. All pumping would be in accordance with the 1986 State Water Allocation Plan. All construction activities would comply with the *Best Management Practices for Construction Activities* (BMPs). To compensate for direct impacts associated with construction, 2,313 acres of cleared land would be acquired in fee title and planted in bottomland hardwood trees. In addition 1,780 acres of cleared land would be acquired in fee title and planted in bottomland hardwood trees to compensate for indirect impacts resulting from hydrological changes.

d. Contaminant Determinations. It is not expected that any significant amounts of contaminants would be introduced, translocated or increased by pumping activities or the discharge of gravel, riprap, and earthen material.

e. Aquatic Ecosystem and Organism Determination.

(1) Plankton Effects. Effects, if any, on plankton communities are expected to be insignificant and of short duration.

(2) Benthos Effects. The benthic community would be physically removed where deposition takes place in water. The arthropod community should reestablish itself in the channels to near existing numbers after a year. The deposition of riprap would physically cover the existing benthos in the existing channels; but, over the life of the project, riprap would provide attachments and sheltered sites for new species. This should lead to a slight increase in diversity and numbers within the immediate riprap areas. Shellfish populations would take a good while to repopulate the deposition sites. However, no significant adverse effects should occur on adjacent shellfish populations.

(3) Nekton Effects. Deposition activities in the watercourses would disrupt feeding and spawning habits of free-swimming organisms, but recolonization of the disrupted areas would take place in a short time. Riprapped sections of stream bank should attract a slightly greater number of organisms due to the additional structure.

(4) Aquatic Food Web Effects. Destruction of the primary plant and animal producers would occur at deposition sites in the channels. Thus, construction would initially affect the flow of energy from primary producers to the higher aquatic trophic levels. Temporary losses would be somewhat offset in the streams with the riprap areas providing new niches for different species. Finally, vegetative cover on the embankments and prairie establishment on canal levees would provide beneficial habitat and increase food chains and community structures for associated upland species.

(5) Special Aquatic Sites Effects.

(a) Sanctuaries and Refuges. Deposition should not have significant effects on aquatic resources within Bayou Meto Wildlife Management Area.

(b) Wetlands. Approximately 1,695 acres of bottomland hardwoods would be lost within the project area as a direct result of earthen material deposition. Also, approximately 135 acres of farmed wetland would be lost to the deposition of fill and excavated material. Earthen material deposition would raise the substrate elevation, resulting in the establishment of plant species adapted to dryer site conditions. In addition, indirect impacts resulting from hydrology changes would occur on approximately 1,897 acres of wetlands. The loss of these wetlands would be offset by land acquisition and subsequent wetlands restoration.

(c) Mud Flats. Not applicable.

(d) Vegetated shallows. Not applicable.

(e) Riffle Pool Complexes. The flatness and the alluvial composition of the land precludes the formation of riffle-pool areas. Hence, there would not be any adverse change in hydrologic movement with project implementation and deposition. No permanent adverse change in hydrologic movement would be expected with riprap deposition and pumping activities. The current would create a small riffling effect at the rock-water interface which would be conducive for new benthic invertebrate species. This riffling effect downstream of weirs would also benefit fisheries.

(6) Threatened and Endangered Species. One endangered species, interior least tern (*Sterna antillarum*), is known to inhabit the study area reach of the Bayou Meto. The bald eagle (*Haliaeetus leucocephalus*) is a threatened species that utilizes the study area. The project should have no adverse impacts on these species.

(7) Other Wildlife. Weir construction would affect small areas that are used for foraging, breeding, and spawning. Discharge activities would temporarily inhibit movement of animals in the affected channels and in the wetland areas adjacent to them. These areas would be reinvaded and return to near existing population levels. It is not expected that there would be any long-term adverse impacts on either resident or transient mammals, birds, fish, reptiles, or amphibians.

(8) Actions Taken to Minimize Impacts. Project construction would coincide with low water flows. Riprap and other fill material would be selectively placed so as to minimize aquatic community disruption. Clearing limits for pipeline construction would be limited in width to 25 feet. To compensate for direct impacts associated with construction, 2,313 acres of cleared land would be acquired in fee title and planted in bottomland hardwood trees. In addition 1,780 acres of cleared land would be acquired in fee title and planted in bottomland hardwood trees to compensate for indirect impacts resulting from hydrological changes.

f. Proposed Disposal Site Determinations.

(1) Mixing Zone Determination. The smallest practical dispersal zone would be used for deposition in the streams as well as the smallest practicable tonnage of riprap. Actual calculations of the mixing zones in the receiving streams could not be made for several reasons. First, there are no gage records for normal low flows during the construction season. Second, no data are available for initial suspended sediment concentrations. Third, the specific gravity of the soil particles is not known.

(2) Determination of Compliance with Applicable Water Quality Standards.

Water quality standards are discussed in further detail in Volume 10, Appendix D, Section VI. The pesticides and heavy metals in introduced surface waters of the Arkansas River would not degrade the water quality of the receiving channels. Strict adherence and compliance with State of Arkansas water quality criteria would be maintained.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water Supply. Not applicable.

(b) Recreational and Commercial Fisheries. No commercial fishing takes place in the tributary channels. Recreational fishing is minimal due to intermittent and sporadic flow in most area channels. While fish would leave the immediate vicinity during project construction, no significant impacts would be expected to occur to fisheries as a result of deposition of riprap and excavated material. Fishery habitat would actually improve in the receiving streams because of weirs and introduced flows.

(c) Water Related Recreation. Fill and excavated material would not be placed in or near recreational areas; therefore, deposition would not hinder any recreational activities. Small game and big game hunting would eventually increase due to the acquisition and reforestation of mitigation lands.

(d) Aesthetics. The deposition of material in wetlands would temporarily reduce the natural aesthetic values of the project area until the levees are revegetated with grasses and vegetation regenerates on pipeline construction sites. Also, increased turbidity would decrease the aesthetic value of the water during construction and maintenance activities.

(e) Parks, National Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. The deposition of fill and excavated material would not have significant impacts on Bayou Meto Wildlife Management Area

g. Determination of Cumulative Effects on the Aquatic Ecosystem. The disposal of fill material into waters of the United States should have no adverse cumulative impacts on the aquatic ecosystem.

h. Determination of Secondary Effects on the Aquatic Ecosystem. No adverse secondary impacts to the aquatic ecosystem should occur as a result of depositing fill material into waters of the United States.

III. FINDING OF COMPLIANCE FOR BAYOU METO BASIN, ARKANSAS PROJECT

1. No significant adaptations of the guidelines were made relative to this evaluation.

2. Alternative disposal sites for excavated material were not evaluated because most excavated material must be used for levee construction immediately adjacent to the new canals. However, excess dredged material not needed for levee construction would be hauled to alternative sites. Riprap fill material would be needed for weirs, gate well structures, check structures, road crossings, drop pipe structures, and scour protection at the mouth of the pump station inlet channel; no alternative sites are practicable.

3. The planned disposal of gravel, riprap, and earthen material would not violate any applicable state water quality standards with the possible exception of turbidity. All other standards would be maintained during and following the placement of fill and riprap material. Water quality analyses in 1996 for project canals revealed that construction and operation of the import system would be in full compliance of Section 307 of the Clean Water Act.

4. The use of the selected disposal sites would not harm any threatened or endangered species or their critical habitats.

5. The proposed disposal of fill and excavated material would not result in significant adverse effects on human health and welfare.

a. No disposal sites, fill sites or embankments would be located near municipal water supply intakes. None of the existing streams are used for municipal or private water supply.

b. Commercial fishing is non-existent in the receiving channels. Sport fishing in most of these channels is very limited and should improve with project construction and operation.

c. No significant impact is foreseen on plankton communities.

d. Spawning and nursery areas for fish would be increased due to the new canals, check structures, and weirs.

e. Shellfish are scarce in the receiving streams, and no significant impacts are anticipated.

f. Aquatic wildlife edge habitat, food chains, and community structure would be altered in wetland disposal sites. The drier land that would become available following deposition would provide beneficial habitat and increase food chains and community structure for those associated upland species. Riprap areas would create additional habitat for various benthic macroinvertebrates.

g. There are no special aquatic sites within the project area that may be adversely impacted.

6. The life stages of aquatic life and other wildlife dependent on the aquatic ecosystem would be affected. Discharge activities would eliminate movement in relation to feeding, spawning,

breeding, and nursery areas of animals that utilize the existing channel embankment edge habitats. Discharge activities would temporarily inhibit movements of animals in the affected channels and in the wetland areas adjacent to the channels. However, many species of wildlife would be able to use newly created upland sites. Fishery habitat would improve as a result of introduced flows, new aquatic acreage, check structures, and weirs. Riprapped areas would also provide new niches for aquatic invertebrates.

7. There would be no adverse impacts on recreational and economic values with deposition of fill and excavated material into wetlands. The establishment of grasses on embankments and revegetation of pipeline rights-of-way would offset degradation of aesthetic values.

8. Appropriate steps to minimize potential impacts of the discharge on aquatic ecosystems include the placement of fill and excavated material during periods of low flow and low rainfall, and the seeding of the embankments to retard erosion.

9. The proposed deposition of fill and excavated material complies with the Section 404(b)(1) guidelines.

SECTION VIII

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW) EVALUATION FOR THE BAYOU METO BASIN, ARKANSAS

1.0 EXECUTIVE SUMMARY

1.1 Project Description

This project was conducted by G.E.C., Inc. (GEC) to provide an Initial Site Assessment (ISA) for the U.S. Army Corps of Engineers (Corps), Memphis District, and to perform a hazardous, toxic, and radioactive waste (HTRW) evaluation of the Bayou Meto Basin in Arkansas. The project area encompasses 779,109 acres in east central Arkansas, between the Arkansas and White rivers, and includes portions of Arkansas, Jefferson, Lonoke, and Prairie counties. This report will be included in the *Bayou Meto Basin, Arkansas, General Reevaluation*, a project that addresses the problems and needs of the area with respect to flood control, groundwater protection and conservation, agricultural water supply, waterfowl management, and environmental enhancement and restoration.

Water supply components identified pursuant to the overall project include conservation through increased irrigation efficiencies, groundwater protection and conservation, additional storage reservoirs, and a water import system. A water diversion structure on the Arkansas River, immediately north of the David D. Terry Lock and Dam at river mile 109, will be used to divert excess surface water into a distribution network. As of May 2000 the network is comprised of approximately 75 miles of new canals, 400 miles of existing streams, and 264 miles of pipeline.

1.2 Purpose

This report has two purposes: (1) to provide the Memphis District with data and a report on the potential for HTRW materials to exist within the project area, especially in the vicinity of the proposed distribution network, and (2) to provide an opinion on the likelihood that land and/or water in, or adjacent to, the project area and distribution network has been contaminated by such materials. Memphis District environmental and project management personnel will use the information provided in this report to assess the significance of HTRW in the project area and to recommend project actions.

1.3 Methodology

This report was prepared in accordance with applicable portions of guidance contained in Corps Regulation ER 1165-2-132, *Water Resources Policies and Authorities, HTRW Guidance for Civil Works Projects, 26 June 1992*; Corps Lower Mississippi Valley Regulation 1165-2-9, *Water Resources Policies and Authorities, HTRW Guidance for Civil Works Projects, 14 June 1996*; and American Society for Testing and Materials (ASTM) Standard E1527-97, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.*

1.4 HTRW Investigation Summary

GEC conducted regulatory agency research of state and federal databases that were reasonably ascertainable. Vista Information Solutions, Inc. (Vista) also conducted a database search. After comparing Vista's database research results with GEC's, a total of 290 database sites of potential concern were either determined to be, or are believed to be, within, or within one mile of, the project area.

GEC also reviewed current and historical aerial photographs and topographic quadrangle maps. The photographs and maps were reviewed to identify areas of potential off-site sources of environmental concern and current/historical land use in the project area.

Pertinent Arkansas regulatory personnel were contacted pursuant to the investigation regarding site history and current conditions and whether environmental concerns are present in the project area. GEC also interviewed landowners in the project area to obtain information regarding aboveground and underground storage tanks (AST/UST).

Finally, GEC conducted an extensive aerial reconnaissance in order to inspect the project area and adjacent properties for structures, pipelines, improvements, and land use, and to note utilities, runoff patterns, and evidence of environmental impacts. An additional 36 potential sites of concern were observed in close proximity to proposed project improvements during the reconnaissance.

In summary, a total of 326 sites of potential HTRW concern were either determined to be, or are believed to be, within, or within one mile of, the project area. Of the 326 sites of potential concern, 22 were found to be located within the ASTM-recommended search radii of specific project features, and six sites located on five different project area quadrangles were determined to be significant based on the criteria described in the following section.

1.5 Significant Findings

Significant findings consist of potential sites of concern (1) that are located in the path of, or in the immediate vicinity of, proposed improvements, and (2) that GEC believes may require special actions on the part of construction personnel regarding personal protective equipment and/or disposal of excavated material and construction debris.

Significant sites include (Note: Two sites are located on the England Quadrangle):

- Lonoke Quadrangle: an area of stained soil and recent earthwork lies in the direct path of a proposed new canal near Bayou Meto. Refer to Section 6.12.

- Carlisle Quadrangle: an area of stained soil and an AST lies in the direct path of improvements proposed for Bayou Two Prairie. Refer to Section 6.14.

- Parkers Corner Quadrangle: a dump on the bank of Bayou Two Prairie lies in the immediate vicinity of improvements proposed for the bayou. Refer to Section 6.20.

- England Quadrangle: two dumps on the bank of Bakers Bayou lie in the immediate vicinity of improvements proposed for the bayou. Refer to Section 6.22.

- Humnoke Quadrangle: a dump and burn site on the bank of Crooked Creek lies in the immediate vicinity of improvements proposed for the creek. Refer to Section 6.23.

1.6 Risk Anticipated

GEC has performed an ISA of the project area in accordance with the scope of work and applicable portions of ASTM E1527-97 and ER 1165-2-132 in order to provide an HTRW evaluation supporting the *Bayou Meto Basin, Arkansas, General Reevaluation.* The assessment indicates no evidence of recognized HTRW environmental conditions that would impact improvements proposed (as of May 2000) in 31 of the 36 project area quadrangles. The remaining five quadrangles contain six total sites of potential HTRW concern located in the path of, or in close proximity to, proposed improvements.

Based on the aerial reconnaissance, records review, interviews, land use data, and best engineering judgment; it is GEC's professional opinion that the relative risk of: (1) an encounter with HTRW in amounts warranting upgrades to levels of personal protective equipment (PPE) greater than Level D, as specified in 29 CFR 1910.120; or (2) regulatory compliance actions associated with handling, storing, disposing, or owning contaminated soil and/or construction debris is low, except at those sites deemed significant. Changes in project actions or project recommendations may render this opinion void and require additional investigation.

For any of the six sites identified as having potential HTRW concerns, project plan analysis and HTRW response analysis should be conducted. Such analyses should identify and evaluate alternatives to respond to potential HTRW problems, and should consider activities including possibly sampling and analysis, identification of alternative response measures, alternative screening, cost analysis of alternatives, and adherence to environmental standards and criteria.

In GEC's opinion no further investigations into the environmental condition of the remaining portions of the above five project quadrangles or the 31 other project quadrangles is currently warranted.

1.7 Additional Information - Air Quality

1.7.1 Current Conditions

The project area lies within the Central Arkansas and Northeast Arkansas Intrastate Air Quality Control Regions (AQCR) as described in the United States Code of Federal Regulations:

The region's classifications for criteria air pollutants are:

Total Suspended Particulates (TSP)	Better than national standards
Sulfur Dioxide (SO_2)	Better than national standards
Carbon Monoxide (CO)	Unclassifiable / Attainment
Ozone (O_3)	One-hour standard not applicable
Nitrogen Dioxide (NO_2)	Cannot be classified / better than national standards

1.7.2 Significant Permit Requirements/Exemptions

Combustion emissions from the propulsion of mobile sources and emissions from refueling these sources do not require permits unless regulated by Title II or Title V of the Clean Air Act, as amended. This does not include emissions from any transportable units, such as temporary compressors or boilers, nor does it include emissions from loading racks or fueling operations covered under other applicable federal requirements.

1.7.3 Summary Statement

Construction work in the project area will comply with Arkansas' state implementation plan (SIP). It is GEC's understanding that the equipment used will be mobile source and, as such, will be exempt from permitting.

SECTION IX

CULTURAL RESOURCES

MANAGEMENT SUMMARY

As a part of the Bayou Meto Irrigation Project Cultural Resources Study, Panamerican Consultants, Inc. conducted an intensive archaeological survey of the Bayou Meto Irrigation Control Project study area for the Memphis District, USACE. The fieldwork was directed by Eric Albertson and included a crew of two. The field investigations primarily took place during the period from January 4 to July 30, 2002.

The field survey resulted in the identification of 216 archaeological sites. These include 169 in Lonoke County, 33 in Jefferson County , three in Prairie County, and one each in Arkansas and Pulaski Counties. In this report both temporary site numbers and AAS site numbers are used. Permanent site numbers (trinomials) have been assigned by the AAS for the 42 sites identified on Indian Bayou and for nine previously recorded sites that were revisited. We have applied for permanent site numbers for the remaining 165 sites, but it will be six to eight weeks before these numbers will be assigned (Lela Donat, AAS Registrar, personal communication). This management summary is being submitted to the USACE Memphis District prior to the assignment of all permanent site numbers in order that project planning may proceed without delay.

POTENTIALLY ELIGIBLE SITES

From a management standpoint the most important project finding is that 14 potentially eligible archaeological deposits are located within various project ROWs (Table 1). There are two possible management options for dealing with these 14 sites: (1) avoidance or project re-alignment; or (2) further archaeological work (i.e., phase II testing to make a determination of each site's NRHP status). If option 1 is selected, then some additional survey work may be required along any new alignment(s).

Table 1. Potentially Eligible sites in ROW

Site No.	Site Name	Project Reach	Site Component
3JE419	Billy Bell	Indian Bayou	twentieth century and Woodland
3JE422	Lyons II	Wabbaseka Bayou	late nineteenth-twentieth century and Late Archaic-Woodland
3JE423	Lyons I	Wabbaseka Bayou	late nineteenth-twentieth century and Woodland
3LN422	Marie Dupree	Indian Bayou	Late Archaic-Woodland and twentieth century (possibly modern)
3LN431	Neal	Indian Bayou	Late Archaic
FS#91	Big Mosquito	existing channel-1500	Middle Archaic-Woodland and twentieth century
FS#110		pipeline-1500.012	Late Archaic-Woodland and late nineteenth-twentieth century
FS#124	Buffalo Gnat	Baker's Bayou	Early Archaic?, Middle Archaic-Woodland, possible Mississippian and twentieth century
FS#153		Baker's Bayou	Late Archaic-Woodland
FS#179		pipeline-2200.10	Early Archaic?, Late Archaic, and possible Woodland (Middle?)
FS#180		pipeline-2200.102	Late Archaic
3LN035	H.C. Ezell Jr.	pipeline-1500.04	Late Archaic?-Woodland and late nineteenth-twentieth century
3LN053	St. Stephens Church	pipeline-2140.035	Late Archaic? and Woodland
3LN215	Ralph Anderson	Baker's Bayou	Late Archaic-Mississippian and twentieth century

Key: FS# = field site number

HISTORIC CEMETERIES

In addition to the archaeological sites that will require some type of management decision, portions of nine historic cemeteries were identified in project ROWs (Table 2). Avoidance is the recommended management action at the nine cemetery locations.

Table 2. Historic Cemeteries in ROW

Site No.	Cemetery Name	Project Reach	Component
3JE416	Central Baptist	Indian Bayou	1873-2001
3JE426	Mt. Pleasant	new canal-1530	1914-1920
3LN417	Tomberlin	Indian Bayou	nineteenth-twentieth century
FS#129		Baker's Bayou	unknown
FS#141		Baker's Bayou	late nineteenth-twentieth century
FS#168		pipeline-3000.04	unknown
FS#200	Union Valley Church	pipeline-2120.0412	twentieth century
FS#210		pipeline-2140.094	twentieth century
FS#221	Cline Family	pipeline-2260.042	twentieth century

Key: FS# = field site number

OTHER SITES

No further work is required for all other sites recorded during the survey. This includes the numerous sites that are recommended as not eligible for NRHP nomination, as well as three sites that are recommended potentially eligible (Field sites 181, 182, and 186) but which are located outside of the project ROWs.

MEMORANDUM OF AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
MEMPHIS DISTRICT,
THE ARKASAS STATE HISTORIC PRESERVATION OFFICER
AND THE BAYOU METO WATER MANAGEMENT DISTRICT
PURSUANT TO 36 CFR PART 800.6(a)

WHEREAS, the United States Army Corps of Engineers (CE), Memphis District, and the Bayou Meto Water management District (BMWMD) has determined that the Bayou Meto Basin, Arkansas project may affect historic properties included in or eligible for inclusion in the National Register of Historic Places, and has consulted with the Arkansas State Historic Preservation Officer (SHPO) pursuant to Section 800.13 of the regulations (36CFR Part 800) implementing Section 106 of the National Historic Preservation Act (16U.S.C.470f); and

WHEREAS, the BMWMD participated in the consultation and has been invited to concur in this Memorandum of Agreement; and

WHEREAS, CE invited the (list NA Tribes) to participate in consultation;

NOW, THEREFORE, CE, Memphis District and the Arkansas SHPO agree that the undertaking shall be implemented in accordance with the following stipulations to take into account the effect of the undertaking on historic properties.

STIPULATIONS

1. Native American consultation (36CFR Part 800.15) will be/has been conducted.

2. All historic properties studies-survey, testing, or mitigation-will follow applicable current Federal (36CFR Part 800.3 through .14) and SHPO guidelines. All historic properties studies shall follow written scopes of work provided to, approved by, or written by the CE.

3. Before commencement of construction of any portion of this project <u>any land area affected by: construction, equipment usage, borrow, or placement of excavated materials</u> shall be surveyed for historic properties eligible for listing in the National Register of Historic Places unless it has been previously surveyed or determined by the CE and SHPO that a survey is unnecessary. Such areas shall be represented on a US Geological Survey 7.5 minute topographic map and provided to the SHPO and concerned Native Americans. Any areas to be surveyed will be determined by the CE District Archeologist. The survey will be completed by a professional meeting the Secretary of the Interior's Professional Standards (48 FR44738-9).

4. Historic properties that cannot be avoided by project work will be tested for National Register significance and mitigation measures taken if required.

5. A draft survey report that complies with the Secretary of The Interior's Standards and Guidelines for Archaeology and Historic preservation and the SHPO reporting standards will be provided the SHPO and concerned Native Americans before the start of any ground-disturbance.

6. Should historic properties, determined to be eligible for listing in the National Register of Historic Places by the CE in consultation with the SHPO, be found within the project boundaries of this undertaking these resources shall be tested, avoided or mitigated before any ground-disturbance commences. The CE, Memphis District, Archeologist shall provide the SHPO and concerned Native Americans any avoidance, testing, minimization, or mitigation plan for the specific area of potential effect before any actual development associated work begins.

7. Should the area of potential effect within the project area change after the original survey is completed, reviewed and approved, all new areas added to the area of potential effect shall be surveyed for historic properties before the start of ground-disturbance activities.

8. Should, as a consequence of additional survey work, additional historic properties, determined to be eligible for listing in the National Register of Historic Places by the CE in consultation with the SHPO, be discovered within the amended project boundaries with this undertaking, these resources shall be tested, avoided, or mitigated before any ground-disturbance commences

9. The SHPO and concerned Native Americans may monitor activities carried out pursuant to this MOA, and the Advisory Council on Historic Preservation shall review such activities if it so requests. The CE, Memphis District shall cooperate with the SHPO in carrying out their monitoring and reviewing responsibilities.

Any party to this Memorandum of Agreement (MOA) may terminate it by providing thirty days notice to the other parties. All the parties to this agreement document shall consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. In the event of termination, the CE, Memphis District will comply with 36 CFR Part 800.4 through 800.6 with regard to individual undertakings covered by the MOA.

In event the CE, Memphis District does not carry out the terms of the MOA within a period of five calendar years following the ratification of this agreement document, the CE, Memphis District will comply with 36CFR Part 800.4 through 800.6 with regard to individual undertakings covered by this MOA.

This MOA will continue in full force and effect until five years from date of the ratification of this agreement document. At any time in the six-month period before this date, the BMWMD may submit a written request to the SHPO and the CE for review of the BMWMD program and consideration of an extension or modification of the MOA. No extension or modification shall be effective unless all parties to the MOA have agreed to it in writing.

Execution of the MOA by CE, Memphis District and the Arkansas SHPO, and implementation of its terms, evidence that the CE, Memphis District has afforded the Council an opportunity to comment on the Bayou Meto Basin, Arkansas project and its effects on historic properties, and the CE, Memphis District has taken into account the effects of the undertaking on historic properties.

U.S. ARMY CORPS OF ENGINEERS, MEMPHIS DISTRICT

By:_________________________________ Date:_______________________
JACK V. SCHERER, COLONEL, DISTRICT ENGINEER

ARKANSAS STATE HISTORIC PRESERVATION OFFICER

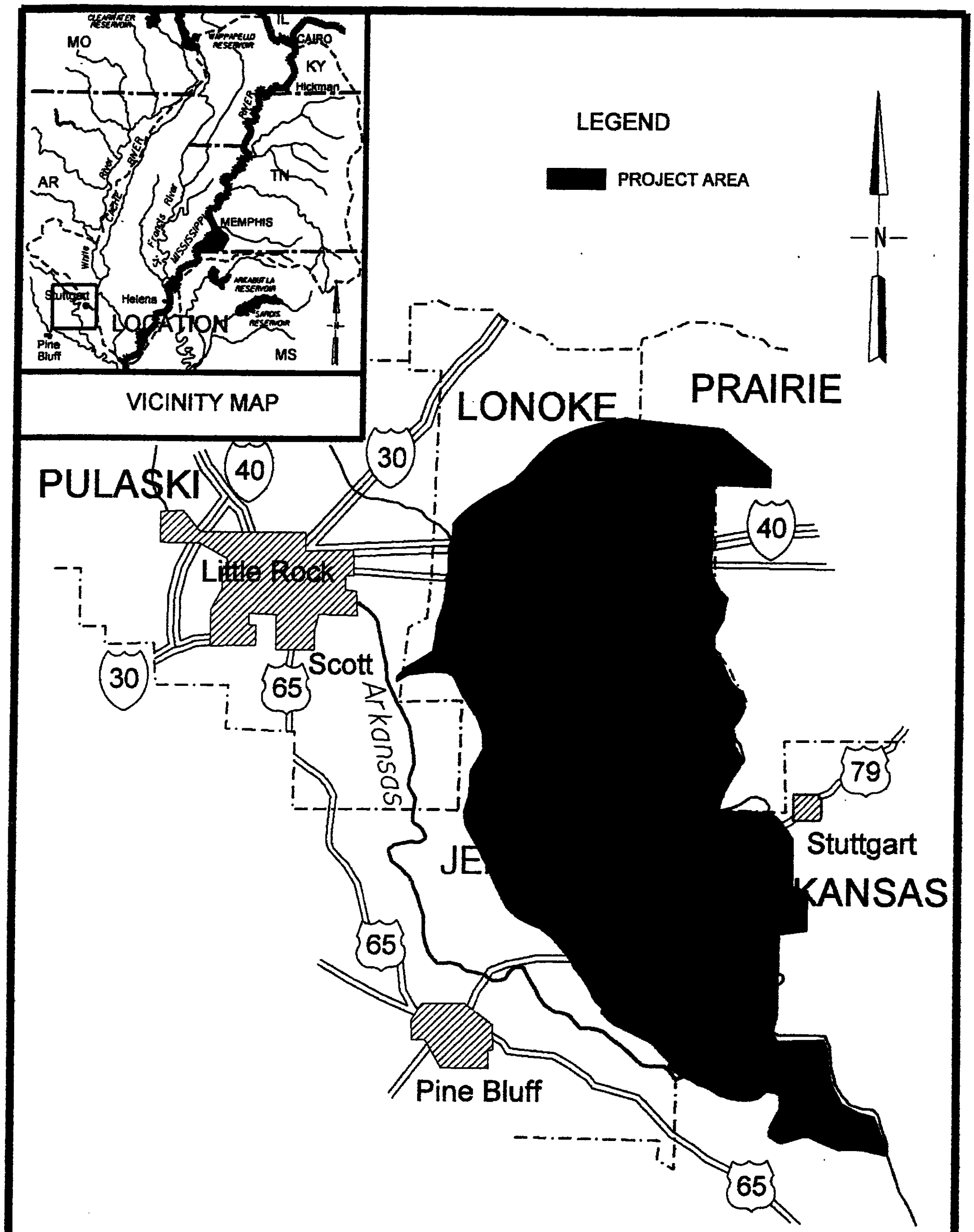
By:_________________________________ Date:_______________________
HERBERT L. HARPER, DEPUTY SHPO

BAYOU METO WATER MANAGEMENT DISTRICT

By:_________________________________ Date:_______________________
, CHAIRMAN

Tribe

By:_________________________________ Date:_______________________
Tribal Chairman/Chief


VICINITY MAP
MO
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CAIRO
Hickman
MEMPHIS
Helena
Stuttgart
Pine Bluff
LOCATION
LEGEND
PROJECT AREA
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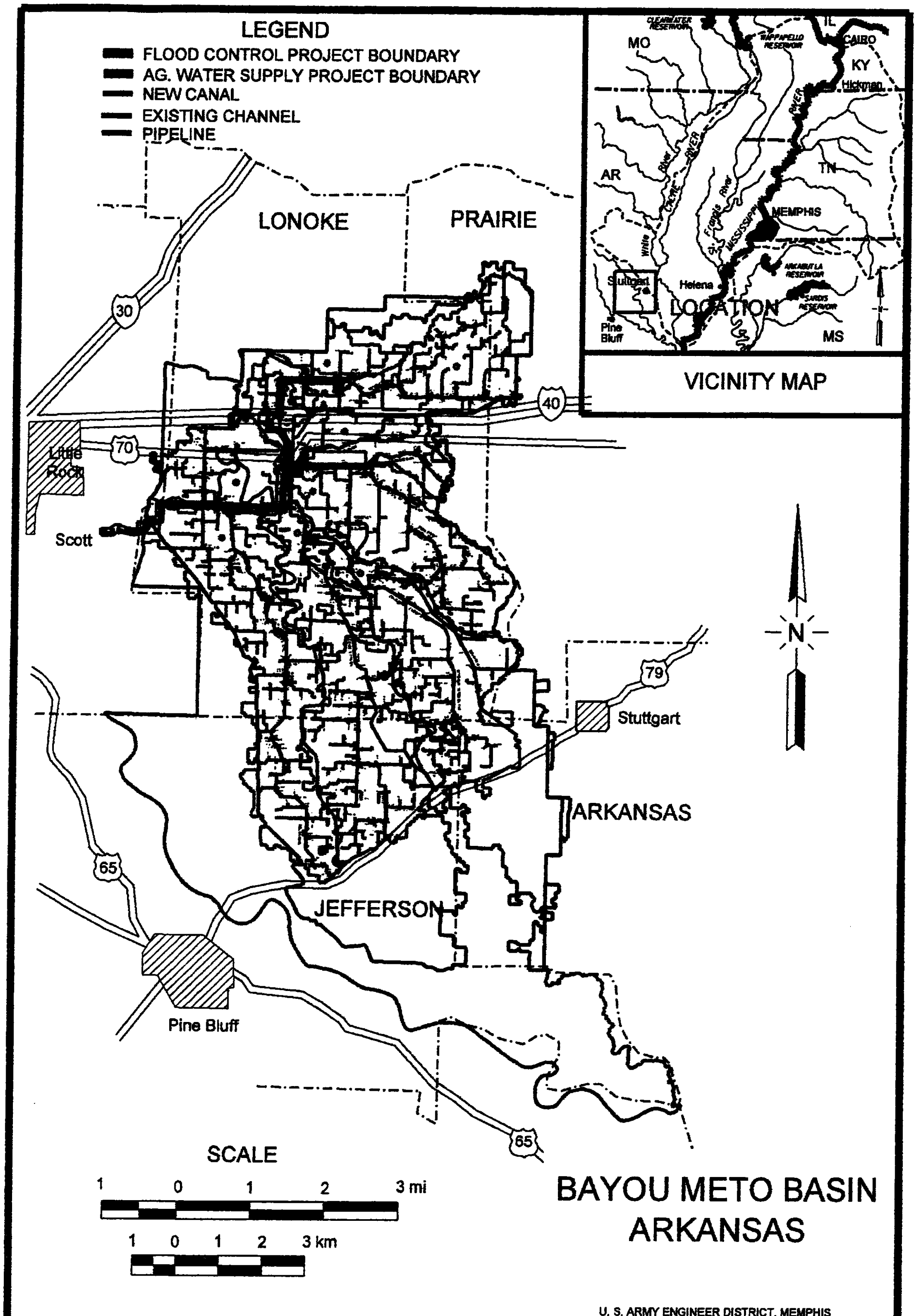
BAYOU METO BASIN
ARKANSAS
U. S. ARMY ENGINEER DISTRICT, MEMPHIS



LEGEND
FLOOD CONTROL PROJECT BOUNDARY
AG. WATER SUPPLY PROJECT BOUNDARY
NEW CANAL
EXISTING CHANNEL
PIPELINE
LONOKE
PRAIRIE
30
40
70
Little Rock
Scott
79
Stuttgart
ARKANSAS
65
JEFFERSON
Pine Bluff
N
VICINITY MAP
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CAIRO
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Hickman
TN
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MEMPHIS
Helena
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BAYOU METO BASIN
ARKANSAS
U. S. ARMY ENGINEER DISTRICT, MEMPHIS

The Department of Arkansas Heritage

Mike Huckabee, Governor
Cathie Matthews, Director

Arkansas Arts Council
▪
Arkansas Natural Heritage Commission
▪
Historic Arkansas Museum
▪
Delta Cultural Center
▪
Old State House Museum

Arkansas Historic Preservation Program

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www.arkansaspreservation.org

November 18, 2004

Mr. Jimmy D. McNeil
District Archeologist
Memphis District Corps of Engineers
167 North Main, Room B-202
Memphis, Tennessee 38103-1984

RE: Multi County - General
Section 106 Review - COE
Bayou Meto Irrigation and Flood Control Project
AHPP Tracking No: 55116

Dear Mr. McNeil:

Thank you for your letter of October 13, 2004 regarding the Bayou Meto Irrigation Project. My staff has considered this matter and we have concluded that a large complex project such as this should have a Programmatic Agreement to address the need for phased completion of the cultural resources work as well as fieldwork and reporting standards, tribal consultation, and other matters. We view reporting standards that comply with Secretary or the Interior standards and the Arkansas State Historic Preservation Plan standards (Appendix B of "A State Plan for the Conservation of Archeological Resources in Arkansas") as particularly important to complete the Section 106 review process.

We look forward to working with you in the future. Thank you for the opportunity to comment on this undertaking. If you have any questions, please contact George McCluskey or Steve Imhoff of my staff at (501) 324-9880.

Sincerely,

Ken Grunewald
Deputy State Historic Preservation Officer

cc: Dr. Steven G. Del Sordo, Advisory Council on Historic Preservation
Dr. Ann M. Early, Arkansas Archeological Survey
Ms. Margie Nowick, Advisory Council on Historic Preservation
Mr. Kalven Trice, Natural Resources Conservation Service
Ms. Carrie V. Wilson, Quapaw Tribe of Oklahoma

PEORIA TRIBE OF INDIANS OF OKLAHOMA

118 S. Eight Tribes Trail (918) 540-2535 FAX (918) 540-2538
P.O. Box 1527
MIAMI, OKLAHOMA 74355

CHIEF
John P. Froman

SECOND CHIEF
Joe Goforth

October 28, 2004

U.S. Army Corps of Engineers
Attn: Jimmy McNeil
District Archeologist
167 North Main Street B-202
Memphis, TN 38103-1894

RE: The Memphis and Vicksburg Districts, Corps of Engineers in partnership with the Bayou Meto Irrigation District, and he Natural Resources Conservation Service plans to participate in an irrigation and flood prevention project within the Bayou Meto Basin, Arkansas.

Thank you for notice of the referenced project. The Peoria Tribe of Indians of Oklahoma is currently unaware of any documentation directly linking Indian Religious Sites to the proposed construction. In the event any items falling under the Native American Graves Protection and Repatriation Act (NAGPRA) are discovered during construction, the Peoria Tribe request notification and further consultation.

The Peoria Tribe has no objection to the proposed construction. However, if human skeletal remains and/or any objects falling under NAGPRA are uncovered during construction should stop immediately, and the appropriate persons, including state and tribal NAGPRA representatives contacted.

John P. Froman
Chief

xc: Bud Ellis, Repatriation/NAGPRA Committee Chairman

October 13, 2004

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Ken Grunewald
Deputy State Historic Preservation Officer
Arkansas Historic Preservation Program
1500 Tower Building
323 Center Street
Little Rock, Arkansas 72201

Dear Mr. Grunewald:

The Memphis and Vicksburg Corps of Engineers Districts in partnership with the Bayou Meto Irrigation District, and the Natural Resources Conservation Service plans to participate in an irrigation and flood prevention project within the Bayou Meto Basin, Arkansas. This project was lightly discussed at the April, 2004, consultation meeting here in Memphis. This letter is to inform you that more information will be forwarded to you in the near future. I have enclosed two drawings related to the project. Drawing 1 depicts the entire project area and the counties where the project is located and directional relationship to near by larger towns. Drawing 2 depicts the project area with existing channels and the preliminary locations of proposed new canals. As this project is in the very early stages of study project size and the location of canals may change.

A cultural literature search and pedestrian survey has been conducted for all the project area above highway 79. The area below highway 79 will be surveyed for cultural resources as soon as our budget allows. The field survey resulted in the identification of 216 archeological sites. These include 169 in Lonoke County, 33 in Jefferson County, three in Prairie County, and one each in Arkansas and Pulaski Counties. Fourteen sites are potentially significant and will either be avoided or tested for significance. Five of the potentially significant sites are prehistoric only while nine sites contain both prehistoric and historic components. There are nine historic cemeteries in the project right of way.

An Environment Impact Statement (EIS) and General Reevaluation Report (GRR) is presently under development and will in the near future be sent to tribes for review and comment. A report detailing the cultural resources survey and findings is also under development (for the portion of the project above highway 79) and will be sent to tribes when it is completed.

Similar information has been sent to interested federally recognized tribes. Should you wish to contact me, I can be reached at 901-544-0710, jimmy.d.mcneil@us.army.mil, or by mail.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosures

DEPARTMENT OF THE ARMY
MEMPHIS DISTRICT CORPS OF ENGINEERS
167 NORTH MAIN STREET B-202

REPLY TO
ATTENTION OF

MEMPHIS TN 38103-1894

October 13, 2004

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Emman Spain
NAGPRA Representative
Seminole Nation of Oklahoma
Post Office Box 1498
Wewoka, Oklahoma 74884

Dear Mr. Spain:

The Memphis and Vicksburg Districts, Corps of Engineers in partnership with the Bayou Meto Irrigation District, and the Natural Resources Conservation Service plans to participate in an irrigation and flood prevention project within the Bayou Meto Basin, Arkansas. This project was lightly discussed at the April 2004, consultation meeting here in Memphis. This letter is to inform you that more information will be forwarded to you in the near future. I have enclosed two drawings related to the project. Drawing 1 depicts the entire project area and the counties where the project is located and directional relationship to near by larger towns. Drawing 2 depicts the project area with existing channels and the preliminary locations of proposed new canals. As this project is in the very early stages of study, project size and the location of canals may change.

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Should you wish to contact me, I can be reached at 901-544-0710, jimmy.d.mcneil@us.army.mil, or by mail.

Sincerely,

Jimmy McNeil
Tribal Liaison

Enclosures

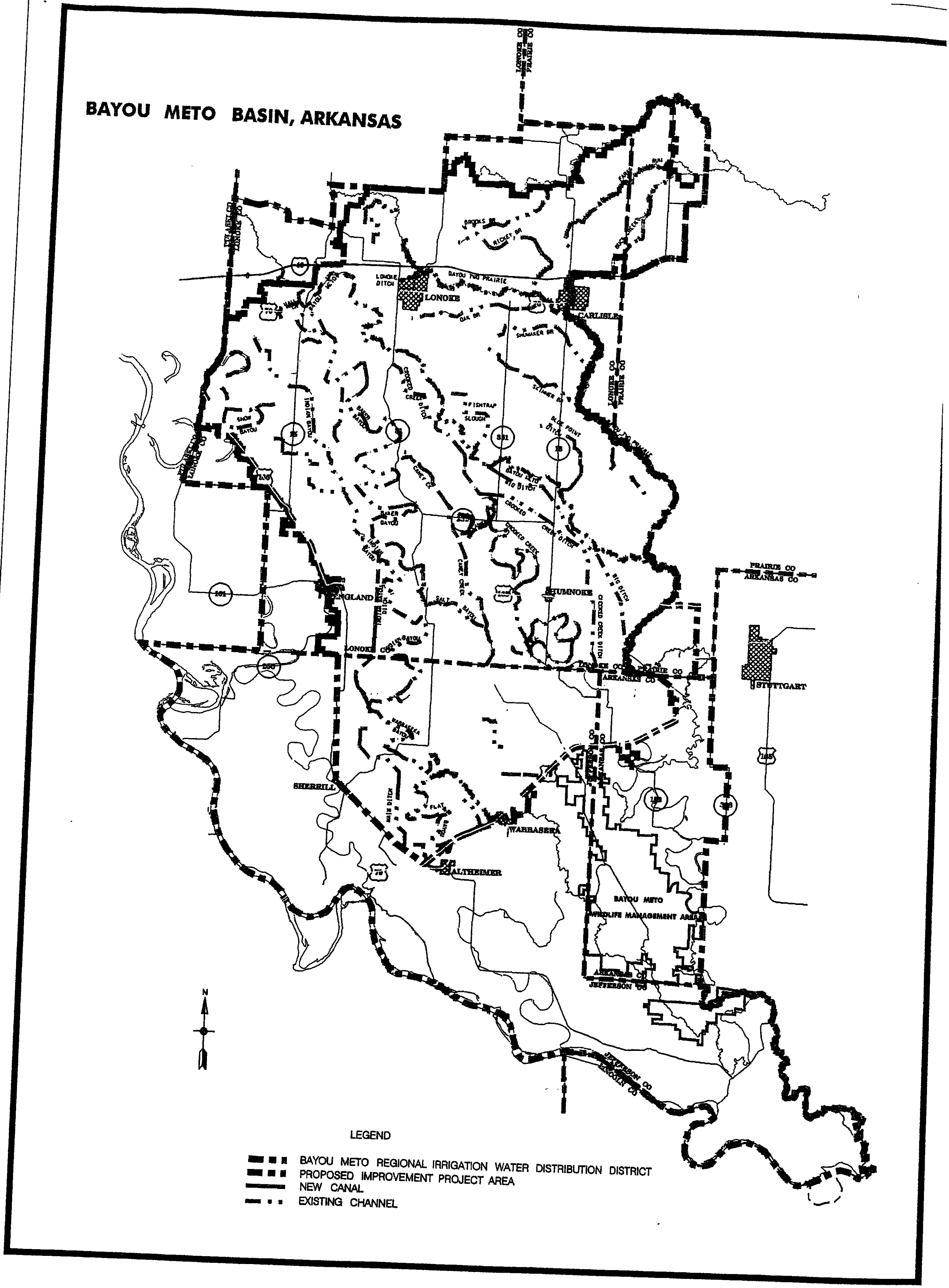
TRIBAL CONTACT

Name	Name of Tribe	POC
Alexander, Alice	Pawnee Tribe	Y
Allen, Richard	Cherokee Nation of Oklahoma	Y
Asbury, Augustine	Alabama-Quassarte Tribal Town	Y
Bahr, Deanne	Sac and Fox Nation of Missouri	Y
Barbry, Jr., Earl	Tunica-Biloxi Tribe of Louisiana	Y
Bear, Joyce A.	Muscogee (Creek) Nation	Y
Beckham, Joann	Eastern Shawnee Tribe of Oklahoma	Y
Bucktrot, Evelyn	Kialegee Tribal Town	Y
Carleton, Kenneth H.	Mississippi Band of Choctaw Indians	Y
Cole, Terry	Choctaw Nation of Oklahoma	Y
Coleman, Charles	Thopthlocco Tribal Town	Y
Ellis, Emmett E.	Peroria Tribe	Y
Francis, Tamara	Delaware Nation	Y
Garza, Raul	Kickapoo Traditional Tribe of Texas	Y
Green, Edmore	Sac and Fox Nation of Missouri	
Greenwood, Joyce	Ponca Tribe of Oklahoma	Y
Hawkins, Rebecca	Shawnee Tribe	Y
Hudson, Mildred	Otoe-Missouria Tribe of Oklahoma	Y
Kanaitobe, Karen	Absentee-Shawnee Tribe	Y
LaDeaux, Chenenia	Sac and Fox Nation of Oklahoma	Y
Mouse, Archie	United Keetoowah Band of Cherokee Indians of Oklahoma	Y
Nail, Virginia	Chickasaw Nation of Oklahoma	Y
Simon, Curtis	Kickapoo Tribe of Kansas	Y

TRIBAL CONTACT

Name	Name of Tribe	POC
Spain, Emman	Seminole Natiion of Oklahoma	Y
Steel, Willard	Ah-Tah-Thi-Ki Museum (Seminol)	Y
Street, Anthony	Tonkawa Tribe	Y
Thompson, Tim	Muscogee (Creek) Nation	
Thrower, Robert	Poarch Band of Creek Indians	Y
Watson, Jr., Theodore R.	Absentee-Shawnee Tribe	
Whitehorn, Anthony	Osage Nation of Oklahoma	Y
Wilson, Carrie	Quapaw Tribe of Oklahoma	Y

Updated August 10, 2004


BAYOU METO BASIN, ARKANSAS
LONOKE
CARLISLE
ENGLAND
HUMNOKE
STUTTGART
SHERRILL
WABBASEKA
ALTHEIMER
LONOKE CO
PRAIRIE CO
ARKANSAS CO
JEFFERSON CO
LINCOLN CO
BAYOU METO WILDLIFE MANAGEMENT AREA
FISHTRAP SLOUGH
N
LEGEND
BAYOU METO REGIONAL IRRIGATION WATER DISTRIBUTION DISTRICT
PROPOSED IMPROVEMENT PROJECT AREA
NEW CANAL
EXISTING CHANNEL

MANAGEMENT SUMMARY

As a part of the Bayou Meto Irrigation Project Cultural Resources Study, Panamerican Consultants, Inc. conducted an intensive archaeological survey of the Bayou Meto Irrigation Control Project study area for the Memphis District, USACE. The fieldwork was directed by Eric Albertson and included a crew of two. The field investigations primarily took place during the period from January 4 to July 30, 2002.

The field survey resulted in the identification of 216 archaeological sites. These include 169 in Lonoke County, 33 in Jefferson County , three in Prairie County, and one each in Arkansas and Pulaski Counties. In this report both temporary site numbers and AAS site numbers are used. Permanent site numbers (trinomials) have been assigned by the AAS for the 42 sites identified on Indian Bayou and for nine previously recorded sites that were revisited. We have applied for permanent site numbers for the remaining 165 sites, but it will be six to eight weeks before these numbers will be assigned (Lela Donat, AAS Registrar, personal communication). This management summary is being submitted to the USACE Memphis District prior to the assignment of all permanent site numbers in order that project planning may proceed without delay.

POTENTIALLY ELIGIBLE SITES

From a management standpoint the most important project finding is that ~~13~~ 14 potentially eligible archaeological deposits are located within various project ROWs (Table 1). There are two possible management options for dealing with these ~~13~~ 14 sites: (1) avoidance or project re-alignment; or (2) further archaeological work (i.e., phase II testing to make a determination of each site's NRHP status). If option 1 is selected, then some additional survey work may be required along any new alignment(s). 9 Cemeterys in R-O-W

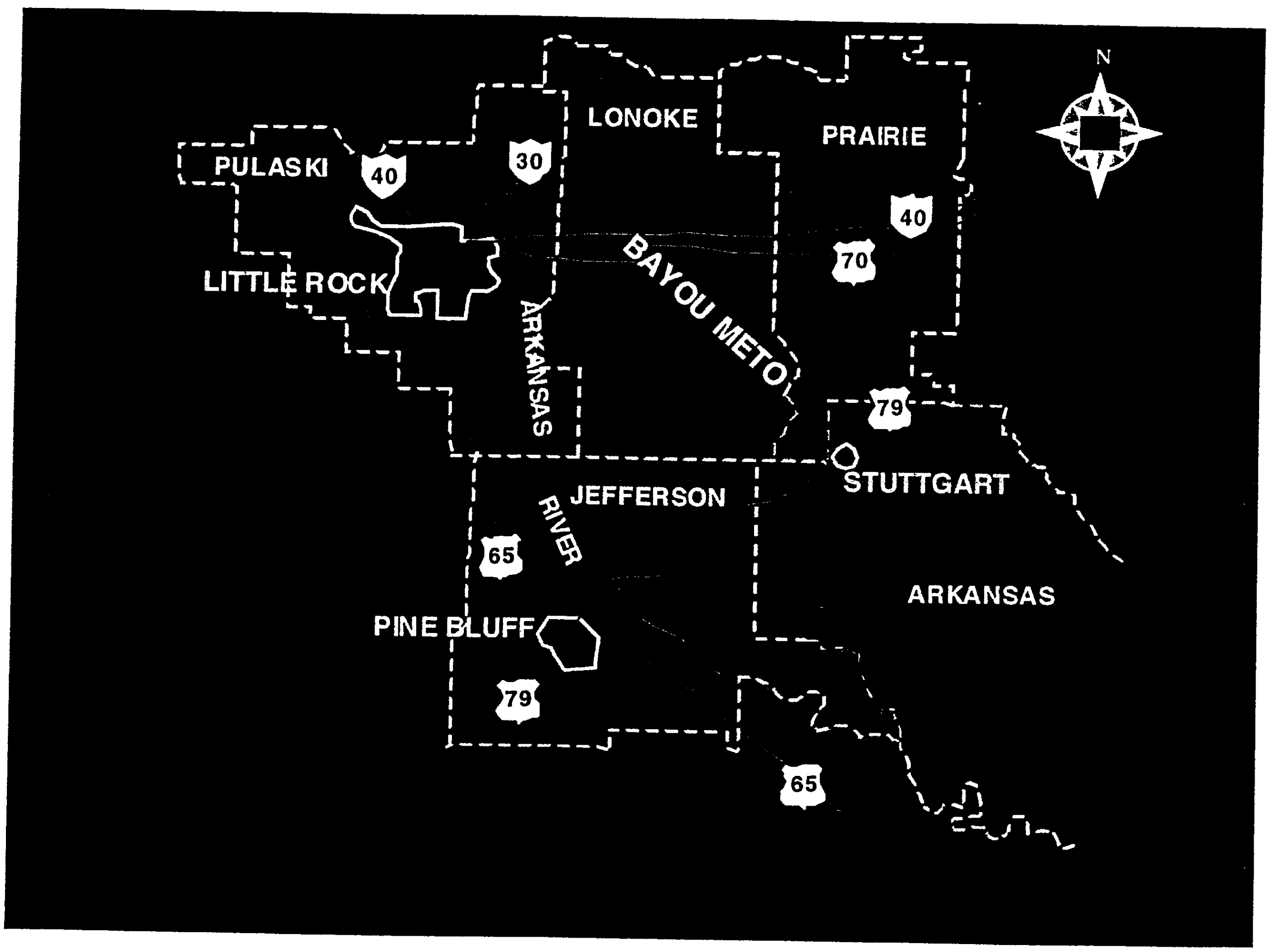
Table 1. Potentially Eligible sites in ROW

Site No.	Site Name	Project Reach	Site Component
3JE419	Billy Bell	Indian Bayou	twentieth century and Woodland
3JE422	Lyons II	Wabbaseka Bayou	late nineteenth-twentieth century and Late Archaic-Woodland
3JE423	Lyons I	Wabbaseka Bayou	late nineteenth-twentieth century and Woodland
3LN422	Marie Dupree	Indian Bayou	Late Archaic-Woodland and twentieth century (possibly modern)
3LN431	Neal	Indian Bayou	Late Archaic
FS#91	Big Mosquito	existing channel-1500	Middle Archaic-Woodland and twentieth century
FS#110		pipeline-1500.012	Late Archaic-Woodland and late nineteenth-twentieth century
FS#124	Buffalo Gnat	Baker's Bayou	Early Archaic?, Middle Archaic-Woodland, possible Mississippian and twentieth century
FS#153		Baker's Bayou	Late Archaic-Woodland
FS#180		pipeline-2200.102	Late Archaic
3LN035	H.C. Ezell Jr.	pipeline-1500.04	Late Archaic?-Woodland and late nineteenth-twentieth century
3LN053	St. Stephens Church	pipeline-2140.035	Late Archaic? and Woodland
3LN215	Ralph Anderson	Baker's Bayou	Late Archaic-Mississippian and twentieth century

Key: FS# = field site number

FS#179 pipeline 2200.10 Early + Late Archaic, possibly woodland

BAYOU METO BASIN, ARKANSAS



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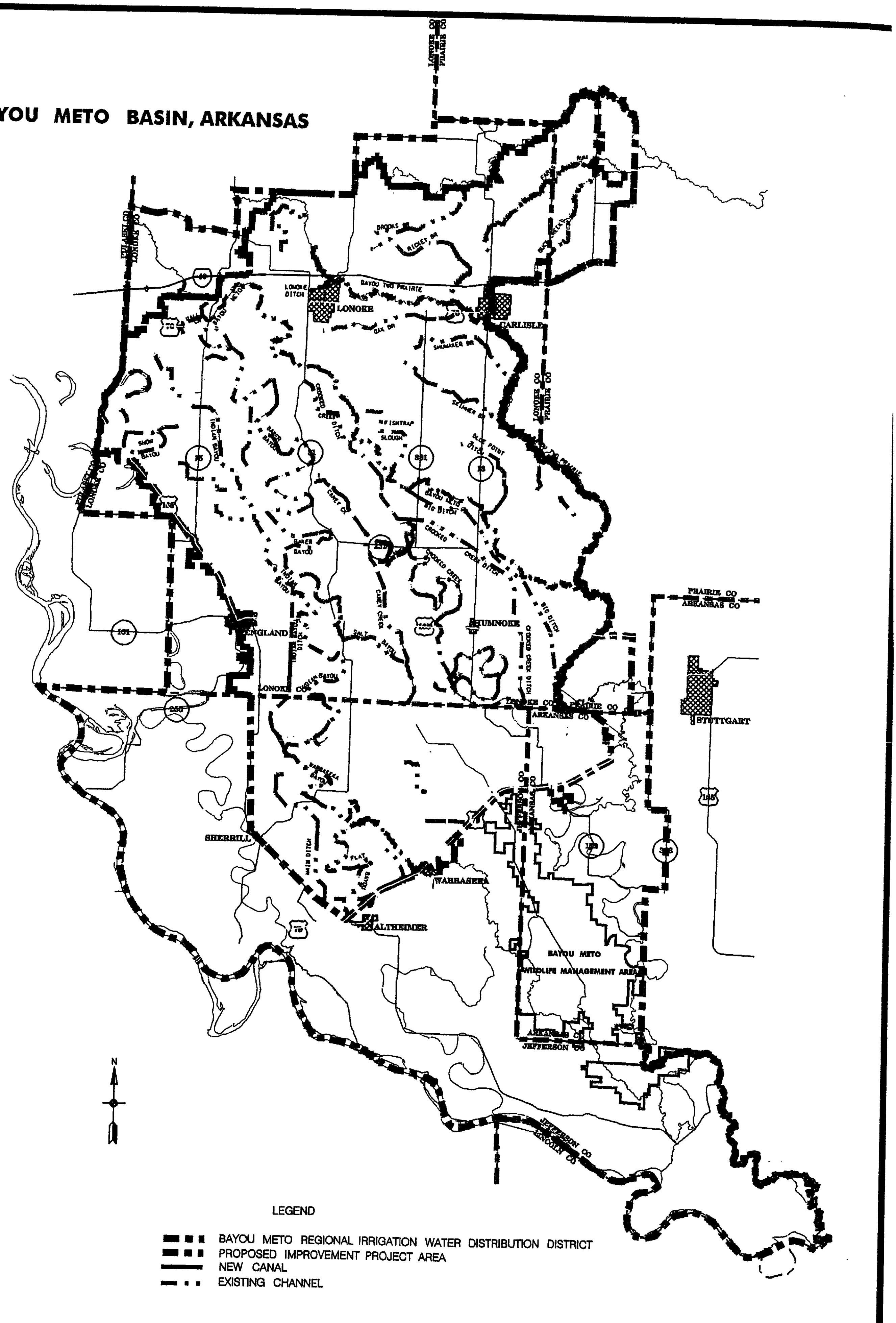

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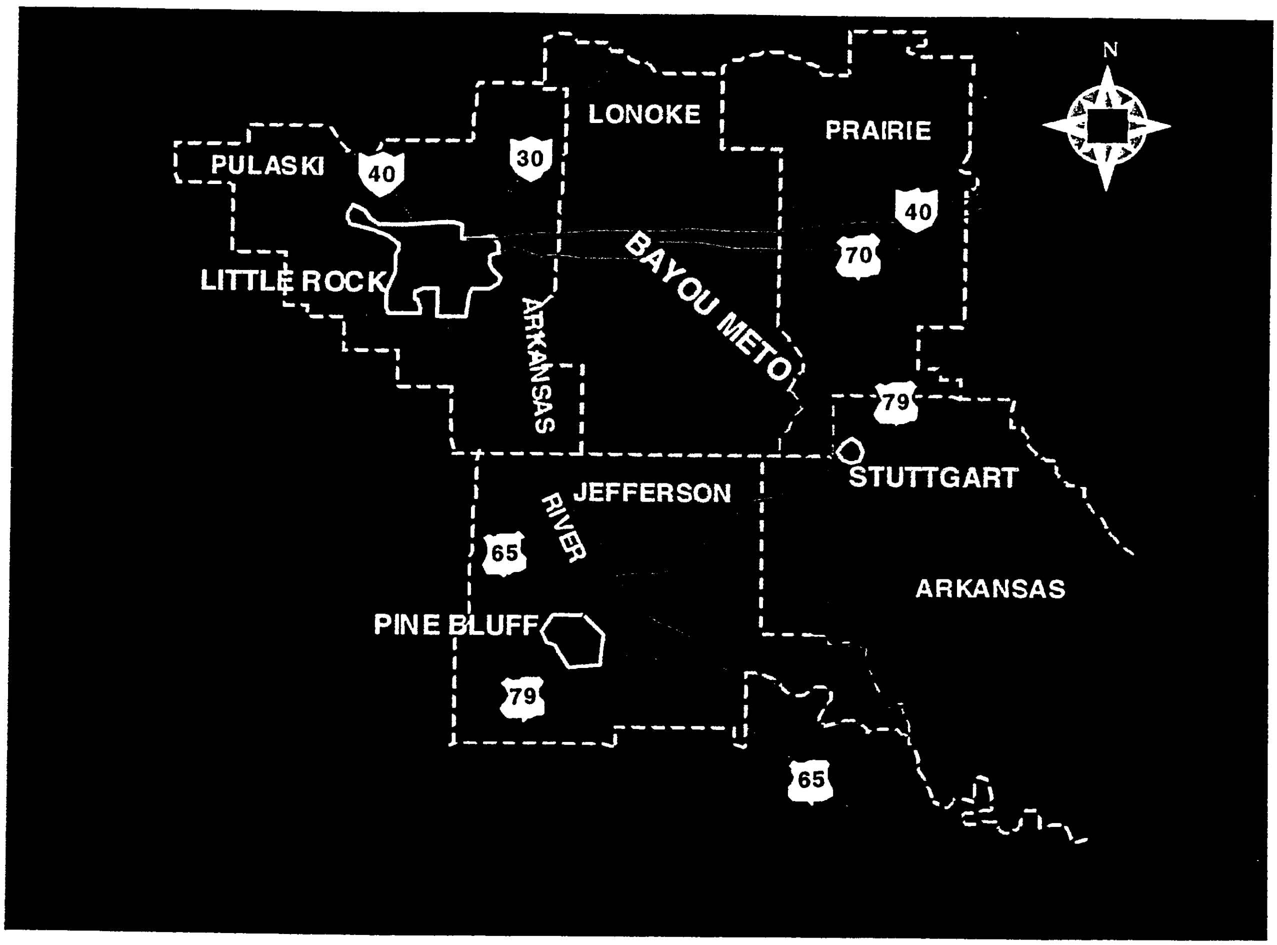

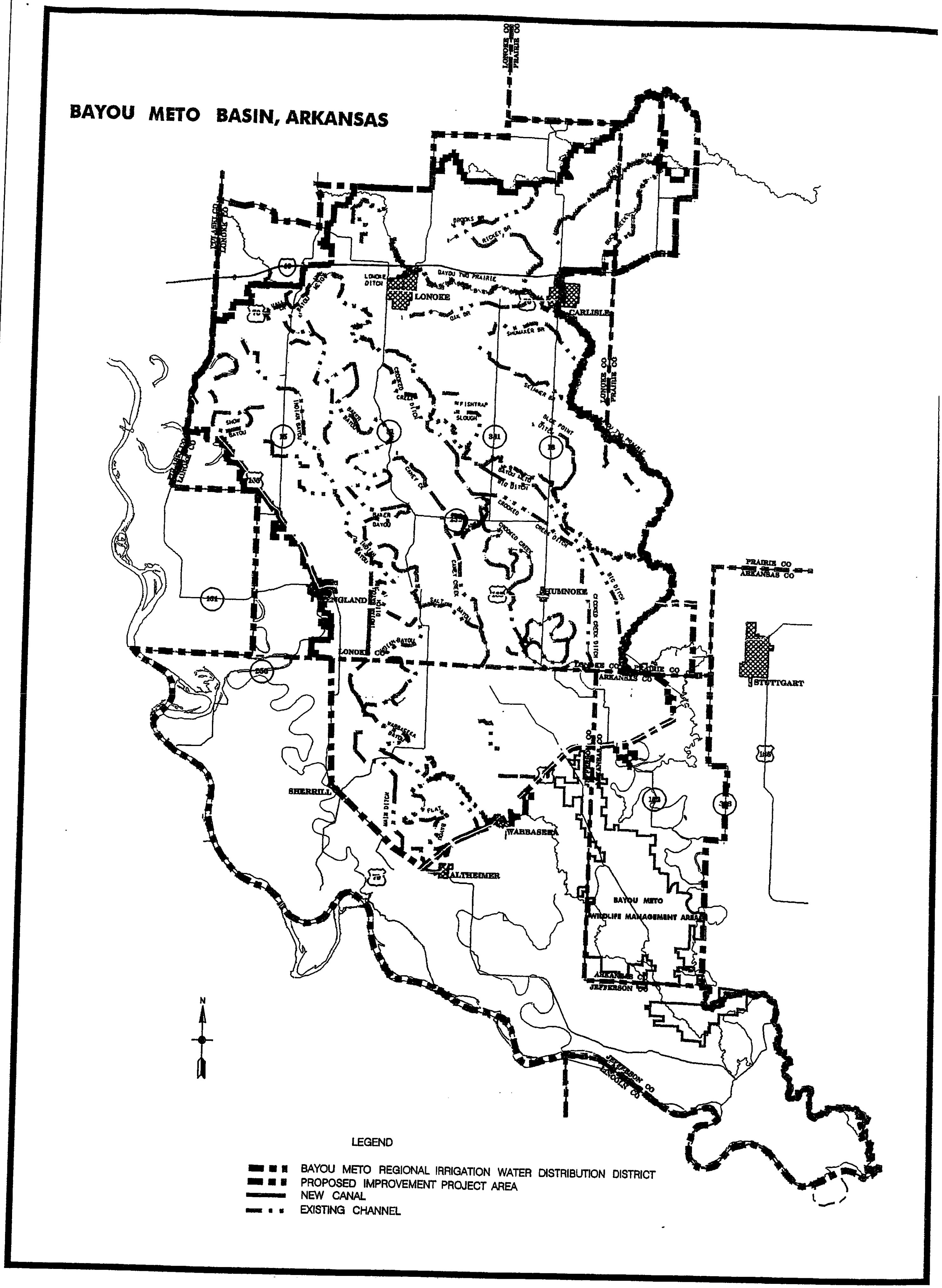
BAYOU METO BASIN, ARKANSAS
LONOKE CO
PRAIRIE CO
LONOKE
CARLISLE
ENGLAND
HUMNOKE
STUTTGART
SHERRILL
WABBASEKA
ALTHEIMER
PRAIRIE CO
ARKANSAS CO
LONOKE CO
JEFFERSON CO
LINCOLN CO
BAYOU METO
WILDLIFE MANAGEMENT AREA
BAYOU TWO PRAIRIE
LONOKE DITCH
INDIAN BAYOU
CROOKED CREEK DITCH
FISHTRAP SLOUGH
BAKER BAYOU
SALT BAYOU
BIG DITCH
WABBASEKA BAYOU
MAIN DITCH
FLAT BAYOU
LEGEND
BAYOU METO REGIONAL IRRIGATION WATER DISTRIBUTION DISTRICT
PROPOSED IMPROVEMENT PROJECT AREA
NEW CANAL
EXISTING CHANNEL

EASTERN SHAWNEE TRIBE
OF OKLAHOMA

P.O. Box 350 · Seneca, MO 64865 · (918) 666-2435 · FAX (918) 666-2186

RECEIVED
OCT 2004

October 22, 2004

Memphis District Corps of Engineers
167 North Main Street B-202
Memphis, TN 38103-1894

Re: Irrigation and Flood Prevention Project
Bayou Meto Basin, Arkansas

Re: Construction of a Pump Station, Gravity Outlet, and Associated Levee Closure
New Madrid Floodway, New Madrid, MO

To Whom It May Concern:

Thank you for notice of the referenced project(s). The Eastern Shawnee Tribe of Oklahoma is currently unaware of any documentation directly linking Indian Religious Sites to the proposed construction. In the event any items falling under the Native American Graves Protection and Repatriation Act (NAGPRA) are discovered during construction, the Eastern Shawnee Tribe request notification and further consultation.

The Eastern Shawnee Tribe has no objection to the proposed construction. However, if any human skeletal remains and/or any objects falling under NAGPRA are uncovered during construction, the construction should stop immediately, and the appropriate persons, including state and tribal NAGPRA representatives contacted.

Sincerely,

Jo Ann Beckham

Jo Ann Beckham
Administrative Assistant

Charles Enyart, Chief
Eastern Shawnee Tribe of Oklahoma

The Department of
Arkansas
Heritage

Mike Huckabee, Governor
Cathie Matthews, Director

Arkansas Arts Council
▪
Arkansas Natural Heritage Commission
▪
Historic Arkansas Museum
▪
Delta Cultural Center
▪
Old State House Museum

Arkansas Historic
Preservation Program

1500 Tower Building
323 Center Street
Little Rock, AR 72201
(501)324-9880
fax: (501)324-9184
tdd: (501)324-9811
e-mail:
info@arkansaspreservation.org
website:
www.arkansaspreservation.org

March 31, 2004

Mr. Jimmy D. McNeil
District Archeologist
Memphis District Corps of Engineers
167 North Main, Room B-202
Memphis, Tennessee 38103-1984

RE: Multi County - General
Section 106 Review - COE
Draft Memorandum of Agreement for cultural resources work in the Bayou Meto Project area
AHPP Tracking No: 44056

Dear Mr. McNeil:

My staff has reviewed the above-referenced draft MOA and we have the following comments for your use. Our primary concerns are that:

1. Since the Native American groups that should be consulted regarding this undertaking are known, they should be specifically included in the MOA.
2. Any required mitigation measures should be implemented by a specific MOA and treatment plan.

We also have included a marked-up copy of the draft MOA with additional suggestions.

Thank you for your interest and concern for the cultural heritage of Arkansas. If you have any questions, please contact Steve Imhoff of my staff at (501) 324-9880.

Sincerely,

Ken Grunewald
Deputy State Historic Preservation Officer

Encl: Draft MOA

cc: Mr. Bill Anoatubby, Chickasaw Nation
Mr. Earl J. Barbry, Tunica-Biloxi Tribe of Louisiana, Inc.
Dr. Ann M. Early, Arkansas Archeological Survey
Mr. Anthony Whitehorn, Osage Nation
Ms. Carrie V. Wilson, Quapaw Tribe of Oklahoma

MEMORANDUM OF AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
MEMPHIS DISTRICT,
THE ARKASAS STATE HISTORIC PRESERVATION OFFICER
~~AND~~ THE BAYOU METO WATER MANAGEMENT DISTRICT
AND [INTERESTED NATIVE AMERICAN GROUPS]
PURSUANT TO 36 CFR PART 800.6(a)

WHEREAS, the United States Army Corps of Engineers (CE), Memphis District, and the Bayou Meto Water management District (BMWMD) ~~has~~ have determined that the Bayou Meto Basin, Arkansas project may affect historic properties included in or eligible for inclusion in the National Register of Historic Places, and ~~has~~ have consulted with the Arkansas State Historic Preservation Officer (SHPO) pursuant to Section 800.~~13~~ 2(c)(1) of the regulations (36CFR Part 800) implementing Section 106 of the National Historic Preservation Act (16U.S.C.470f); and

WHEREAS, [Identify the undertaking]

WHEREAS, [Identify the APE]

WHEREAS, the BMWMD participated in the consultation and has been invited to concur in this Memorandum of Agreement; and [Entities having specific responsibilities under the MOA should be signatories]

WHEREAS, CE invited the (list NA Tribes) to participate in consultation;

NOW, THEREFORE, CE, Memphis District, the BMWMD, [Native American Groups], and the Arkansas SHPO agree that the undertaking ~~shall~~ will be implemented in accordance with the following stipulations to take into account the effect of the undertaking on historic properties.

STIPULATIONS

1. Native American consultation (36CFR Part 800.15) will be/has been conducted.

2. All historic properties studies-survey, testing, or mitigation follow ~~applicable current Federal (36CFR Part 800.3 through .14)~~ Secretary of the Interior's *Standards and Guidelines for Archeology and Historic Preservation* (48 FR 44716) and ~~SHPO guidelines~~ Appendix B of *A State Plan for the Conservation of Archeological Resources in Arkansas*. All historic properties studies ~~shall~~ will follow written scopes of work provided to, approved by, or written by the CE.

3. Before commencement of construction of any portion of this project any land area affected by: construction, equipment usage, borrow, or placement of excavated materials ~~shall~~ will be surveyed for ~~historic~~ properties eligible for listing in the National Register of Historic Places unless it has been previously surveyed or determined by the CE and SHPO that a survey is unnecessary. Such areas ~~shall~~ will be represented on a US Geological Survey 7.5 minute topographic map and provided to the SHPO and concerned Native Americans. Any areas to be surveyed will be determined by the CE District Archeologist in consultation with the SHPO and concerned Native American Groups.

The survey will be completed by a professional archeologist who meets Secretary of the Interior's Professional Standards (48 FR44738-9).

4. Historic properties that cannot be avoided by project work will be tested for National Register significance and mitigation measures taken if required.

5. A draft survey report that complies with the Secretary of The Interior's *Standards and Guidelines for Archaeology and Historic ~~p~~Preservation* and ~~the SHPO reporting standards~~Appendix B of *A State Plan for the Conservation of Archeological Resources in Arkansas* will be ~~provided~~ submitted to and commented upon by the SHPO and concerned Native Americans before the start of any ground-disturbance.

6. Should historic properties, determined to be eligible for listing in the National Register of Historic Places by the CE in consultation with the SHPO and concerned Native American Groups, be found within the project boundaries of this undertaking these resources ~~shall~~will be tested, avoided or mitigated before any ground-disturbance commences. The CE, Memphis District, Archeologist ~~shall~~will ~~provide~~ provide the SHPO and concerned Native Americans any avoidance, testing, minimization, or mitigation plan for the specific area of potential effect before any actual development associated work begins.

7. Should the area of potential effect within the project area change after the original survey is completed, reviewed and approved, all new areas added to the area of potential effect ~~shall~~will be surveyed for historic properties before the start of ground-disturbance activities.

8. Should, as a consequence of additional survey work, additional historic properties, determined to be eligible for listing in the National Register of Historic Places by the CE in consultation with the SHPO, be discovered within the amended project boundaries with this undertaking, these resources ~~shall~~will be tested, avoided, or mitigated before any ground-disturbance commences

9. The SHPO and concerned Native Americans may monitor activities carried out pursuant to this MOA, and the Advisory Council on Historic Preservation ~~shall~~ may review such activities if it so requests. The CE, Memphis District ~~shall~~will cooperate with the SHPO in carrying out their monitoring and reviewing responsibilities.

10. [Disposition of Human remains.]

11. Cultural materials recovered during investigations of this undertaking will be curated in accordance with 36 CFR § 79 and the standards contained in Appendix G of *A State Plan for the Conservation of Archeological Resources in Arkansas* at a facility in the State of Arkansas.

Should any signatory or concurring party to this MOA object to any action or any failure to act pursuant to this MOA or to the manner in which this MOA is being implemented, they may, within 30 days, file written objections with the CE. The CE will consult with the objecting party and other consulting parties, as appropriate, to resolve the objection. If the objection cannot be resolved, the CE will forward all relevant documentation to the Advisory Council on Historic Places and request their comments in accordance with 36 CFR § 800.2(b) or 800.7.

Any party to this MOA may propose to the other parties that it be amended, whereupon the parties will consult in accordance with 36 CFR § 800.(c)(7) to consider such amendment.

Any party to this ~~Memorandum of Agreement (~~MOA~~)~~ may terminate it by providing thirty days notice to the other parties. All the parties to this agreement document shall consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. In the event of termination, the CE, Memphis District will comply with 36 CFR Part 800.4 through 800.6 with regard to individual undertakings covered by the MOA.

In event the CE, Memphis District does not carry out the terms of the MOA within a period of five calendar years following the ratification of this agreement document, the CE, Memphis District will comply with 36CFR Part 800.4 through 800.6 with regard to individual undertakings covered by this MOA.

This MOA will continue in full force and effect until five years from date of the ratification of this agreement document. At any time in the six-month period before this date, the BMWMD may submit a written request to the SHPO and the CE for review of the BMWMD program and consideration of an extension or modification of the MOA. No extension or modification ~~shall~~will be effective unless all parties to the MOA have agreed to it in writing.

Execution of the MOA by CE, Memphis District and the Arkansas SHPO, and implementation of its terms, evidence that the CE, Memphis District has afforded the Council an opportunity to comment on the Bayou Meto Basin, Arkansas project and its effects on historic properties, and the CE, Memphis District has taken into account the effects of the undertaking on historic properties.

U.S. ARMY CORPS OF ENGINEERS, MEMPHIS DISTRICT

By:_________________________________ Date:__________________

JACK V. SCHERER, COLONEL, DISTRICT ENGINEER

ARKANSAS STATE HISTORIC PRESERVATION OFFICER

By:_________________________________ Date:__________________

~~HERBERT L. HARPER~~KEN GRUNEWALD, DEPUTY SHPO

BAYOU METO WATER MANAGEMENT DISTRICT

By:_________________________________ Date:__________________

, CHAIRMAN

Tribe

By:_________________________________ Date:__________________

Tribal Chairman/Chief

The Department of
Arkansas
Heritage

Mike Huckabee, Governor
Cathie Matthews, Director

Arkansas Arts Council
▪
Arkansas Natural Heritage Commission
▪
Historic Arkansas Museum
▪
Delta Cultural Center
▪
Old State House Museum

Arkansas Historic Preservation Program

1500 Tower Building
323 Center Street
Little Rock, AR 72201
(501)324-9880
fax: (501)324-9184
tdd: (501)324-9811
e-mail:
info@arkansaspreservation.org
website:
www.arkansaspreservation.org

December 5, 2003

Mr. Jimmy D. McNeil
District Archeologist
Memphis District Corps of Engineers
167 North Main, Room B-202
Memphis, Tennessee 38103-1984

RE: Multi County - General
Section 106 Review - COE
Indian Bayou cleanout and Wabbaseka Bayou channel improvements
AHPP Tracking No: 44056

Dear Mr. McNeil:

My staff has reviewed the information submitted regarding cultural resources survey conducted in connection with the above-referenced undertaking. We regret that we cannot provide review comments at this time. It is our policy not to review reports of incomplete fieldwork in an absence of a Programmatic Agreement that provides a mechanism for such review. In addition, the site descriptions provide insufficient information to enable us to arrive at an independent evaluation were we to attempt to provide comments. We understand your eagerness to proceed with the review process, given the large number of archeological sites involved., but we are unable to do so at this time.

Thank you for your interest and concern for the cultural heritage of Arkansas. If you have any questions, please contact Steve Imhoff of my staff at (501) 324-9880.

Sincerely,

Ken Grunewald
Deputy State Historic Preservation Officer

cc: Mr. Earl J. Barbry, Tunica-Biloxi Tribe of Louisiana, Inc.
Mr. Terry Cole, Choctaw Nation of Oklahoma
Dr. Ann M. Early, Arkansas Archeological Survey
Ms. Carrie V. Wilson, Quapaw Tribe of Oklahoma

November 03, 2003

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Ken Grunewald
State Historic Preservation Officer
1500 Tower Building
323 Center Street
Little Rock, Arkansas 72201

Dear Mr. Grunewald:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. Maps of the project area was sent to your office in July 2001; the survey and literature search was conducted by Panamerican Consultants of Memphis. A report of the survey findings is being prepared and will be forwarded to your office as soon as the draft is completed. The Indian Bayou and Wabbaseka Bayou projects, though separate from but adjacent to the Bayou Meto project, were surveyed under the same contract as the Bayou Meto project and will be written-up in the same report.

The Indian Bayou Cleanout and Wabbaseka Bayou Channel Improvement are smaller portions of the larger project. The Indian Bayou Cleanout will consist of cleaning out the existing channel to its original bank lines and bottom depth and width. There will not be any extra widening or deepening of the bayou. However, Wabbaseka Bayou Channel will be enlarged and made deeper.

Five sites were found in or near the Indian Bayou right of way; only a historic cemetery was found in this portion of Wabbaseka Bayou. I have provided engineering drawings with the sites located and marked "Do Not Disturb, Environmentally Sensitive Area" (marked this way so the contractors won't know it is an archeological site). For your convenience I have also marked the site numbers in red ink. I have also enclosed a description of each site and the archeological contractors thoughts on that site. A section of the Sherrill, Ark., 7.5 min. topographic map, with sites located on it, is also enclosed. Site 3JE424 was not located on the drawings. However, any site outside the right of way will not be in danger as the contractor is not allowed outside the designated right of way.

Similar packages have been mailed to the Tunica-Biloxi and the Choctaw NAGPRA Representatives.

Should you have questions about the project, you can contact me at (901) 544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosures

November 03, 2003

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Kenneth H. Carleton
Tribal Archeologist
Mississippi Band of Choctaw Indians
P.O. Box 6257
Choctaw Branch
Philadelphia, Mississippi 39350

Dear Mr. Carleton:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. Maps of the project area were sent to your office in July 2001; the survey and literature search was conducted by Panamerican Consultants of Memphis. A report of the survey findings is being prepared and will be forwarded to your office as soon as the draft is completed. The Indian Bayou and Wabbaseka Bayou projects, though separate from but adjacent to the Bayou Meto project, were surveyed under the same contract as the Bayou Meto project and will be written-up in the same report.

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Similar information packets have been sent to the Arkansas SHPO.

Under provisions of the National Historic Preservation Act, we are seeking your advice for determining the scope of identification efforts in: 1) determining the area of potential effects

(APE) for the project, 2) obtaining knowledge, or concerns with, historic properties in the Area of Potential Effect, and 3) identifying properties which may be of religious and cultural significance to your tribe (36 CFR 800.4).

Should you need additional information about the project, I can be contacted at 901-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosure

November 03, 2003

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Earle J. Barbry, Jr.
Tunica-Biloxi Indians of Louisiana
Tribal Historic Preservation Officer
P. O. Box 1589
Marksville, Louisiana 71351

Dear Mr. Barbry:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. Maps of the project area was sent to your office in July 2001; the survey and literature search was conducted by Panamerican Consultants of Memphis. A report of the survey findings is being prepared and will be forwarded to your office as soon as the draft is completed. The Indian Bayou and Wabbaseka Bayou projects, though separate from but adjacent to the Bayou Meto project, were surveyed under the same contract as the Bayou Meto project and will be written-up in the same report.

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Five sites were found in or near the Indian Bayou right-of-way; only a historic cemetery was found in this portion of Wabbaseka Bayou. I have provided engineering drawings with the sites located and marked "Do Not Disturb, Environmentally Sensitive Area" (marked this way so the contractors won't know it is an archeological site). For your convenience I have also marked the site numbers in red ink. I have also enclosed a description of each site and the archeological contractors thoughts on that site. A section of the Sherrill, Ark., 7.5 min. topographic map, with sites located on it, is also enclosed. Site 3JE424 was not located on the drawings. However, any site outside the right-of-way will not be in danger as the contractor is not allowed outside the designated right of way.

Similar information packets have been sent to the Arkansas SHPO.

Under provisions of the National Historic Preservation Act, we are seeking your advice for determining the scope of identification efforts in: 1) determining the area of potential effects (APE) for the project; 2) obtaining knowledge or concerns with historic properties in the Area of Potential Effect; and 3) identifying properties which may be of religious and cultural significance to your tribe (36 CFR 800.4).

Should you need additional information about the project, I can be contacted at 901-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosures

November 24, 2003

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Ken Grunewald
State Historic Preservation Officer
1500 Tower Building
323 Center Street
Little Rock, Arkansas 72201

Dear Mr. Grunewald:

Please find enclosed a copy of the draft Memorandum of Agreement (MOA) for cultural resources work in the Bayou Meto Project area. You previously received maps for the project and a summary report for the findings of the cultural resources survey conducted by our contractor. I have enclosed two maps showing the basic project area. Please review the MOA and provide your comments by January 5, 2004.

The draft MOA has also been sent to enterested Native American Tribes for review. Should you have questions about the project or MOA, you can contact me at 901)-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosure

MEMORANDUM OF AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
MEMPHIS DISTRICT,
THE ARKASAS STATE HISTORIC PRESERVATION OFFICER
AND THE BAYOU METO WATER MANAGEMENT DISTRICT
PURSUANT TO 36 CFR PART 800.6(a)

WHEREAS, the United States Army Corps of Engineers (CE), Memphis District, and the Bayou Meto Water management District (BMWMD) has determined that the Bayou Meto Basin, Arkansas project may affect historic properties included in or eligible for inclusion in the National Register of Historic Places, and has consulted with the Arkansas State Historic Preservation Officer (SHPO) pursuant to Section 800.13 of the regulations (36CFR Part 800) implementing Section 106 of the National Historic Preservation Act (16U.S.C.470f); and

WHEREAS, the BMWMD participated in the consultation and has been invited to concur in this Memorandum of Agreement; and

WHEREAS, CE invited the (list NA Tribes) to participate in consultation;

NOW, THEREFORE, CE, Memphis District and the Arkansas SHPO agree that the undertaking shall be implemented in accordance with the following stipulations to take into account the effect of the undertaking on historic properties.

STIPULATIONS

1. Native American consultation (36CFR Part 800.15) will be/has been conducted.

2. All historic properties studies-survey, testing, or mitigation-will follow applicable current Federal (36CFR Part 800.3 through .14) and SHPO guidelines. All historic properties studies shall follow written scopes of work provided to, approved by, or written by the CE.

3. Before commencement of construction of any portion of this project <u>any land area affected by: construction, equipment usage, borrow, or placement of excavated materials</u> shall be surveyed for historic properties eligible for listing in the National Register of Historic Places unless it has been previously surveyed or determined by the CE and SHPO that a survey is unnecessary. Such areas shall be represented on a US Geological Survey 7.5 minute topographic map and provided to the SHPO and concerned Native Americans. Any areas to be surveyed will be determined by the CE District Archeologist. The survey will be completed by a professional meeting the Secretary of the Interior's Professional Standards (48 FR44738-9).

4. Historic properties that cannot be avoided by project work will be tested for National Register significance and mitigation measures taken if required.

5. A draft survey report that complies with the Secretary of The Interior's Standards and Guidelines for Archaeology and Historic preservation and the SHPO reporting standards will be provided the SHPO and concerned Native Americans before the start of any ground-disturbance.

6. Should historic properties, determined to be eligible for listing in the National Register of Historic Places by the CE in consultation with the SHPO, be found within the project boundaries of this undertaking these resources shall be tested, avoided or mitigated before any ground-disturbance commences. The CE, Memphis District, Archeologist shall provide the SHPO and concerned Native Americans any avoidance, testing, minimization, or mitigation plan for the specific area of potential effect before any actual development associated work begins.

7. Should the area of potential effect within the project area change after the original survey is completed, reviewed and approved, all new areas added to the area of potential effect shall be surveyed for historic properties before the start of ground-disturbance activities.

8. Should, as a consequence of additional survey work, additional historic properties, determined to be eligible for listing in the National Register of Historic Places by the CE in consultation with the SHPO, be discovered within the amended project boundaries with this undertaking, these resources shall be tested, avoided, or mitigated before any ground-disturbance commences

9. The SHPO and concerned Native Americans may monitor activities carried out pursuant to this MOA, and the Advisory Council on Historic Preservation shall review such activities if it so requests. The CE, Memphis District shall cooperate with the SHPO in carrying out their monitoring and reviewing responsibilities.

Any party to this Memorandum of Agreement (MOA) may terminate it by providing thirty days notice to the other parties. All the parties to this agreement document shall consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. In the event of termination, the CE, Memphis District will comply with 36 CFR Part 800.4 through 800.6 with regard to individual undertakings covered by the MOA.

In event the CE, Memphis District does not carry out the terms of the MOA within a period of five calendar years following the ratification of this agreement document, the CE, Memphis District will comply with 36CFR Part 800.4 through 800.6 with regard to individual undertakings covered by this MOA.

This MOA will continue in full force and effect until five years from date of the ratification of this agreement document. At any time in the six-month period before this date, the BMWMD may submit a written request to the SHPO and the CE for review of the BMWMD program and consideration of an extension or modification of the MOA. No extension or modification shall be effective unless all parties to the MOA have agreed to it in writing.

Execution of the MOA by CE, Memphis District and the Arkansas SHPO, and implementation of its terms, evidence that the CE, Memphis District has afforded the Council an opportunity to comment on the Bayou Meto Basin, Arkansas project and its effects on historic properties, and the CE, Memphis District has taken into account the effects of the undertaking on historic properties.

U.S. ARMY CORPS OF ENGINEERS, MEMPHIS DISTRICT

By:______________________________________ Date:__________________________

JACK V. SCHERER, COLONEL, DISTRICT ENGINEER

ARKANSAS STATE HISTORIC PRESERVATION OFFICER

By:______________________________________ Date:__________________________

HERBERT L. HARPER, DEPUTY SHPO

BAYOU METO WATER MANAGEMENT DISTRICT

By:______________________________________ Date:__________________________

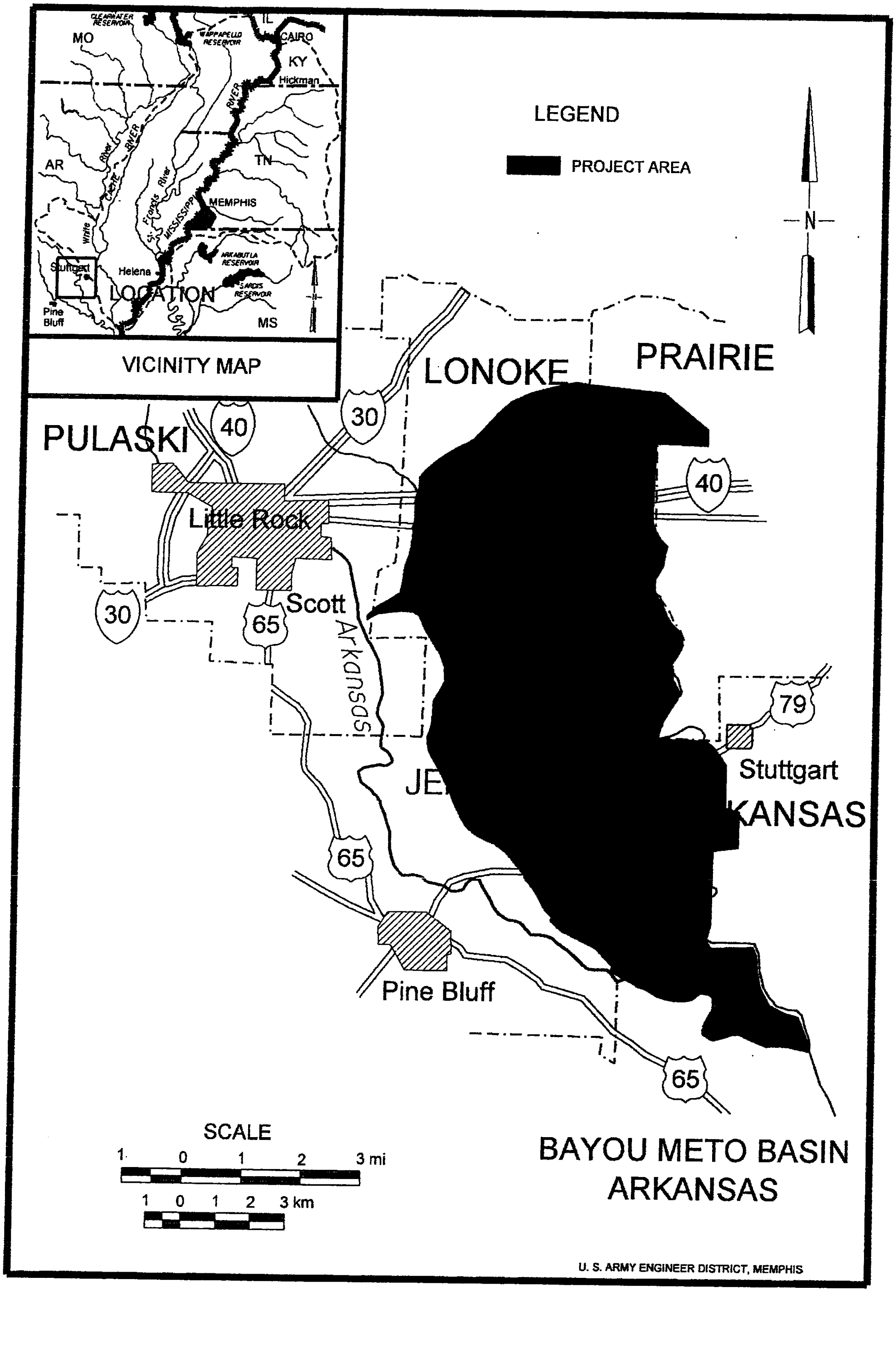
, CHAIRMAN

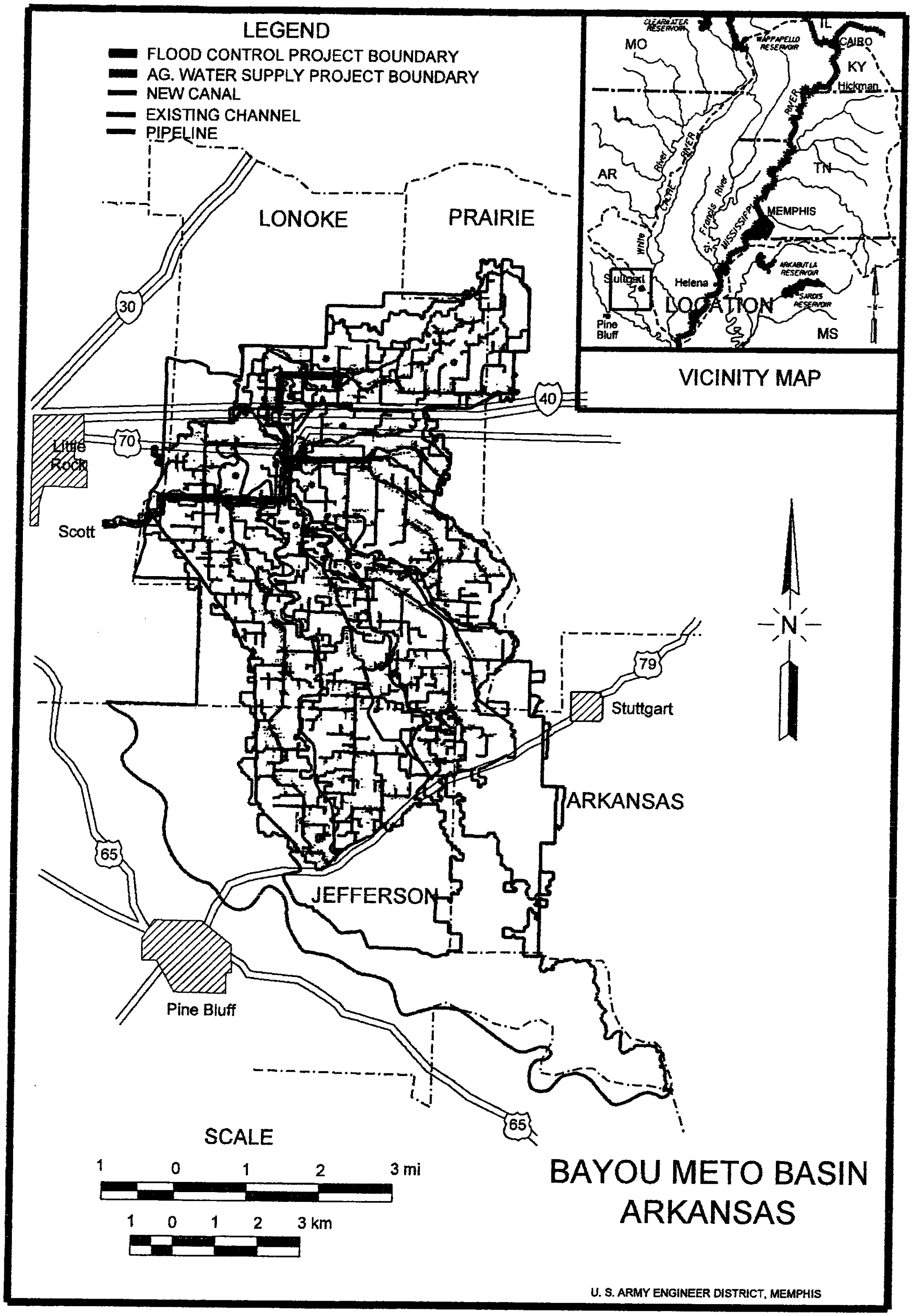
Tribe

By:______________________________________ Date:__________________________

Tribal Chairman/Chief

**ARCHEOLOGICAL SITE LOCATION INFORMATION
WILL BE AVAILABLE UPON REQUEST
FROM AUTHORIZED PERSONNEL ONLY**


VICINITY MAP
MO
AR
TN
MS
KY
IL
CAIRO
Hickman
MEMPHIS
Helena
Stuttgart
Pine Bluff
LOCATION
LEGEND
PROJECT AREA
N
LONOKE
PRAIRIE
PULASKI
40
30
Little Rock
Scott
65
Arkansas
79
Stuttgart
KANSAS
Pine Bluff
SCALE
1 0 1 2 3 mi
1 0 1 2 3 km
BAYOU METO BASIN
ARKANSAS
U. S. ARMY ENGINEER DISTRICT, MEMPHIS


LEGEND
FLOOD CONTROL PROJECT BOUNDARY
AG. WATER SUPPLY PROJECT BOUNDARY
NEW CANAL
EXISTING CHANNEL
PIPELINE
LONOKE
PRAIRIE
30
40
70
Little Rock
Scott
79
Stuttgart
ARKANSAS
65
JEFFERSON
Pine Bluff
N
MO
IL
CAIRO
KY
Hickman
AR
TN
MEMPHIS
Helena
LOCATION
MS
VICINITY MAP
SCALE
1 0 1 2 3 mi
1 0 1 2 3 km
BAYOU METO BASIN
ARKANSAS
U. S. ARMY ENGINEER DISTRICT, MEMPHIS

November 24, 2003

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Kenneth H. Carleton
Tribal Archeologist
Mississippi Band of Choctaw Indians
P.O. Box 6257
Philadelphia, Mississippi 39350

Dear Mr. Carleton:

Please find enclosed a copy of the draft Memorandum of Agreement (MOA) for cultural resources work in the Bayou Meto Project area. You previously received maps for the project and a summary report for the findings of the cultural resources survey conducted by our contractor. I have enclosed two maps showing the basic project area. Please review the MOA and provide your comments by January 5, 2004.

The draft MOA has also been sent to the Arkansas SHPO for review. Should you have questions about the project or MOA, you can contact me at 901)-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosure

November 24, 2003

Planning, Programs, & Project
Management Division
Environmental Analysis Branch

Mr. Earl J. Barbry, Jr.
NAGPRA Representative
Tunica-Biloxi Indian Tribe of Louisiana
P.O. Box 331
Marksville, Louisiana 71351

Dear Mr. Barbry:

Please find enclosed a copy of the draft Memorandum of Agreement (MOA) for cultural resources work in the Bayou Meto Project area. You previously received maps for the project and a summary report for the findings of the cultural resources survey conducted by our contractor. I have enclosed two maps showing the basic project area. Please review the MOA and provide your comments by January 5, 2004.

The draft MOA has also been sent to the Arkansas SHPO for review. Should you have questions about the project or MOA, you can contact me at (901)-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosures

November 24, 2003

Planning, Programs, & Project
Management Division
Environmental Analysis Branch

Ms. Carrie Wilson
Quapaw Tribe of Oklahoma
NAGPRA Representative
223 East Lafayette
Fayetteville, Arkansas 72701

Dear Ms. Wilson:

Please find enclosed a copy of the draft Memorandum of Agreement (MOA) for cultural resources work in the Bayou Meto Project area. You previously received maps for the project and a summary report for the findings of the cultural resources survey conducted by our contractor. I have enclosed two maps showing the basic project area. Please review the MOA and provide your comments by January 5, 2004.

A copy of this letter and MOA has been mailed to the Arkansas SHPO. Should you need additional information I can be contacted at 901-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosure

The Department of Arkansas Heritage

Mike Huckabee, Governor
Cathie Matthews, Director

Arkansas Arts Council
•
Arkansas Natural Heritage Commission
•
Historic Arkansas Museum
•
Delta Cultural Center
•
Old State House Museum

Arkansas Historic Preservation Program

1500 Tower Building
323 Center Street
Little Rock, AR 72201
(501)324-9880
fax: (501)324-9184
tdd: (501)324-9811
e-mail:
info@arkansaspreservation.org
website:
www.arkansaspreservation.org

May 1, 2003

Mr. Jimmy D. McNeil
District Archeologist
Memphis District Corps of Engineers
167 North Main, Room B-202
Memphis, Tennessee 38103-1984

RE: Multi County - General
Section 106 Review - COE
"Management Summary for the Bayou Meto Irrigation Control Project Cultural Resources Survey"
AHPP Tracking No: 44056

Dear Mr. McNeil:

My staff has reviewed the management summary submitted regarding cultural resources survey conducted in connection with the Bayou Meto Irrigation Control Project. We regret that we cannot provide review comments at this time. It is our policy not to review reports of incomplete fieldwork in an absence of a Programmatic Agreement that provides a mechanism for such review. In addition, the site descriptions contained in this document provide insufficient information to enable us to arrive at an independent evaluation were we to attempt to provide comments. We understand your eagerness to proceed with the review process, given the large number of archeological sites involved, but we are unable to do so at this time.

Thank you for your interest and concern for the cultural heritage of Arkansas. If you have any questions, please contact Steve Imhoff of my staff at (501) 324-9880.

Sincerely,

Ken Grunewald
Deputy State Historic Preservation Officer

cc: Mr. C. Andrew Buchner, Panamerican Consultants, Inc.
Dr. Ann M. Early, Arkansas Archeological Survey
Mr. Jim Roan Gray, Osage Nation
Ms. Carrie V. Wilson, Quapaw Tribe of Oklahoma

April 14, 2003

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Ken Grunewald
State Historic Preservation Officer
1500 Tower Building
323 Center Street
Little Rock, Arkansas 72201

Dear Mr. Grunewald:

Please find enclosed one copy of the "Management Summary for the Bayou Metro Irrigation Control Project Cultural Resources Survey". This management summary details the basic information about all the sites found in this portion of the project. A project draft report has not yet been written as I am having the contractor hold off until the remainder of the project area is surveyed and all the possibly significant and significant sites have been tested. I am doing this so all the information will be in one report. Please review this summary and its conclusions. If agree or disagree with the conclusions please inform me.

Should you have questions about the project, survey or report, you can contact me at 901)-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosure

April 30, 2003

Planning, Programs, & Project
Management Division
Environmental Branch

Mr. Ken Grunewald
State Historic Preservation Officer
1500 Tower Building
323 Center Street
Little Rock, Arkansas 72201

Dear Mr. Grunewald:

On April 14, I mailed a copy of the "Management Summary for the Bayou Metro Irrigation Control Project Cultural Resources Survey". This management summary details the basic information about all the sites found in this portion of the project. However, the associated maps were inadvertently left out of the package. With this letter I am enclosing the associated maps.

Should you have questions about the project, survey, or report, you can contact me at (901) 544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosure

April 30, 2003

Planning, Programs, & Project
Management Division
Environmental Analysis Branch

Ms. Carrie Wilson
Quapaw Nation
NAGPRA Representative
223 East Lafayette
Fayetteville, Arkansas 72701

Dear Ms. Wilson:

The Memphis District, Corps of Engineers, is planning to test 14 sites in the Bayou Meto Irrigation project, for significance. I have enclosed a copy of the "Management Summary for the Bayou Meto Irrigation Control Project Cultural Resources Survey" and associated topographic maps sections for the associated sites. A project survey report has not yet been completed as I wanted to include the testing information so all the information would be in a single report.

A copy of this letter has been mailed to Quapaw Tribal Headquarters and the Arkansas SHPO.

Should you need additional information I can be contacted at 901-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosure

April 30, 2003

Planning, Programs, & Project
Management Division
Environmental Analysis Branch

Mr. John Berrey
Business Committee Chairman
Quapaw Tribe of Oklahoma
P.O. Box 765
Quapaw, Oklahoma 74363

Dear Mr. Berrey:

The Memphis District, Corps of Engineers, is planning to test 14 sites in the Bayou Meto Irrigation project, for significance. I have enclosed a copy of the "Management Summary for the Bayou Meto Irrigation Control Project Cultural Resources Survey" and associated topographic maps sections for the associated sites. A project survey report has not yet been completed, as I wanted to include the testing information so all the information would be in a single report.

A copy of this letter has been mailed to the Quapaw Tribal NAGPRA Representative and the Arkansas SHPO.

Should you need additional information I can be contacted at 901-544-0710.

Sincerely,

Jimmy McNeil
District Archeologist
Memphis District
Corps of Engineer

Enclosure

September 25, 2001

Planning, Programs, & Project
Management Division
Environmental Analysis Branch

Ms. Carrie Wilson
Quapaw Nation Representative
223 East LaFayette
Fayetteville, Arkansas 72701

Dear Ms. Wilson:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. On July 31, 2001, I mailed a discussion of the proposed project and a large map of the project area and asked if the Quapaw Tribe would be interested in the projects cultural resource findings.

Under provisions of the National Historic Preservation Act, we are seeking your advice for determining the scope of identification efforts in (1) documenting the area of potential effects (APE) for this project, (2) obtaining knowledge or concerns with historic properties in the Area of Potential Effect, and (3) identifying properties which may be of religious and cultural significance to your tribe (36CFR 800.4).

Should you have questions, concerns, comments, or information about the project or the project area, you can contact me at 901-544-0710.

Sincerely

Jimmy McNeil
District Archeologist

September 25, 2001

Planning, Programs, & Project
Management Division
Environmental Analysis Branch

Mr. Earl J. Barbry, Jr.
Tribal Historic Preservation Officer
Tunica-Biloxi Tribe
P.O. Box 1589
Marksville, Louisiana 71351

Dear Mr. Barbry:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. On July 31, 2001, I mailed a discussion of the proposed project and a large map of the project area and ask if the Tunica-Biloxi Tribe would be interested in the projects cultural resource findings.

Under provisions of the National Historic Preservation Act, we are seeking your advice for determining the scope of identification efforts in (1) documenting the area of potential effects (APE) for this project, (2) obtaining knowledge or concerns with historic properties in the Area of Potential Effect, and (3) identifying properties which may be of religious and cultural significance to your tribe (36CFR 800.4).

If you have any questions regarding this submittal, please contact me at 901-544-0710; my email is jimmy.d.mcneil@mvm02.usace.army.mil.

Sincerely,

Jimmy McNeil
District Archeologist

September 25, 2001

Planning, Programs, & Project
Management Division
Environmental Analysis Branch

Mr. Kenneth H. Carleton
Tribal Archeologist
Mississippi Band of Choctaw Indians
P.O. Box 6257, Choctaw Branch
Philadelphia, Mississippi 39350

Dear Mr. Carleton:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. I have enclosed a discussion of the proposed project and a large map of the project area.

Panamerican Conusltants of Memphis has the contract to conduct the archeological study(s) in the project area. The cultural resources study will soon start; work to be conducted will consist of a records and literature search, pedestrian survey, and possibly testing and mitigation. As findings become available, your office will be contacted if you are interested in the findings.

If the Mississippi Band of Choctaw have an interest in this area, then under provisions of the National Historic Preservation Act, we are seeking your advice for determining the scope of identification efforts in (1) documenting the area of potential effects (APE) for this project, (2) obtaining knowledge, or concerns with, historic properties in the Area of Potential Effect, and (3) identifying properties which may be of religious and cultural significance to your tribe (36CFR 800.4).

Should you have questions, concerns, comments, or information about the project or the project area, you can contact me at 901-544-0710.

Sincerely

Jimmy McNeil
District Archeologist

Enclosure

24 September 2001

At approximately 2:30 PM today I called Ms. Christine Norris, Representative of the Jena Band of Choctaw Indians in Jena, Louisana. I told her about the Bayou Meto project and ask if the tribe was interested in receiving information about it or had any interest in this area. She told me that they did not have their TIPO office setup yet and was trying to deal with areas in Louisana and Mississippi at the present. She said that after they got their office staffed and running properly they might be interested in projects in our area but not until then. I ask her to contact us (I had already sent her a letter with our/my address) when their office was ready and that we could then talk more about what areas of our district they were interested in. She stated that she would.

Jimmy McNeil
District Archeologist

The Department of
Arkansas
Heritage

Mike Huckabee, Governor
Cathie Matthews, Director

Arkansas Arts Council
▪
Arkansas Natural Heritage Commission
▪
Historic Arkansas Museum
▪
Delta Cultural Center
▪
Old State House Museum

Arkansas Historic Preservation Program

1500 Tower Building
323 Center Street
Little Rock, AR 72201
(501)324-9880
fax: (501)324-9184
tdd: (501)324-9811
e-mail:
info@arkansaspreservation.org
website:
www.arkansaspreservation.org

August 27, 2001

Mr. Jimmy D. McNeil
District Archeologist
U.S. Army Corps of Engineers, Memphis District
167 North Main Street, B-202
Memphis, Tennessee 38103-1984

RE: Multi-County – General
Section 106 Review – COE
Bayou Meto Basin Project
AHPP Tracking No. 44056

Dear Mr. McNeil:

Thank you for the information regarding the proposed project in the Bayou Meto area. We look forward to reviewing the cultural resources work by Panamerican Consultants. If we can be of assistance, do not hesitate to let us know.

Thank you for your interest and concern for the cultural heritage of Arkansas. If you have any questions, please contact Steve Imhoff of my staff at (501) 324-9880.

Sincerely,

Ken Grunewald
Deputy State Historic Preservation Officer

cc: Quapaw Tribe of Oklahoma
Arkansas Archeological Survey

July 31, 2001

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Ken Grunewald
State Historic Preservation Officer
1500 Tower Building
323 Center Street
Little Rock, Arkansas 72201

Dear Mr. Grunewald:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. I have enclosed a discussion of the proposed project and a large map of the project area.

Panamerican Consultants of Memphis has the contract to conduct the archeological study(s) in the project area. The cultural resources study will soon start; work to be conducted will consist of a records and literature search, pedestrian survey, and possibly testing a mitigation. As findings become available, your office will be contacted.

A similar packet of material has been sent to the Quapaw representative.

Should you have questions about the project, you can contact me at (901)544-0710.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosure

July 31, 2001

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Ms. Carrie Wilson
Quapaw Nation Representative
223 East LaFayette
Fayetteville, Arkansas 72701

Dear Ms. Wilson:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. I have enclosed a discussion of the proposed project and a large map of the project area.

Panamerican Conusltants of Memphis has the contract to conduct the archeological study(s) in the project area. The cultural resources study will soon start; work to be conducted will consist of a records and literature search, pedestrian survey, and possibly testing and mitigation. As findings become available, your office will be contacted if you are interested in the findings.

Should you have questions, concerns, comments, or information about the project or the project area, you can contact me at 901-544-0710.

Sincerely

Jimmy McNeil
District Archeologist

Enclosure

August 2, 2000

Planning, Programs, & Project
Management Division
Environmental & Economic Analysis Branch

Mr. Earl J. Barbry, Jr.
Tribal Historic Preservation Officer
Tunica-Biloxi Tribe
P.O. Box 1589
Marksville, Louisiana 71351

Dear Mr. Barbry:

The Memphis District, Corps of Engineers, is proposing to conduct a large project in the Bayou Meto Basin portion of Arkansas. I have enclosed a discussion of the proposed project and a large map of the project area.

Panamerican Conusltants of Memphis has the contract to conduct the archeological study(s) in the project area. The cultural resources study will soon start; work to be conducted will consist of a records and literature search, pedestrian survey, and possibly testing and mitigation. As findings become available, your office will be contacted if you are interested in the findings.

If you have any questions regarding this submittal, please contact me at 901-544-0710; my email is jimmy.d.mcneil@mvm02.usace.army.mil.

Sincerely,

Jimmy McNeil
District Archeologist

Enclosures

SECTION X

WATERFOWL ANALYSIS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1500 Museum Road, Suite 105
Conway, Arkansas 72032
Tel.: 501/513-4470 Fax: 501/513-4480

IN REPLY REFER TO:

March 31, 2005

Colonel Charles O. Smithers
U.S. Army Corps of Engineers
167 North Main Street, Room B-202
Memphis, TN 38103-1894

Dear Colonel Smithers:

Attached is the draft Coordination Act Report relative to the Bayou Meto Basin, Arkansas, General Reevaluation. The information and recommendations contained in this report are submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. et seq.). This constitutes a draft of the report of the Department of Interior, Fish and Wildlife Service, as required by Section 2(b) of the Act. A Waterfowl Appendix to this report detailing project effects upon waterfowl carrying capacity and a Shorebird Appendix regarding the habitat needs of shorebirds are attached.

We appreciate the opportunity to provide these comments and commend the aid provided by your staff throughout the planning stage of this project. We hope to continue working closely with the Corps and other involved agencies if this project is funded. Should you or your staff have questions about this report, please do not hesitate to call me.

Sincerely,

Allan J. Mueller
Field Supervisor

cc: Arkansas Game and Fish Commission, Little Rock, AR
Arkansas Natural Heritage Commission, Little Rock, AR
Natural Resources Conservation Service, Little Rock, AR
FWS, Regional Office, Atlanta, GA
Environmental Protection Agency, Dallas, TX
Arkansas Soil and Water Conservation Commision, Little Rock, AR
Arkansas Department of Environmental Quality, Little Rock, AR
Ducks Unlimited, Little Rock, AR
Bayou Meto Irrigation District, Lonoke, AR

APPENDIX A

WATERFOWL TECHNICAL APPENDIX FOR THE BAYOU METO BASIN, ARKANSAS, GENERAL REEVALUATION

EXECUTIVE SUMMARY

BAYOU METO BASIN, ARKANSAS, GENERAL REEVALUATION

WATERFOWL APPENDIX

The U.S. Fish and Wildlife Service's (Service) Waterfowl Technical Appendix (appendix) was prepared to quantify the impacts of the Memphis District, U.S. Army Corps of Engineers (Corps) Bayou Meto Basin, Arkansas, General Reevaluation on waterfowl. It is the Service's understanding that this appendix is to become an integral part of the Corp's environmental report.

Because of dry conditions in traditional breeding areas and the loss of both breeding and wintering habitat, continental waterfowl breeding populations are below long term averages. Since the loss and degradation of habitat have been identified as the major waterfowl management problems in North America, quantifying the impacts of the proposed alternatives for the Bayou Meto Basin, Arkansas, General Reevaluation in terms of alteration to wintering waterfowl carrying capacity and foraging habitat is the primary purpose of this appendix.

Using with and without hydrology modifications and land use data supplied by the Corps, the impact methodology used in this appendix was based on food as an index of wintering waterfowl carrying capacity expressed in terms of the number of duck-use-days (DUD). This methodology also accounts for the effects of seed consumption and decomposition for agricultural waste grains. Project impacts in terms of increases and decreases of average seasonal acres flooded, during the 120 day wintering period from November 15 to March 15, were also identified. Project impacts were determined by comparing existing conditions to those resulting from the direct (i.e., construction) and indirect (i.e., alteration of hydrologic regimes) impacts associated with flood control and water supply alternatives. None of the water supply alternatives would have an effect on the winter hydrology within the Bayou Meto basin, so the indirect impacts of this project component are not discussed further in this analysis.

Implementation of purely structural flood control features would result in adverse impacts to migratory waterfowl wintering habitat (maximum average annual loss of 626,375 DUD, Alternative FC3B, 3,000 cfs pump). Losses would occur both on private and public lands and would be evident in seven of the eleven hydrologic reaches. From the final array of six, alternative FC2 would reduce wintering waterfowl foraging habitat carrying capacity by 267,817 DUD due to the effects of the reduction in hydrology from channel cleanouts/enlargements. Alternative FC2A, which incorporates additional channel work, would result in a loss of 269,929 DUD. A loss of 482,948 DUD would result from Alternative FC3A which includes the addition of a 1,000 cfs pump at the mouth of Little Bayou Meto. A nonstructural plan incorporating reforestation within the two year floodplain would result in a loss of DUD compared to existing conditions. This is due to the fact that fallow cropland habitats provide 1.7 times the forage density and caloric value (and DUD/acre) of reforested habitats. The restoration of 15,140 acres of forests on cropland (including fallow land) in the two year floodplain (4,256 acres in the "waterfowl flood scene") would result in a loss of 12,304 DUD.

The Corps combined the features in water supply alternative WS4B (water conservation, 8,832 acres of storage reservoirs, and a 1,750 cfs import system) with those in flood control alternative FC3A (channel cleanouts/enlargements and a 1,000 cfs pump) to form their preferred alternative (National Economic Development, or NED plan). This assessment only addresses the impacts to waterfowl due to indirect hydrologic impacts. The preferred alternative would result in a loss of 482,948 DUD due to the flood control component. The mitigation required for direct impacts due to spoil, reservoirs, pump stations, and other infrastructure was addressed separately by the Corps using the Habitat Evaluation Procedures (HEP). The preferred alternative also includes the following proposed waterfowl management features: 1) reforestation of 23,000 acres in the post-project two and five year floodplains; 2) reforestation of 2,643 acres of riparian buffers in the two year floodplain; 3) development of 240 acres of moist soil habitat; 4) enhancement of 26,000 acres of BLH in Bayou Meto Wildlife Management Area Greentree Reservoirs; and 5) restoration and creation of 2,000 acres of seasonal herbaceous wetland and wet prairie. The benefits of these waterfowl management features in terms of DUD gains was detailed by Heitmeyer (2005).

Quantifying food availability and consumption by waterfowl represents only one facet of waterfowl biology. It also represents only part of waterfowl habitat requirements. The availability of winter water for other uses, i.e., loafing and pair bonding, are equally important and should be considered equally when a proposed alternative would reduce winter water. Forested areas contain foods (acorns and macroinvertibrates) that contribute to a nutritionally complete diet. Forested areas also provide complex cover for protection, loafing, and pair bonding. These are proven values not provided by flooded crops (or provided to a much lesser extent) but that are very difficult to quantify. Also, the reduction in wintering waterfowl habitat that has occurred due to the completion of flood control projects in the Lower Mississippi Alluvial Valley is of concern to the Service not just because of adverse impacts to migratory waterfowl, but cumulative impacts to the floodplain ecosystem.

Due to the planning efforts of the Corps, the Service, and other interested parties, decision makers now have the opportunity to reforest a significant portion of the Bayou Meto project area, benefiting all fish and wildlife species dependent on forested wetland habitats. Special emphasis should be placed on reforestation of the without project two year floodplain. This technique has been widely recognized as providing multiple benefits including reduction in flood damages on marginal farm land, increase of fish and wildlife habitat, and improvement of water quality. Much of this land was cleared when soybean prices where high enough to justify the risks associated with farming frequently flooded areas. Today prices have moderated and many such areas can no longer be profitably farmed. Because of this, the owners of these properties are much more likely to participate in incentive based reforestation initiatives than those who own property at higher elevations. Although more difficult to obtain, fee title and easement purchases of property above the two year flood frequency should be considered as well. Although these higher sites flood less frequently, they do provide important foraging opportunities for waterfowl during high flood events and will support less water tolerant native plant communities that are currently quite rare in the basin due to agricultural conversion.

INTRODUCTION

This draft Waterfowl Technical Appendix (appendix) is submitted in partial fulfillment of the Fiscal Year 2005 scope of work for U.S. Fish and Wildlife Service (Service) activities pertaining to the U.S. Army, Corps of Engineers (Corps), Memphis District activities associated with the Bayou Meto Basin, Arkansas, General Reevaluation. The purpose of this appendix is threefold: first, to identify the relative importance of the general project area in terms of historic trends in wetlands and wintering waterfowl, primarily Mallards (*Anas platyrhynchos*); secondly, to document existing wintering waterfowl carrying capacity in the project area, and thirdly, to document project induced impacts compared to future without-project conditions using food as an index of carrying capacity expressed in terms of duck-use-days (DUD). Quantifying food availability and consumption by waterfowl represents one facet of waterfowl biology, and it represents only part of waterfowl habitat requirements. The availability of winter water for other uses, i.e., loafing and pair bonding, are equally important, but difficult to quantify. Flood control projects that reduce the extent, duration, and frequency of winter water are of concern to the Service.

Flood control projects should be approached on an ecosystem basis with the goal of creating economically and ecologically sustainable land uses. The use of purely structural traditional flood control methods such as channelization, channel widening, and pumps address only the economic aspect. The adoption of incentive based two year flood zone reforestation as a major component of flood damage reduction projects considers both the economic and ecological services provided by a river basin. The Service believes the trend should be towards using primarily nonstructural methods supplemented by traditional techniques.

The information contained in this appendix is submitted in accordance with the referenced scope of work and with provisions of the Fish and Wildlife Coordination Act, but does not constitute the final report of the Department of Interior, U.S. Fish and Wildlife Service, as required by Section 2(b) of the Act.

PROJECT DESCRIPTION

The Bayou Meto Basin, Arkansas, General Reevaluation is the result of more than fifty years of efforts to implement a water development project in the Bayou Meto watershed. Authorization for a flood control project in the Grand Prairie Region and the Bayou Meto Basin in eastern Arkansas was originally given in Section 204 of the Flood Control Act of 1950 (64 Stat 174). Due to a lack of local sponsorship, the project was deauthorized by Section 1001(B) of the Water Resources Development Act of 1986 (33 U.S.C. 579A(B)). However, because of concerns about drought conditions and declining aquifers, the project was reauthorized by Section 363(a), Project Reauthorizations, of the Water Resources Development Act of 1996, Public Law 104-303. The reauthorized project expanded the original scope of work to include ground water protection and conservation, agricultural water supply, and waterfowl management in addition to flood control. In 1998 reports submitted by the U.S. House of Representatives and U.S. Senate directed the U.S. Army Corps of Engineers (Corps) to initiate a reevaluation of the Bayou Meto Basin portion of the project.

The Bayou Meto basin project area encompasses 779,109 acres in portions of Arkansas, Jefferson, Lonoke, Prairie, and Pulaski Counties. The majority of the project area drains into Bayou Meto, a tributary of the Arkansas River, although a small northeastern portion of the area drains into tributaries of the White River. Other streams in the area include Bayou Two Prairie, Indian Bayou, Little Bayou Meto, Wabbaseka Bayou, Baker's Bayou, Salt Bayou Ditch, and Crooked Creek. The major land use in the area is agriculture including production of rice, soybeans, cotton, wheat, grain sorghum, and baitfish (aquaculture). Another prominent practice in the basin is the management of land to provide fish and wildlife habitat. Bayou Meto Wildlife Management Area (BMWMA), covering approximately 32,000 acres, contains a large portion of the bottomland hardwood habitat in the basin. Early and unvaried flooding of green tree reservoir units to provide dependable waterfowl hunting opportunities has resulted in some timber mortality, loss of timber regeneration, and/or conversion to more water tolerant species. Difficulty in removing water from the timber in the spring has also contributed to these problems. Much of this late flooding is the result of or exacerbated by previous flood control projects (i.e., upper basin channelization and lower Bayou Meto and Little Bayou Meto flood gates that are closed to prevent backflow from the Arkansas River), basin wide land use practices (i.e., streams sedimented in due to agricultural runoff), and damming by beavers. The primary problems identified in the basin are agricultural flooding and depletion of the alluvial aquifer due to overuse as an irrigation source. The project seeks to address the flooding damage through a combination of structural and nonstructural methods. Some of these measures may also assist in removing water from the BMWMA during the spring. The diversion of surface water from the Arkansas River is proposed to lessen the pumping demand on the aquifer.

PROJECT ALTERNATIVES

The flood control and irrigation water conveyance components of this project are being studied separately by the Vicksburg and Memphis Districts of the Corps, therefore each has an array of alternatives. Aside from the direct impacts associated with the construction of water conveyance infrastructure, the irrigation component will have little effect upon the availability of waterfowl foraging habitat. The flood control portion of the project has greater potential for reducing the amount of available foraging habitat due to reductions in flood frequency, extent, and duration. Components of water supply alternative WS4B (water conservation, 8,832 acres of storage reservoirs, and a 1,750 cfs import system) were combined with those in flood control alternative FC3A (channel cleanouts/enlargements and a 1,000 cfs pump) to form the Corps' preferred alternative. This alternative also includes waterfowl management features including reforestation, moist soil development, herbaceous wetland and wet prairie restoration, and internal water management features with Bayou Meto WMA. All flood control and water supply alternatives and the Corps' preferred alternative are discussed separately below and in Table 1.

Four structural flood control alternatives in addition to no-action and nonstructural alternatives were carried forward for detailed investigation. For each structural alternative, the project area was divided into 11 reaches with specific actions such as channel cleanouts, excavations, or channel enlargements designated for each reach. The details of each alternative follow:

1. Alternative FC1 - This no action alternative assumes that no work will occur and conditions will remain similar to those that currently characterize the project area.

2. Alternative FC6 - This nonstructural plan would involve reforestation of 15,140 acres of cropland in the pre-project two year floodplain.

3. Alternative FC2 - This alternative would involve an array of selective clearing, channel cleanout, weir placement, and excavation work on eight stream reaches. It would provide a reduction in flooding for the most frequently flooded reaches in the project area.

4. Alternative FC2A - This alternative is identical to alternative 2 except for some additional channel enlargement in Indian Bayou Ditch, Crooked Creek Ditch, and Crooked Creek to accommodate some of the water supply features.

5. Alternative FC3A - This alternative incorporates all of the features of alternative 2A while adding additional excavation and channel enlargement in Little Bayou Meto, Boggy Slough, and Boggy Slough diversion. More notably, this alternative also includes the installation of a 1,000 cfs pump near the mouth of Little Bayou Meto.

6. Alternative FC3B - This alternative is identical to alternative 3A except that a 3,000 cfs pump would be used in place of the 1,000 cfs pump. The increase in pump capacity would also require modification of the existing Cannon Brake water control structures to pass the extra water volume.

Five water delivery alternatives, including the no action alternative, were considered for this project. They incorporate a combination of on-farm water conservation measures and supplemental water via a delivery system from the Arkansas River. Several alternatives have sub-alternatives that detail various on-farm surface water storage capacities. Descriptions of each alternative follow:

1. Alternative WS1: No Action - This alternative represents the conditions that will occur in the project area in the absence of the proposed project. The desired land use and demand for irrigation water will remain at current levels. Only 45 percent of the project area can be sustainably irrigated in an average year without the project.

2. Alternative WS2: Conservation with storage - This alternative would increase the amount of on-farm water storage and conservation measures in an effort to maximize the use of existing water sources. This would involve increasing the irrigation water use efficiency from 60 percent to 70 percent. An additional 4,941 acres of reservoirs would also be constructed. This is the maximum acreage that could be constructed without a supplemental delivery system. With this alternative in place approximately 60 percent of the area could remain irrigated if groundwater withdrawal was regulated at the safe yield level.

3. Alternative WS3: Conservation and storage plus a 1,650 cfs water import system - While this alternative would similarly increase water use efficiency to 70 percent and feature the construction of on-farm storage reservoirs, it would also incorporate a system for the distribution of supplemental water. Water from the Arkansas River would be pumped throughout the project

area via a system of new canals and pipelines in addition to existing streams. The addition of this water would allow the construction of additional acres of on-farm storage. The following sub-alternatives feature the above components plus three options for new reservoir construction.

Sub-alternative WS3A: 5,954 acres of additional storage reservoirs.

Sub-alternative WS3B: 8,832 acres of additional storage reservoirs.

Sub-alternative WS3C: 14,544 acres of additional storage reservoirs.

4. Alternative WS4: Conservation and storage plus a 1,750 cfs water import system - This alternative is identical to alternative WS3 except for a 100 cfs increase in water import capacity. The acreage of storage reservoirs (sub-alternatives WS4A-WS4C) remains the same.

5. Alternative WS5: Conservation and storage plus a 1,850 cfs water import system - This alternative is identical to alternative WS3 except for a 200 cfs increase in water import capacity. The acreage of storage reservoirs (sub-alternatives WS5A-WS5C) remains the same.

The Corps' selected plan, or preferred alternative, consists of a combination of water delivery alterative WS4B and flood control alternative FC3A. This plan will also incorporate waterfowl management features including bottomland hardwood reforestation, herbaceous wetland/wet prairie restoration, and water management improvements with Bayou Meto WMA.

TABLE 1. ARRAY OF PROJECT ALTERNATIVES, BAYOU METO GENERAL REEVALUATION.

Project Component	Alternative	Description
Water Conveyance	WS1	No action
Water Conveyance	WS2	Increase in water conservation and construction of on-farm storage
Water Conveyance	WS3	Increase in water conservation and construction of additional on-farm storage made possible by a 1,650 cfs supplemental water supply from the Arkansas River
Water Conveyance	WS4	Same as above with 1,750 cfs supplemental water supply
Water Conveyance	WS5	Same as above with 1,850 cfs supplemental water supply
Flood Control	FC1	No Action
Flood Control	FC2	Selective channel cleanouts and enlargements
Flood Control	FC2A	Same as above with additional channel reaches enlarged to handle conveyance of irrigation water
Flood Control	FC3A	Same as above with addition of a 1,000 cfs pump at the mouth of Little Bayou Meto
Flood Control	FC3B	Same as above with a 3,000 cfs pump
Flood Control	FC6	Reforestation of the two year floodplain on frequently flooded cleared areas
Multipurpose	Selected Plan	Combination of water conveyance alternative WS4B and flood control alternative FC3A plus waterfowl management features

HISTORICAL PERSPECTIVE OF WETLANDS AND WATERFOWL IN THE MISSISSIPPI ALLUVIAL VALLEY

Wetlands

Before settlement by Europeans and Africans, the Mississippi Alluvial Valley (MAV) was an intricate maze of bottomland hardwood forests, swamps, and bayous, and historically, the largest forested wetland in North America (25 million acres) extending approximately from southeastern Missouri to southern Louisiana. The transformation of this vast forest into agricultural use was gradual, yet deliberate, with more than 80 percent of the forest in this region cleared. Most of the MAV was subject to periodic flooding by the Mississippi River and its tributaries. Following the Flood Control Act of 1941, hydrologic relationships in the MAV were altered by federally funded water resource developments for flood control and agriculture (Reinecke *et al.* 1988). Despite these changes to the landscape and hydrology in the MAV, it remains a critical ecoregion for North American waterfowl and other wildlife (Kaminski 1999).

Congress enacted a series of Swamplands Acts in the mid-1800's that deeded more than 20 million acres of swamplands to the states. With the proceeds from the sale of these lands being used for reclamation, wetlands were cleared, drained, and converted to agricultural use. Extensive settlement of the MAV occurred by 1900. As the result of devastating floods (1912, 1913, 1916, and 1927), Congress enacted the comprehensive flood protection program called the Mississippi River and Tributaries Project (MR&T). As a direct result of the construction of 1,500 miles of mainline levees along both banks of the Mississippi River under the MR&T

Project, thousands of acres of bottomland hardwood forests were cleared for agricultural production. These lands were generally high in elevation for the Delta, well drained, and the most productive in the MAV. Today, these lands are primarily used for the production of cotton, corn, soybeans, rice, grain sorghum, and wheat.

Following the completion of interior flood control projects, the period from 1950 through the 1970's saw the expansion of agriculture into the lower, wetter, flood prone land. During this time period, approximately 3.5 million acres of wooded wetlands were converted to agricultural production in the MAV (MacDonald *et al.* 1979). The high price of soybeans during this period made farming even flood prone lands profitable. As soybean prices dropped, the futility of farming marginal, flood prone land was made evident during the devastating floods that occurred from 1973 through 1993, despite the occasional periods of drought. As the result of this extended period of flooding, Congress enacted legislation to protect and restore wetlands (marginal, flood prone agricultural land brought into production during the period from 1950-1970): the 1985 Farm Bill, the Emergency Wetlands Protection Act of 1986, the Water Resources Development Act of 1986, the Agriculture Credit Act of 1987, the Conservation Reserve Program, the 1990 Farm Bill, the Food Security Act of 1992, the Wetlands Reserve Program (WRP), and the Federal Agriculture Improvement and Reform Act of 1996. For example, under the provisions of WRP, the federal government pays land owners fair market value for marginal cropland (farmed wetlands) and assists in replanting these areas in bottomland hardwood species. Today, the trend of federal policy is decidedly toward (1) wetland restoration that will benefit waterfowl and other wildlife dependent on wetland habitat, and (2) sound floodplain management.

Waterfowl

Historically, the MAV served as a major wintering area for waterfowl. Waterfowl population numbers began to decline in the 1960's as the direct result of extensive droughts and loss of nesting habitat in the prairie pothole region of the North America and the conversion of wintering areas in the MAV (bottomland hardwoods) to agricultural production. Waste grain, rice, and soybeans are now the dominant food sources of waterfowl in the MAV. These crops are often grown on frequently flooded cropland. Federal flood control and drainage programs have reduced the extent of these flooded areas, the result being that naturally flooded or ponded habitat is limited for a significant portion of the wintering period and areas that do flood are less extensive and more ephemeral.

The net effect of wetland conversion and drainage has been that natural habitat is no longer sufficient to meet the needs of wintering waterfowl and other migratory birds. Clearing for grazing, timber harvesting, agriculture, and reservoir projects have all contributed to the decline of bottomland hardwoods in the region.

Over the last decade several species of North American waterfowl, including Mallards, showed signs of recovery approaching or exceeding the population levels recorded in the 1950's (Annual Breeding Duck Survey, Table 2). However, dry conditions on the traditional Canadian and northern United States nesting grounds over the last several years have resulted in declines in the overall waterfowl population. Total duck abundance in the traditional survey area for 2002 was estimated at 31.2 million birds, a decrease of 14 percent from that of 2001, and 6 percent lower than the 1955-2001 average. Mallard abundance was 7.5 million, which was near the 2001 estimate of 7.9 million and essentially equal to the long term average. Blue-winged Teal (*Anas discors*) abundance was 4.2 million, or 27 percent below the 2001 estimate. Despite this decline, the population size remains near the long term average. Northern Pintail (*Anas acuta*; 1.8 million, - 46 percent), Northern Shoveler (*Anas clypeata*; 2.3 million, - 30 percent), and Gadwall (*Anas strepera*; 2.2 million, - 17 percent) all declined since 2001. Green-winged Teal (*Anas crecca*; 2.3 million), American Wigeon (*Anas americana*; 2.3 million), Redhead (*Aythya americana*; 0.6 million), Canvasback (*Aythya valisineria*; 0.5 million), and scaup (*Aythya marila* and *A. affinis*; 3.5 million) populations remained near the 2001 estimates. Gadwall (+ 37 percent), Green-winged Teal (+28 percent), and Northern Shoveler (+10 percent) all remained above their long term averages while American Wigeon (- 12 percent), Northern Pintail (- 58 percent), Canvasback (- 14 percent), and scaup (- 34 percent) were below long term averages. The number of Redheads remained near their long term average. Northern Pintails and scaup, which exhibited the lowest and second lowest numbers on record, respectively, are of special conservation concern.

While the annual breeding duck surveys are the most reliable estimates of waterfowl populations, population estimates are also available from extensive surveys of wintering ducks as well as waterfowl harvest data. The midwinter waterfowl survey for the Mississippi Flyway, conducted in by the Service and the states, is an attempt to count the total number of ducks of each species

TABLE 2. BREEDING DUCK POPULATION ESTIMATES (in thousands) [1].

Years	Mallard	Gadwall	Am. Wigeon	Green-winged Teal	Northern Shoveler	Northern Pintail	Blue-winged Teal
1955-60	9,386	651	3,195	1,584	1,556	8,543	4,909
1961-65	6,062	928	2,310	1,228	1,368	3,514	3,601
1966-70	7,805	1,641	2,702	1,652	2,105	5,177	4,138
1971-75	8,284	1,544	2,973	1,873	2,026	5,968	4,617
1976-80	7,800	1,457	3,012	1,851	1,910	4,891	4,695
1981-85	5,915	1,483	2,616	1,612	1,934	3,240	3,645
1986-90	5,932	1,443	2,002	1,860	1,789	2,334	3,584
1991	5,444	1,584	2,254	1,558	1,716	1,803	3,764
1992	5,976	2,033	2,208	1,773	1,954	2,098	4,333
1993	5,708	1,755	2,053	1,694	2,046	2,053	3,193
1994	6,980	2,318	2,382	2,108	2,912	2,972	4,616
1995	8,269	2,836	2,614	2,301	2,855	2,758	5,140
1996	7,941	2,984	2,272	2,500	3,449	2,736	6,407
1997	9,940	3,897	3,118	2,507	4,120	3,558	6,124
1998	9,640	3,742	2,857	2,087	3,183	2,520	6,398
1999	11,257	3,235	2,983	2,834	3,889	3,057	7,149
2000	9,470	3,158	2,733	3,193	3,520	2,907	7,431
2001	7,904	2,679	2,493	2,508	3,313	3,296	5,757
2002	7,503	2,235	2,334	2,333	2,138	1,789	4,206

[1] U.S. Fish and Wildlife Service 2002a.

(Table 3). Total duck abundance in 2002 was 7.2 million birds, a decrease of 7 percent over that of 2001, but exceeding the 1992-2001 average by 16 percent. Mallard abundance was 2.8 million, an increase of 10 percent over 2001 and 18 percent over the 1992-2001 average. Numbers of most other ducks decreased from 2001 and fell below the 1992-2001 average. Midwinter population estimates for the most common species follow, with the first percentage representing the change since 2001 and the second percentage representing the deviation from the 1992-2002 average: Blue-winged Teal (68,212; - 3 percent, - 41 percent), Northern Pintail (417,918; -65 percent, - 17 percent), Green-winged Teal (625,204; - 28 percent, - 18 percent), Northern Shoveler (189,359; - 17 percent, - 5 percent), American Wigeon (158,321; - 30 percent, -39 percent), Redhead (55,074; + 206 percent, + 101 percent), Canvasback (105,171; - 52 percent, - 24 percent), scaup (308,508; - 22 percent, + 34 percent). These population estimates are not considered of sufficient reliability to measure trends in abundance of most duck species because of the large area which must be surveyed and the difficulty of counting birds, especially in wooded habitats, and the lack of a valid statistical sampling scheme. Mid-winter waterfowl surveys provide useful, general information on wintering waterfowl population levels. Further, comparing the statewide numbers from year to year does not account for extremes of temperature or above or below normal rainfall; factors known to influence the arrival and departure of wintering waterfowl. Therefore, these surveys tend to count fewer ducks than are actually present, but the amount of undercount is unknown and is likely variable from year-to-year.

Waterfowl harvests have fluctuated since records have been kept, being lowest during the early 1960's when waterfowl populations, potential hunters, and days afield were low. In most years,

TABLE 3. MIDWINTER WATERFOWL SURVEYS, ARKANSAS in thousands [1].

Years	Mallard	Northern Pintail	Dabbling Ducks (all)	Diving Ducks (all)	All Ducks *
1971-1975	1,053	81	1,196	28	1,230
1976-1980	557	19	606	8	633
1981-1985	698	50	831	73	912
1986-1990	833	57	1,035	64	1,099
1991-1995	691	163	1,067	70	1,137
1996	581	59	812	14	827
1997	373	68	556	111	668
1998	526	24	784	8	792
1999	397	50	604	18	622
2000	236	10	316	4	320
2001	439	52	581	23	604
2002	810	93	1,119	18	1,143

[1] Gamble 2002

* May not be equal to the sum of dabbling and diving ducks due to rounding.

harvests have tracked the fluctuation of these factors, especially waterfowl populations. In recent years, nationwide harvests of the heavily hunted mallard and of total ducks remained relatively constant, while hunter numbers declined and hunter success increased. It appears that fewer hunters have been increasingly successful at harvesting ducks. In the Mississippi Flyway, preliminary estimates are that 2.5 million Mallards were harvested in 2001, or 48 percent of the total Mallard harvest in the United States, followed by 873,200 Gadwall (61.6 percent of the total harvest), 628,700 Green-winged Teal (43.9 percent of the total harvest), and 561,000 Wood Ducks (*Aix sponsa*) (61.2 percent of the total harvest). Within Arkansas, Mallards also comprised the majority of the ducks harvested (57.2 percent), followed by Gadwall (16.3 percent), Green-winged Teal (9.2 percent), and Wood Duck (4.1 percent) (U.S. Fish and Wildlife Service 2002b). Active adult hunters afield in Arkansas totaled 57,797 in 2001 (4 percent more than 2000) and total hunter days equaled 790,361 days (10 percent more than 2000). Total duck harvest in Arkansas in 2001 was 1,113,800 ducks with an average annual bag of 14.4 ducks per adult hunter.

WINTERING WATERFOWL BIOLOGICAL CHARACTERISTICS

The loss and degradation of waterfowl habitat has been identified as the major waterfowl management problem in North America (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986). Wintering waterfowl habitat requirements can be broken down into three components: habitat availability, utilization, and suitability in meeting social behavioral requirements. Waterfowl populations and recruitment in the MAV are a direct function of these three components.

Habitat Availability

Relationships exist among availability of wetland habitat and food during winter and waterfowl physiological, behavioral, and population responses (Kaminski 1999). Hydrology and resulting wetland habitat and intrinsic resources are critical proximate factors related to waterfowl use of alluvial environments like the lower Mississippi Delta (Fredrickson and Heitmeyer 1988). Additionally, current and cross seasonal physiological status, survival, and reproductive performance of waterfowl have been linked to winter habitat and food resources (Table 4).

Studies of wild Mallards and Wood Ducks have revealed that landscape scale flooding and dry conditions during winter influence distribution and abundance of these and likely other species of waterfowl and wetland birds (Kaminski 1999). Widespread winter flooding in the MAV resulted in regional increases in Mallards (Nichols *et al.*. 1983), and below average precipitation during spring and summer in southeastern United States caused Wood Ducks to disperse to more southerly latitudes during fall and winter where wetland availability apparently was greater (Hepp and Hines 1991). Additionally, increased wetland availability during winter presumably enhances foraging opportunities and food availability for Mallards and other waterfowl (Wright 1961, Delnicki and Reinecke 1986, Reinecke *et al.* 1988, Wehrle *et al.* 1995), which in turn have been related to increased body weights in mallards (Delnicke and Reinecke 1986), earlier prebasic molt and acquisition of basic (breeding) plumage in female mallards (Heitmeyer 1987, Richardson and Kaminski 1992), and increased mallard survival (Reinecke *et al.* 1987) and reproductive rates (Heitmeyer and Fredrickson 1981, Kaminski and Gluesing 1987). The results of recent research shows that winter wetland availability is linked to current and cross seasonal

TABLE 4. POTENTIAL GENERIC BENEFITS TO MALLARDS AND WOOD DUCKS FROM FAVORABLE WINTER WATER (HABITAT) AND FEEDING CONDITIONS IN THE MISSISSIPPI ALLUVIAL VALLEY OR UNDER CAPTIVE CONDITIONS (adapted from Reinecke *et al.* 1988)

POTENTIAL BENEFIT	REFERENCE
Improved foraging	
Natural foods (e.g. seeds, invertebrates)	Wright (1961), Wehrle *et al.* (1995)
Agricultural seeds (rice)	Reinecke *et al.* (1988)
Improved physiological condition	
Increased body weight	Delnicki and Reinecke (1986), Demarest *et al.* (1997)
Earlier prebasic molt in females	Heitmeyer (1987), Richardson and Kaminski (1992), Barras (1993)
Increased pair formation	Demarest *et al.* (1997), Vrtiska (1995)
Changes in distribution and habitat use	
Response to local/regional flooding	Reinecke (unpubl. data), Hepp and Hines (1991)
Regional increase in winter population	Nichols *et al.* (1983)
Increased survival and reproductive performance	
Survival	Reinecke *et al.* (1987), Demarest *et al.* (1997), Vrtiska (1995)
Reproductive performance	Heitmeyer and Fredrickson (1981), Kaminski and Gluesing (1987), Dubovsky and Kaminski (1994), and Vrtiska (1995)

life cycle events of Mallards and Wood Ducks, and possibly other waterfowl using alluvial environments like the Delta (Kaminski 1999).

Managed and unmanaged wintering waterfowl habitats are present in the MAV. Managed habitats, using structural measures and vegetation manipulation, are primarily found on federal and state lands, and represent the core wintering habitat during dry (below normal rainfall) years.

As of 2003 the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife program and the Arkansas Partners program (a cooperative effort by the U.S. Fish and Wildlife Service, Ducks Unlimited, and the Arkansas Game and Fish Commission) have provided assistance to hundreds of private land owners to manage 137,028 acres as winter waterfowl habitat (2,028 acres under the Partners for Fish and Wildlife program and 135,000 acres under the Arkansas Partners program).

Unmanaged winter habitat provides important foraging habitat to wintering waterfowl during years of normal or above normal rainfall. These periods of above normal rainfall show increases in available foraging habitat from 900 percent in Mississippi to 1,200 percent in Arkansas (Reinecke *et al.* 1988). The increased availability of wintering habitat also effects the distribution of wintering waterfowl in the MAV. Proportionately more waterfowl have been found to winter in the MAV during periods of above normal rainfall and cold winters (Nichols *et al.* 1983, Reinecke *et al.* 1987). This unmanaged and flood susceptible habitat, which is so important to wintering waterfowl, has long been subject to federal flood control drainage projects in the MAV.

Habitat Utilization

Waterfowl are mobile and opportunistic, and their feeding habits have changed over time, presumably in response to the large scale conversion of native wooded wetlands to small grain agricultural crops. The principal foods of Mallards generally include agricultural grains; seeds and tubers of native plants; acorns; and invertebrates such as isopods, snails, and fingernail clams (Reinecke *et al.* 1987). Heitmeyer (1985) and Combs (1987) found that pin oak (*Quercus palustris*) and cherrybark oak (*Quercus falcata* var. *pagodaefolia*) acorns dominate the Mallard diet during years of good mast production and favorable water conditions in southeastern Missouri. Nuttall oak (*Quercus nuttalli*) fills the same ecological niche in the Bayou Meto basin as pin oak in Missouri.

In the early fall, Mallards concentrate on shallowly flooded openings in bottomland forests. Shortly after arrival, Mallards complete prealternate (breeding plumage) molt and consume aquatic insects and moist soil seeds. Following molt, Mallards begin courtship and by early January 90 percent of the birds are paired (Bellrose 1980). During pairing Mallards forage intensively in flooded forests or agricultural fields, where they consume acorns and cereal grains. After pairing Mallards readily use shallowly flooded forests and continue to consume acorns, but increase consumption of macroinvertebrates (Fredrickson and Batema 1992).

Wood Ducks and Hooded Mergansers (*Lophodytes cucculatus*) use overcup oak, cypress/tupelo forest types, and scrub/shrub habitats during fall courtship and pairing (Bellrose 1980). Both species breed in Arkansas and nest in natural tree cavities or artificial nest boxes. After pairing, wintering habitat includes the deeper areas of lowland hardwoods, cypress/tupelo, overcup oak, and scrub/shrub habitats.

Wright (1961) and Delnicki and Reinecke (1986) demonstrated the importance to waterfowl of large areas of flooded rice and soybean fields. Seeds and tubers of grasses, sedges, and other moist soil plants are also important components of the diet (Wright 1961, Wills 1970, Heitmeyer 1985, Delnicki and Reinecke 1986, Combs 1987). Invertebrates generally provide less than 10 percent of the diet in agricultural (Delnicki and Reinecke 1986) and moist soil (McKenzie 1987) habitats, but may be more important in forested wetlands (Heitmeyer 1985).

Although the nutrition of wintering waterfowl is not well understood, it is, however, increasingly clear that nutrition affects dietary energy and protein intake, and that meeting these dietary requirements is positively related to winters with normal or above normal rainfall. Studies conducted in Mississippi during the wet winter of 1982-83 show increased Mallard body weights while the dry winter of 1980-1981 show decreased Mallard body weights (Delnicke and Reinecke 1986). Similar results in Missouri indicated that Mallard body weights increased when water conditions and mast production were favorable, or when rainfall was sufficient to flood low lying cropland (Heitmeyer 1985, Combs 1987). The condition in which waterfowl return to the breeding grounds has been shown to have a major impact on their breeding success and survival (Bellrose 1980, Reinecke *et al.* 1989).

In recent years, research has focused on relative waterfowl use and associated food availability in natural and agricultural foraging habitat. Use of agricultural fields differs among crops (Nelms and Twedt 1996). Herbaceous native vegetation is used to a greater extent than any agricultural crops. Bottomland hardwoods are used for foraging to a certain extent and roosting, loafing, and pair formation to a large extent (Reinecke *et al.* 1989). (Caloric values, seed consumption, and seed decomposition rates of available waterfowl foraging habitat form the basis for determining project impacts and are discussed in detail in the Impact Assessment Methodology section of this appendix.)

Social Behavior

During winter, courtship and pair formation dominate the social behavior of dabbling ducks. Most of the project area is agricultural land, replacing forested wetlands as the primary foraging habitat. The forested wetlands and normally associated shrub swamps, beaver ponds, riparian habitat, and other deep water habitat are used as resting or roosting areas and provide isolation from human disturbance, protection from predators, and a location for courtship and other social activities where pairs are visually isolated. Whereas much of the foraging and nutritional requirements can be met by flooded agricultural lands, a variety of habitats is needed to satisfy the total biological requirements of wintering waterfowl, because members of the population may differ in their habitat needs at any particular time (Reinecke *et al.* 1987). Examples include the likelihood of juvenile or unpaired Mallards feeding in agricultural lands and adults and pairs seeking the isolation of shrub swamps to avoid harassment from courting parties (Heitmeyer 1985).

PROJECT IMPACTS

Project adverse impacts include the direct loss of wooded wetlands and seasonally flooded farm fields due to construction of the water delivery system, storage reservoirs, and flood control measures and indirect loss of wintering waterfowl habitat due to the flood reduction provided by the channel modifications and operation of the pump.

Impact Assessment Methodology

In this section, the term wintering waterfowl includes primarily puddle ducks consisting of the Mallard, Northern Pintail, American Wigeon, Gadwall, Green-winged Teal, Northern Shoveler, and Blue-winged Teal.

Prior waterfowl appendices incorporated a methodology that used available food (energy) as an index of the carrying capacity of winter foraging habitat for dabbling ducks in the MAV. This methodology was developed in 1992 by Mr. Robert Barkley (U.S. Fish and Wildlife Service, Vicksburg Field Office) and Dr. Kenneth J. Reinecke (United States Geological Survey, Mississippi Valley Research Field Station). This method was used on several Corps flood control projects to quantify the impact of altering hydrology on traditional waterfowl wintering areas and for designing appropriate mitigation measures (U.S. Army Corps of Engineers 1991, 1993). This method has also been used in setting habitat management goals for wintering waterfowl habitat in the MAV (Loesch *et al.* 1994).

The Corps prepared a hydrologic model tailored to identify the acres of available foraging habitat under existing conditions and future conditions with and without the project. For a determination of existing and future carrying capacities (based on the implementation of an alternative), land use was broken down into available foraging habitats having food value to wintering waterfowl: soybeans, rice, moist soil, bottomland hardwood forested wetlands, and other (includes pasture, open water, etc.).

To determine carrying capacity in terms of numbers of duck-use-days (DUD), data requirements include land use, hydrology, and available food during the 120 day (November 1 to March 1) waterfowl wintering period. The data were specific to those habitats and food resources that were available and used by foraging waterfowl.

The amount of food available on a unit area of agricultural land (small grain crop residue, native moist soil seeds, and invertebrates) was determined by Reinecke *et al.* (1989), McAbee (1994), and Stafford *et al.* (2005). The amount of food available in bottomland hardwood and moist soil habitats (acorns, invertebrates, moist soil seeds, roots, and tubers) was determined by Heitmeyer (2005).

For this waterfowl appendix the previously described methodology was further refined to include information on crop seed deterioration rates and seed abundance, invertebrate abundance, as well as depth and duration of flooding (Nelms unpublished). Waterfowl foraging habitat, regardless of food value, is only of use to wintering waterfowl if available. Food availability is dependent on flooding. Waterfowl use relatively shallow water areas, eighteen inches or less, for feeding.

Through the use of extensive hydrological data (1949-1997), the Corps provided seasonal acres flooded eighteen inches or less for the wintering season. The land use data provided for the study area were specific to those acres inundated and represent only potential available foraging habitat. By including the factors described above, the present methodology is more representative of winter waterfowl foraging habitat.

The index of carrying capacity for wintering waterfowl foraging habitat is expressed in duck-use-days (DUD) per acre which represents the capacity of the available forage per acre that meets the energy requirements of one duck for one day. The information used to estimate DUD for agricultural lands were: (1) current land use, including crop type, (2) extent, duration, and depth of flooding, (3) amount of winter food present by land use, (4) energy of food items, (5) deterioration rates of food items, (6) energy requirements of waterfowl, and (7) estimated density of waterfowl. The equation for this is as follows:

$$DUD\ /\ Acre = \frac{Food \times Energy}{Duck\ \ Energy\ \ Needs}$$

The equation used to estimate DUD was further refined by factoring in the amount of seed deterioration that occurs over time because seed deterioration has a significant impact on DUD. Deterioration rates were estimated from experimental data using the best fitting regression model (Nelms and Twedt 1996). Daily seed consumption estimates were also incorporated into the equation to preclude overestimating the influence of seed deterioration because foods consumed by ducks are not subject to deterioration. Since DUDs are a function of the weight of the food available and food is easily converted to calories, calculations are in terms of the weight of food. The equation for food available to ducks on a given day when seed consumption and deterioration are taken into account is:

$$Food_j = Food_0 - \sum_{i=0}^{j} (Food_{consumed_i} + Food_{deteriorated_i})$$

where:

$$Food_{consumed} = \frac{Mean\ duck\ density \times Kcal\ consumed / duck / day}{Kcal / kg\ of\ food}$$

and

$$Food_{deteriorated} = Food \times Deterioration\ rate \times Days_i$$

where i and j are days.

Duck-use-days per acre, adjusted for deterioration, are calculated by multiplying the number of days times the projected density of ducks. By converting to DUD, units are comparable across habitats which facilitates both wetland mitigation efforts and management decisions. This is particularly useful when the loss of one habitat must be mitigated with another habitat type due to practical constraints or the need to meet multiple ecosystem management goals. DUD provide an objective index of the relative value of different habitats for dabbling ducks as winter foraging habitats.

To facilitate calculation, food item densities, deterioration rates, and energy values were aggregated within a given habitat type. Weighted averages based on weights of food items were used to calculate the aggregate values. Aggregate values are representative of any generic unit of food in the habitat of interest.

Once aggregate values were calculated, the density of ducks feeding in the habitats of interest is projected so that daily consumption can be estimated. An overall average of systematic observations of waterfowl in flooded moist soil, rice, and soybean fields in the MAV was used to estimate duck density. The estimated diurnal density of ducks in flooded rice, soybean, and moist soil fields in the MAV from data collected by McAbee (1994) and Dr. Dan Twedt (U.S. Geological Survey) and Mr. Curtis Nelms (U.S. Fish and Wildlife Service, Vicksburg) (unpublished data) is 10.1 ducks/ha. Little information is available on nocturnal feeding densities of waterfowl, although this has been shown to be an important phenomenon (Paulus 1980, Reinecke unpublished data). To adjust for nocturnal foraging, the estimate of diurnal density is doubled to 20.2 ducks/ha. The role of the projected density and subsequent consumption estimates is to dampen the effects of seed deterioration on food availability. If the average daily consumption estimates were not included in the model then the influence of seed deterioration would be overestimated because foods consumed by ducks are no longer subject to deterioration.

Reasonable estimates were generated for the number of days of flooding until exhaustion of food resources occurred at an average duck density. This density is assumed to be the point where declining foraging efficiency causes ducks to abandon a field. Reinecke *et al.* (1989) found this threshold foraging efficiency to be 50 kg/ha. The estimated Days To Exhaustion (DTE) of food resources is useful for determining the impact of the length of flooding on habitat values. DTE allows the inclusion of data on flood duration and is useful in determining the impacts of flood control projects on wintering waterfowl foraging habitat.

From the above calculations and assumptions, DUD/acre was generated for agricultural crops. Generally in waterfowl impact analyses the same technique would also be applied to moist soil and forested habitats. However, waterfowl experts from the Lower Mississippi Valley Joint Venture (LMVJV), in conjunction with experts from academia, are currently in the process of revising the DUD/acre values for forested and moist soil habitats in the lower Mississippi Alluvial Valley (MAV). In the interim, Heitmeyer (2005) provided estimates of food availability and waterfowl consumption rates in the MAV and calculated DUD values to determine the benefits of proposed waterfowl management actions associated with the Bayou Meto project. In an effort to maintain the ability to compare benefits and impacts in terms of DUD loss/gains, the Service has adopted these values until new estimates are issued by the LMVJV. All DUD/acre values used in this assessment are detailed in Table 5.

TABLE 5. DUCK-USE-DAYS (PER HECTARE AND PER ACRE) FOR FLOODED MOIST SOIL, RICE, SOYBEAN, AND BOTTOMLAND HARDWOOD FORESTS.

Habitat	Duck-use-days/ha	Duck-use-days/ac
Moist Soil (managed)[1]	4,216	1,706
Moist Soil (natural)[2]	2,108	853
Rice[3]	324	131
Soybean[3]	299	121
BLH (≥ 30% Red Oak)[1]	1,243	503
BLH (< 30% Red Oak)[4]	1,171	474

[1]Heitmeyer 2005

[2]The value of "natural" moist soil areas such as fallow fields was adjusted to half that of intensively managed units to account for variability in the disturbance and flood regime and the resultant variance in seed and invertebrate production.

[3]Stafford *et al.* 2005

[4]The value of 503 DUD/acre estimated by Heitmeyer (2005) assumed a forest containing ≥ 30% red oak component, ≥ 50% herbaceous ground cover, and less than 10% damage to red oaks. We calculated an average of these variables for existing forests (excluding those influenced by levees and greentree reservoir management) using data from Heitmeyer and Ederington (2004) and adjusted the DUD/acre figure accordingly.

CONSTRUCTION IMPACTS

Construction impacts are those impacts that would be associated with the construction of the pumps, reservoirs, canals/ditches, and pipelines; maintenance of rights-of-way; or placement of dredged/fill material from ditch cleanouts/enlargements. These impacts are "direct" in that an acre-for-acre change in land use occurs. Although mitigation for some of these direct impacts will be required, they are not used in the calculations of gained or lost DUD due to operational impacts. All alternatives from the irrigation component will directly impact 798 acres of forested wetlands and 289 acres of farm land. The Corps estimates that up to 12 acres of the affected farm land will be classified as "farmed wetland". Additionally, the on-farm construction of reservoirs and tailwater recovery systems is estimated to affect up to 100 acres of farmed wetlands and 100 acres of forested wetlands. The selected flood control plan (FC3A) will directly impact 797 acres of forested wetlands and 572 acres of farm land (estimated 23 acres of farmed wetland). The total acreage of directly impacted forested wetlands for both the irrigation and flood control components is 1,695 acres (including on-farm features). The total acreage of cleared lands impacted is 961 acres (including on-farm features), with 135 acres of this estimated to fall within designated "farmed wetlands".

OPERATIONAL IMPACTS (CHANGES IN SEASONAL FLOODING)

Future With and Without-Project Analysis

For existing habitats with value as waterfowl foraging areas and that would be impacted by the hydrology alteration resulting from the operation of a pump and channel modifications, foraging value could be reduced or eliminated. The waterfowl management component of the project will have positive benefits for waterfowl, however that portion of the project is designed as a separate component intended to restore and manage habitat above and beyond that required for compensatory mitigation. The benefits of the waterfowl management component are detailed by Heitmeyer 2005 and elsewhere in the "Waterfowl Management and Restoration Plan" description.

According to the Bayou Meto WMA Wetland Management Plan (Heitmeyer *et al.* 2004) and an assessment of forest health elsewhere in the Bayou Meto basin (Heitmeyer and Ederington 2004), there are significant forested areas in the lower portion of the basin that would benefit from a reduction in flooding duration. Most notably, many red oaks in and adjacent to greentree impoundments in Bayou Meto WMA (and on private land) are currently stressed, dying, and/or converting to more water tolerant species such as overcup oak or green ash. The proposed pump station at the mouth of Little Bayou Meto and internal WMA drainage improvement will help alleviate extended spring flooding that has contributed to this problem. To account for areas that are hydrologically disconnected from the floodplain (GTRs) or that will benefit from a reduction of flood duration during the spring (Bayou Meto WMA), these areas were treated as separate land use categories and given a value of zero DUD/acre to exclude them from the impacts analysis. The true value of these habitats and potential benefits that will result from the waterfowl management components of the project are detailed by Heitmeyer (2005).

Total DUD for baseline conditions and each alternative plan (including the selected plan) are presented in Tables 6 through 12. Based on the Corps' data analysis, seasonal acres flooded by land use categories, for all hydrological reaches flooded 18 inches deep or less, total 14,620 acres for baseline conditions. This value included a land use category "other" that does not provide waterfowl foraging habitat (i.e., roads) and habitats that will be neutrally or positively impacted (GTRs, Bayou Meto WMA). Baseline seasonal acres flooded were adjusted based on the percent of actual foraging habitat by reach and was determined to be 9,427 acres. Using these acres of habitat average seasonal duck-use-days for all hydrological reaches total 3,523,197 duck-use-days (baseline conditions). Implementation of purely structural flood control features would result in adverse impacts to migratory waterfowl wintering habitat (Alternatives FC2, FC2A, FC3A, FC3B). Losses would occur both on private and public lands and would be evident in seven of eleven hydrological reaches. For example, wintering waterfowl foraging habitat carrying capacity would be reduced annually by 267,817 DUD and 269,929 DUD for alternatives FC2 and FC2A. Alternatives FC3A and FC3B, which incorporate 1,000 and 3,000 cfs pumps, would result in losses of 482,948 DUD and 626,375 DUD, respectively. Alternative FC6, which consists of reforesting 15,140 acres of cropland in the two year floodplain, would result in a small loss of 12,304 DUD. This loss of DUD is not due to reduced hydrology. This loss is result of the assumption that all available farm land in the "waterfowl scene" would be reforested. A component of this includes reforestation of fallow fields (853 DUD/acre verses

503 DUD/acre) which accounts for the small loss of DUD. The selected plan, which is a combination of water conveyance alternative WS4B and flood control alternative FC3A would result in an indirect loss of 482,948 DUD due to decreased extent and duration of flooding.

CONCEPTUAL MITIGATION MEASURES

Depending on the alternative selected, wintering migratory waterfowl habitat losses could occur in seven of the eleven reaches. The following discussion, which is conceptual, is intended to provide examples of how intensively managing wintering waterfowl habitat can both increase foraging habitat for wintering waterfowl and meet their broader ecological requirements.

Reforestation

Reforestation is the Service's preferred mitigation technique for several reasons: 1) Reforestation constitutes an ecosystem approach to replacing the waterfowl values that would be lost through project construction. Instead of concentrating on implementing a mitigation feature aimed at primarily replacing the lost food values, reforestation would address all wintering waterfowl habitat requirements. In this appendix we have used food as an index of waterfowl habitat needs. Waterfowl are not able to divide their world and habitat needs into such specific compartments. A bottomland hardwood forest ecosystem provides food and other waterfowl habitat needs such as courtship sites, protection from predators and adverse weather, resting and roosting areas, and isolation from human disturbance. 2) Reforestation would provide a stable, low maintenance, high reliability mitigation feature. These mitigation features are supposed to last for the 50 year project life. Other mitigation techniques that would replace lost waterfowl food values, such as moist soil management areas, would require periodic maintenance and/or active operation in order to provide the predicted food supply. With constantly changing funding priorities a "no maintenance-no operation-self sustaining" mitigation feature is much more reliable and cost effective. 3) The chance of successful waterfowl habitat value replacement is highest with reforestation. Reforestation would create a system that would mimic the previously existing bottomland hardwood ecosystem, which historically had a proven record of providing high quality waterfowl habitat (Reinecke *et al.* 1989). 4) Application of the principles of landscape ecology dictates that we use reforestation as the primary mitigation technique. The project area contains large blocks of agricultural land and few large blocks of forested habitat. To establish ecosystem diversity, additional large blocks of forested habitat should be established by enlarging or connecting existing blocks. While meeting the goals of waterfowl, reforestation of large tracts of bottomland hardwood forests could also meet the needs of neotropical migratory birds many of which are declining (Hunter *et al.* 1993). Other management techniques would not benefit neotropical migratory birds. 5) Reforestation would also offset terrestrial and wetland losses. 6) Reforestation of the floodplain would offset losses to fishes that use such habitats for spawning, foraging, or as nurseries. 7) Reforestation would take irrigated agriculture out of production, thus lessening the demand on the aquifer. 8) Reforestation of marginal agricultural (farmed wetlands) or other cleared lands is easily accomplished. Actions required include direct seeding or planting seedlings and other activities ranging from extensive mowing and fertilization to only seed bed preparation.

Reforested mitigation areas should be subject to frequent and sustained winter flooding 18 inches deep or less. Forest stand composition should intentionally favor, but not be exclusively composed of, heavy seeded species dominated by red oaks for maximum benefits to wintering waterfowl. Table 13 shows the potential mitigation acres that would be required for the four structural flood control plans that result in a loss of DUD. For example, if a mitigation site was reforested and contained at least 30% red oaks then the acres required (assuming 503 DUD/acre) to mitigate for impacts associated with Alternative FC3A would be as follows: 482,948 DUD lost and 960 acres required to offset impacts. Through the use of water control structures, moist soil and rice fields could be used to offset impacts resulting from project construction, and further reduce the mitigation acres required. However, costly and intensive management would be required to achieve desired results with these two methods and the multiple benefits of reforestation mentioned above would not be realized. Benefits from reforestation could be expected immediately due to the presence and availability of native moist soil plants in the newly planted "forest" and would gradually change to those benefits associated with forests dominated by red oaks and the associated invertebrate community.

Based on costs developed by the Service and the Corps, seed bed preparation for either direct seeding or planting seedlings amounts to approximately $10 per acre using a bush-hog or $20 per acre using a disc (Mr. John Kaiser, Vicksburg District Corps, pers. comm.; Eric Johnson, USFWS, Cache River NWR, pers. comm.). Depending upon the availability of seeds or seedlings, planting costs are approximately $130 per acre. Bare root seedlings, purchased in lots of 100,000 or more, cost $195 per thousand; containerized seedlings cost $298 per thousand. Annual operation and maintenance costs vary from $1 to $20 per acre depending on the intensity of management efforts.

TABLE 6. DUCK USE DAYS AVAILABLE FOR BASELINE CONDITIONS (INCLUDES ALTERNATIVE FC1 OF NO ACTION)

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6 *	R7	R8	R9	R10	R11			
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	29	52	74	107	6	130	16	42	103	751	853	640,212
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	6	36	156	38	13	456	15	65	134	1,120	131	146,676
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	32	105	219	129	29	666	124	271	451	2,394	121	289,678
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	68	193	450	274	48	1,253	155	377	689			1,076,566
BLH Acres	52	61	63	30	31	73	16	23	30	28	31	221	1,206	135	93	260	910	56	1,688	77	173	343	5,162	474	2,446,631 ***
Subtotal												374	1,810	203	287	711	1,184	104	2,941	232	550	1,032			3,523,197
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	11	25	137	62	246	4,346	23	68	66	5,193	0	0
Total Acres												425	1,968	213	312	847	1,246	351	7,287	255	617	1,097			3,523,197

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 7. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC2

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6*	R7	R8	R9	R10	R11			
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	23	30	51	107	6	119	14	42	93	676	853	576,694
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	5	21	107	38	13	417	13	65	121	1,000	131	130,964
Soybeans Crop	15	15	15	34	26	10	8	9	49	44	41	64	303	26	61	151	129	29	608	109	271	408	2,158	121	261,067
Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	54	112	309	274	48	1,144	136	377	622			968,724
BLH Acres	52	61	63	30	31	73	16	23	30	28	31	221	1,206	108	54	179	910	56	1,541	68	173	310	4,824	474	2,286,655 ***
Subtotal												374	1,810	162	166	488	1,184	104	2,685	204	550	932			3,255,380
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	9	15	94	62	246	3,968	20	68	59	4,750	0	0
Total Acres												425	1,968	170	181	581	1,246	351	6,654	224	617	991			3,255,380

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 8. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC2A

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6*	R7	R8	R9	R10	R11				
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	23	30	51	107	6	119	14	42	93	675	853	575,969	
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	5	20	107	38	13	417	13	65	121	999	131	130,823	
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	26	60	150	129	29	608	109	271	408	2,156	121	260,821	
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	54	110	307	274	48	1,144	136	377	622			967,614	
BLH Acres	52	61	63	30	31	73	16	23	30	28	31	221	1,206	108	53	178	910	56	1,541	68	173	310	4,822	474	2,285,655	***
Subtotal												374	1,810	162	163	484	1,184	104	2,685	204	550	932			3,253,268	
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	9	14	93	62	246	3,968	20	68	59	4,750	0	0	
Total Acres												425	1,968	170	178	577	1,246	351	6,654	224	617	991			3,253,268	

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 9. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC3A WITH LOSSES COMPARED TO BASELINE CONDITIONS

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6*	R7	R8	R9	R10	R11				
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	23	30	51	107	4	94	14	42	93	648	853	553,051	
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	5	20	107	38	9	329	13	65	121	907	131	118,826	
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	26	60	150	129	20	481	109	271	408	2,019	121	244,272	
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	54	110	307	274	33	905	136	377	622			916,148	
BLH Acres	52	61	63	30	31	73	16	23	30	28	31	221	1,206	108	53	178	910	38	1,218	68	173	310	4,481	474	2,124,101	***
Subtotal												374	1,810	162	163	484	1,184	70	2,123	204	550	932			3,040,249	
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	9	14	93	62	167	3,137	20	68	59	3,839	0	0	
Total Acres												425	1,968	170	178	577	1,246	237	5,260	224	617	991			3,040,249	

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 10. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC3B

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6*	R7	R8	R9	R10	R11				
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	23	30	51	107	3	77	14	42	93	630	853	537,722	
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	5	20	107	38	7	269	13	65	121	845	131	110,718	
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	26	60	150	129	16	393	109	271	408	1,927	121	233,186	
Crop Subtotal	36	31	32	62	53	22	14	17	61	61	63	153	604	54	110	307	274	26	740	136	377	622			881,626	
BLH	52	61	63	30	31	73	16	23	30	28	31	221	1,206	108	53	178	910	30	996	68	173	310	4,251	474	2,015,197	***
Acres Subtotal												374	1,810	162	163	484	1,184	57	1,736	204	550	932			2,896,822	
Other **	12	8	5	8	16	5	70	60	9	11	6	51	158	9	14	93	62	134	2,565	20	68	59	3,233	0	0	
Total Acres												425	1,968	170	178	577	1,246	190	4,301	224	617	991			2,896,822	

* Bayou Two Prairie was removed from the flood control plan therefore these values remain constant for all alternatives.
** "Other" includes cotton, bare soil, water, urban, private greentree reservoirs, and the Bayou Meto WMA. For the purposes of this assessment, the latter two were assigned a value of zero DUD/acre due to their hydrologic disconnect from the natural flood regime or because they will benefit from a reduced flood regime. The actual values of these habitats to waterfowl are addressed by Heitmeyer 2005.
*** The DUD/acre value of BLH reflects the fact that 10% of existing forests do not contain at least 30% red oak composition.

TABLE 11. DUCK USE DAYS AVAILABLE FOR ALTERNATIVE FC6 *

Land Use	Percent Land Use											Acres											Total Acres	DUD/ acre	Total DUD
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11			
Fallow Fields	7	8	14	17	9	9	2	2	6	7	9	29	162	29	52	74	107	6	130	16	42	103	751	853	640,212
Rice	14	7	3	11	18	3	4	6	6	11	12	60	139	6	36	156	38	13	456	15	65	134	1,120	131	146,676
Soybeans	15	15	15	34	26	10	8	9	49	44	41	64	303	32	105	219	129	29	666	124	271	451	2,394	121	289,678
Crop Subtotal *	36	31	32	62	53	22	14	17	61	61	63	153	604	68	193	450	274	48	1,253	155	377	689			1,076,566
BLH (existing) Acres	52	61	63	30	31	73	16	23	30	28	31	221	1,206	135	93	260	910	56	1,688	77	173	343	5,162	474	2,446,631
Subtotal												374	1,810	203	287	711	1,184	104	2,941	232	550	1,032			3,523,197
Other	12	8	5	8	16	5	70	60	9	11	6	51	158	11	25	137	62	246	4,346	23	68	66	5,193	0	0
Reforestation *	36	31	32	62	53	22	14	17	61	61	63	154	614	68	195	453	273	49	1,231	155	375	689	4,256	503	2,140,828
Total Acres												579	2,582	282	506	1,300	1,519	400	8,519	410	993	1,786			

Total existing forest and reforested value	4,587,459
Existing crop value	1,076,566
Final value	3,510,893

* This alterative would consists wholly of non-structural flood damage reduction in the form of reforestation of 15,140 acres of the pre-project two year floodplain. We maximized the potential reforestation within the "waterfowl scene" by assuming that all fallow fields, rice, and soybeans within this scene would be reforested (4,256 acres). Due to the high food value of fallow fields, this reforestation would actually result in a small loss of DUD.

TABLE 12. GAINS OR LOSSES IN DUCK-USE-DAYS FOR EACH FLOOD CONTROL ALTERNATIVE COMPARED TO BASELINE CONDITIONS

Alternative	DUD	Baseline DUD	Change in DUD
FC1	3,523,197	3,523,197	0
FC2	3,255,380	3,523,197	-267,817
FC2A	3,253,268	3,523,197	-269,929
FC3A	3,040,249	3,523,197	-482,948
FC3B	2,896,822	3,523,197	-626,375
FC6	3,510,893	3,523,197	-12,304

Average Annual Benefits

Mitigation values achieved would vary depending on the cover type established. Average annual duck-use-days/acre within the project area could be expected to range from 1,706 DUD/acre for a moist soil area exclusively devoted to wintering waterfowl to 503 DUD/acre for reforested bottomland hardwoods with at least 30 percent red oak composition to 121 DUD/acre for a flooded harvested soybean field that has not been fall plowed or burned. Potential mitigation acres required for various alternatives and land management schemes are shown in Table 13.

In addition to food values, other benefits to wintering waterfowl would also be realized from the establishment or enhancement of forested wetlands. Benefits would include isolation for pair bonding, better protection from disturbance and harassment than in more open areas, and protection from predation and extremes in weather conditions.

Unquantified benefits resulting from establishment of more dependable wintering waterfowl foraging habitat accrue to the whole range of resident and migratory species attracted to wetlands as well as overall wetland functional values. Not intended as all inclusive, the list of fauna benefiting would include resident aquatic furbearers, resident and migrant shore and water birds, insectivorous and granivorous neotropical migratory birds, native amphibians and reptiles, and the broad range of resident game and nongame birds and mammals known to inhabit forested wetlands and herbaceous wetlands (such as moist soil areas).
Other functional wetland values attributable to reforested areas include flood water storage, improved water quality, ground water recharge, esthetics, and scientific study opportunities. Additionally, economic benefits resulting from crop damage reduction, added outdoor recreation

opportunities, and the harvest of timber and other wood products could offset economic losses resulting from instances where existing agricultural practices/leases might have to be modified.

CONCLUSIONS

Implementation of purely structural flood control features (e.g., Alternatives FC2-FC3B) would result in adverse impacts to migratory waterfowl wintering habitat. Losses would occur both on private and public lands and would be evident in seven of eleven hydrological reaches. Project alternatives that reduce the extent, duration, and frequency of winter water are of concern to the Service. The no action plan would result in no loss of DUD while Alternative FC6 would result in a small loss of 12,304 DUD. This nonstructural alternative, while resulting in small loss of DUD from a caloric standpoint, would provide multiple unquantifiable benefits to many species and reduce flood damages on frequently flooded farmland.

The purpose of this appendix was threefold: first, to identify the relative importance of the general project area in terms of historic trends in wetlands and wintering waterfowl; secondly, to document existing (baseline) wintering waterfowl carrying capacity in the project area, and thirdly, to document project induced impacts by comparing future with and without-project conditions using food as an index of carrying capacity expressed in terms of duck-use-days (DUD). However, quantifying food availability and consumption by waterfowl in shallow water (18 inches deep or less) represents only one facet of waterfowl biology and only part of waterfowl habitat requirements. The availability of winter water at depths greater than 18 inches and for other uses, i.e., loafing and pair bonding, is equally important and should be considered when selecting a plan that could reduce the extent of wintering waterfowl habitat.

Table 13. PLANS THAT RESULT IN A LOSS OF DUCK-USE-DAYS AND THE POTENTIAL MITIGATION ACRES REQUIRED UNDER VARIOUS MANAGEMENT OPTIONS

		Management Schemes			
Alternative	Loss of DUD	Moist Soil acres @ 1,706 DUD/ac	Rice acres @ 131 DUD/ac	Soybean acres @ 121 DUD/ac	≥ 30% Red Oak BLH acres @ 503 DUD/ac
FC1*	0	0	0	0	0
FC2	267,817	157	2,044	2,213	532
FC2A	269,929	158	2,061	2,231	537
FC3A	482,948	283	3,687	3,991	960
FC3B	626,375	367	4,781	5,177	1,245
FC6**	12,304	7	94	102	24

* FC1 represents the "no action" alternative, therefore no mitigation is recommended.

** FC6 represents the "non-structural" alternative which would result in a loss of 12,304 DUD due to the reforestation (503 DUD/acre) of fallow fields (853 DUD/acre).

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APPENDIX B

SHOREBIRD HABITAT AND BIOLOGY

SHOREBIRDS

Introduction

Wetland management efforts have historically been focused primarily on waterfowl, but in the 1990's shorebirds (Aves: Charadriiformes) and other nongame waterbirds have become increasingly appreciated by the public and subsequently wetland management efforts have expanded to include them (Helmers 1992). Although data are limited, significant population declines in most shorebird populations are evident (Helmers 1993). The North American Waterfowl Management Plan, a large scale multi-organization wetland management effort, has incorporated shorebirds into its management strategies (Helmers 1992, 1993; Streeter *et al.* 1993). The study area falls within the review of the Mississippi Alluvial Valley (MAV) Migratory Bird Initiative, which identifies habitat goals for migratory birds including shorebirds (Loesch *et al.* 2000). The well being of shorebirds has been compromised by wetland losses, hydrologic alterations due to stream channelization and flood control efforts, human development, and environmental contaminants. Shorebirds include a diverse assemblage of birds that breed, migrate, and winter throughout the Bayou Meto basin. Thirty-six species of shorebirds occur in Arkansas on a regular basis, nearly all of which have been observed in the project area, and several more species have been observed in isolated instances (James and Neal 1986).

American Woodcock (*Scolopax minor*) and the Black-necked Stilt (*Himantopus mexicanus*) may breed in the project area. However, the only species of shorebird that has been documented to breed in this part of the state is the Killdeer (*Charadrius vocerifus*). This species is thriving in the area and has adapted well to modern land uses. Killdeer are anticipated to maintain relatively stable populations in the foreseeable future.

Killdeer and Wilson's Snipe (*Gallinago delicata*) are common throughout the winter whereas yellowlegs (*Tringa* spp.) and Calidrid sandpipers (*Calidris* spp.) are consistently present, but less abundant. Shorebird densities were greater in soybean fields than in rice fields and moist soil units from November to January (Twedt *et al.* in press). During February and March, shorebird densities in soybean and rice fields were similar, but greater than in moist soil units.

Seasonal Movements

Spring--It is usually wet during spring and flooded habitat is abundant. Shorebirds are most often observed on mudflats and on rice fields with little cover. More than 70 percent of shorebirds are associated with areas having water approximately two inches deep. Black-necked Stilts and yellowlegs (*Tringa flavipes* and *T. melanoleuca*) are associated with water deeper than two inches. Whereas, Killdeer, Pectoral Sandpipers (*Calidris melanontos*), and many of the smaller species were commonly observed on mudflats. In northeastern Louisiana, Ouchley (1992) observed shorebirds most often on shallow flooded areas with little cover, such as rice fields with little post-harvest residue. Flooding fields with about two inches of water is most beneficial to shorebirds, but deeper flooding is also beneficial if shallow water edge habitat is associated with the flood regime.

Summer—Suitable shorebird habitat in late summer is limited, with most of the habitat being provided by moist soil areas on national wildlife refuges. High species diversity and abundance of shorebirds during July, August, and early September underscore the need for shallow flooded habitat during summer. However, excess summer water is usually not available and flooding is not compatible with agricultural practices during this time. Suitable stopover habitat, particularly during the late summer is likely a limiting factor for shorebird populations that migrate through the Mississippi Alluvial Valley (Helmers 1992).

Fall/Winter—Intensive management of small areas can provide valuable fall and winter shorebird habitat. Rice fields and plowed fallow fields provide shorebird habitat from early fall through early winter. Rolling or lightly discing rice fields tends to break down stubble, increasing their value to shorebirds. Drawn-down impoundments (including aquaculture ponds), with exposed mudflats and little cover, seem to attract more fall migrants than disced fields. Higher shorebird use of flooded soybean fields may be due to sparse vegetation cover and looser textured soil surface; these characteristics probably increase invertebrate productivity. Soybean is one of the most widely planted crops in the MAV, but soybean fields are not usually artificially flooded during winter. The opportunity exists to greatly increase shorebird winter habitat by artificially flooding soybean fields.

Many species of shorebirds migrate from Arctic breeding grounds to Central and South American wintering grounds with a major migration corridor passing through the MAV (Helmers 1992). Some shorebirds migrate up to 7,500 miles between their breeding and wintering areas. To migrate successfully, shorebirds require highly productive stopover sites where they can efficiently forage to replenish fat reserves. They typically require habitat with an abundance of invertebrates that is either shallowly flooded (< four inches) or comprised of mudflats. This habitat can be provided by impounding water on agricultural fields and moist soil units and by drawing down reservoirs in a timely fashion (Twedt *et al.* in press). Most species of shorebirds avoid wooded wetlands although they may use suitable openings in them occasionally.

Shorebird Behavior

Cotton, soybean, and rice are the three most common crops within the MAV (Bellow and Graham 1992). Flooded cotton fields offer only limited benefits to shorebirds; however, rice and soybean are used extensively by wintering and migrating shorebirds (Twedt and Nelms 1995).

Diurnal observations were made of behavior of flocks of birds using rice, soybean, and moist-soil habitats in Arkansas and Mississippi (Twedt and Nelms 1995). Specifically, behavior of flocks of Wilson's Snipe and yellowlegs were compared among habitats and among seasonal periods during winter and early spring. Study areas included the Lower Yazoo River basin in Mississippi and the Grand Prairie in Arkansas. During the winters of 1991-92 and 1992-93, sixty fields, 20 of each habitat type, were selected from landowners enrolled in cooperative "private lands" projects supplemented with eight moist-soil habitats which were not under cooperative agreements but on which water was managed during winter.

Beginning November 15 of both winters, flocks of specific bird species were observed on selected fields twice during each of nine consecutive two-week periods and once during each of three additional consecutive two-week periods. If the selected fields did not have bird flocks present, the next flock of birds was observed in the appropriate habitat encountered. Observations were made systematically on randomly selected dates (within each period) beginning at randomly selected times, but all observations were diurnal. During each visit scan-sampling was used to record the behavior of all individuals within small flocks (six bird minimum flock size) or the first 200 individuals encountered in large flocks. Behaviors were recorded as: feeding, moving, resting, flying, alert, social, and other. Before statistical analysis, the proportions of the four primary behaviors; feeding, resting, moving, and alert; within each flock were subjected to arcsine transformation (Zar 1984). Also the twelve two-week observation periods were equally grouped in four seasons: early winter, mid winter, late winter, and spring. For Wilson's Snipe and yellowlegs, a separate multivariate analysis of variance (MANOVA) was performed on the transformed behavioral proportions of flocks to examine differences among habitats or in all seasons, comparisons were only made where representative date were available. Seasonal comparisons for snipe and yellowlegs were between the aggregate of all winter periods and spring. Additionally, snipe behaviors were only compared between rice and soybean habitats.

Thirty-three Wilson's Snipe flocks with a mean flock size of 24 birds and 29 yellowlegs flocks with a mean of 22 birds per flock were observed (Twedt and Nelms 1995). Preliminary analyses indicate that the interaction of habitat and season did not significantly impact the analyses for either Wilson's Snipe or yellowlegs and was removed from these MANOVA. No significant differences were detected among habitats for either snipe or yellowlegs. However, significant differences in behavior were detected between winter and spring seasons for both snipe and yellowlegs in preliminary analyses. Greater proportions of both snipe flocks and yellowlegs flocks moved during winter than during spring. Additionally, snipe flocks had a greater proportion of individual feeding during spring than during winter. Increased feeding behavior of snipe flocks during late winter and spring may be the result of hyperphagia to develop fat deposits for northward migration and subsequent breeding. Alternatively, this increase in feeding behavior may be a response to diminished food resources on areas depleted earlier in the winter.

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SECTION XI

MIGRATORY BIRD PLAN

Migratory Bird Management Plan for the Bayou Meto Basin, Arkansas

U.S. Fish and Wildlife Service
Arkansas Field Office
and
Arkansas Game and Fish Commission

October 2002

The Bayou Meto basin is part of the Mississippi Alluvial Valley physiographic area. The U.S. Army Corps of Engineers, Vicksburg and Memphis Districts, is conducting a study of the agricultural irrigation and flood control needs in a 765,745 acre portion of the basin that includes portions of Lonoke, Jefferson, Prairie, Arkansas, and Pulaski Counties in east central Arkansas. This study could lead to a large water management project that would take water from the Arkansas River and distribute it to farms throughout the project area and construct levees or channel modifications to control flooding the southern part of the basin. Migratory bird management is an important consideration in the design of this project. The Arkansas Game and Fish Commission's Bayou Meto Wildlife Management Area is the most important wildlife habitat in the basin and has been managed primarily to provide habitat for waterfowl. This area also provides substantial habitat for other migratory birds including song birds, shorebirds, and wading birds.

Migratory birds can be divided into four groups: shorebirds, waterfowl, land birds, and other water birds. The Mississippi Alluvial Valley Migratory Bird Initiative quantified the habitat needs of shorebirds, waterfowl, and song birds in the Mississippi Alluvial Valley (Hunter *et al.* 1996, Mueller 1996, Twedt *et al.* 1999, Loesch *et al.* 2000, Mueller *et al.* 2000, Mueller *et al.* In press). Elliott and McKnight (2000) provide additional information on shorebirds, and the North American Waterbird Conservation Plan southeast working group is preparing a plan that will address the needs of wading and marsh birds.

Shorebirds

The habitat goal for shorebirds in the Mississippi Alluvial Valley is 5,000 acres of mudflat (Twedt *et al.* 1999) available for feeding during the southward (fall) migration period (July-September). This has been further stepped down to a need for 1,300 acres in Arkansas (Table 1). Currently 367 acres of fall mud flat habitat is being provided on national wildlife refuges in Arkansas (Bald Knob, Oakwood, Overflow, and Wapanocca), none of which are in the Bayou Meto basin. The remainder (933 acres) of the fall Arkansas shorebird habitat goal is unmet at this time.

Table 1
Shorebird Habitat Goals in the Mississippi Alluvial Valley

State	Acres
Arkansas	1,300
Illinois	175
Kentucky	88
Louisiana	1,300
Mississippi	1,500
Missouri	175
Tennessee	462
Total	5,000

Fall shorebird habitat in the Bayou Meto basin is present in very limited amounts. Drying of streams and lakes creates low quality mud flats that quickly dry up or grow up in herbaceous vegetation. The normal management regime of fish hatcheries and aquacultural facilities creates high quality shorebird habitat when ponds are drained for cleaning and refurbishing. The ponds are high in nutrients and, consequently, have a high population of benthic invertebrates, the prime food source for shorebirds. Ponds are drained throughout the year so their occurrence during the southward shorebird migration period is accidental and not assured. Also during the typically hot fall migration period (July-September) the drained ponds rapidly dry up, destroying their mud flat characteristics.

The Arkansas Game and Fish Commission's Joe Hogan Fish Hatchery is in the Bayou Meto basin and the University of Arkansas at Pine Bluff (UAPB) owns 13 fish ponds (approximately 200 acres) near Lonoke. The management of these facilities could be modified to provide a small amount of fall shorebird habitat. The UAPB ponds need renovating at a cost of approximately $2,000/acre (pers. comm. Carol Ingle, UAPB). After renovation these ponds could be used by UAPB to research the management of irrigation reservoirs to provide fisheries habitat, with possible income to farmers from sport fishing, and also to provide fall shorebird habitat. Our current recommendations for the design of irrigation ponds to increase their value as fish and wildlife habitat include:

- Provide multilayered woody and herbaceous vegetation down to the water's edge on one or more sides.
- Create variable bottom topography - deep holes and shallow edges.
- Create islands inside the reservoir.
- Provide gradual bottom slopes.
- Construct variable side slopes, some gradual (<20H:1V) and some steep (>4H:1V).
- Construct sinuous or irregular shorelines with peninsulas and islands.

Each of these design features, and others, could be investigated by UAPB to determine their usefulness for creating fish and wildlife habitat in irrigation reservoirs. Once established these design features, and complimentary management techniques, could be applied throughout eastern Arkansas, where the number of irrigation reservoirs are rapidly increasing.

The potential exists to provide a much greater amount of fall shorebird habitat on the privately owned aquaculture farms in the basin. The Bayou Meto basin has approximately 15,925 acres of catfish and baitfish farm ponds. A partnership based, financial incentive program could be formed to assure that each farm would drain one or more ponds during the fall shorebird migration period and maintain one to four inches of water in the pond(s) to provide prime mud flat feeding areas. Both the Arkansas Game and Fish Commission and the Fish and Wildlife Service have private lands biologists already on staff that could effectively deliver such a program.

Waterfowl

Arkansas is a major wintering area for waterfowl and achieving its waterfowl habitat goals (Table 2) is critical to the North American waterfowl population. Unmet goals remain for bottomland hardwood forest and moist soil. Methods of reestablishing bottomland hardwood forests have been refined in recent years, and this is now a practical management technique. Moist soil management requires careful annual attention and the ability to regulate water levels. Consequently, moist soil management will usually be applied only on public lands. On the other hand, bottomland hardwood reestablishment requires a large initial effort (planting and hydrology restoration as needed), but little annual effort. This makes bottomland hardwood restoration practical on both private and public lands.

Table 2
Duck habitat goals (acres) in Arkansas

Habitat	**Public Land**		**Private-Managed**		**Private-Unmanaged**
	Goal	Achieved	Goal	Achieved	Goal
Bottomland Hardwoods	86,485	80,848	207,452	200,000	45,194,800
Moist Soil	12,505	3,523	All	(estimate)	Duck-use-days
Unharvested Crop	3,086	3,011	habitat		
Harvested Crop	665	2,420	types		

The Bayou Meto Wildlife Management Area (BMWMA) is a major contributor of waterfowl habitat in Arkansas. Every winter the BMWMA floods approximately 14,000 acres for waterfowl and waterfowl hunting. The BMWMA also maintains 800 acres of greentree reservoirs and 250 acres of rice field management. Water management on the BMWMA and conflicts with adjacent farms should be addressed. The inability to move water quickly through the BMWMA sometimes causes flooding of adjacent crop land, preventing or delaying harvest or planting. This situation could be resolved by improving the water management capability on the BMWMA or by reforesting the crop land. Ducks Unlimited does the only other waterfowl management in the basin, consisting of agreements with private landowners to winter flood 721 acres of harvested crop land.

Although the statewide waterfowl habitat goals have not been stepped down to the Bayou Meto basin, a moist soil acreage goal of 874 acres has been established for the BMWMA. The management area currently provides a maximum of 1,058 acres of moist soil habitat. If these moist soil units were operated at full capacity each year, the goals of this habitat type would be exceeded. However, due to variations in water control capabilities and rainfall patterns, in any given year only about 60 percent of the acreage can be flooded. This results in a moist soil deficit of 240 acres.

Forest Breeding Birds

The Mississippi Alluvial Valley Migratory Bird Initiative identified over 100 Forest Bird Conservation Areas (FBCA) throughout the Mississippi Alluvial Valley (Twedt *et al.* 1999) to meet the needs of forest breeding birds. Two FBCAs are in the Bayou Meto basin, the Big Ditch and Bayou Meto FBCAs (Figure 1). To the extent practical, each FBCA should be an unbroken stand of forest. This was established to reduce or eliminate the adverse effects of forest fragmentation on forest breeding bird success. To be assured of long term, secure populations, many forest breeding birds require "core" or interior forest, that is habitat some distance from the forest edge. The Bayou Meto FBCA meets its forest goals. The Big Ditch FBCA meets the total forest area goal, but is lacking in core forest (Table 3). Reforestation of key tracts in the Big Ditch FBCA would reduce fragmentation and enable the core forest goal to be met with a relatively small amount of reforestation.

Table 3
Forest Area Goals (acres) for the Big Ditch and Bayou Meto Forest Bird Conservation Areas

	Forest Goal	Existing Forest	Core Forest Goal	Existing Core Forest
Big Ditch	10,000	10,732	5,200	2,216
Bayou Meto	20,000	52,384	12,800	15,618

While establishing large, unbroken blocks of forest is the most important step in providing habitat for forest breeding birds, other measures are also beneficial. Reforesting marginal agricultural lands would increase migratory bird, including waterfowl, habitat while only slightly reducing agricultural production. The two year floodplain is difficult to farm and is a logical area in which to focus reforestation efforts. (Reforesting the two year floodplain would also provide substantial fisheries benefits.) The recently established Conservation Reserve Enhancement Program, a cooperative effort between the Arkansas Game and Fish Commission and the Natural Resources Conservation Service, is an excellent program that could reforest much of the two year floodplain. Additional marginal farm lands should be reforested by the irrigation project.

Wading and Marsh Birds

The North American Waterbird Conservation Plan is in the early stages of setting wading (herons, egrets, and bitterns) and marsh bird (rails, wrens, and moorhen) population and habitat goals for the nation and the southeast. At this time they have not produced any goals that can be applied to Bayou Meto. Wading and marsh bird occurrence in the project area is poorly known. Three wading bird breeding colony sites have been identified (Table 4). Several other locations appear to be suitable to support breeding colonies, especially the Bayou Meto Wildlife Management Area, yet no additional colonies are known. This basic information must be gathered before an effective management plan can be formulated. Surveys to locate all breeding colonies are required. The locations of feeding concentrations points and fall and winter roosts would also be valuable information. A wading and marsh bird management plan would address the conservation needs of each species and any depredation problems identified in the basin.

Table 4
Wading Bird Colonies in the Bayou Meto Project Area[a]

Species/Colony[b]	McSwain	Pine Tree	Preston Hamilton Reservoir
Great Blue Heron	X		
Great Egret	X	X	X
Snowy Egret	X	X	X
Little Blue Heron	X	X	X
Cattle Egret		X	
Green Heron	X	X	X
Black-crowned Night-Heron	X		

[a] - Based on information provided by Micheal Kearby, Wildlife Services, Stuttgart, AR.
[b] - Colony locations available on request.

RECOMMENDATIONS

These recommendations are made in the spirit of the 1989 "Cooperative Agreement Between the Department of the Interior and the Department of the Army Regarding Waterfowl Habitat Conservation Opportunities Associated with Corps of Engineers Civil Works Projects and Activities Consistent with the North American Waterfowl Management Plan." The habitat recommendations of the Mississippi Alluvial Valley Migratory Bird Initiative were established in cooperation with the North American Waterfowl Management Plan.

1. Fund an incentive based, partnership program to assure the presence of shorebird habitat on privately owned aquaculture facilities during the fall shorebird migration period. This program would be delivered by existing staff of the Fish and Wildlife Service and the Arkansas Game and Fish Commission.

2. Fund the UAPB to establish a research program to investigate the design and management of irrigation reservoirs to provide sport fish, shorebird, and waterfowl habitat.

3. Until the UAPB produces new recommendations, design and manage irrigation reservoirs as described in this document.

4. Do not construct irrigation reservoirs in wetlands or wooded upland habitat.

5. Resolve water management issues associated with BMWMA by improving the water management capability of the BMWMA or by reforesting adjacent crop land.

6. Reforest key tracts in the Big Ditch Forest Bird Conservation Area to achieve the core forest area goal required for forest breeding birds. This reforestation would also contribute valuable waterfowl habitat.

7. Coordinate with the Service and the Arkansas Game and Fish Commission to fund the establishment of 240 acres of moist soil management on newly purchased lands adjacent to BMWMA.

8. Design project features to be compatible with the Conservation Reserve Enhancement Program.

9. Survey the entire project area to locate and census wading bird breeding colonies, roost sites, and feeding concentration points.

10. Conduct surveys to identify the locations and species of marsh birds present in the project area.

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SECTION XII

ENDANGERED SPECIES

BIOLOGICAL ASSESSMENT

OF THE

BALD EAGLE (*HALIAEETUS LEUCOCEPHALUS*)
INTERIOR LEAST TERN (*STERNA ANTILLARUM ATHALASSOS*)

FOR

BAYOU METO, ARKANSAS, GENERAL REEVALUATION PROJECT

INTRODUCTION

This Biological Assessment (BA) evaluates the potential impacts to federally listed threatened and endangered species by the implementation of irrigation and flood control in the Bayou Meto Basin, located in Lonoke, Prairie, Jefferson, Arkansas, and Pulaski counties in Arkansas. Per the Planning Aid Letter from U.S. Fish & Wildlife Service, dated 9 June 2000, the species listed that are the focus of this BA are the interior least tern (*Sterna antillarum athalassos*) and the bald eagle (*Haliaeetus leucocephalus*). Pertinent biological and ecological data for these endangered species are based on both published and unpublished literature, communications with experts, and findings of recent U.S. Army Corps of Engineers investigations. This BA is being submitted to the U.S. Fish and Wildlife Service pursuant to Section 7 of the Endangered Species Act, as amended.

AUTHORIZED PROJECT

The Grand Prairie-Bayou Meto Project was reauthorized by the Water Resources Development Act of 1996 with a broadened scope of work, to include ground water protection and conservation, agricultural water supply, and waterfowl management. Congressional language contained in the Energy and Water Appropriations Act, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto Basin. The fiscal year 1999, 2000, 2001, and 2002 Appropriations Acts provided funding to continue the reevaluation.

The selected plan consists of components from water supply and flood control alternatives from the National Economic Development (NED) Plan and components from the National Ecosystem Restoration (NER) Plan, which includes waterfowl management. The NED plan includes a 1,750 CFS import system to divert flow from the Arkansas River, a 1,000 CFS pump station to reduce flooding the southern portion of the Basin; 8,832 acres of new on-farm irrigation reservoirs, on-farm tail-water recovery systems, restoration of prairie vegetation and bottomland hardwood forests, and water available for the annual flooding of 33,382 acres of harvested rice fields (on an average annual basis) for waterfowl. The water distribution system utilizes approximately 121 miles of existing streams and channels, 107 miles of new canals, and 472 miles of new pipelines to transfer an average of 268,324 acre-feet annually of surface water from the Arkansas River to the project area. Fifty-six weirs would be built in ditches and existing streams, and numerous other hydraulic structures (e.g., gated check structures, culverts, siphons, turnouts, bridges) would be constructed in association with the water delivery system (including all associated hydraulic structures). Channel excavation and enlargement to selected ditches will be required for flood control.

The NER plan consists of features that would restore 9,000 acres of prairie and 73,593 acres of forest and riparian buffer. It would also create 240 acres of moist-soil habitat for waterfowl and other wetland birds. The prairie restoration feature could allow reintroduction of the greater prairie chicken by creating two distinct prairie chicken management units. Forest restoration would provide critical habitat for sensitive species such as black bear and forest breeding birds. These features could also provide substantial, quantifiable benefits to terrestrial wildlife, fisheries, and waterfowl. The riparian buffers will reduce sedimentation. Forest, riparian buffer, and prairie restoration on cleared lands will reduce the amount of agricultural land in the project area, thereby reducing the amount of pesticides entering streams and ditches and improving water quality.

ENDANGERED/THREATENED SPECIES ASSESSMENT

BALD EAGLE (*Haliaeetus leucocephalus*) (Threatened)

Description

The bald eagle is a large raptor, has a wingspan of about 7 feet, is 3.5 feet long, and weighs between 8 and 15 pounds. Its plumage is mainly dark brown; adults have a pure white head and tail. First-year juveniles are often chocolate brown to blackish, sometimes with white mottling on the tail, belly and under wings. The head and tail become increasingly white with age until full adult plumage is reached in the fifth or sixth year. The sexes are difficult to differentiate due to identical coloration and variability in size. An opportunistic predator, the bald eagle feeds primarily on fish, but also takes a variety of live birds, mammals, turtles and carrion. Fish compose 60 to 90 percent of the bald eagle diet (USACE 1999).

Life History

The bald eagle prefers riparian habitat and usually nests near bodies of water where it feeds. Selection of nesting sites varies according to tree species in a particular area. Nests which are often 5 feet wide and 3 feet deep, are usually constructed in living trees; however, bald eagles do occasionally use dead trees (USACE 1998). Eagles require large diameter trees for roosting, perching and nesting. The trees must be sturdy and open to support a nest that is often 5 feet wide and 3 feet deep. Adults tend to use the same breeding areas year after year, and often the same nest, though a breeding area may include one or more alternate nests (Federal Register 1999b).

Breeding requires a readily available food source of moderate to large fish and minimal disturbance from humans. The breeding season varies with latitude. However, the general tendency is for winter breeding in the south. The nesting season typically begins in mid-February with a clutch of 2-3 eggs. Egg laying may be delayed into March and April, depending upon the weather (USACE 1999).

Both parents incubate the eggs, which takes from 34 to 40 days. Re-nesting may occur if the eggs are lost early in incubation. Eaglets are feathered, nearly full grown and able to fly by 10 to 11 weeks of age. The adults continue to care for the eaglets for approximately 4 to 6 weeks after fledging. Bald eagles mature slowly, requiring 4 to 5 years to gain adult plumage and reach breeding age (USACE 1999).

Bald eagles are long-lived. In captivity, bald eagles may live 40 or more years. It is presumed that once they mate, the bond is long-term, though documentation is limited (Federal Register 1999b).

Distribution

The bald eagle ranges throughout much of North America, nesting on both coasts from Florida to Baja California, Mexico in the south and from Labrador to the western Aleutian Islands, Alaska, in the north (Federal Register 1999b).

Reason for Concern

The major factor leading to the decline of the bald eagle was lowered reproductive success following the introduction of the pesticide DDT in 1947. Current factors affecting bald eagle recovery include habitat destruction, human disturbance, electrocution, illegal shooting, impact injuries, and lead poisoning. Bald eagle tolerance of disturbance is lowest during egg laying, incubation, and the first several weeks after hatching (USACE 1998).

Evaluation of Potential Impacts

Coordination with the Arkansas Natural Heritage Commission (ANHC) revealed that there are 2 approximate nesting locations suitable for bald eagles within the Bayou Meto project area; however, these locations are outside the irrigation boundaries. Therefore, no potential impacts to bald eagles are expected to result from the project. Restoration of bottomland hardwoods could potentially provide suitable nesting habitat for bald eagles over time.

INTERIOR LEAST TERN (*Sterna antillarum althalssos*) (Endangered)

Description

The interior least tern is a migratory, colonial shorebird. It is the smallest of the American terns, measuring from 8.5 inches to 9.75 inches long with a wingspan of approximately 20 inches. They have a black-capped crown, white forehead, a black-tipped yellow bill, gray back and dorsal wings, white belly, and orange legs. The sexes are virtually identical. Juveniles tend to have a darker, mottled, brownish plumage and bill compared to adults, with a dark band behind the eye and a dark shoulder patch (USACE 1999).

Life History

Interior least terns spend 4 to 5 months at their breeding sites. They arrive on the Mississippi River nesting areas from late April through mid-May. Courtship and nesting begin in late May and early June and continue through late July, depending upon river stages and the availability of exposed sandbars. Reproduction (mating, egg laying, hatching) takes place from late May through early August. Soon after arrival in the breeding area, least terns form colonies ranging from less than a dozen to several hundred birds (USACE 1999).

Courtship and breeding are followed by nest excavation and egg laying. The nest is a shallow and inconspicuous depression in an open, sandy area, gravelly patch, or exposed flat. (USFWS 1990).

Interior least tern eggs are pale to olive buff and speckled or streaked with dark purplish-brown, chocolate, or blue-gray markings (USFWS 1990). Numerous surveys conducted since 1985 of the Mississippi River by John P. Rumancik, Jr., (biologist, Memphis District Corps of Engineers) and Kenneth H. Jones (biology professor, Dyersburg State Community College, Dyersburg, Tennessee) revealed that nests contained an average of 3 eggs. Both sexes share in incubating the eggs which generally lasts 20 to 25 days. Fledging occurs after three weeks, although parental attention continues until migration (USFWS 1990).

Distribution

The interior least tern breeds and rears its young throughout the Mississippi, Missouri, Arkansas, and Ohio River systems. Nesting occurs on islands and sand bars devoid of vegetation within wide unobstructed river channels. The least tern also utilizes artificial habitats such as sand and gravel pits and dredge spoil islands for nesting (USFWS 1990). Large populations of interior least terns have been observed on sand bars along the lower Mississippi River (John P. Rumancik, Jr. and Kenneth H. Jones, personal communication). Surveys on the lower Mississippi River have recorded an estimated average of 6,000 adults since 1994, with 8,080 adults recorded in 2003 (Rumancik 1985-1996, Jones 1997-2003).

Reason for Concern

Many rivers have become the focus of recreational activities. Human presence reduces reproductive success. In mid-America, sandbars are fast becoming the recreational counterpart of coastal beaches (USFWS 1990).

Flow regimes on rivers differ greatly from historic regimes. Along the Lower Mississippi River and elsewhere, natural river discharge may exert considerable influence on reproductive success. A wet spring may delay river fall and habitat may not be available until late July or early August. Rises in the river during the spring and summer may inundate nests and wash away chicks (Rumancik 1986 and 1989).

Evaluation of Potential Impacts

According to ANHC, no interior least terns have been recorded within the project area. The available habitat with the basin is not suitable (John P. Rumancik, personal communication); therefore, the interior least tern will not be impacted by the proposed project.

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