US Army Corps of Engineers®
Memphis District

GRAND PRAIRIE REGION AND BAYOU METO BASIN, ARKANSAS PROJECT

BAYOU METO BASIN, ARKANSAS

GENERAL REEVALUATION REPORT

VOLUME 1

MAIN REPORT
&
FINAL
ENVIRONMENTAL IMPACT STATEMENT
(EIS)

NOVEMBER 2006
REVISED MARCH 2007

BAYOU METO BASIN, AR PROJECT
GENERAL REEVALUATION REPORT (GRR)
SYLLABUS

The Bayou Meto Basin, AR Project general reevaluation was conducted in response to Congressional direction outlined in Section 363(a), Project Reauthorizations, of the Water Resources Development Act (WRDA) of 1996, Public Law 104-303. Congress reauthorized the original Grand Prairie Region and Bayou Meto Basin flood control project with a broadened scope of work as follows:

> "Grand Prairie Region and Bayou Meto Basin, Arkansas.--The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, authorized by section 204 of the Flood Control Act of 1950 (64 Stat. 174) and deauthorized pursuant to section 1001(b) of the Water Resources Development Act of 1986 (33 U.S.C. 579a(b)), is authorized to be carried out by the Secretary; except that the scope of the project includes ground water protection and conservation, agricultural water supply, and waterfowl management if the Secretary determines that the change in the scope of the project is technically sound, environmentally acceptable, and economic, as applicable."

The purpose of the Bayou Meto Basin, AR General Reevaluation Report (GRR) is to develop plans of improvement that address the identified water resources problems and opportunities, as they relate to the Congressional direction outlined in WRDA 96, within the Bayou Meto Basin.

Water is one of Arkansas' most valuable resources and its protection and conservation are of paramount importance. The agricultural economy, which supports the eastern Arkansas region, cannot exist without a dependable supply of irrigation water. Continued withdrawals at the current rate will deplete the Alluvial and Sparta aquifers such that they will no longer be viable sources of irrigation water; and agriculture, as it is now practiced, will be impossible. The economic and environmental results of exhausting the aquifers would be catastrophic.

The general reevaluation was conducted to fully evaluate and determine the best plan of improvement for flood control, agricultural water supply, and waterfowl management. Alternatives were developed and analyzed using USACE planning criteria to determine a plan consisting of measures that best meet the area's needs. Once the plan was identified, detailed engineering and design studies were completed to the level of detail required for preparation of a baseline cost estimate and schedule for implementation.

Pertinent economic data for the selected plan for the current interest rate of 5.125 percent and a 50 year period of analysis are as follows:

Estimated First Cost (Oct 05 Price Level)	$530,381,000
Estimated Average Annual Costs	$ 33,493,000
Estimated Average Annual Benefits	$ 51,468,000
Benefit-to-Cost Ratio	1.54

Included in the annual cost is $ 5,733,000 for average annual operation, maintenance, replacement, repair, and rehabilitation (OMRR&R).

The recommendation is that this GRR be approved as the basis for proceeding to the development of a Record of Decision (ROD), a Project Cooperation Agreement (PCA), plans and specifications, and subsequent project construction of the Bayou Meto Basin, AR Project in accordance with cost-sharing and financing arrangements satisfactory to the President and Congress.

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

MEMPHIS TN 38103-1894

December 8, 2006

Planning, Programs, & Project
Management Division
Environmental Branch

To Interested Parties:

The Bayou Meto Basin, General Reevaluation Report, Main Report and Final Environmental Impact Statement, was submitted for public review on December 4, 2006. However, some outdated monetary costs and benefits were mistakenly reported in the final environmental impact statement (FEIS). These erroneous costs and benefits had not been adjusted to reflect updated flood control costs and October 2005 price leveling. Cost and benefit figures in the FEIS should be updated according to the information provided below.

FEIS, page 1, last sentence of abstract – The estimated fully funded cost reported as "$576,299,000" is actually $530,381,000. Also, the benefit/cost ratio is 1.19, not "1.13."

FEIS, page 3, paragraph 1.5, last sentence – The estimated fully funded cost is $530,381,000, not "$576,299,000." The benefit cost ratio is 1.19, not "1.13."

FEIS, page 3, paragraph 1.6, second sentence – Annual net benefits of the selected plan are $39,883,000, not "$37,593,000." The benefit/cost ratio was mistakenly report as "1.13"; the correct benefit/cost ratio is 1.19.

FEIS, page 45, Table 4-1 (contd.), Water Supply Alternative 4B/Flood Control Alternative 3A – The total first cost is $442,859,000, not "$420,204,000." Net benefits are $39,883,000, not "$37,593,000." The correct benefit/cost ratio is 1.19, not "1.13."

FEIS, page 45, Table 4-1 (contd.), WM Plan – Total first cost is $87,522,000, not "$87,423,000."

FEIS, page 45, Table 4-1 (contd.), Combined NED/WM Plan – Selected Plan – Total first cost is $530,381,000, not "$576,299,000."

I apologize for any inconvenience that these misreported figures might have caused. Please contact Mr. Mark Smith (mark.r.smith@mvm02.usace.army.mil or 901-544-0670) or Mr. Tracy James (tracy.m.james@mvm02.usace.army.mil or 901-544-0673) if you have questions or need additional information.

Sincerely

David L. Reece
Chief, Environmental Branch

US Army Corps of Engineers®
Memphis District

GRAND PRAIRIE REGION AND BAYOU METO BASIN, ARKANSAS PROJECT

BAYOU METO BASIN, ARKANSAS

GENERAL REEVALUATION REPORT

VOLUME 1

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

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

MAIN REPORT & EIS

Table of Contents

Table of Contents (Cont'd)

Title **Page**

SECTION I –AGRICULTURAL WATER SUPPLY COMPONENT

PLAN FORMULATION

Table of Contents (Cont'd)

Table of Contents (Cont'd)

Title **Page**

Table of Contents (Cont'd)

Title **Page**

DESCRIPTION OF SELECTED PLAN IMPROVEMENT FOR AGRICULTURAL WATER SUPPLY

Table of Contents (Cont'd)

Table of Contents (Cont'd)

SECTION II - FLOOD CONTROL COMPONENT

PLAN FORMULATION

Table of Contents (Cont'd)

DESCRIPTION OF RECOMMENDED PLAN OF IMPROVEMENT FOR FLOOD CONTROL

Table of Contents (Cont'd)

SECTION III – WATERFOWL MANAGEMENT AND RESTORATION PLAN

Table of Contents (Cont'd)

DESCRIPTION OF RECOMMENDED PLAN OF IMPROVEMENT FOR WATERFOWL MANAGEMENT

SECTION IV – COMBINED NED/WATERFOWL MANAGEMENT PLAN

PLAN FORMULATION

Table of Contents (Cont'd)

Table of Contents (Cont'd)

Table of Contents (Cont'd)

List of Tables

Table of Contents (Cont'd)

List of Tables (Cont'd)

Table of Contents (Cont'd)

List of Tables (Cont'd)

Title **Page**

List of Tables (Cont'd)

Title **Page**

Table of Contents (Cont'd)

List of Plates

List of Figures

Table of Contents (Cont'd)

List of Figures (Cont'd)

INTRODUCTION

This report is a cooperative effort of Federal, state, and local agencies to address the water resources problems and opportunities in the Bayou Meto Basin, Arkansas. The report is presented in 12 volumes. **Volume 1**, which includes the main report and the final environmental impact statement (EIS), is a non-technical presentation of the study results, including a broad overview of the overall project history and formulation process, the EIS, and study recommendations. The remaining volumes are as follows:

<u>Volume 2</u>
Appendix A: Natural Resources Plan For On-Farm Portion

<u>Volume 3</u>
Appendix B: Engineering Investigations & Analyses
Agricultural Water Supply Component
Section I: Hydraulics and Hydrology

<u>Volume 4</u>
Appendix B: Engineering Investigations & Analyses
Agricultural Water Supply Component
Section II: Geology & Soils

<u>Volume 5</u>
Appendix B: Engineering Investigations & Analyses
Agricultural Water Supply Component
Section III: Civil Design
Section IV: Structural, Electrical & Mechanical
Section V: Pumping Stations
Section VI: Relocations
Section VII: Geospatial
Section VIII: Survey

<u>Volume 6</u>
Appendix B: Engineering Investigations & Analyses
Agricultural Water Supply Component
Section IX: Cost Engineering Report

<u>Volume 7</u>
Appendix B: Engineering Investigations & Analyses
Agricultural Water Supply Component
Section X: Reference Maps

Volume 8
Appendix C: Engineering Investigations & Analyses
Flood Control Component
Section I: Hydraulics and Hydrology

Volume 9
Appendix C: Engineering Investigations & Analyses
Flood Control Component
Section II: Geology & Soils
Section III: Levee & Drainage
Section IV: Structural, Electrical & Mechanical
Section V: Relocations
Section VI: Geospatial
Section VII: Survey
Section VIII: Cost Engineering Report

Volume 10
Appendix D: Environmental Analyses

Volume 11
Appendix E: Economics
Agricultural Water Supply Component
Appendix F: Economics
Flood Control Component
Appendix G: Real Estate
Agricultural Water Supply Component
Appendix H: Real Estate
Flood Control Component

Volume 12
Appendix I: Quality Control Plan & QC/QA Documentation

AUTHORITY

HISTORY

Section 204 of the Flood Control Act of 1950 (64 Stat 174) authorized a project for the Grand Prairie Region and the Bayou Meto Basin in eastern Arkansas. Due to a lack of local sponsorship, this project was never funded and was subsequently deauthorized in the late 1980's due to a provision in Section 1001(B) of the Water Resources Development Act of 1986 (33 U.S.C. 579A(B)). However, a severe drought in 1980 and a renewed concern for declining groundwater levels prompted interest in developing water conservation and supply projects.

Responding to the concerns of state agencies, local officials, and individuals, the Committee on Public Works and Transportation of the United States House of Representatives adopted a resolution on 23 September 1982, which authorized the Corps of Engineers to study the feasibility of developing water conservation and water supply projects in eastern Arkansas. The resolution, sponsored by former Congressman Bill Alexander, is quoted as follows:

> "Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Mississippi River and Tributaries Project, published as House Document Numbered 308, 88th Congress, and other pertinent reports, with a view to determining whether any modification of the recommendations contained therein are advisable at this time, with particular reference to the need and feasibility of improvements in the Bayou Meto, L'Anguille, St. Francis, Cache, and Lower White River Basins including their tributaries in the Alluvial Valley of Eastern Arkansas, in the interest of water conservation and water supply of both surface and subsurface water for municipal, industrial and agricultural purposes. These investigations will be fully coordinated with the State of Arkansas, appropriate local government entities, and interested Federal agencies."

As a result of this legislation, the Corps of Engineers conducted the *Eastern Arkansas Region Comprehensive Study*, which identified five potential project areas. The Bayou Meto Basin was included as one of these project areas. The draft report was published in August 1990.

PROJECT REAUTHORIZATION

In 1996, Congress reauthorized the original Grand Prairie Region and Bayou Meto Basin, Arkansas project with a broadened scope of work. Section 363(a), Project Reauthorizations, of the Water Resources Development Act (WRDA) of 1996, Public Law 104-303, is quoted as follows:

> "Grand Prairie Region and Bayou Meto Basin, Arkansas.--The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, authorized by section 204 of the Flood Control Act of 1950 (64 Stat. 174) and deauthorized pursuant to section 1001(b) of the Water Resources Development Act of 1986 (33 U.S.C. 579a(b)), is authorized to be carried out by the Secretary; except that the scope of the project includes ground water protection and conservation, agricultural water supply, and waterfowl management if the Secretary determines that the change in the scope of the project is technically sound, environmentally acceptable, and economic, as applicable."

This Act language reauthorized the flood control project of 1950 and included a change in scope that would allow for agricultural water supply and waterfowl management components to be included as part of the project. The flood control project was deauthorized in the late 1980's due to a provision of WRDA 1986 and conditionally reauthorized the Bayou Meto flood control project that included the change in scope in WRDA 1996. The flood control component has been revised from the 1950 project. However, a legal opinion addressing the reformulated flood control plan states that the Chief of Engineers has the discretionary authority to implement the changes. As for the other components of the project, the Assistant Secretary of the Army for Civil Works will have to approve the changes in scope that include agricultural water supply and waterfowl management.

GENERAL REEVALUATION

The Energy and Water Development Appropriations Act, 1998, was accompanied by report language found in Senate Report 105-44, House of Representatives Report 105-190, and House of Representatives Report 105-271 (Conference Report) that provided for initiation of a reevaluation on the Bayou Meto portion of the Grand Prairie Region and Bayou Meto Basin, Arkansas Project.

STUDY PURPOSE AND SCOPE

Congressional language contained in the Senate and House Reports accompanying the Energy and Water Appropriations Act, 1998, directed the Corps to initiate a reevaluation of the Bayou Meto Basin. Act language did not include cost sharing requirements; that was addressed in the Report language. Fiscal years 1999 thru 2006 Appropriations Acts provided funding to continue the reevaluation.

The purpose of the general reevaluation is to develop plans of improvement that address the identified water resources problems and opportunities within the Bayou Meto Basin. The general reevaluation was conducted to fully evaluate and determine the best plan of improvement for flood control, agricultural water supply, and waterfowl management. Based on the planning criteria, alternatives were developed and analyzed to the extent required to identify the plan consisting of measures that best meets the area's needs. Once the plan was identified, detailed engineering and design studies were completed to the level of detail required for preparation of a baseline cost estimate and schedule for implementation.

REPORT AND STUDY PROCESS

REPORT

This report, which includes the final environmental impact statement (EIS) and appendices, has been prepared in response to the referenced authorities and guidance. The general reevaluation report (GRR) is a complete decision document that provides a presentation of the study findings and results and describes the detailed plan of improvement for the Bayou Meto Basin. This document is of sufficient detail and content to serve as the basis for proceeding to design documentation reports, as needed, and plans and specifications for project construction.

STUDY PROCESS

The first step of the general reevaluation effort was completion of a Project Study Plan (PSP). This document, developed in close coordination with participating agencies and local interests, provided a plan of study to define and manage the development and conduct of the study. The Bayou Meto Basin PSP documented the assumptions, work tasks, products, and level of detail required for conducting the general reevaluation. The purpose of the general reevaluation was to identify problems and opportunities; inventory and forecast resources; formulate, evaluate and compare alternative plans of improvement; and select the recommended plan of improvement for flood control, agricultural water supply, and waterfowl management. Alternatives were evaluated at a level to determine the maximum net economic development benefits and assess the environmental and social effects of the selected plan of improvement. The PSP established the baseline for time and cost, provided District management a mechanism for cost and schedule control, facilitated technical review and quality control, and served as the basis for higher authority reporting requirements. Open Plan and Primavera software was utilized to schedule activities, monitor milestones, and program and allocate monetary and personnel resources to the study effort. The first phase of the general reevaluation included all data collection and analyses necessary for identification of the best plan of improvement. The second phase consisted of detailed planning, engineering, and design studies required for preparation of the baseline cost estimate and schedule for implementation. The next step is the review, processing, and coordination of the GRR and EIS.

PRIOR STUDIES, REPORTS, AND PROJECTS

STUDIES AND REPORTS

The following studies conducted by the Memphis District, Corps of Engineers provided significant background and information in the development of the Bayou Meto Basin, Arkansas Project.

Eastern Arkansas Region Comprehensive Study (Draft Report)*, August 1990.*

Grand Prairie Area Demonstration Project, General Reevaluation Report, September 1999.

OTHER PERTINENT REPORTS ON WATER SUPPLY IN EASTERN ARKANSAS

Numerous studies and reports concerning water supply and groundwater depletion in eastern Arkansas have been conducted by Federal, state and local agencies, research institutions and individuals. Many of these studies were researched for background and historical information during conduct of the Eastern Arkansas Region Comprehensive Study and the Bayou Meto Basin, Arkansas general reevaluation and were the source for much data. Some of the studies include:

House Document No. 255, 81st Congress, 1st Session, *White and Arkansas Rivers and Tributaries, Grand Prairie Region, Arkansas*, July 1949.

House Document No. 308, 88th Congress, 2nd Session, *Mississippi River and Tributaries, Grand Prairie Region and Bayou Meto Basin, Arkansas*, Annex P, October 1959.

Arkansas State Water Plan, Eastern Arkansas Basin, Main Report, Executive Summary and Synopsis, Arkansas Soil and Water Conservation Commission, June 1988.

BAYOU METO BASIN, ARKANSAS GENERAL REEVALUATION

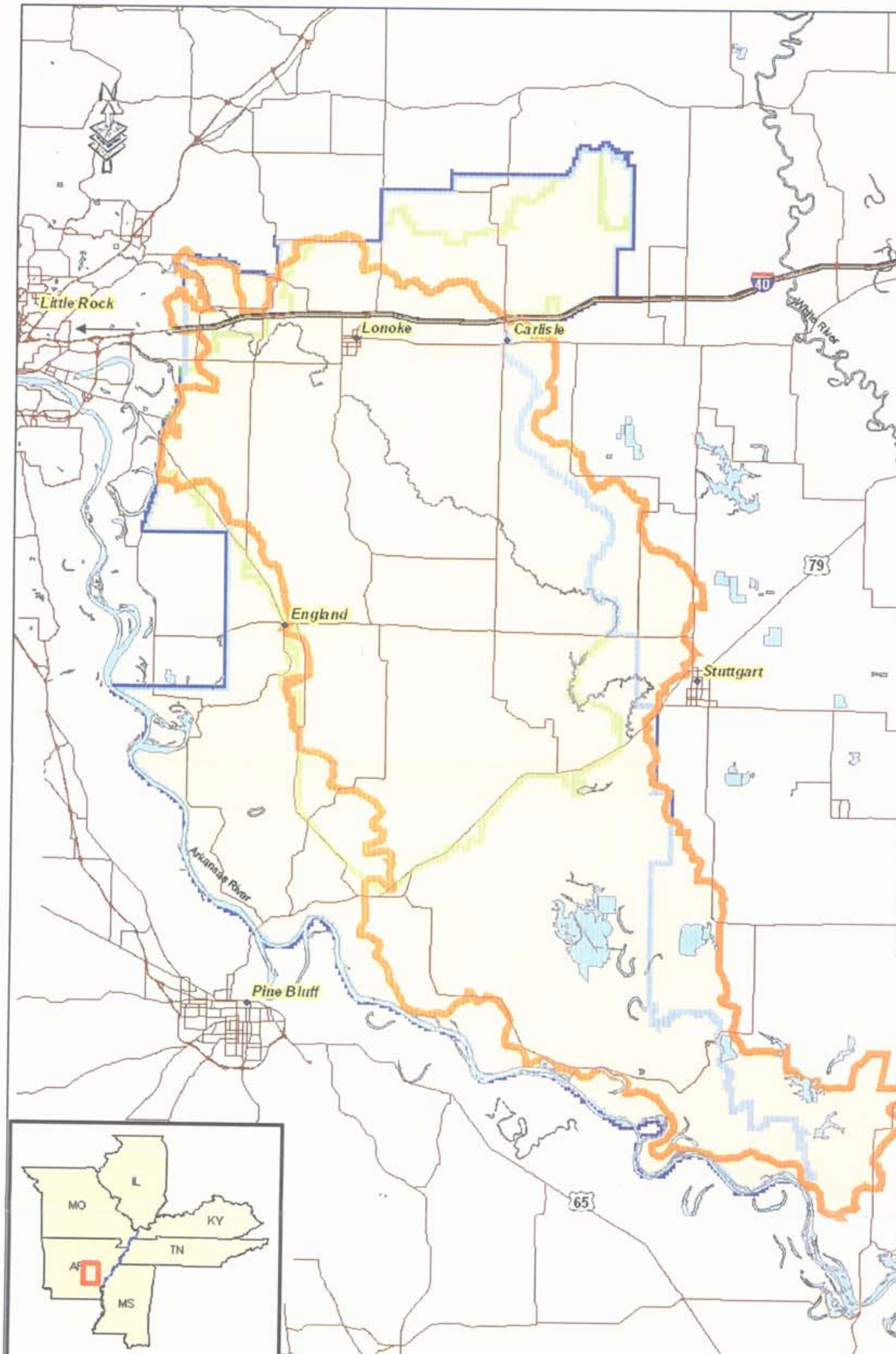
GENERAL

The Bayou Meto Basin, Arkansas (GRR) presents the study findings for a large multi-purpose project. Authorized project purposes include flood control, groundwater protection and conservation, agricultural water supply, and waterfowl management. To conduct the general reevaluation the combined resources of the Memphis and Vicksburg Districts of the Corps of Engineers were utilized. Memphis District (MVM) had responsibility for overall project management and development of the agricultural water supply component. Vicksburg District (MVK) had responsibility for the flood control component. Even though the work effort was generally divided along these lines, analyses and evaluations were conducted to insure that both components could work in concert with one another. The environmental project component was split between the two participating districts based on capabilities and workload. For example, the Memphis District was tasked with cultural resources and waterfowl management plan development, while the Vicksburg District was responsible for impact assessment and mitigation analysis. Section I of the Main Report pertains to the agricultural water supply component and Section II covers the flood control component. The agricultural water supply component is totally confined to the Bayou Meto Improvement Project Area (IPA) where there is some overlap of flood control component in the IPA. Section III covers the waterfowl management component. Section IV presents the combined comprehensive plan of improvement and Section V describes project implementation.

STUDY AREA

The Bayou Meto Basin, Arkansas general reevaluation study area as shown on Plate 1 includes all lands within the Bayou Meto Regional Irrigation Water Distribution District (BMRIWDD) boundary and those areas outside the BMRIWDD required to evaluate the hydrologic and hydraulic properties of the Bayou Meto watershed. Plate 1 provides a general location and vicinity map for the study area. The study area is located in east central Arkansas approximately 20 miles east of Little Rock and includes portions of Arkansas, Jefferson, Lonoke, Prairie, and Pulaski counties. The total study area encompasses some 863,712 acres. The total study area is approximately 58 miles in length (north to south) and 29 miles in width (east to west). Lonoke and England are two major towns within the area. The Bayou Meto Improvement Project Area (IPA) is contained entirely with the BMRIWDD. The individual acreages for the BMRIWDD, IPA, and flood control boundaries are 765,745, 433,166, and 641,408 respectively. As shown on Plate 1, these boundaries overlap each other because each boundary serves different political or geographical functions within the total project. Waterfowl management opportunities exist throughout the study area.

Rice, soybeans, cotton, wheat, and baitfish are the primary crops produced within the total project area. Arkansas is ranked number one in rice production in the United States and produces nearly 50 percent of the national crop. The largest baitfish production facility in the world is located in the project area. Arkansas ranks first in mallard harvest in the United States. Hunting and fishing opportunities abound or are abundant on and around the Bayou Meto Wildlife Management Area (WMA), which is located at the southern end of the area. The Bayou Meto Basin is a major wintering area for waterfowl in Arkansas. This area is underlain by the Mississippi River Valley alluvial aquifer of Quaternary age, which supplies about 82 percent of all the water used in the total project area, and its primary use is agricultural irrigation.



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Memphis District

Bayou Meto Regional Irrigation Water Distribution District (BMRIWDD)
Flood Control Boundary
Improvement Project Area (IPA)
Waterfowl Management Opportunities

Bayou Meto Basin, AR
Study Area

PLATE 1

SECTION I AGRICULTURAL WATER SUPPLY COMPONENT

PLAN FORMULATION

Plan formulation is the design of alternative plans that will meet planning objectives. An alternative plan consists of a system of structural and/or nonstructural measures, strategies, or programs formulated to alleviate specific problems or to take advantage of specific opportunities associated with water and related land resources. This section includes a description of the problems, needs, and opportunities; a description of current and future conditions pertinent to the IPA; and a presentation of the development, evaluation, and screening of alternative plans of improvement.

PROBLEMS AND OPPORTUNITIES

EXISTING CONDITIONS

Existing conditions pertinent to this study are those physical and socioeconomic conditions related to flood control, groundwater protection and conservation, agricultural water supply, waterfowl management, and the environment and those associated with impacts of the alternative plans developed to address identified problems and opportunities.

PHYSICAL CONDITIONS

This section provides a description of the existing physical characteristics of the land and water resources within the Bayou Meto IPA.

Study Area

The Bayou Meto Regional Irrigation Water Distribution District (BMRIWDD), pursuant to Arkansas Code Annotated (A.C.A.) 14-116-501, formed the Bayou Meto Improvement Project Area (IPA) in July 2001. The Bayou Meto IPA included all lands that would have access to water imported from the Arkansas River. Formation of the IPA provides for the assessments of benefits to landowners by the BMRIWDD.

The Bayou Meto IPA as shown on Plate 2 encompasses approximately 433,166 acres, which includes 276,814 acres of irrigated cropland and 22,079 acres of commercial fish ponds. The IPA includes approximately 323,603 acres in Lonoke County; 80,917 acres in Jefferson County; 16,384 acres in Prairie County; 10,201 acres in Arkansas County; and 2,061 in Pulaski County.

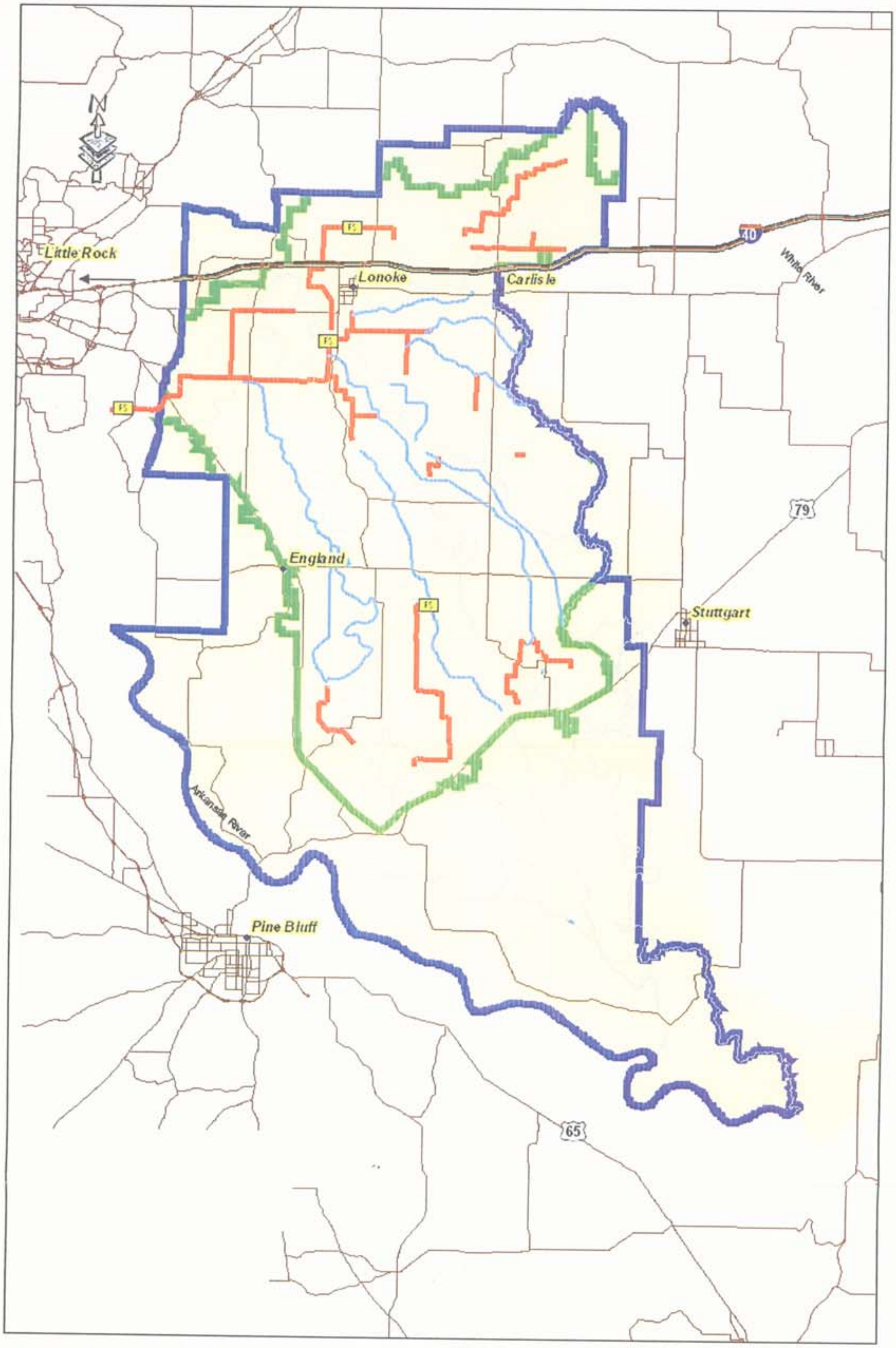
The area within Lonoke County includes, for the most part, lands bounded on the north by Wattensaw Bayou between the Prairie County line and Arkansas Highway 31; Arkansas Highway 236 between Arkansas Highway 31 and Arkansas Highway 89; and Interstate 40 between Arkansas Highway 15 and the Pulaski County line. The area is bounded on the west by Arkansas Highway 165 and Arkansas Highway 15, on the east by Prairie County, and on the south by Jefferson County.

Lands within the IPA in Jefferson County generally includes the area bounded on the north by Lonoke County, on the west by Arkansas Highway 15 and Arkansas Highway 88, and on the south and east by Arkansas Highway 79.

The IPA area within Prairie County generally includes lands bounded on the north by Wattensaw Bayou, on the west by Lonoke County, on the east in the general vicinity of Arkansas Highway 86, and on the south by Interstate 40.

Lands within the IPA in Arkansas County generally includes the area bounded on the north by Lonoke and Prairie County, on the west by Jefferson County, on the east by Big Ditch, and on the south by Arkansas Highway 79.

The IPA does not include all lands within the Bayou Meto Regional Irrigation Water Distribution District; however, all lands within the IPA are located within the Bayou Meto Regional Irrigation Water Distribution District boundaries. The IPA includes all lands within the delineated boundaries and contiguous land in same ownership.



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Memphis District

- Improvement Project Area (IPA)
- Bayou Meto Regional Irrigation Water Distribution District (BMRIWDD)
- Major Pump Stations
- Man-Made Canals
- Distribution Ditches
- Existing Streams
- Waterfowl Management Opportunities

Bayou Meto Basin, AR
IPA & BMRIWDD Boundaries

HISTORY

Rice was introduced as a commodity crop about 1905 to 1910 and has proven to be well suited to the area due to many factors including soils, topography, climate, and water supply. This area is part of one of the major rice producing areas in the world. Arkansas, ranked number one in rice production in the United States, annually produces approximately one half of the national crop. The problem of declining groundwater levels in the alluvial aquifer was first noted in 1927, and can be directly attributed to the extensive groundwater pumpage necessary to irrigate rice. By 1930, the U. S. Geological Survey (USGS) reported water levels were declining 10-14 inches/year in the alluvial aquifer. Numerous studies by Federal and state agencies since that time have shown that serious water declines in the water table have continued over the area. A project to provide supplemental water to the Grand Prairie Region and flood control to the Bayou Meto Basin was authorized by the Flood Control Act of 1950 and outlined in House Document 255; however, a project was never funded or constructed. The originally authorized project on Bayou Meto did not include a water supply component. The reevaluation of the project was initiated in 1998, subsequent to section 363(a) of WRDA 1996. Since the declining groundwater issue has become more prominent in the Bayou Meto Basin in recent years, there is a sense of urgency to find a solution as soon as possible. Analyses have shown that a total water management plan, which includes agricultural water supply, flood control, and waterfowl management, will provide for the protection of our natural resources, which includes migratory bird habitat and groundwater.

TOPOGRAPHY

The Bayou Meto project area is a flat alluvial plain forming a northwest to southeast elongated lowland lying generally between the Arkansas and White Rivers. The plain slopes gently southeastward from an elevation of about 260 feet northwest of Lonoke to about 190 feet at Highway 79. Relief is slight but more prominent along shallow stream valleys. The terrain consists of fluvial bottomland containing remnants of abandoned stream beds, meander scars, swamps, and oxbow lakes.

LAND USE

Table 1		
BAYOU METO BASIN, ARKANSAS		
Bayou Meto IPA		
Land Use		
Land Use	**Acres**	**Percent**
Cropland	276,814	64
CRP	4,453	1
Pasture & Hayland	33,717	8
Woodland	41,350	10
Reservoirs	4,893	1
Fish Ponds	22,079	5
Lakes, Streams, Other Water	10,650	2
Other 1/	39,210	9
Total	433,166	100

1/ This category includes transportation services, commercial/industrial, community services and "other" land uses.

Agricultural production accounts for most of the economic activity in the project area and is expected to continue to be the dominant economic activity in the foreseeable future. Forestland is 10 percent of the project area and is made up primarily of bottomland hardwood communities and isolated upland communities. Other land use consists primarily of urban areas, roads, utilities, and domestic and agricultural buildings. Primary land use is shown in Table 1.

Future cropping patterns and land use are expected to shift to dryland cropping as the water available for irrigation decreases under the without project conditions even though some landowners have tapped the Sparta aquifer to preserve land values and meet crop loan requirements. It should be noted that this is a temporary measure which is unsustainable and accomplished at a net loss to the farmer.

With project, the cropping pattern would remain basically the same as present. The quantity of prime farmland and farmland of statewide importance are also expected to be reduced by the amount of land required for storage reservoirs, tailwater recovery systems, and the delivery system of the project.

WATER RESOURCES

The water resources of eastern Arkansas, groundwater and surface water, cannot meet the demands that are being placed on them. The large quantity of water withdrawn for irrigation has resulted in rapidly declining groundwater levels.

Water is essential to the farmers of eastern Arkansas. Each year, these farmers risk planting crops that may be lost due to a lack of water. Such risk combined with tight credit and high production cost, could result in bankruptcy for a farmer with just one bad crop year. Water is the insurance that producers cannot be without. When securing financing, producers utilizing irrigation systems are considered much better risks. Today, a majority of lending institutions insists on irrigation systems before a loan application will be considered.

Irrigation is very important to crop production in Arkansas. Arkansas ranks fourth in the United States in irrigated acreage with approximately four million acres. Water has always been essential in growing rice - which is a billion dollar industry in eastern Arkansas. Arkansas accounts for almost 50 percent of the rice that is produced in the United States. Now, irrigation of other crops has become essential in sustaining production at profitable levels. When growth and yield factors are rated according to importance, the availability of water ranks at the top. Arkansas Soybean Performance Tests showed consistent yields in the 50 bushels per acre range when irrigated, compared to an average of 10 to 20 bushels per acre without irrigation.

Water Use

Water in eastern Arkansas is derived from groundwater and surface water, and is used primarily for agriculture and fish farming. Groundwater in eastern Arkansas is supplied primarily from the alluvial aquifer. Water use has continued to increase with time, particularly in the last 25 years following the elimination of rice acreage controls. Withdrawal of groundwater from the alluvial aquifer for agriculture started in the early 1900's in the Grand Prairie for irrigation of rice, and to a lesser extent, soybeans. Water-level declines in the alluvial aquifer were first documented in 1927. Capturing and storing runoff in tailwater recovery pits and reservoirs as a source of irrigation water has become common practice in the area.

The Corps' role in this project is to design a system that would utilize an alternate source of water, which would reduce the use of groundwater. Once approval is given to construct the project, the State of Arkansas will have the opportunity to regulate the groundwater. However, since rice production is at an optimum level, economics will determine future rice production.

The Bayou Meto IPA lies within parts of Lonoke, Prairie, Arkansas, and Jefferson Counties, all of which have experienced growth in groundwater usage. Figures 1A and 1B show this growth in two counties that make up the majority of the project area, and Figure 1C shows, in 1000 acres cells, the increase and decline in irrigated acreage through out the State of Arkansas. In recent years there has been substantial development of this deeper Sparta aquifer, particularly in those areas where the alluvial aquifer has experienced its greatest declines. The greatest area of development of the Sparta aquifer in eastern Arkansas has been in Lonoke County (Figure 1B), which is the northern portion of the Bayou Meto IPA. Water use from the Sparta aquifer has increased over seven hundred percent in Lonoke County in the last 10 years. As mentioned previously, this is both an uneconomic and unsustainable means of irrigation. Once a project is in place to provide supplemental water, Arkansas law will allow regulation of groundwater.

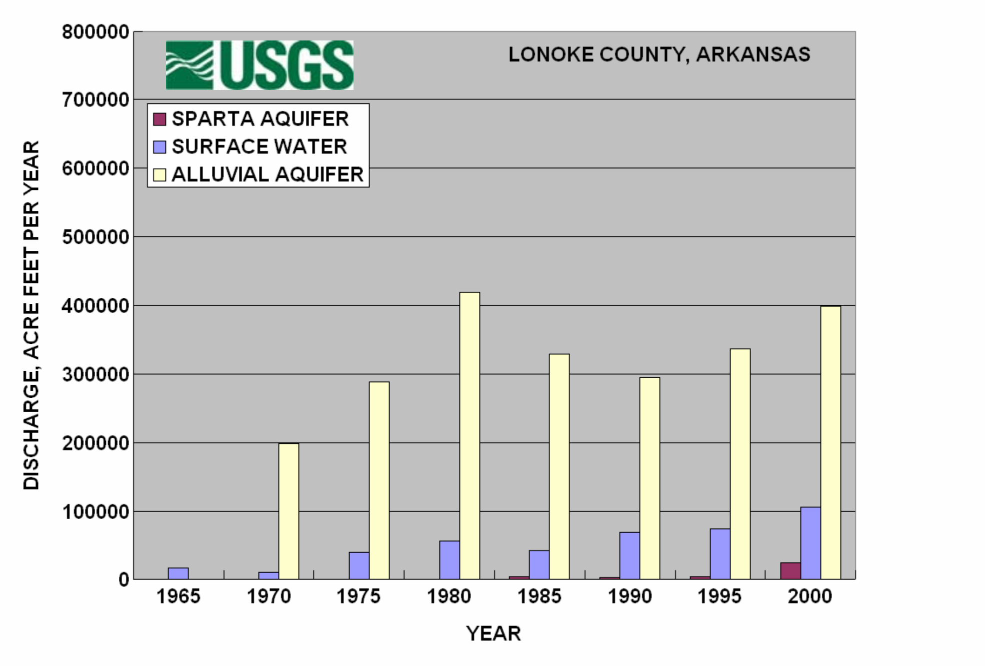


Figure 1A - Water Use in Lonoke County, 1965 through 2000.

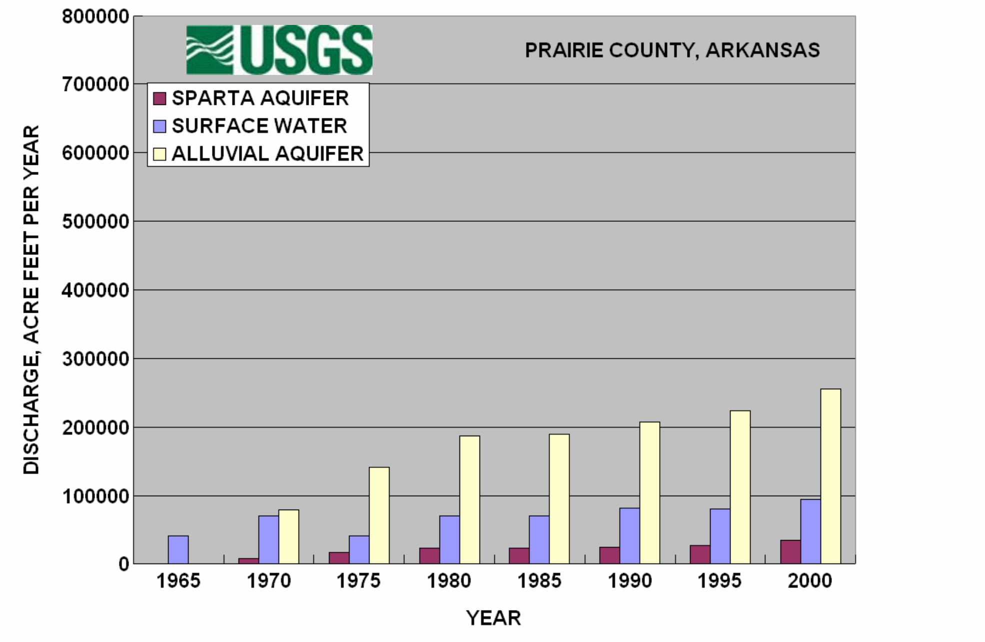


Figure 1B - Water Use in Prairie County, 1965 through 2000.

Red Dots = 1000 acre **decrease** in irrigated acres

Blue Dots = 1000 acre **increase** in irrigated acres

Source: (USDA National Agricultural Statistics Service)

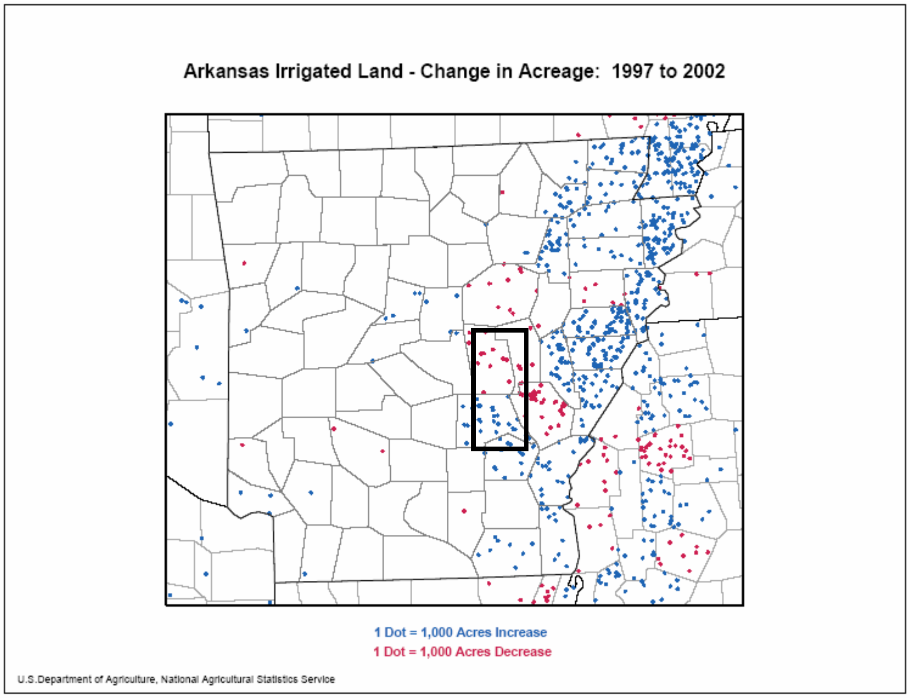


Figure 1C - Changes in Irrigated Acreage in Arkansas

Water Levels

Water levels in the alluvial aquifer are affected by groundwater use. As groundwater use increases, water levels in many parts of the alluvial aquifer have declined (Figures 3 and 5). Continuing water level declines in the alluvial aquifer have caused decreased flow from the alluvial aquifer to rivers where the water table still intercepts the river channels. In areas where the water table has dropped below these channels, inflow from the rivers into the aquifer occurs. Water in some areas of eastern Arkansas is being withdrawn from the alluvial aquifer at rates that exceed recharge, and therefore cannot be sustained indefinitely. This water-budget imbalance has resulted in regional water-level declines, formation of extensive cones of depression, reduction of the amount of water in storage, and decreases in well yields. Large cones of depression have formed in two areas (the Cache River area west of Crowleys Ridge and the Grand Prairie – Bayou Meto area) and continue to expand. Water levels will continue to decline unless withdrawals from the alluvial aquifer are reduced and needed water is supplied from supplemental sources.

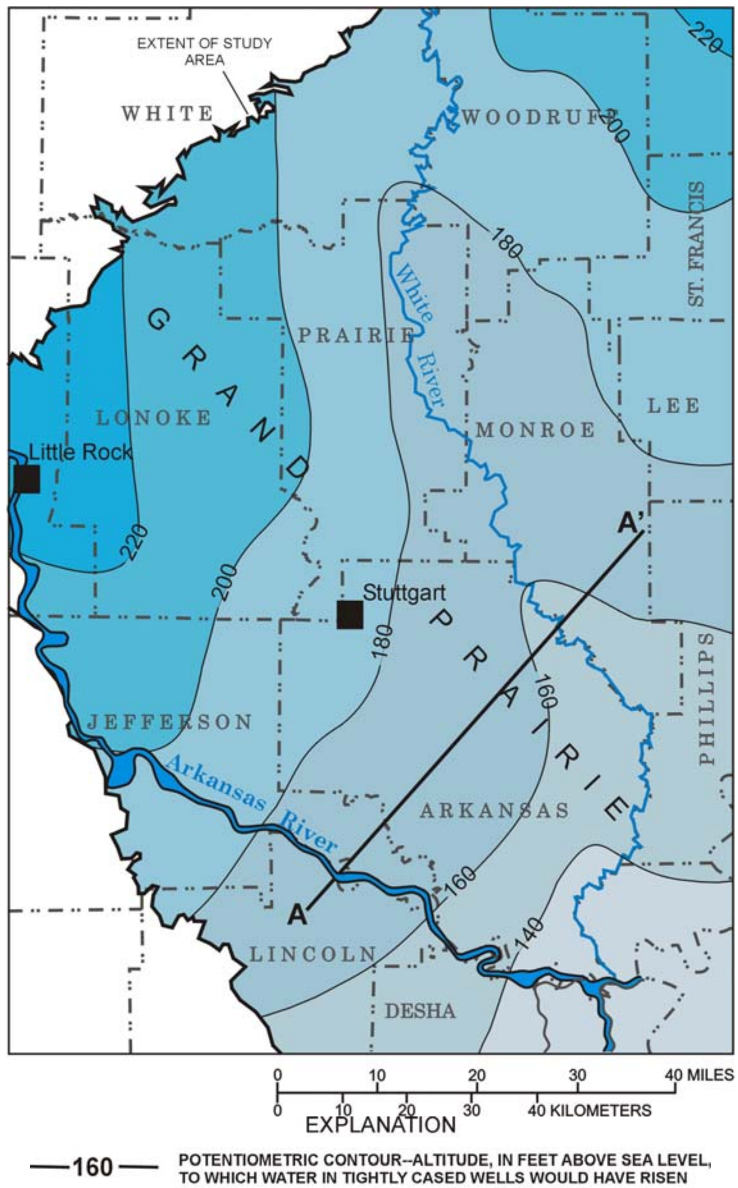


Figure 2 - Simulated predevelopment potentiometric surface of the alluvial aquifer in the Grand Prairie area (modified from Ackermann, 1996). The potentiometric surface represents the level to which water in a tightly cased well would have risen. Prior to development, the alluvial aquifer was under confined conditions; that is, water levels in the aquifer would rise higher than the base of the "clay cap".

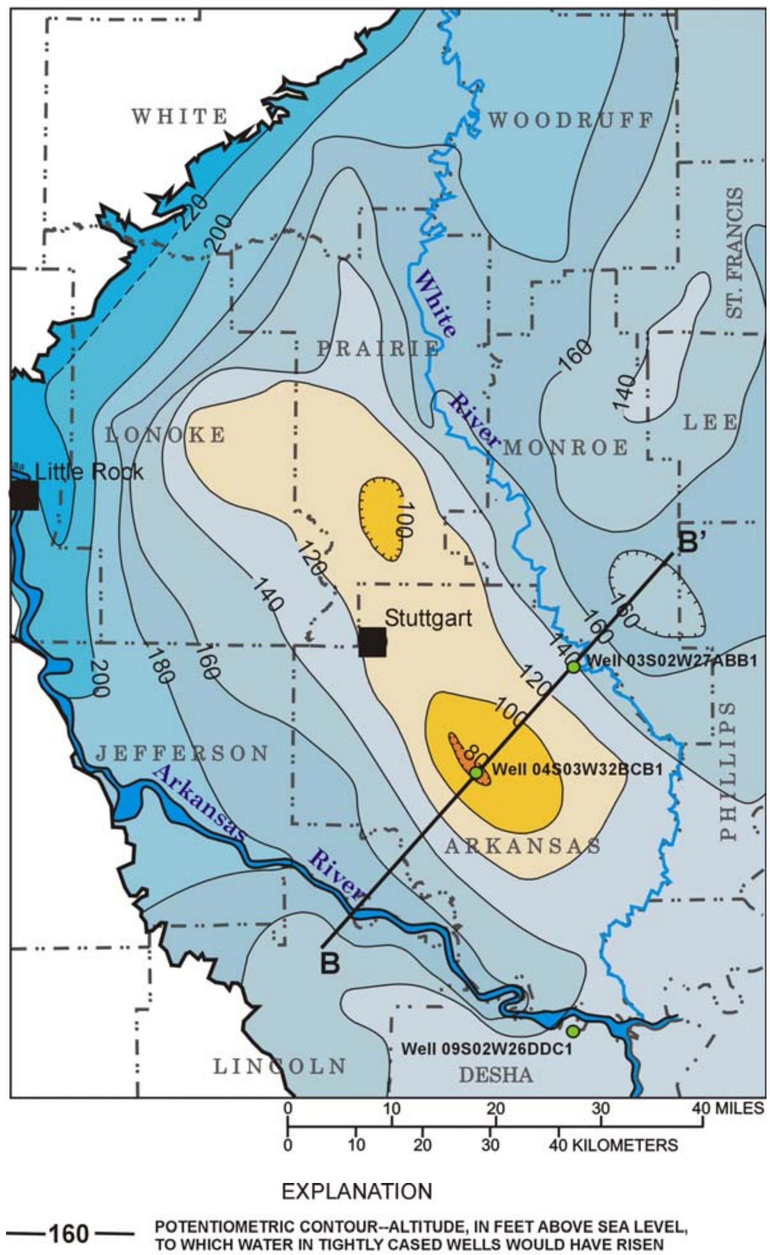


Figure 3 - Potentiometric surface of the alluvial aquifer in the Grand Prairie area, spring 1998 (Joseph, 1999). Water levels have declined below the "clay cap" in many areas.

Hydrologic Characteristics

The Mississippi River Valley alluvial aquifer (hereafter referred to as the alluvial aquifer) is an excellent source of water because of its favorable hydrologic characteristics. Total thickness of the alluvial aquifer in Arkansas ranges from about 50 to 150 feet, thus providing a limited but still considerable amount of stored groundwater. Throughout much of Arkansas, the alluvial aquifer is overlain by a silt and clay unit that is generally 10 to 50 feet thick but in places may exceed 100 feet. This unit is referred to locally as the "clay cap." Water levels in wells completed in the alluvial aquifer prior to 1900 (defined as predevelopment conditions) were above the base of this clay cap (Figures 2 and 4), caused by confined conditions within the underlying aquifer (that is, all the pore spaces within the aquifer were water filled, and the hydraulic pressure was greater than atmospheric pressure). Subsequent heavy pumping and declining water levels (Figures 3 and 5) have resulted in: (1) unconfined conditions (that is, some of the upper parts of the aquifer are now partially air filled), and (2) reductions in hydraulic pressure, saturated thickness, stored water, lateral flow within the alluvial aquifer, and base flow to streams throughout most of its extent in Arkansas.

The alluvial aquifer is critically important to the economy of the Bayou Meto IPA. However, its water has been mined for agricultural practices at a rate that exceeds its capacity to replenish itself dynamically. This is certainly not sustainable for the long term. Prior to development of the aquifer for rice production at the turn of the century, discharge from the aquifer served as a source to streams within the basin and the adjacent rivers such as the White and Arkansas (Figure 4). However, as irrigated acreage increased, the demands placed on the aquifer also increased. Eventually, the demands placed upon the aquifer became such that it no longer served as a source of water to the rivers. Instead of being a source, the alluvial aquifer is now recharged by these major rivers (Figure 5). Although the alluvial aquifer is being recharged by the adjacent rivers, this induced recharge plus all additional recharge induced from non-river sources (rainfall on the land surface, underlying and adjacent formations, and the interior highlands) is not sufficient to match groundwater withdrawals. Thus water levels within the alluvial aquifer will continue to decline.

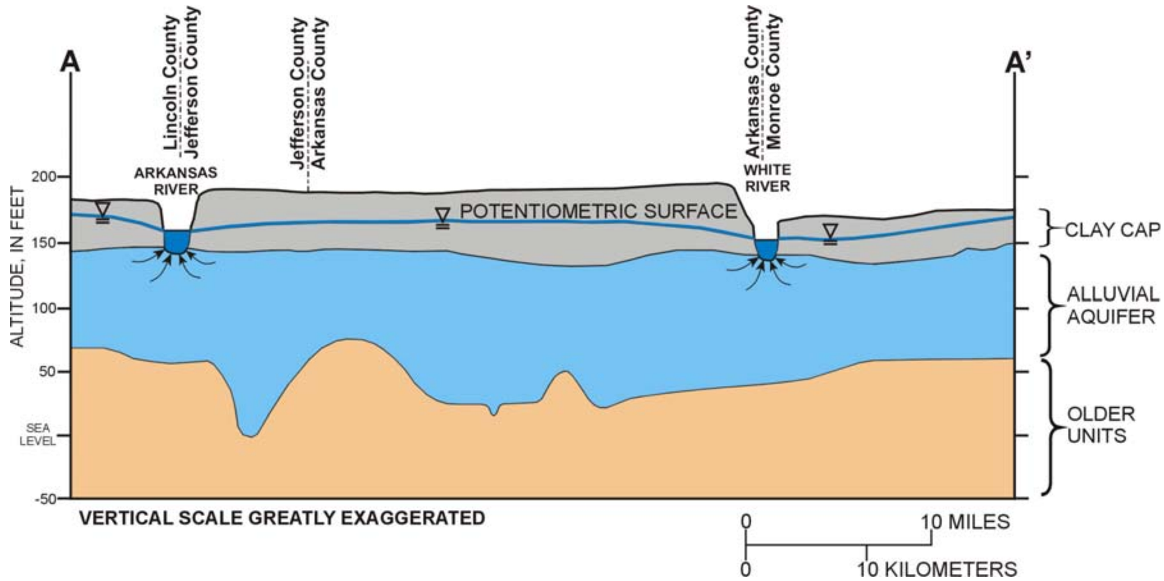


Figure 4 - Predevelopment surface along a southwest to northeast line of section through the alluvial aquifer. Confined conditions existed throughout the area. Geologic unit contacts were derived from borehole cuttings and geophysical logs (Czarnecki and others, 2002). Corresponding line of section appears in Figure 2.

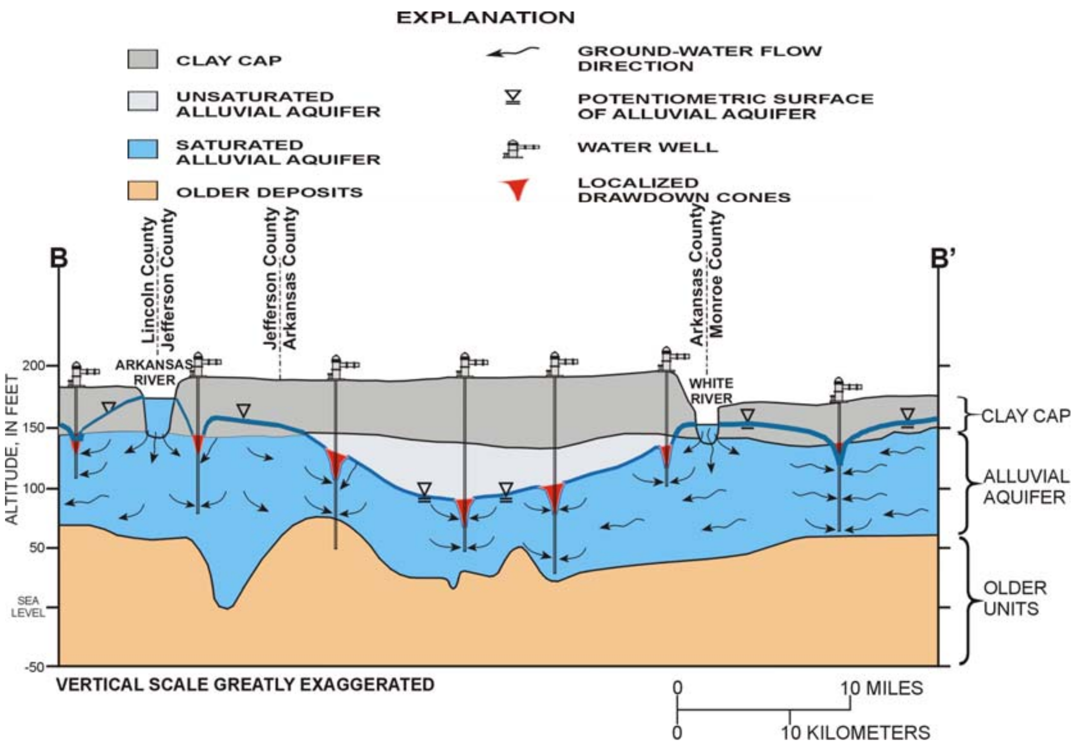


Figure 5 - Water levels in spring 1998 following sustained pumping along a southwest to northeast line of section through the alluvial aquifer. Unsaturated and unconfined conditions have occurred in zones that were previously confined (Czarnecki and others, 2002). Corresponding line of section appears in Figure 3.

Surface Water

Natural drainage of the project area is provided by tributaries of the Arkansas River and White River. The major tributaries include Bayou Meto, Two Prairie Bayou, Indian Bayou, Wattensaw Bayou, and Little Bayou Meto. Smaller tributary systems include Wabbaeska Bayou, Baker's Bayou, Salt Bayou Ditch, Big Ditch, and Crooked Creek.

Bayou Meto is the primary tributary within the project area and provides drainage for urban, agricultural, and woodland areas. The headwaters of Bayou Meto are located north and west of the project area near Jacksonville, Arkansas. Bayou Meto flows generally south and east from Jacksonville, toward and through the Bayou Meto Wildlife Management Area, and continues to its confluence with the Arkansas River near Gillett. The Bayou Meto Basin is a major wintering area for waterfowl in Arkansas.

Two Prairie Bayou begins west of Cabot, flows generally south and east toward Carlisle and then meanders south to its confluence with Bayou Meto north of U.S. Highway 165. The Smoke Hole State Natural Area is located adjacent to Two Prairie Bayou.

Indian Bayou starts at Kerr and flows generally south and east toward England. A large portion of Indian Bayou has been channelized. East of England, the flow is split. The original channel continues south and east. Indian Bayou Ditch turns due south along the range line between range 8 and 9 west. Near Tucker Prison Farm, Indian Bayou Ditch turns back southwest to its intersection with Wabbaseka Bayou. The original Indian Bayou channel continues its wide meander pattern to its junction with Wabbeseka Bayou on the Tucker Prison Farm.

The hydraulics and hydrology of the area have been significantly modified by man-made ditches and levees. Although a significant amount of channel work has been completed, flooding is still a major concern of the landowners within the Bayou Meto Basin, particularly in the southern portion of the basin.

Groundwater

Groundwater serves as a source of well water and can provide base flow for some streams. Aquifers are geologic formations capable of storing and transmitting water: they serve as both a storage reservoir and a conduit for water flow. There are generally two types of aquifers, unconfined and confined. In unconfined aquifers, the saturated zone is free to rise and fall in response to recharge and discharge to wells. Atmospheric pressure changes are freely transmitted downward, through the unsaturated zone, to the saturated zone which is commonly called the water table. Unconfined aquifers yield water by draining aquifer material near a well. A well produces water by lowering the water table adjacent to it in the shape of an inverted cone commonly referred to as a "cone of depression".

Unconfined Aquifer

The Mississippi River Valley alluvial aquifer, often simply termed the "alluvial aquifer", is a water-bearing assemblage of gravels and sands that underlies some 32,000 square miles of the Mississippi embayment extending from the apex of the embayment near the Illinois border, to the Gulf of Mexico, including parts of Illinois, Missouri, Kentucky, Tennessee, Mississippi, Alabama, Louisiana, Texas, and Arkansas. In Arkansas, the alluvial aquifer extends from the Mississippi River in the eastern part of the State to near the fall line (the line dividing the mountainous highlands of Arkansas from the lowland area) roughly defined by the Interstate 30-Highway 167 corridor and is the uppermost aquifer across this area.

Thickness of the alluvial aquifer sands and gravels ranges from about 50 to 150 ft. Through much of Arkansas, these sands and gravels are overlain by a silt and clay unit that is generally 10 to 50 ft in thickness but occasionally exceeds 100 ft. This unit is termed the Mississippi River Valley confining unit and frequently is simply called the "clay cap".

The development of water from the alluvial aquifer has primarily been for agricultural use. Withdrawal of large quantities of water for irrigation started in the early 1900's in the Grand Prairie and Bayou Meto Basin. Substantial decreases in water levels were first documented in 1927. The primary use of groundwater in this region has been for agricultural purposes since the early 1900's. Rice and, to a lesser extent, soybeans have been the major crops grown. Studies conducted by the U. S. Geological Survey and Arkansas Soil and Water Conservation Commission show that, throughout portions of eastern Arkansas, water levels in the alluvial aquifer are declining about 1 foot per year. In some areas water levels in the alluvial aquifer have declined as much as 90 feet since irrigation began. Since 1965, the USGS has published water-use data for Arkansas every 5 years. The water-use estimates were determined using county crop irrigated acreage totals and multiplying the acreage by a water-use coefficient (by crop type). This method of estimation was used until about 1995. Since 1995, site-specific water-use data have been available on an annual basis. Estimated water-use from the alluvial aquifer has increased from 113.45 million gallons per day (Mgal/d) in 1965 to 517.39 Mgal/d in 1998. This represents an increase in water use from the alluvial aquifer of 356 percent.

The trend of growth in ground-water use through time and across various areas has controlled the response of alluvial aquifer water levels; that is to say, that as ground water has been developed in an area, water levels have responded by declining in that area and that as groundwater use has been maintained at levels greater than recharge or increased through time, a long-term trend of declining water levels through time has been established. Although pumpage and water level declines in the alluvial aquifer have resulted in decreased outflow from the aquifer to rivers, increased inflow into the aquifer from rivers, and an increase of inflow through the clay layer, these increased recharge inputs have not been sufficient to meet growing demands. Recent hydrologic data show that water in many areas of eastern Arkansas is being withdrawn from the alluvial aquifer at rates that are much greater than recharge to the aquifers, and hence are much greater than what can be sustained for the long term. The long-term excess of pumpage over recharge has resulted in regional water-level declines, formation of cones of depression, reduction of the amount of water in storage, and decreases in well yields. Massive cones of depression in aquifer water levels have formed two areas (the Cache River area west of Crowleys Ridge and the Grand Prairie – Bayou Meto area) and continue to grow. The largest cone of depression in the alluvial aquifer in the State lies in the Grand Prairie – Bayou Meto area. Water levels will continue to decline unless withdrawals from the alluvial aquifer are reduced by a gross decrease in water use or some combination of water conservation and development of alternative resources.

Water from the Mississippi River Valley alluvial aquifer is suitable for most uses and is used extensively for irrigation and industry. It is used for public supply, usually with treatment, only where an adequate supply of water of better quality is not available from deeper aquifers. The water characteristics cited most frequently that limit the usefulness of water for public supply from the alluvial aquifer are excessive hardness, high concentrations of iron and manganese, and high salinity. However, in most areas the alluvial aquifer is very well suited for agricultural supply.

While the alluvial aquifer is an exceptional aquifer, capable of supplying volumes of water needed for high-demand agricultural needs, the aquifer does have its limits. The aquifer represents a finite and specific volume of sediment that holds a limited amount of water with a very limited, low rate of recharge water being added through time; this recharge rate is much lower than current pumping rates and therefore water is being removed from the aquifer and water levels continue to decline in many areas. Some areas of the aquifer exhibit greater water-level declines; these areas are at a disadvantage with respect to receiving recharge while the aquifer is under intense pumping stress because the remote, downstream/downgradient position of the areas relative to the river recharge and interception of recharge by wells located near the rivers. The rate at which water is being removed from the alluvial aquifer cannot be sustained indefinitely. The small zones of depletion (less than 50 ft of saturated thickness) that currently exist will grow under the current pumpage rates just as the cones of depression have expanded; this rate of expansion will increase with any increases in pumpage rates. However, areas of the aquifer located near rivers will always be in good condition relative to areas remote from the rivers because of the time that recharge water takes to move from the input point to areas downgradient and because of the interception of much of the recharge by wells located near the rivers.

Water use in the Bayou Meto IPA between 1965 and 2000 increased 187 percent in the alluvial aquifer.

<u>Confined Aquifer</u>

Confined aquifers are those that are overlain and underlain by impermeable rock, clay or other material which prevents vertical movement of air or water. When a confined aquifer is penetrated by a tightly cased well, water will rise in the pipe to an elevation above the top of formation being tapped. These aquifers are termed "artesian" although all do not discharge water above the ground surface. Confined aquifers yield water by expansion of the water, compression of the aquifer, drainage of adjacent unconfined zones, and vertical leakage through confining layers.

The Sparta aquifer is a confined aquifer of regional importance that extends from south Texas, north into Louisiana, Arkansas, and Tennessee, and eastward into Mississippi and Alabama. The thickness of the Sparta aquifer ranges from less than 100 ft in some areas near the outcrop up to 1,000 ft in the southeastern part of the State. Because the Sparta aquifer is confined and is fully saturated, water within the aquifer is under pressure, and, when a cased well is completed in the Sparta, water levels rise above the top of the formation. Changes in pumping cause pressure changes within the aquifer, and these pressure changes rapidly transfer across the aquifer. If water levels drop below the top of a confined aquifer, offset of the weight of the Sparta Sand and overlying formations by hydraulic pressure head reaches a minimum and buoyant support of the aquifer by water is lost. These conditions result in compaction of aquifer material and can damage the aquifer by decreasing the rate at which water can move through the aquifer. Therefore, maintaining water levels above the top of a confined aquifer protects the integrity of the aquifer for long-term use.

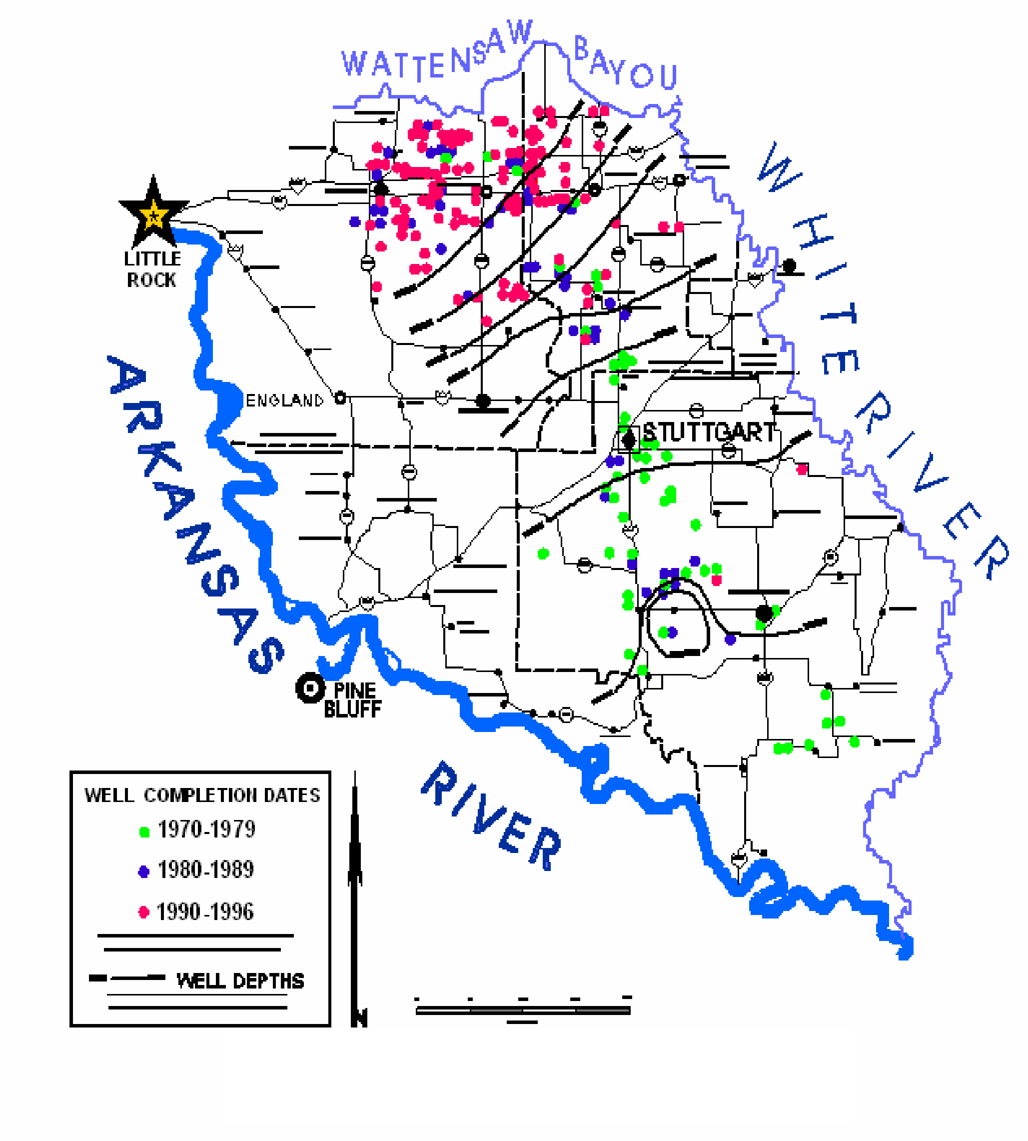
As a confined aquifer, the Sparta aquifer produces water under pressure—that is a volume of water is yielded from the aquifer by incurring a reduction in pressure. The amount of water available from storage in a confined aquifer is quite small in comparison with an unconfined aquifer like the alluvial aquifer. To give a direct comparison to the alluvial aquifer, a 1-ft decline in water level in the alluvial aquifer results in the yield of about 0.3 ft^3 of water from a 1-ft^2 area. To produce an equal volume from the Sparta aquifer, a 1-ft decline in water levels across a 500,000 ft^2 area is required. While the Sparta aquifer is capable of producing considerable amounts of very high quality water, the Sparta aquifer is obviously not capable of producing volumes comparable to the alluvial aquifer. Heavy, long-term pumping stresses in the Sparta aquifer result in the regionally extensive water level declines and formation of regional scale cones of depression. Even though the amount of water being withdrawn annually from the Sparta aquifer is much less than what is withdrawn from the alluvial aquifer, the extensive water-level declines observed in the Sparta aquifer and the development of cones of depression show that water is being withdrawn from the Sparta aquifer at rates that are much greater than the rate at which water is being recharged to the aquifer. The Sparta aquifer will not indefinitely sustain the current rates of withdrawals, and certainly will not be able to sustain the continued growth in withdrawals rates observed in many areas. This growth in withdrawals rates observed will result in accelerated water level declines. The impact of increased pumping will be particularly pronounced in areas where high-volume, agricultural alluvial aquifer users are beginning to tap the Sparta as a supplemental source of water.

The trend of growth in ground water use through time and across various areas has controlled the response of Sparta aquifer water levels; that is to say, that as ground water use has been developed in an area, water levels have responded very rapidly (due to the confined condition of the aquifer) by declining in that area. As ground water use in an area has been maintained at levels greater than recharge, or increased through time, a long-term trend of declining water levels through time has been established. Recent studies show that water in several areas of eastern and southeastern Arkansas is being withdrawn from the Sparta aquifer at rates that are much greater than recharge, and hence are much greater than what can be sustained for the long term. The long-term excess of pumpage over recharge has resulted in regional water-level declines, formation of cones of depression, reduction of the amount of water in storage, and decreases in well yields. Large cones of depression in aquifer water levels have formed in several areas in eastern Arkansas and continue to grow. Water levels will continue to decline unless withdrawals from the alluvial aquifer are reduced by a gross decrease in water use or some combination of water conservation and development of alternative resources.

The Sparta aquifer that underlays the alluvial aquifer offers little with respect to long-term dependability. This aquifer cannot provide the volume of groundwater that the alluvium aquifer does; widespread use would quickly deplete reserves. However, this aquifer is being tapped as the alluvial aquifer is depleted; and, as a consequence, water levels in the Sparta aquifer in the Grand Prairie Region and Bayou Meto Basin have declined as much as 100 feet since 1905.

The greatest area of development in the Sparta aquifer in eastern Arkansas has been in Lonoke County in the northern portion of the Bayou Meto IPA. Water use in the Bayou Meto IPA between 1965 and 2000 increased 67 percent in the Sparta aquifer. In Lonoke County water use in the Sparta aquifer increased over 700 percent in the last 10 years. Figures 6 and 7 show this graphically. Figure 8 shows the Sparta well developed from 1970 to 1996. Placement of these "deep" wells has been considered as a last resort due to the depths of the wells (some in excess of 800 feet) and the high-energy costs required to recover the water. As a note, the hydraulic conductivity, which can be thought of as a measurement of the aquifers capability to recharge itself, of this deeper aquifer is much less than the "shallow" or alluvial aquifer, as previously discussed. The deep wells that have been installed to date are already creating significant declines on the water levels within the aquifer. Current well data shows near 100-foot declines in the Sparta aquifer for some areas. Obviously, this deep aquifer which serves as the municipal water supply within this region cannot be viewed as a solution to the declining groundwater levels within the alluvial aquifer. As mentioned previously, use of the Sparta aquifer for agricultural production is a temporary measure that is both uneconomical and unsustainable for the farmer.

Figure 8
SPARTA WELL DEVELOPMENT
Grand Prairie Region and Bayou Meto Basin



Critical Groundwater Designation

The Arkansas Ground Water Protection and Management Act (Act 254 of 1991) provides for the designation of critical groundwater areas based on significant groundwater declines and/or water quality degradation. The Arkansas Natural Resources Commission (ANRC) has this responsibility. The ANRC has authority through Act 154 of 1991 to limit groundwater use through the issuance of groundwater rights within critical groundwater areas. However, regulation is a last resort and conservation to include development of alternative sources of water and education are the preferred method of groundwater protection. Act 1426 of 2001 provides:

- Any well constructed after 30 September 2001 must be metered.
- After 30 September 2006 all wells must be metered.

Figure 9
Critical Groundwater Area
Sparta and Alluvial
Aquifers
Bayou Meto Basin

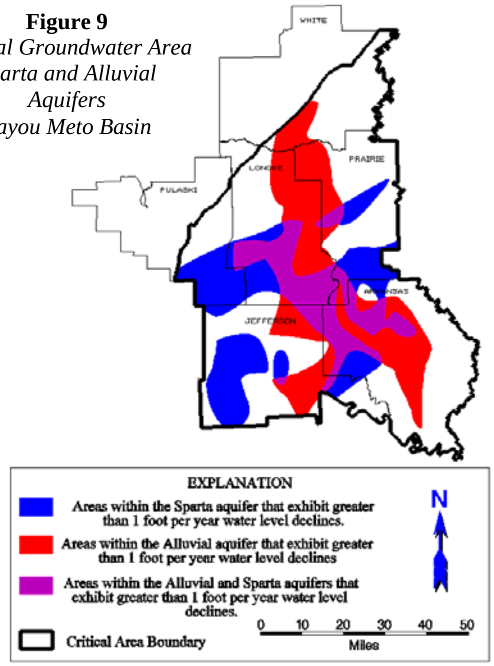


Figure 10

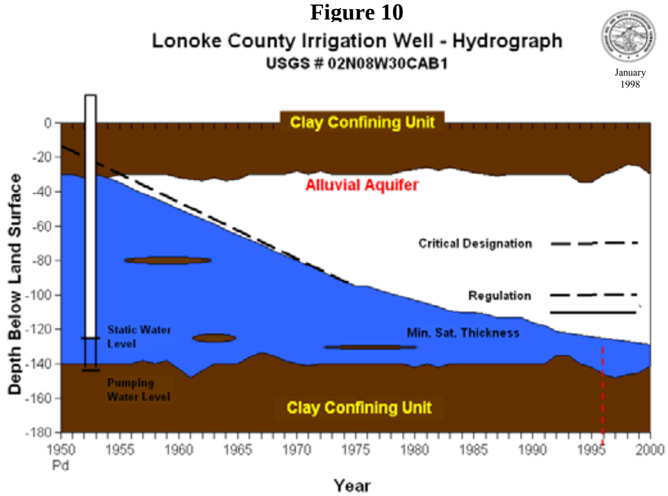


Figure 9 shows one of the two areas in eastern Arkansas that is currently designated as a critical groundwater area. This area which includes the Bayou Meto project area was designated as a critical groundwater area in 1998. Figure 10 shows the aquifer level (50% remaining saturated thickness) at which critical designation occurs and where regulation would be proposed.

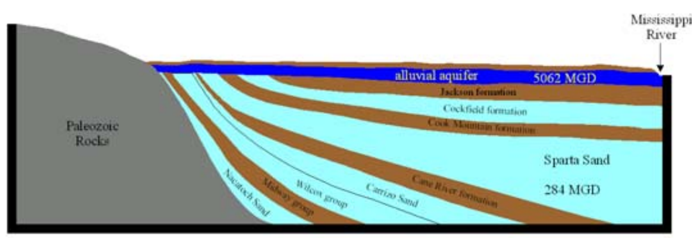
HYDROLOGY

The topography of the project area is that of old river runs adjacent to prairie land. Many existing streams dissect the topography creating a complicated drainage system. The largest stream within the project area is Bayou Meto, which originates in the northwest corner of the project area and flows toward the southeast, passing east of the Bayou Meto Wildlife Management Area and exiting into the Arkansas River through gated drainage structures. Most of the project area drains toward the south, but the portion north of Interstate 40 primarily drains to the northeast.

GEOLOGY

Figure 11

Generalized Geology of Eastern Arkansas



Modified from USGS Water Supply Paper 2275

The Bayou Meto Project lies within the Mississippi Alluvial Plain physiographic region, which in turn is a part of the Gulf Coastal Plain physiographic province. The project is underlain by deep sedimentary deposits of the Mississippi Embayment, a geosynclinal trough plunging southward beneath the Mississippi River Valley. The western margin of the embayment is marked by the northeast-southwest trending "Fall Line" which passes through Little Rock near the northwest end of the project. The Fall Line is a common name applied to the abrupt decline of highland rock formations beneath the younger unconsolidated sediments of the alluvial plain; structurally, it represents the western flank of the embayment.

Sediments in the Bayou Meto Project area consist of Recent to Pleistocene alluvial deposits ranging in thickness from about 50 to 150 feet. The predominantly fine-grained Recent alluvium blankets the surface of the project area. The underlying Pleistocene strata consist of a basal gravel and coarse to medium sand grading upward to fine sand overlain by clay and silt. The upper, low-permeability soils form a confining layer to the underlying sands and gravel which are waterbearing. This confining layer, known locally as the "clay cap", is generally about 25 feet thick over the project area, but can range in thickness from

10 feet to more than 50 feet. The water-bearing sediments are continuous over most of eastern Arkansas, and are known as the Mississippi River Valley alluvial aquifer. The aquifer has an estimated hydraulic conductivity ranging from 120 feet to 390 feet per day, and in the Bayou Meto project area, its thickness varies from 50 feet to 150 feet. These thickness variations in the aquifer are related to the paleotopography of the underlying Tertiary contact as well as the variable thickness of the confining layer.

Regional ground-water flow is generally southward throughout the alluvial aquifer except in areas of large withdrawals. One large withdrawal area is the Grand Prairie, just northeast of Bayou Meto, where rice and other crops require considerable irrigation pumpage. The alluvial aquifer was early recognized as a ready source of irrigation water, and the impermeable surface soils were recognized as a natural seepage retardant. Irrigation water demands have created a cone of depression beneath the Grand Prairie, and lowered the groundwater in the project area. As a result, the groundwater flow in the Bayou Meto project is largely northeast into this cone of depression, rather than the typical southward regional flow.

The Mississippi River Valley alluvial aquifer is underlain by generally less permeable Tertiary strata. Successively downward, the Tertiary deposits consist of interbedded clay, silt, and sand of the Jackson, Claiborne, Wilcox, and Midway Groups. Although some water is produced from sands in the upper three groups, the overlying Quaternary alluvium remains the principal aquifer.

SOILS

The soils within the project area range from the heavy clays to the loams, to the river sands. Most of the soils can be classified as prime farmland provided adequate drainage has been accomplished. These soils are very well suited for crop production and provide excellent yields with proper moisture levels.

Major soils within the Bayou Meto IPA include the Perry, Hebert, Crowley, Calhoun, Calloway, and Portland series.

The Perry series consists of deep, poorly drained, very slowly permeable soils that formed in clayey alluvium on bottomlands of the Arkansas River. These soils are on broad flats and in depressions that were backswamps of the Arkansas River. They have a high water table in late winter and early spring. The native vegetation under which these soils formed was mixed hardwood forest. The slopes range from 0 to 1 percent.

The Hebert series consists of deep, somewhat poorly drained, moderately slowly permeable, level soils that formed in loamy alluvium on bottomlands of the Arkansas River. These soils are on the lower parts of the natural levees bordering abandoned stream channels of the Arkansas River. The native vegetation under which these soils formed was mixed hardwood forest. The slopes range from 0 to 1 percent.

The Crowley series consists of deep, level, somewhat poorly drained, very slowly permeable, loamy soils on terraces. These soils typically have layers with high clay content within about 12 to 30 inches of the surface. Depth to these layers should be determined before land leveling is attempted. This soil is well suited to cultivated crops such as rice, soybeans, and grain sorghum. Wetness is a moderate limitation and surface drainage may be needed in some areas. Nearly all the acreage of this soil is cultivated.

The Calhoun series consists of deep, level, poorly drained, slowly permeable, loamy soils on broad flats. These soils are well suited for rice production and moderately suited for most other crops. Wetness is the main restriction on these soils and surface drainage is needed in most areas. Most areas of this soil have been cleared and are used for production of rice, soybeans, and grain sorghum.

The Calloway series consists of deep, level to nearly level, somewhat poorly drained, slowly permeable, loamy soils on terraces. These soils typically have a compact, brittle fragipan at a depth of about 24 to 36 inches. These soils are well suited for crop production. Wetness is a moderate limitation on level areas and surface drains may be needed. Erosion is a moderate hazard on nearly level areas. Practices such as minimum tillage, contour farming, and the use of cover crops help reduce runoff and control erosion. Most areas of this soil have been cleared and are used for production of soybeans, rice, grain sorghum, and wheat.

The Portland series consists of deep, somewhat poorly drained, very slowly permeable soils that formed in clayey slackwater deposits in bottomlands of the Arkansas River. They have a high water table in late winter and early spring. The native vegetation under which these soils formed was mixed hardwood forest. The slopes range from O to 1 percent.

Minor soils within the project area include moderately steep, moderately well drained, silty loam Loring soils on terraces and uplands in the Loess Hills and Loess Plains; well drained, silty loam Rilla soils on higher parts of older natural levees; moderately well drained, silty loam Stuttgart soils on broad flats and terraces in the Loess Plains; and poorly drained, silty loam Tichnor soils on floodplains of streams in the Loess Hills and Loess Plains.

The majority of the soils in the project area has restrictive layers (i.e., traffic pans) that limit rooting and water holding capacity, as well as restrict vertical groundwater recharge. This is due to movement over the landscape by agricultural equipment. As a result, crops cannot endure long periods without moisture replenishment during summer months.

Table 2 BAYOU METO BASIN, ARKANSAS Bayou Meto IPA Soils Information					
SOILS SERIES	**GENERAL CHARACTERISTICS**	**PHYSICAL LOCATION**	**PROBLEMS**	**LAND USE**	**CROPS**
Perry	Deep, poorly drained, very slowly permeable, loamy soils	Broad flats and depressions	Wetness	Woodland	None
Hebert	Deep, somewhat poorly drained, moderately slowly permeable, level	Old abandoned channels of the Arkansas River	Wetness and surface drainage	Mixed Hardwood	None
Crowley	Deep, level, somewhat poorly drained, very slowly permeable, loamy soils	Terraces	Moderate wetness and surface drainage	Cropland	Rice, soybeans, and grain sorghum
Calhoun	Very deep, level, poorly drained, slowly permeable, loamy soils	Broad flats	Wetness and surface drainage	Cropland	Rice, soybeans, and grain sorghum
Calloway	Very deep, level to nearly level, somewhat poorly drained, slowly permeable, loamy soils	Terraces	Moderate wetness and erosion	Cropland	Soybeans, rice, grain sorghum, and wheat
Portland	Deep, somewhat poorly drained, very slow permeability, loamy soils	Bottomlands	Wetness and surface drainage	Mixed bottomland hardwood	None

NAVIGATION

The River and Harbor Act of July 24, 1946 (Public Law 91-649), authorized the development of the Arkansas River and its tributaries for the purposes of navigation, flood control, hydropower, water supply, recreation, and fish and wildlife. Public Law 91-649 stated that the project would be known as the McClellan-Kerr Arkansas River Navigation System. Reservoirs in the upper Arkansas River Basin support navigation and are operated as part of the navigation system to maintain flow. A series of 17 locks and dams, 12 in Arkansas and 5 in Oklahoma, provide navigation from the Mississippi River to the Port of Catoosa near Tulsa, Oklahoma, a distance of about 450 miles. A map of the McClellan-Kerr Arkansas River Navigation System is shown in Figure 12.

The navigation channel begins at the confluence of the White and Mississippi Rivers in southeastern Arkansas. The first 10 miles upstream are navigated via the White River to the Arkansas Post Canal, which conveys river traffic into the Arkansas River. The navigable waterway crosses Arkansas into Oklahoma. The system changes from the Arkansas River into the Verdigris River at Muskogee, Oklahoma and terminates 50 miles upstream on the Verdigris River at Catoosa. The McClellan-Kerr Arkansas River Navigation System provides a year round navigation channel with a minimum nine-foot depth. System channel widths maintained by the Corps of Engineers are as follows:

- White River - 300 Feet
- Lake Langhofer - 300 Feet
- Arkansas Post Canal - 300 Feet
- Arkansas River - 250 Feet
- Sans Bois Creek - 225 Feet
- Verdigris River - 150 Feet

Each of the seventeen locks measures 110 feet wide and 600 feet long. Individual locks have lifts ranging from 14 feet to 54 feet. The locks in the system provide a total lift of 420 feet. The upstream lakes in eastern Oklahoma play a vital role in the system operation. These multipurpose lakes provide for low flow regulation, sediment control, flood control, domestic and industrial water supply, hydroelectric power, recreation, and fish and wildlife habitat.

The Montgomery Point Lock and Dam has been constructed one-half mile upstream from the Mississippi River in the White River Entrance Channel. The project includes a 600-foot by 110-foot lock, a 300-foot navigable pass dam, and a 200-foot concrete spillway. Construction of the Montgomery Point Lock and Dam will allow control of the water level in the entrance channel which will maintain the reliability of the navigation system during periods of low water.

The Flood Control Act of 1946, which authorized construction of the navigation project, was modified by Public Law 100-202 dated 22 December 1987, to include agricultural water supply as an authorized purpose. This provision allowed for raising pools for purposes of irrigation provided that other authorized purposes are not adversely impacted and adequate real estate easements are obtained.

There have been discussions to increase the navigation channel to 12 foot deep throughout the Arkansas River navigation system. The reliability of the agricultural water delivery system was based on the current system which has a navigation channel that is 9 foot deep. A 12 foot deep navigation channel would increase the reliability of the agricultural water delivery system. Since the maximum diverted flow will remain 1,750 cfs, the effect on the Arkansas River will remain insignificant.

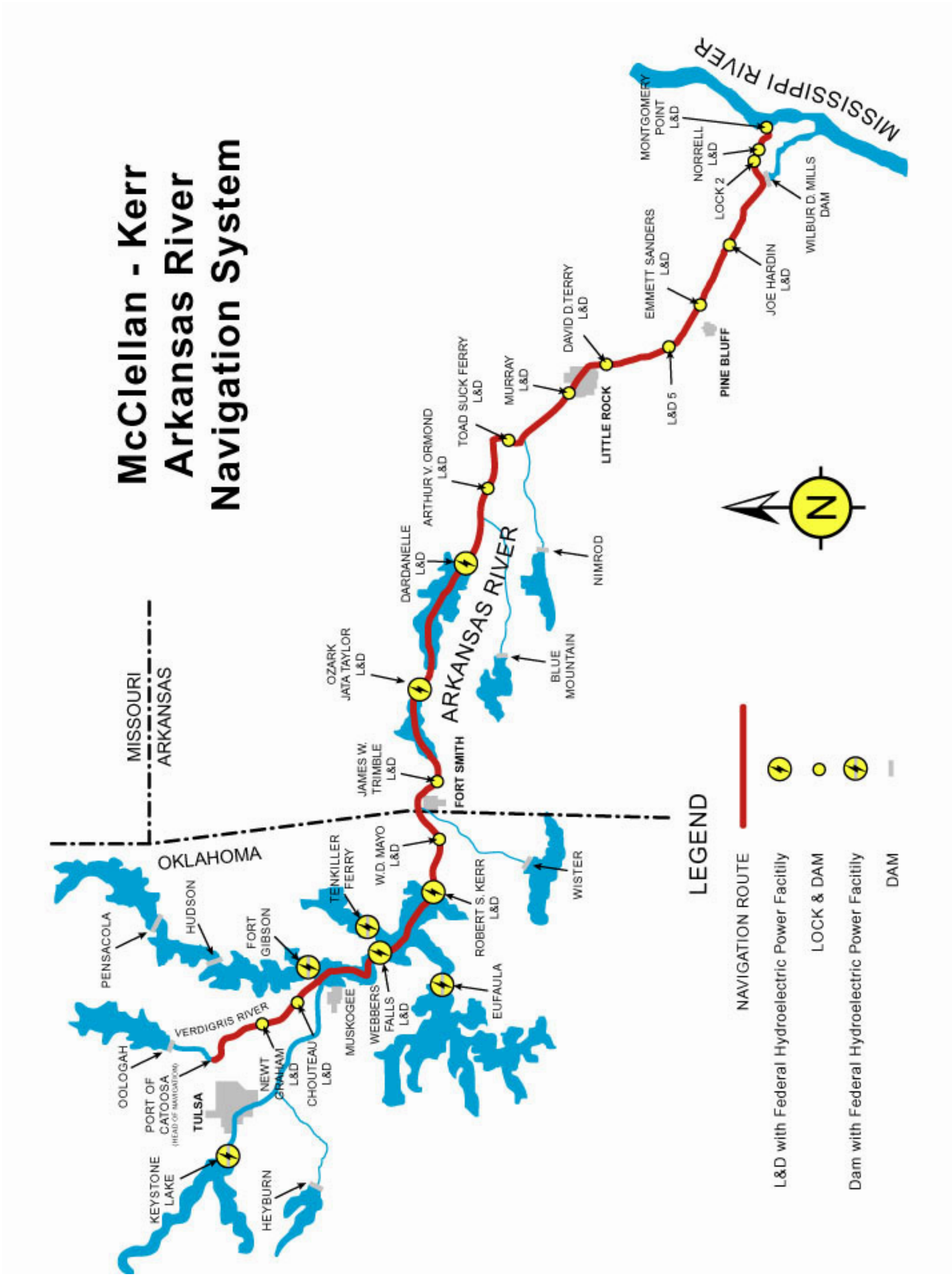


Figure 12
McClellan-Kerr Arkansas River Navigation System

Meteorology

The climate is broadly classified as ranging from humid to subhumid. Monthly average temperatures range from approximately 43 degrees ^{o}F in January to approximately 83 degrees ^{o}F in July. Summers are normally long and warm with relatively mild and short winters. However, occasional periods of excessive summer heat and winter cold are characteristic of the area. The first and last killing frosts normally occur in early November and early April. The mean freeze-free period is about 200 days.

Precipitation is predominantly of the shower type except for occasional periods of general rainfall during the late fall, winter, and early spring. The average annual number of days with measurable precipitation is about 73. Rainfall quantities are the least in the summer and fall when monthly precipitation totals average 3 to 4 inches. The average annual rainfall for the project area is approximately 47 inches based upon the gage station at the University of Arkansas Experiment Station east of Stuttgart.

Rainfall varies from a maximum monthly average of about 5 inches in May to 2.7 inches in October.

Water Quality

Surface water quality is primarily influenced by the area's topography, soils, and land use. The primary surface water pollutant is suspended sediment which is a direct result of the area's extensive agricultural land use practices. Irrigation water currently being used in the Bayou Meto Basin is a mixture of groundwater extracted from the alluvial and Sparta Sand aquifers and surface water captured in tailwater recovery systems. Water from these sources is mixed and applied to the crops in various proportions. Existing data indicates that the quality of both surface water and groundwater is relatively good and poses no immediate problem to agriculture. The key characteristic of importance to agricultural productivity is salinity or total dissolved solids. Salinity does not appear to be a problem in the area. All water sources currently being used have moderate levels of total dissolved solids, well below the suggested limits for long-term agricultural activity.

A water quality assessment relative to agricultural water supply was conducted for the Bayou Meto IPA to include the potential use of Arkansas River water as a supplemental source of irrigation water. This assessment is included in Volume 10, Appendix D, Environmental Analyses. In general, data indicates that Arkansas River water is as good or better than the representative alluvial well water.

Environment

The Bayou Meto Basin is a diverse and unique area, with landscapes that were formed and shaped by depositional and erosional dynamics of the Arkansas River. Landscape features in the Basin range from upland and prairie terrace in the northeast to a highly interspersed mosaic of currently active drainages, abandoned courses and channels of the Arkansas River in the southeast. There are over 20 oxbow lakes larger than 30 acres in size within the basin.

These lakes formed in abandoned channels of the Arkansas River, and support a wide variety of fish, waterfowl, wading and shorebirds, reptiles, and amphibians. Similarly, manmade lakes and reservoirs are also utilized by many of these same types of wildlife. Hunters utilize both natural and manmade lakes and reservoirs in addition to large acreages of seasonally flooded agricultural fields during duck season. Many bayous, ditches and streams intersect the Basin, and these waterbodies and their associated vegetation are the preferred habitat to various types of wildlife. Some of the streams support limited communities of freshwater mussels, although use of the stream water for agricultural purposes has severely limited the areas where mussels can be found. One of the largest state-owned wildlife management areas in the nation, the Bayou Meto Wildlife Management Area (WMA), is located within the Basin. This 32,000-acre area is mostly comprised of bottomland hardwood forests, although six lakes, with a total area of 1,080 acres, are also present in the WMA. During the duck hunting season 13,000 acres are flooded. Although historically there were areas of prairie in the northeastern portion of the Basin, few remnants remain today.

Natural Resources

The Bayou Meto Basin contains numerous abandoned courses and channels of the Arkansas River. Areas along these courses and the numerous active streams within the basin contain significant tracts of bottomland hardwoods, natural forests, and wetlands.

The Bayou Meto Wildlife Management Area (WMA) located in the southern part of the Bayou Meto Basin contains the largest tract of bottomland hardwoods in the basin. This area is one of the most significant waterfowl resources along the North American Flyway. The WMA offers some of the best duck hunting in the state, and averages 350 duck hunters daily throughout the season.

Wildlife Habitat

Wildlife distribution and populations depends largely on the quantity and quality of available habitat. Habitat conditions are in turn influenced by land use, land management, distribution of water, climate, human influences, and other limiting factors. Therefore, wildlife populations are, in general, directly proportional to the availability and suitability of their habitat requirements. Some animals (generalists) are able to exploit a number of different habitat types, and are therefore widespread throughout the Basin. Examples of this type of animal would include white-tailed deer, raccoons, green sunfish, and birds such as the American robin. Other types of wildlife have very specific habitat requirements (specialists) that limit their range to specific areas or habitat types. For example, the prairie mole cricket is confined to prairie habitats, while the red-cockaded woodpecker requires old-growth pine trees for nesting. Areas that contain a number of different habitat types generally have a diverse assemblage of wildlife.

Terrestrial Habitat. The land use of the project area has been placed into five categories. Wildlife habitat can best be described in terms of vegetative cover types. From the five land use categories, three general vegetative cover types can be delineated to describe the terrestrial wildlife habitat of the project area.

Timbered habitat is the second largest cover type in the project area and accounts for 41,350 acres. Both timbered wetlands and upland communities are included in this category. Species composition varies according to soil type, moisture conditions, slope aspect, and other external factors.

Dominant upland forested community types that occur within the project area are as follows:

(1) Southern Red Oak-White Oak-Hickory sp.
(2) Oak spp.-Mixed hardwoods
(3) White Oak-Post Oak
(4) White Oak-Sweetgum-Mockernut Hickory
(5) Loblolly Pine
(6) Post Oak

Timbered habitat provides all or some life requisites for many wildlife species. Wildlife species or groups that rely on timbered habitats include white-tailed deer, fox squirrels, gray squirrels, southern flying squirrel, woodchuck, eastern cottontail rabbits, swamp rabbits, eastern spotted skunks, striped skunks, river otters, bobcat, mink, raccoon, coyote, ninebanded armadillo, mice, rats, wild turkeys, woodpeckers, owls, hawks, and song birds including nuthatches, warblers, and chickadees. Several species of reptiles and amphibians are also present.

Pasture and hayland occupy 33,717 acres and are the third most abundant cover type. Native and improved pasture are included with species composition varying according to soil type, moisture condition, and management practice.

Well-managed native range or pasture is a mixture of tall grasses composed principally of big bluestem, little bluestem, switchgrass, and Indian grass. These areas may also include numerous forbs. If not managed properly, broomsedge, common weeds, and alien species may become dominant. Introduced pasture in the basin consists mainly of bermudagrass.

Wildlife species or groups commonly associated with pasture land include white-tailed deer, rabbits, skunks, coyotes, fox, mice, rats, bob-white quail, birds of prey, songbirds, reptiles, and amphibians.

Cropland is the dominant cover type and consists of 276,814 acres of monocultures of seasonal crops requiring frequent or seasonal tillage, intensive management practices, or both. Vegetative composition varies according to soil types, moisture conditions, and production goals or purposes. Crops within the basin include wheat, soybeans, rice, grain sorghum, corn and cotton. Wildlife species rely heavily on croplands as a food source due to the abundance of insect species and the actual crops grown. Some species or groups that are commonly encountered in the cropland cover type and the adjacent edge communities include white-tailed deer, rabbits, raccoons, fox, mice, rats, wild turkey, bob-white quail, mourning doves, flycatchers, sparrows, birds of prey, waterfowl, and a number of shorebirds.

Waterfowl. Arkansas has long been considered to be one of the "Meccas" for waterfowlers throughout the continent. This circumstance has resulted from a number of factors including its location at the heart of the wintering range for the Mississippi Flyway, its historically abundant wetland resources, and its national ranking as the most important wintering state for mallards. (Yaich et al. 1999) Mallards, pintails, and black ducks typically comprise 2/3 to 3/4 of the harvest in the state. To illustrate the importance of Arkansas from a waterfowl harvest and hunter activity perspective, some national rankings for Arkansas' 1988-89 waterfowl season are as follows (for comparison, Arkansas ranked 33rd in total human population in the 1980 census):

Mallard harvest	1st
Total duck harvest	5th
Wood duck harvest	5th
Days hunted/adult hunter	3rd
Ducks /adult hunter day	4th
Ducks harvested/adult hunter (season)	1st

These statistics not only provide support for the statement that Arkansas is one of the most important harvest areas for ducks in the country, but also exhibit evidence of the biological importance of Arkansas in providing for the needs of wintering waterfowl. Midwinter survey records indicate that during the 1970s an average of 5.23% (1.06 million) of all ducks counted in the nation were observed in Arkansas. The average count of mallards during this period was 919,000, approximately one-third of the Mississippi Flyway's total. Arkansas plays as a dominant role in the provision of mallard wintering habitat as it does in harvest. (Yaich et al. 1990)

The principal habitats utilized by waterfowl -- bottomland hardwoods, scrub-shrub swamps, irrigation reservoirs, herbaceous wetlands, moist-soil areas, rice farms, etc. -- fall into three general habitat management categories. These basic categories are: (1) unmanaged, naturally ponded or flooded habitat; (2) public managed habitat; and (3) private managed habitat. While acreage included in the managed categories already contributes consistently to the annual habitat needs of wintering waterfowl, land in the unmanaged category provides habitat only when flooded by natural overflow. One basic habitat problem is that wintering waterfowl are currently dependent upon this unmanaged habitat for the provision of a very significant portion of their needs, particularly for foraging. Although flooding is common, it cannot be relied upon to occur annually, and its duration and extent are highly variable. (Yaich et al. 1990)

Shorebirds. Thirty-one species of shorebirds migrate through the state of Arkansas each year. In addition, two local species reside in the area and seven other species are infrequent visitors in the state. This magnificent group of birds is heavily sought after each spring and fall by hundreds of birders. The majority of the birds migrate through eastern

Arkansas utilizing drying reservoirs and mudflats for food and cover. Surface water reservoirs with a moderate slope along the bottom provide excellent habitat. These reservoirs exhibit sizable areas of shallow water with high levels of invertebrates. Invertebrates are critical forage for shorebirds, due to their high protein levels. Reservoirs in this region provide shore bird habitat that is essential during migration.

Fisheries

Although the fish community in the Bayou Meto Basin reflects the impacts of human disturbance, 55 species of fish were collected in 2001 in the Basin's streams and ditches. Approximately 75% of the total number of fish collected was from species that are tolerant to stressors, and included mosquitofish, bluegill, red and golden shiners, and green sunfish. However, stream reaches remain that are less disturbed and support a more diverse assemblage of species. Human impacts to the fishery include withdrawal of water from the streams and ditches, which reduces water levels and causes stagnant pools with low dissolved oxygen, and cleared stream banks that increase water temperature (through lack of shading) and increase sediment load.

Wetlands

The Bayou Meto Basin contains a significant amount of wetlands, with over 60,690 acres of forested wetlands alone. These bottomland hardwood forests are composed primarily of an oak/hickory climax type. Overcup oak, water oak, willow oak, Nuttall oak, cherrybark oak, water hickory, American elm, green ash, shagbark hickory, and sweetgum are among the most common canopy species in the project area, with tree species varying according to the wetness of the growing sites. Overcup oak and water hickory are the dominant species in areas that are relatively wet, while willow oak, water oak, water oak, Nuttall oak, and sweetgum being dominant in drier areas. In areas that are either permanently or semi permanently flooded, the tree species are dominated by *Baldcypress*, water tupelo, swamp tupelo, and black willow. Other types of wetlands found in the Basin include scrub/shrub swamps, which are dominated by woody vegetation less than 20 feet in height, with common plant species being the black willow and buttonbush. Scrub/shrub swamps can be found in areas that range from being temporarily to permanently flooded. Other types of wetlands that have been present in the Basin include seasonal herbaceous wetlands, which occur in small topographic depressions of the Deweyville and Grand Prairie terraces. These wetlands received moisture primarily from surface sheet flow following local rains. The plant community is dominated by plant species that have rapid growth and high seed production. Animals that inhabited these wetlands possessed many of the same characteristics as the plants (rapid reproduction and short life cycles).

Cultural Resources

An intensive archaeological survey was conducted for 9,271 acres of a total 62,876 acres estimated for the project's total cultural resources Area of Potential Effect. Of 216 historic and prehistoric sites identified, 14 are interpreted to be potentially eligible for listing in the National Register of Historic Places. While the overall process of identification, evaluation for significance of findings, and assessment of effects for precise project features is not completed (as typical for a project of this size and complexity), project design will strive to avoid impacts to any significant cultural resources sites. A Programmatic Agreement to improve coordination and treatment of these resources also is being planned.

Endangered Species

Federally listed threatened or endangered animals that are known to utilize areas in or near the Basin include the bald eagle and the interior least tern. The bald eagle was originally listed as an endangered species below the 40th parallel in 1973, and was upgraded to threatened in the contiguous states in 1996. The bald eagle is a large raptor that occurs primarily near sea coasts, rivers, and large lakes. This bird is an opportunistic feeder; food consumed by the bald eagle ranges from fish to other birds to carrion, with fish comprising the major portion of its diet. Catfish are a favorite food in the Southeast; but other fish, coots, gallinules, waterfowl, and turtles are also among the food items taken by bald eagles. The bald eagle is primarily considered a transient species within the Basin, utilizing areas along the Arkansas River for resting and feeding during its winter migration. The interior least tern is a small white bird with grayish back and wings, black crown and black-tipped yellow bill. Least terns nest in small colonies on reservoir beaches and river sandbars along most of the large rivers. Nests consist of small scrapes in the sand with 2-3 eggs laid in a clutch. Although the young are fairly mobile soon after hatching, both parents feed and remain with the young until fall migration. Interior least terns feed primarily on small fish. Major threats include predation, human disturbance and the construction and operation of mainstem reservoirs. The ivory-billed woodpecker, a recently rediscovered endangered species, is known to inhabit the forests in the Cache River Basin but has not been found in the project area and would not be impacted. Other listed threatened or endangered animals considered in the study included the pallid sturgeon and the fat pocketbook mussel. Although there are some reports of pallid sturgeon in the Arkansas River, they were most likely extirpated from the reaches near the Basin when the lock and dam structures were built on the river approximately 25 years ago. The fat pocketbook mussel is known to occur in the St. Francis River Basin in Arkansas, but was not found in the Bayou Meto Basin during an intensive survey conducted in 2001.

Hazardous, Toxic, and Radioactive Waste (HTRW)

A Phase 1 Assessment of the potential for HTRW was conducted for the project area. The assessment was conducted through research of state and Federal regulatory agency databases, aerial photographs and topographic maps, and an extensive aerial reconnaissance. Pertinent Arkansas regulatory personnel and project area landowners were contacted pursuant to the investigation regarding site history, current conditions, environmental concerns, and storage tanks. Based on these investigations, five (5) sites were identified that may require special attention during construction activities. Additional sampling and analysis will be conducted at these sites during detailed design studies to determine their significance and identify and evaluate alternatives to respond to the potential HTRW problems. Volume I of the HTRW Phase 1 Assessment is included in Volume 10, Appendix D, Environmental Analyses.

Recreation

The large number of waterfowl that winter in the state has produced a great waterfowling tradition on the part of both resident and non-resident hunters over the years. Additionally, enthusiasm for waterfowl hunting has resulted in the production of an economic benefit for the state proportionally larger than for other types of hunting. For example, in 1996, an estimated $55 million dollars was spent in Arkansas on expenditures related to migratory bird hunting. In addition, the tradition of Arkansas as the most important wintering area for mallards in the country, coupled with the mallards' reputation as the duck of choice for most waterfowlers, has led to a significant flow of non-resident hunters (with their attendant economic benefits) into the state. Non-residents brought a conservatively estimated $7.3 million into the state for trip-related expenses (gas, food, lodging) alone in 1985. Additionally, a larger proportion of the total migratory bird hunting in the state was conducted by non-residents (22 percent) than for any other type of hunting (Yaich et al. 1990).

When compared to hunting, there are a greater number of individuals that participate in non-consumptive wildlife recreation. In 1991, the Arkansas Game and Fish Commission estimated that 45% of the Arkansans over the age of 16 (812,000) participated in this type of recreation. Both residents and non-residents visit this area of the state each year to observe the large numbers of wintering waterfowl and shore birds. An estimated $189 million dollars is spent on non-consumptive recreation each year.

SOCIOECONOMIC PROFILE

The study area encompasses parts of Arkansas, Jefferson, Lonoke, Prairie, and Pulaski counties in east central Arkansas. All of the cities of Lonoke and England and half of Carlisle are in the area. Other smaller communities partially or completely in the project area are Coy, Humnoke, Allport, Keo, Sherrill, Humphrey, Altheimer, and Wabbaseka. The population within the study area was estimated to be 13,109 in 2000. About 30 percent of the population was minority. The 2000 population for the state of Arkansas and for the United States was 2,673,000 and 281,422,000 persons, respectively. The 2000 study area population was 347 persons, or two percent more than the 1990 population. This compares to a national growth rate of 13.2 percent and a 13.7 percent growth for the state.

The labor force in the area totaled 6,900 in 2001, with an unemployment rate of about 6.0 percent. Employment for the state and the United States for the same period was 1,226,000 and l44,815,000, respectively. This employment was concentrated in manufacturing and retail trade for the study area, state, and nation. The average unemployment was 5.1 percent for the state of Arkansas and 4.8 percent for the United States as of 2001. Per capita income for the study area was estimated to be $16,300 for 2000 and was lower than the $16,900 and $21,600 for the state and nation, respectively.

In 2000, there were 1,218 farms in the study area, with an average area per farm of about 330 acres and an average value per acre of land and buildings of $1,100. About 28 percent of the farmers have their principal occupation off the farm. There are 212 women and 234 minority farmers in the area. Seven farmers are handicapped and approximately 22 percent of the producers in the project area are limited resource farmers. No one landowner controls more than 25 percent of the farm acreage that would directly benefit from the project.

Present (2000) Farm and Tract Data
Without-Project Conditions
Bayou Meto, Arkansas

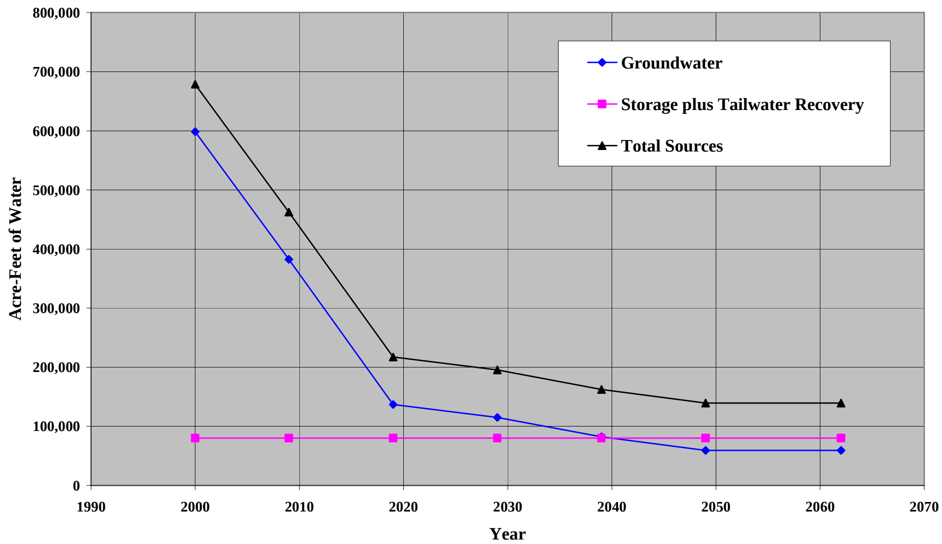
	Tract Data			Farm Data		
	Tracts	Total Cropland	Average Cropland	Farms	Total Cropland	Average Cropland
Arkansas Co.	40	5,877	147	30	5,877	196
Lonoke Co.	1,803	233,289	129	885	233,289	264
Prairie Co.	77	10,723	139	59	10,723	182
Jefferson Co.	460	63,640	138	234	63,640	272
Pulaski Co.	13	1,455	112	10	1,455	146
Total	2,393	314,984	132	1,218	314,984	259
Median		68			330	
Maximum		2,997			388	
Minimum		0.4			130	

FUTURE WITHOUT PROJECT CONDITIONS

AQUIFER RESOURCES / AGRICULTURAL WATER SUPPLY

Agriculture is the primary user of water from the Alluvial aquifer. Almost every other significant user withdraws water from the Sparta aquifer. The Sparta is a much higher quality source of water that is better suited for municipal (drinking) and industrial use. The existing or desired land use and the demand for irrigation water would not be expected to change at anytime in the foreseeable future. However, the availability of groundwater to sustain existing and future agriculture needs is expected to significantly decline as the aquifer is depleted. The available supply of irrigation water is projected to decrease as shown in Figure 13, based on groundwater modeling by the USGS which shows that groundwater usage must be reduced to a sustainable rate (sustainable yield) to protect the integrity of the aquifers. The groundwater model does include all water use, even though other water use is insignificant when compared to irrigation use. Existing on-farm storage and in-season recovery of irrigation water and rainfall are projected to remain the same. Continued declines in aquifer will result in drastic reductions of available water in the near future. The IPA has experienced groundwater withdrawals of such magnitude that demand on the aquifer far exceeds natural recharge, resulting in consistently falling groundwater levels. Pumpage at the current rate allows the saturated thickness of the alluvial aquifer to drop well below 50 percent of the original saturated thickness. This is the level that the state of Arkansas has determined to be critical and the level at which no pumpage would be permitted if regulation measures were implemented. The sustainable groundwater yield for the Bayou Meto IPA that meets State's goals and objectives for groundwater conservation and protection is 148,565 acre-feet per year. The project area was divided into two separate areas in formulating alternatives to meet water needs in the IPA due to significant differences in existing and projected future conditions of the areas relative to groundwater resources, water availability, and land use. The line dividing the IPA into these two separate areas is Bayou Meto. The defining factor in this division is the volume of storage needed in each area to meet future water needs.

Figure 13
Without Project Water Sources
Bayou Meto IPA



ECONOMIC RESOURCES

The reduction in available irrigation water translates into a substantial reduction in irrigated acreage. Projected without project land use is presented in Table 3. (Note: Cropland, irrigated cropland, and water supply and demand data presented in Table 3 excludes 8,832 acres of proposed on-farm storage that is taken out of the single-cropped soybean.) The aquifer will continue to be depleted causing approximately 206,302 acres of irrigated cropland to convert to dryland farming and 15,945 acres of fish ponds to be lost by 2019. This trend will continue until the year 2049 when 240,539 acres of cropland are shifted to dryland and 20,200 acres of fish ponds are lost. As mentioned on page 16, some landowners have tapped into the Sparta aquifer for irrigation in order to delay the conversion of irrigated cropland to dryland cropland. This was done as a temporary measure to preserve land values and meet crop loan requirements, but is neither economic nor sustainable. A detailed discussion of the without project conditions is provided in Volume 11, Appendix E.

Table 3
Present and Projected Land Use
Without-Project Conditions
Bayou Meto IPA

Item	Year					
	2000	2009	2019	2029	2039	2049
Total Cropland	267,982	267,982	267,982	267,982	267,982	267,982
Irrigated	267,982	169,862	61,680	53,101	38,455	27,443
Dryland	0	98,120	206,302	214,881	229,527	240,539
Irrigated Crops						
Rice	81,479	49,767	18,212	15,646	11,122	7,858
Soybeans	105,723	64,217	25,005	21,805	15,815	11,611
DC Soybeans	40,581	26,521	11,612	9,111	6,550	4,811
Corn	2,369	1,991	1,370	1,172	1,164	695
Milo	1,384	1,068	581	554	320	303
Cotton	36,446	26,298	4,900	4,813	3,484	2,165
Total	267,982	169,862	61,680	53,101	38,455	27,443
Dryland Crops						
Soybeans	0	73,218	143,985	149,751	160,265	167,733
DC Soybeans	0	14,060	28,969	31,470	34,031	35,770
Corn	0	378	999	1,197	1,205	1,674
Milo	0	316	803	830	1,064	1,081
Cotton	0	10,148	31,546	31,633	32,962	34,281
Total	0	98,120	206,302	214,881	229,527	240,539
Baitfish Ponds	22,079	16,232	6,125	3,770	2,727	1,879

REASONABLENESS OF BENEFIT PROJECTION FACTORS

The benefit projection factors developed and used in Appendix E reflected approximately an 80% increase in benefits by the year 2062, the end of the period of analysis. This would approximate an increase in soybean yields from the current irrigated yield of 48 bushels to 85 bushels per acre. Rice would have a corresponding increase in yield from 7,200 to 12,800 pounds per acre. This increase caused a question to be raised during the report review as to whether this was reasonable. The Memphis District asked three agricultural economists from the University of Arkansas, Louisiana State University, and Mississippi State University to review the reasonableness of the projection process.

These three universities are the prominent agricultural universities in the Mississippi Delta region.

USE OF THE SPARTA AQUIFER AS AN ALTERNATE IRRIGATION SOURCE

The Sparta aquifer is a deep, high quality, low yielding aquifer located beneath the project area. It was never assumed to be a viable long-term source of irrigation water due to its high cost. Irrigating from the Sparta aquifer costs more than the revenue gained in all but the most favorable market conditions. However, a relatively small number of the area's farmers have been put in an unfavorable short term situation by their lenders. Their lenders have forced them to tap into the Sparta in order to secure their loans. The lenders are securing the collateral backing up their farm loans since irrigated land has a higher market value than land that has lost its irrigation water source. Currently there are estimated to be 100 wells irrigating 20,000 acres from the Sparta in the project area. Since there are some farmers irrigating from the Sparta, it was decided to include it in the projection of without-project irrigated acreage.

DRYLAND SOYBEAN YIELDS

Dryland soybean yields were estimated by interviews with local farmers. The farmers repeatedly stated that their high clay content prairie soils were not suited for growing dryland soybeans. They estimated their yields in a range of 20 to 25 bushels or an average of 22.5 bushels per acre. County information stated that county dryland averages were more in the range of 26 bushels per acre. This was explained in that soil types varied greatly within the very large total project area. The flood protection component of the total project used dryland soybean yields of 30 bushels per acre. The soil type in the flood protection component is more of a sandy-silty complex typically found in overflow areas that is more suitable for growing dryland crops. The clay soils of the prairie found in the irrigation component of the total project is not as suitable for dryland crops. The average of the two areas is very close to the 26 bushel average. Because of this along with more conversations with area residents and NRCS experts, it was felt that 22.5 bushels was a reasonable yield estimate for the irrigation component. However, in order to be conservative, it was decided to use 26 bushels per acre as the dryland soybean yield level.

WITHOUT-PROJECT CONDITIONS

a. Crop Budgets. Current crop budgets were developed for the Sparta and Alluvial aquifers, surface water, conservation and dryland practices. These budgets were developed using University of Arkansas Extension Service crop budgets for the eastern Arkansas area as a base. They were revised using NRCS irrigation data to reflect project area specific irrigation practices/costs. These budgets are presented in Tables 3a through 3e. The Sparta budget data presented in Table 3a indicates that only baitfish production is profitable. However, it should be noted that the local cash market price ($9.00/cwt range) is much higher than the current normalized price of $5.34 per cwt that is mandated for use by the Corps. At the market price level irrigating from the Sparta aquifer may be profitable until groundwater depths decline further making pumping unprofitable.

Table 3a
Crop Data for Irrigated Practices
Using Sparta Aquifer as the Irrigation Source
Bayou Meto, Arkansas
(October 2005 Price Levels)

Item	Unit	Price 1/	Yield	Gross Revenues	Production Cost 2/	Net Return
		($)		($)	($)	($)
Soybeans	bu.	5.33	48	255.84	332.89	-77.05
Rice	cwt.	5.34	72	384.48	415.42	-30.94
Double-Crop				360.82	365.84	-5.02
Soybeans	bu.	5.33	41			
Wheat	bu.	2.56	56			
Cotton				547.68	602.63	-54.95
Lint	lb.	0.467	1,000			
Seed	ton	91.68	0.88			
Corn	bu.	2.13	175	372.75	502.94	-130.19
Grain Sorghum	cwt.	3.68	64	235.52	327.81	-92.29
Baitfish	lb.	2.75	450	1,237.50	1,123.81	113.69

1/ FY 2005 Current Normalized Prices.
2/ Excludes charges for land and management, 2006 crop budgets from University of Arkansas Extension Service revised for project area irrigation practices.

Table 3b
Crop Data for Irrigated Practices
Using Alluvial Aquifer as the Irrigation Source
Bayou Meto, Arkansas
(October 2005 Price Levels)

Item	Unit	Price 1/	Yield	Gross Revenues	Production Cost 2/	Net Return
		($)		($)	($)	($)
Soybeans	bu.	5.33	48	255.84	249.86	5.98
Rice	cwt.	5.34	72	384.48	304.94	79.54
Double-Crop				360.82	297.00	63.82
Soybeans	bu.	5.33	41			
Wheat	bu.	2.56	56			
Cotton				547.68	519.43	28.25
Lint	lb.	0.467	1,000			
Seed	ton	91.68	0.88			
Corn	bu.	2.13	175	372.75	408.97	-36.22
Grain Sorghum	cwt.	3.68	64	235.52	248.09	-12.57
Baitfish	lb.	2.75	450	1,237.50	922.19	315.31

1/ FY 2005 Current Normalized Prices.
2/ Excludes charges for land and management, 2006 crop budgets from University of Arkansas Extension Service revised for project area irrigation practices.

Table 3c
Crop Data for Irrigated Practices
Using Surface Water as the Irrigation Source
Bayou Meto, Arkansas
(October 2005 Price Levels)

Item	Unit	Price 1/	Yield	Gross Revenues	Production Cost 2/	Net Return
		($)		($)	($)	($)
Soybeans	bu.	5.33	48	255.84	230.56	25.28
Rice	cwt.	5.34	72	384.48	276.85	107.63
Double-Crop				360.82	282.00	78.82
Soybeans	bu.	5.33	41			
Wheat	bu.	2.56	56			
Cotton				547.68	500.13	47.55
Lint	lb.	0.467	1,000			
Seed	ton	91.68	0.88			
Corn	bu.	2.13	175	372.75	386.66	-13.91
Grain Sorghum	cwt.	3.68	64	235.52	229.90	5.62

1/ FY 2005 Current Normalized Prices.
2/ Excludes charges for land and management, 2006 crop budgets from University of Arkansas Extension Service revised for project area irrigation practices.

Table 3d
Crop Data for Irrigated Practices
Conservation Practices
Bayou Meto, Arkansas
(October 2005 Price Levels)

Item	Unit	Price 1/	Yield	Gross Revenues	Production Cost 2/	Net Return
		($)		($)	($)	($)
Soybeans	bu.	5.33	48	255.84	219.31	36.53
Rice	cwt.	5.34	72	384.48	260.48	124.00
Double-Crop				360.82	273.25	87.57
Soybeans	bu.	5.33	41			
Wheat	bu.	2.56	56			
Cotton				547.68	488.88	58.80
Lint	lb.	0.467	1,000			
Seed	ton	91.68	0.88			
Corn	bu.	2.13	175	372.75	373.65	-0.90
Grain Sorghum	cwt.	3.68	64	235.52	219.30	16.22

1/ FY 2005 Current Normalized Prices.

2/ Excludes charges for land and management, 2006 crop budgets from University of Arkansas Extension Service revised for project area irrigation practices.

Table 3e
Crop Data for Dryland Crops
Bayou Meto, Arkansas
(October 2005 Price Levels)

Item	Unit	Price	Price 1/	Gross Revenues	Production Cost 2/	Net Return
		($)		($)	($)	($)
Soybeans	bu.	5.33	26	138.58	159.89	-21.31
Double-Crop				249.96	315.26	-65.30
Soybeans	bu.	5.33	20			
Wheat	bu.	2.56	56			
Cotton				397.07	478.64	-81.57
Lint	lb.	0.467	725			
Seed	ton	91.68	0.638			
Corn	bu.	2.13	110	234.30	335.30	-101.00
Grain Sorghum	cwt.	3.68	43	158.24	196.79	-38.55

1/ FY 2005 Current Normalized Prices.
2/ Excludes charges for land and management, 2006 crop budgets from University of Arkansas Extension Service.

b. Irrigation Water Sources. The without-project estimates for the Alluvial aquifer are based on detailed USGS studies. The methodology used to apply these studies to the smaller project specific area is outlined in Appendix E. This methodology remains unchanged. The without-project estimates for surface water capture and on-farm storage reservoir use also remains unchanged. It is based on detailed NRCS modeling of individual farms located within the project area. This result of this process is presented in the NRCS appendix.

The primary change in without-project water sources is the inclusion of the Sparta aquifer as a viable groundwater source. Initially this aquifer was not included in the without-project analysis because it was not considered to be a long-term water source from either a physical or an economic standpoint. It does not have the yield to replace the lost alluvial groundwater. It also is not an economic source due to its depth and the cost of pumping from it. However, some local farmers are using it as a source. This addendum reflects current and forecasted use of the Sparta aquifer.

This addendum relies heavily on data furnished by USGS, the Arkansas Natural Resources Commission, and NRCS to estimate current and future use of the Sparta aquifer. Currently there are approximately 100 Sparta wells located in the project area that serve about 20,000 acres. The Sparta aquifer is a pressurized aquifer located at a depth of about 450 feet. Since the aquifer is pressurized the wells drilled into it have water levels that are less than 450 feet deep. The average is in excess of 200 feet. As the aquifer is pumped, the pressure will lessen and the pumping depth will increase. When all pressure is relieved and water depths reach the top of the aquifer, permanent damage will occur in the aquifer. Historical trends show that these wells are being drilled at a rate of 10 to 20 per year. Studies indicate that if current trends continue the Sparta aquifer will be depleted or highly damaged by 2027.

Current Sparta use is estimated at approximately 51,000 acre-feet annually. This is well above the safe yield mark that is estimated at 31,000 acre-feet. Anything above the safe yield mark causes the level in the aquifer to decline. NRCS has estimated that farmers can viably use the Sparta at less than 300 feet in depth. This point is forecast to be reached by 2012 when approximately 43,000 acres will be irrigated by Sparta wells. At this point it is expected that future drilling into the Sparta will cease. However the farmers will attempt to maintain these well as long as they are functional. After 2019 irrigation from the Sparta is expected to decline as the aquifer depth becomes greater and greater. For the purpose of this analysis it was assumed that withdrawals will decline to the safe yield level of 31,000 acre-feet by 2039. This is probably an over optimistic forecast that was used as an upper boundary of potential Sparta use. Two factors will probably limit Sparta use long before this level: (1) the forecast of 2027 as the point of depletion, a physical limitation and (2) the extreme depth and cost of pumping from the Sparta will force farmers into bankruptcy if this trend continues. Table 3f and Figure 13a illustrate the future water use forecasts.

c. Acres of Irrigated and Dryland Crops. Irrigated and dryland acreage forecasts are presented in Table 3g and Figure 13b. Irrigation is forecast to decline from a high of 290,061 acres in 2000 to 59,526 acres in 2049. The majority of the dryland crops is expected to be soybeans. This forecast is backed-up by historical trends in irrigation. Irrigated acreage in Lonoke and Jefferson counties (the two counties containing most of the project area) has decreased by 31,460 and 16,326 acres respectively between the years 1997 and 2002. This data is taken from USDA NASS data that is published every 5 years. More recent data will not be available until after the 2007 crop year. However, a review of satellite imaging of the project area counties by NRCS has shown that irrigation has continued to decrease for the years 2003, 2004, and 2005.

Table 3f
Present and Projected Irrigation Water Sources
Without-Project Conditions
Bayou Meto, Arkansas

	2000	2006	2009	2012	2019	2027	2029	2039	2049	2062
Alluvial Aquifer	598,573	454,436	382,367	308,762	137,017	119,545	115,177	82,259	59,216	59,216
Sparta Aquifer	0	50,647	65,000	75,970	40,517	0	0	0	0	0
Storage plus Tailwater Recovery	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051
Total Sources	678,624	585,134	527,418	464,783	257,585	199,596	195,228	162,310	139,267	139,267

Figure 13a
Without Project Water Sources
Bayou Meto IPA

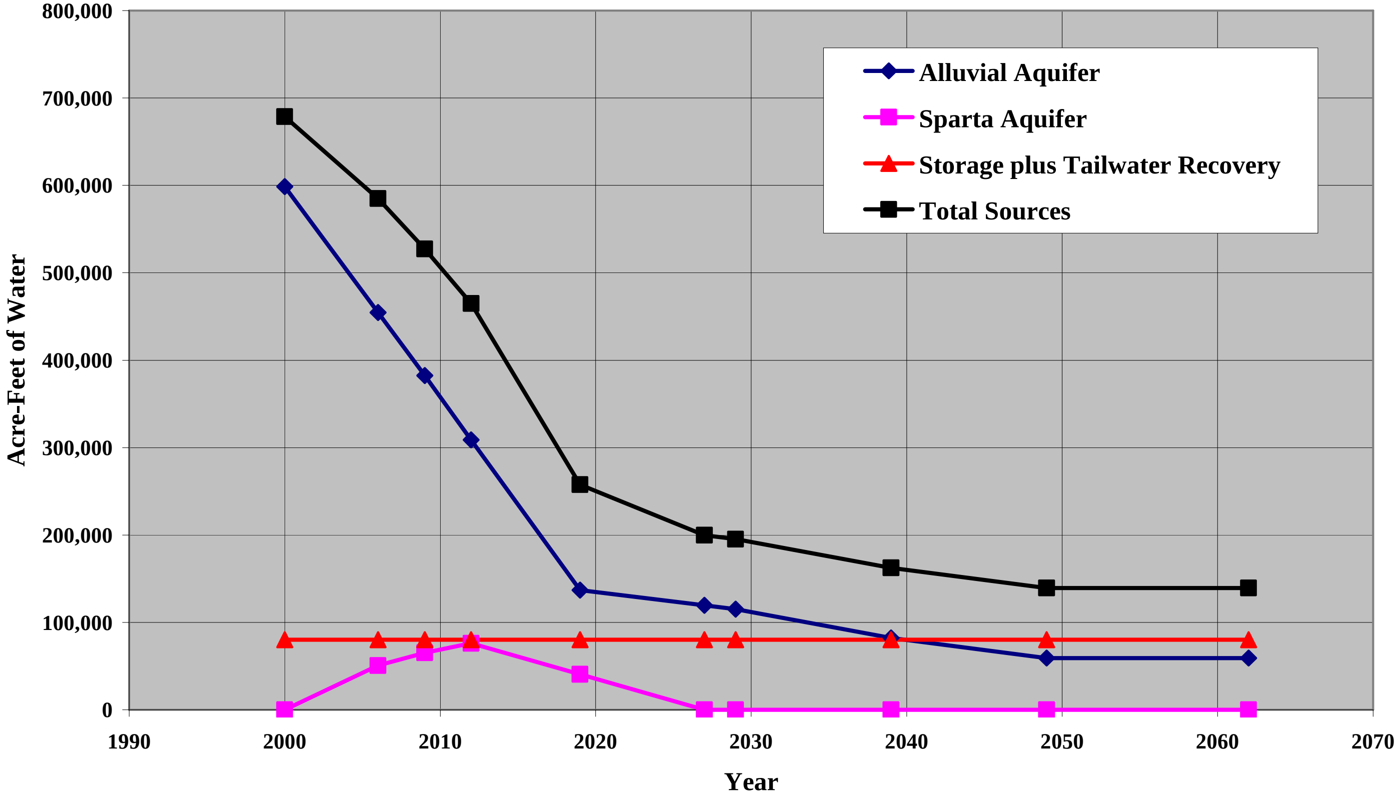
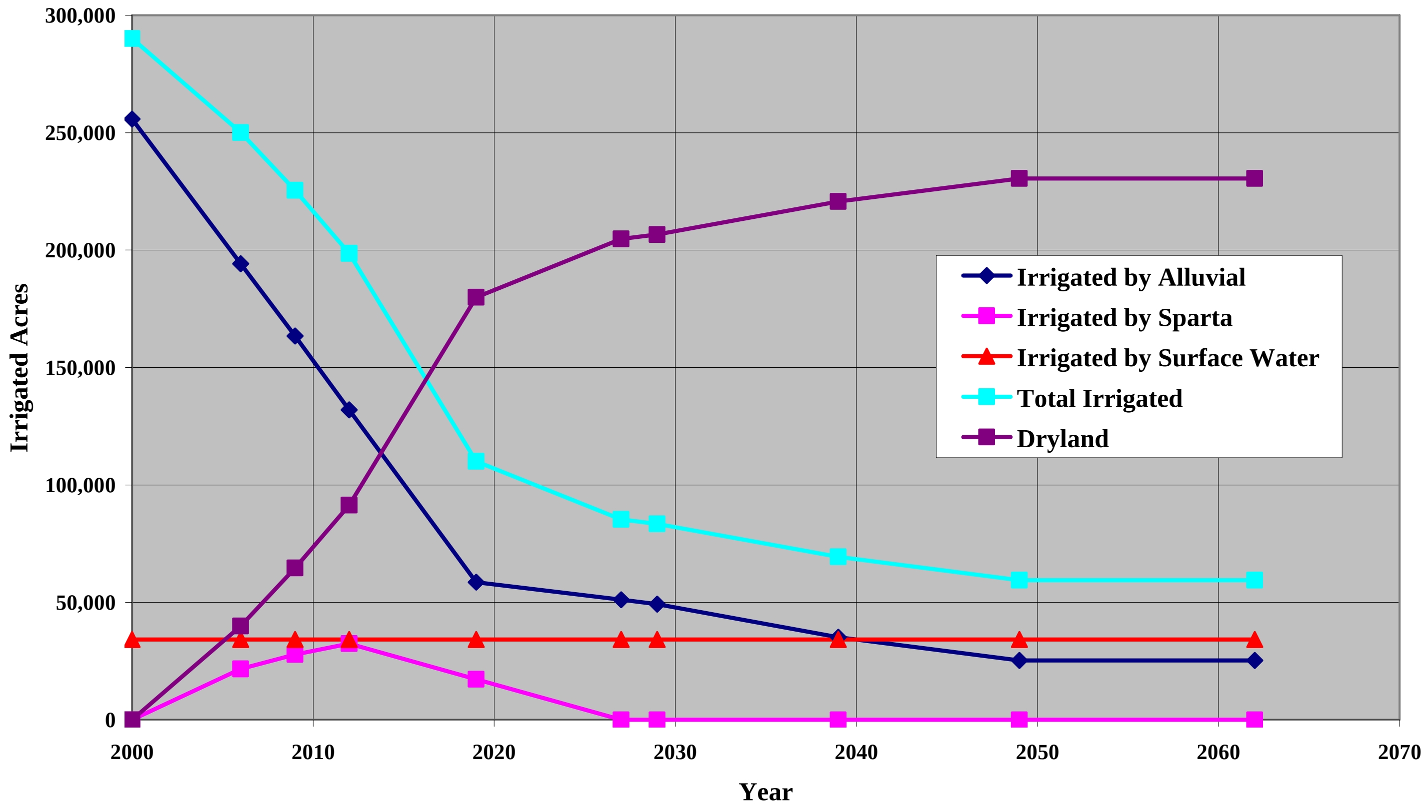


Table 3g
Present and Projected Irrigated and Dryland Acreage
Without-Project Conditions
Bayou Meto, Arkansas

Item	2000	2006	2009	2012	2019	2027	2029	2039	2049	2062
Irrigated by Alluvial	255,845	194,237	163,433	131,973	58,564	51,097	49,230	35,160	25,310	25,310
Irrigated by Sparta	0	21,648	27,783	32,471	17,318	0	0	0	0	0
Irrigated by Surface Water	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216
Total Irrigated	290,061	250,101	225,432	198,660	110,098	85,313	83,446	69,376	59,526	59,526
Dryland	0	39,960	64,629	91,401	179,963	204,748	206,615	220,685	230,535	230,535
Total	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061

Figure 13b
Without Project Irrigated Acreage
Bayou Meto IPA



WITH-PROJECT CONDITIONS

a. Crop Budgets. The crop budgets presented in Tables 3a through 3e are also used for with-project conditions.

b. Irrigation Water Sources. The projected irrigation water sources are presented in Table 3h. The import, conservation, existing surface water, and alluvial aquifer projections are the same as those presented in Appendix E. Additionally the basis of the with-project conservation figures is presented in the NRCS appendix. The primary difference again is the Sparta aquifer. Existing State of Arkansas law allows the State to regulate groundwater when an alternative surface water source is provided. When the project begins to provide supplemental surface water to the project area, the State is expected to begin regulating the Sparta aquifer. As a minimum, new well drilling will not be allowed. Also existing Sparta usage is expected to drastically decline since the with-project water will be much cheaper than Sparta water.

c. Acres of Irrigated and Dryland Crops. Under with-project conditions, 277,474 acres of the original 290,061 acres are expected to remain in irrigation for an average year. Only 12,587 acres are expected to be converted to dryland practices. This data is presented in Table 3i.

Table 3h
Present and Projected Irrigation Water Sources
With-Project Conditions
Selected Plan -- WS4B
Bayou Meto, Arkansas

Item	2000	2006	2007	2008	2009	2010	2011	2012	2013	2019	2027	2029	2039	2049	2062
Alluvial Aquifer	598,573	454,436	430,413	406,390	382,367	347,272	312,177	312,176	148,565	148,565	148,565	148,565	148,565	148,565	148,565
Sparta Aquifer	0	50,647	0	0	0	0	0	0	0	0	0	0	0	0	0
Storage plus Tailwater Recovery	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051	80,051
With Project Import	0	0	0	0	0	0	189,451	189,451	323,613	323,613	323,613	323,613	323,613	323,613	323,613
With Project Conservation	0	0	19,389	38,778	58,168	77,557	96,946	96,946	96,946	96,946	96,946	96,946	96,946	96,946	96,946
Total Sources	678,624	585,134	529,853	525,219	520,586	504,880	678,625	678,624	649,175	649,175	649,175	649,175	649,175	649,175	649,175

Table 3i
Present and Projected Irrigated and Dryland Acreage
With-Project Conditions
Selected Plan -- WS4B
Bayou Meto, Arkansas

Item	2000	2006	2007	2008	2009	2010	2011	2012	2013	2019	2027	2029	2039	2049	2062
Irrigated by Alluvial	255,845	194,237	183,969	173,701	163,433	148,433	133,432	133,432	63,500	63,500	63,500	63,500	63,500	63,500	63,500
Irrigated by Sparta	0	21,648	0	0	0	0	0	0	0	0	0	0	0	0	0
Irrigated by Existing Surface Water	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216	34,216
With Project Surface Water	0	0	0	0	0	0	80,976	80,976	138,320	138,320	138,320	138,320	138,320	138,320	138,320
With Project Conservation	0	0	8,287	16,575	24,862	33,150	41,437	41,437	41,437	41,437	41,437	41,437	41,437	41,437	41,437
Total Irrigated	290,061	250,101	226,473	224,492	222,511	215,798	290,061	290,061	277,474	277,474	277,474	277,474	277,474	277,474	277,474
Dryland	0	39,960	63,588	65,569	67,550	74,263	0	0	12,587	12,587	12,587	12,587	12,587	12,587	12,587
Total	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061	290,061

ENVIRONMENTAL RESOURCES

Without project implementation, the water levels will continue to decline, rapidly increasing the distance from the wetlands to the water table. This will have a drying effect on the wetlands. Recharge from the aquifer to natural streams will decrease as the aquifer declines, thereby changing the ecology of the riverine system. Aquatic organisms that inhabit the streams, ditches and bayous are negatively impacted by the withdrawal of water for irrigation purposes. Most of the fish present in the Basin are from taxa considered to be tolerant of stressors. Benthic macroinvertebrate communities, including freshwater mussels, are limited both in distribution and numbers, primarily due to low flow conditions and unsuitable habitat caused by sedimentation.

NAVIGATION

The operating plan in place for the McClellan-Kerr Arkansas River Navigation System during the design of this project was adopted in 1986. Since that time, a revision to the operating plan, along with the completion of the Montgomery Point Lock and Dam that will provide for more better system management and operation. These modifications were adopted to improve the safety and efficiency of commercial navigation operations while having no significant impact on flood control, recreation, and low flow situations.

WATER QUALITY

Agricultural practices in the project area are not expected to change in the foreseeable future; thus, the demand for irrigation water will remain. As the aquifer is further depleted the potential for intrusion of salt water is increased. Continued and more intensified use of surface water for irrigation will degrade the quality of the water and further lower the quality of fish and wildlife habitat.

CONCISE STATEMENT OF PROBLEMS, NEEDS AND OPPORTUNITIES

NATURAL RESOURCES

Heitmeyer et al. (2002) identified native ecosystem and habitat alterations within the Bayou Meto Basin and approaches for successful restoration; this entire report is contained in Volume 10, Appendix D. The Bayou Meto Basin is a vastly diverse area. Most landscapes in the basin were formed by depositional and erosion dynamics of the Arkansas River. Landscapes in the Bayou Meto Basin range from higher elevation prairie terrace in the northeast to a highly interspersed mosaic of currently active drainages, abandoned courses and channels of the Arkansas River, natural levees, and point bar and backswamp deposits in the south. Herbaceous wetlands/prairie complex, savannas, riparian forests, and a vast bottom hardwood ecosystem historically occupied the project area. Unfortunately, about 85% of the native plant communities were destroyed between European settlement and present. The aquatic communities in the streams and bayous of the Basin have been seriously impacted by hydraulic alterations and water withdrawal for agricultural purposes.

It is likely that the addition of water from the Arkansas River to the Basin will not only directly benefit aquatic organisms by providing adequate amounts of water to streams proposed to carry irrigation water, but will also benefit fish and wildlife that inhabit other streams by decreasing the need to pump directly out of those streams. Additionally, using the Stream Obstruction Removal Guidelines (SORG) to identify flow obstructions, the removal of blockages, primarily siltation deposits, from some of the Basin streams will allow a more natural flow regime that will benefit aquatic life.

Numerous opportunities exist to restore native plant communities and waterfowl habitat through implementation of a Waterfowl Management Plan (See Section III). Restoration of herbaceous wetlands, bottomland hardwoods, and stream buffers are all integral project components. Creation of moist-soil habitat will provide important forage for waterfowl and other migratory birds. The installation of drop-pipe structures in ditches and small tributaries will help reduce sedimentation and facilitate waterfowl flooding. The project will also provide a dependable source of water for flooding crop fields for waterfowl and for waterfowl management within the Bayou Meto Wildlife Management Area.

On-farm reservoir designs include alternative management options for fish and wildlife. These options include features for fisheries, waterfowl, and shorebirds. Different features, such as changes in morphology and plant types will be incorporated into the reservoirs, depending on the selected management option.

AGRICULTURAL WATER SUPPLY

The major resource problem in the Bayou Meto IPA and eastern Arkansas is the lack of a dependable water supply to continue irrigation of cropland. The alluvial aquifer, which is the primary source of agricultural irrigation water for all eastern Arkansas, is seriously depleted. Groundwater withdrawals over several decades in excess of recharge (safe yield) have resulted in several large cones of depression in the aquifer. The largest cone is centered over the Grand Prairie Region and Bayou Meto Basin in Arkansas, Prairie, Lonoke, and Jefferson counties. Groundwater depletion is one of the most serious and far reaching problems that faces the area. Impacts will be of national significance as this region produces approximately one half of the national product of rice and significantly contributes in soybean, wheat, and other grain crops.

FLOOD CONTROL

Flooding and drainage problems within the IPA are expected to worsen without any improvements. Continuous development in and around Jacksonville will increase the flooding problems in the northern area along Bayou Meto. Section II of this report discusses the flood control component in detail.

ECONOMIC

Use of water in eastern Arkansas is closely related to economic growth and development. The economic results of exhausting the aquifer would be catastrophic. The social well being of the people would be jeopardized. The future of the industry that is the economic base of the region and supports all other industry - agriculture, is threatened to non-existence.

Many farms within the project area cannot meet all of an average year's water needs and, as such, only partially irrigate their crops. Farmers have started tapping a deep aquifer to supplement their water needs. Studies have shown that this is only a short-term solution. The deep aquifer cannot sustain a yield to meet the irrigation requirements and is very expensive both in capital investment and operating costs. Farmers can only justify using the deep aquifer in conjunction with the much cheaper surface and shallow aquifer costs.

Without a feasible alternative source of water, irrigation to sustain farming at profitable levels cannot continue. This will have a significant, adverse economic impact on the local economy. It will force farmers, farm supply dealers, and lending institutions into bankruptcy, along with others not directly related to agriculture, whose livelihood depends on the moneys provided by agriculture to the local economy.

SUMMARY

The consequences of aquifer depletion can be prevented or at least limited by providing a supplemental source of irrigation water, thereby maintaining the aquifer at a level which would allow for a sustained yield. The best solution to eastern Arkansas' groundwater problem is the development of alternative water supplies with conservation. Flood protection and water management measures are essential for the protection of the area's human and natural resources. This project also offers significant opportunity for waterfowl management throughout the basin.

PROJECT PLANNING AND DEVELOPMENT

INVENTORY AND FORECAST RESOURCES

The collection, assimilation, management and utilization of data for a project of the magnitude and complexity of the Bayou Meto Basin, Arkansas, could not be efficiently accomplished without a data management system. This was even more important since the data would be collected, developed, analyzed, utilized, and shared by two Corps districts and numerous other parties outside the Corps. Easy transfer of data to and from a central data bank was essential to efficient execution of studies. In order to be compatible with existing in-house survey and mapping, computer-aided drafting and design (CADD), and database software, a Geographic Information System (GIS) was developed using Intergraph Microstation MGE software and ESRI Arcview.

BASE MAPPING

Existing mapping of the Bayou Meto area consisted of U. S. Geological Survey quadrangle maps and associated Digital Line Graphics (DLG). The 1:24,000 scale maps were used for planning, engineering and design studies.

AERIAL PHOTOGRAPHY / SATELLITE IMAGERY

Project boundaries were established and aerial photography and satellite imagery for the project area were obtained. Based on the data needs and analyses required for the study and an evaluation of the cost associated with mapping of the area at various altitudes, it was determined that 30 meter satellite data would provide the level of detailed needed for the land cover and wetlands. It was also determined that 1 meter satellite imagery would provide the level of detailed needed to assist in planning and design. Imagery at this altitude provided current mapping at accuracy within acceptable design limits.

TOPOGRAPHIC INFORMATION

Channel cross sections along existing streams were obtained for hydraulic modeling and engineering design. Detailed surveys of the pumping stations and diversion sites along the existing streams and rivers were conducted. Other topographic information was obtained to meet the planning, engineering and design needs for the general reevaluation. All survey data was input into the model for improved accuracy.

DATA COLLECTION AND ASSIMILATION

DATABASE & GEOGRAPHIC INFORMATION SYSTEM (GIS)

The topographical model was the base of the GIS system. Other information was input on levels that could be active or inactive depending on data needs. The structure and various layers of data contained within the GIS are shown in Table 4. Briefly, the GIS consist of base map data, hydrography, natural resources, landuse, and project features. Each of the data layers is described in the following sections. The true utility of the GIS lies in its ability to link tabular and graphical data. Along with all of the graphical features contained within the GIS, there exists a corresponding tabular entry containing descriptive information about each unique feature. Table 5 describes the tabular data for each of the data layers within the GIS.

Table 4
BAYOU METO BASIN, ARKANSAS
Bayou Meto IPA
Summary of GIS Database

THEME/ CATEGORY	DESCRIPTION	SOURCE	FORMAT
Base Map	Physical Features (Roads, Railroads, Cities, Airports, etc.) Jurisdictional (City Limits, County Lines, BMRIWDD & BMIPA Boundaries, etc.) Property Lines & Ownership Land Use/Land /Cover Construction Items	USGS 1:24,000 DLG Aerial Photography USGS 1:24,000 DLG County Maps Legal Documents County Plat Books Farm Service Agency Satellite Imagery Project Design	Intergraph MGE, Arcview Intergraph MGE, Arcview Intergraph MGE, Arcview Intergraph MGE, Arcview Intergraph MGE, Arcview
Hydrography	Rivers & Streams Wetlands	USGS 1:24,000 DLG USFWS - National Wetlands Inventory, 30m Satellite Imagery	Intergraph MGE, Arcview
Natural Resources	Forested Areas Natural Areas Soils	30m Satellite Imagery 30 m Satellite Imagery USDA	Intergraph MGE, Arcview Intergraph MGE, Arcview Arcview
Project Features	Canals and Pipelines Structures Ditches Relocations Canal & Pipeline Rights-Of-Way	Project Design Project Design Project Design Hardcopy, Field Investigations Project Design	Intergraph MGE, Arcview Intergraph MGE, Arcview Intergraph MGE, Arcview Intergraph MGE, Arcview Intergraph MGE, Arcview

Table 5 BAYOU METO BASIN, ARKANSAS Tabular Data Associated with Each GIS Data Layer		
THEME/ CATEGORY	**DESCRIPTION**	**TABULAR DATA**
Base Map	Roads Property Lines & Ownership Land Use/Land Cover Construction Items	USGS Road Classification (Interstate, US Highway, State Highway, or County Road FSA Identification Number; Township, Range, and Section Numbers; Owner and Operator Name and Address Land Use/Land Cover Classification Identification Number (Item Number)
Hydrography	Rivers & Streams Wetlands	Stationing & Cross Section Data NWI Wetlands Classification, COE Habitat Classification, Acreage
Natural Resources	Forested Areas Natural Areas Soils	COE Habitat Classification, Acreage Land Class type Soil Type
Project Features	Canals and Pipelines Structures Ditches Canal and Pipeline Rights-Of-Way Relocations	Identification Number Identification Number Identification Number Identification Number Type of Facility and Number of Each Location

The REEGIS schema was modified to accommodate the structure needs of the database to meet the data needs of the study. GIS features and attributes were developed both in Intergraph MGE and ESRI Arcview environments and combined to an Arcview environment for analysis.

LANDUSE

The base unit to which all landuse data is tied is the tract. A tract is a unit of land, identified by legal description and coordinate system, and having a unique Farm Service Agency (FSA) identification number. The NRCS Documentation Report, Volume 2, Appendix A, Section G provides detailed information on the FSA tract identification system. A farm may consist of a single tract or a group of tracts. Each individual farm also has an identification number. FSA maintains comprehensive records containing land use and cropping history for each farm tract participating in USDA farm programs. The FSA tract number was used as the record identifier for tract data.

Landuse was obtained from 30-meter satellite imagery and field inspection. Location, perimeter and area were calculated utilizing the GIS functionality. Base acreages are computed on a land cover type basis. Individual tracts were computed by overlaying the land use layer on the tract layer and clipping the land use to the tract boundaries. Acres were re-calculated. Other bodies of water (fish & wildlife lakes, treatment lagoons, irrigation reservoirs, etc.) and landuse (woodlands, pasture, prairie, etc.) were identified from the satellite imagery and as location, type, perimeter and area were determined from the GIS software.

SUSTAINABLE YIELD

Results from a MODFLOW digital groundwater flow model of the alluvial aquifer by USGS showed that continuous pumping at 1997 rates for a 50-year period would result in water levels dropping well below half the saturated thickness of the formation, making these rates unsustainable in the context of Arkansas' Critical Ground Water Area designation as defined by the Arkansas Soil and Water Conservation Commission. Steady-state conditions (that is, water is not removed from storage, and recharge and discharge sum to equal amounts) are assumed for calculating sustainable yield (the amount of water that can be pumped indefinitely without violating specified hydraulic-head or stream-flow constraints). Sustainable yield (that is, optimized steady-state pumpage derived from an optimization model of the aquifer system) for the Bayou Meto IPA is 148,565 acre-ft/yr, which is 65 percent less than the 1997 pumping rate of 435,000 acre-ft/yr for the area. Relative to the 1997 pumping rate, the unmet demand (the difference between the 1997 pumping rate and the optimized sustainable yield) is calculated as 286,435 acre-ft/yr. Detailed analyses of water requirements for the IPA resulted in a total demand of 678,624 acre-ft/yr. A supply of 530,059 acre-ft of water to the Bayou Meto IPA from existing and proposed alternative measures and sources on the average is sufficient to meet that demand and to conserve and to protect groundwater resources indefinitely. Figure 14 shows ratios of optimized well pumping rates relative to 1997 rates within the Bayou Meto IPA and adjacent areas.

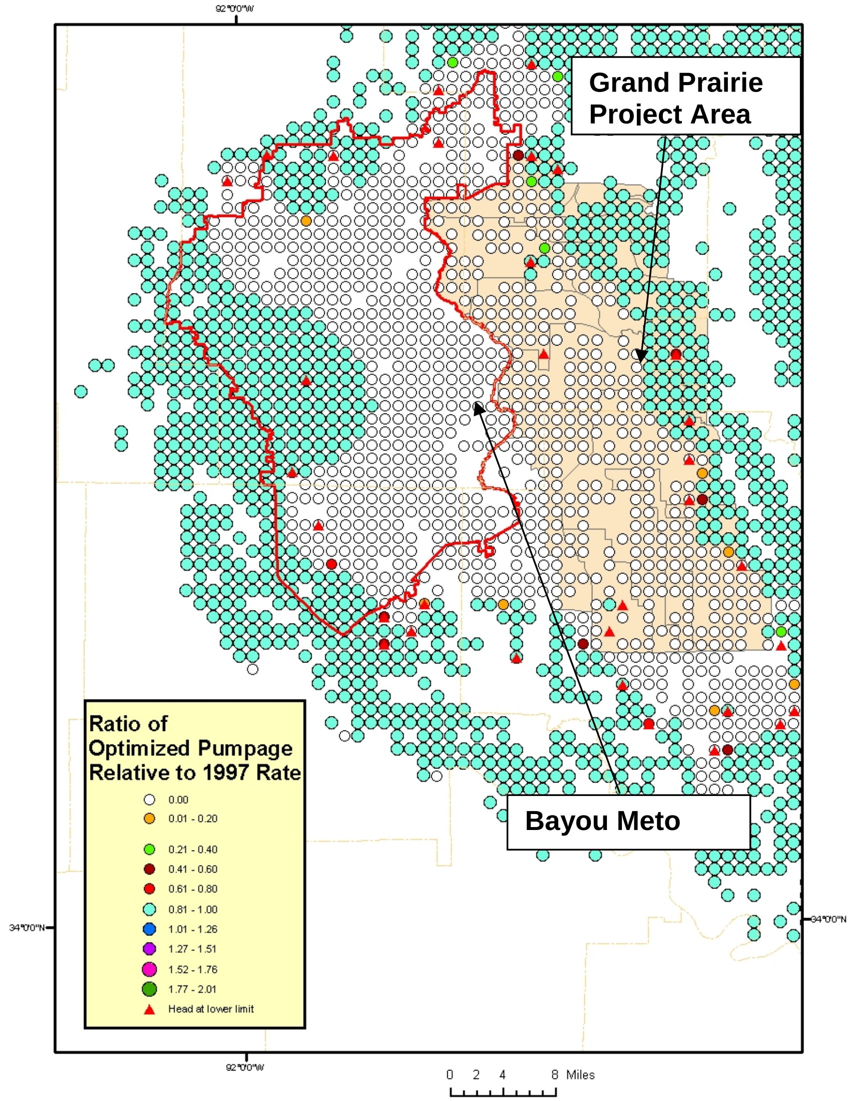


Figure 14. Ratio of optimized pumpage to 1997 pumpage. Circles are located at 1-square-mile model cells at which pumpage occurred in 1997. Open circles represent cells with an optimized pumping rate of zero; colored cells correspond to non-zero rates. Triangles occur at model cells where the projected hydraulic head is at half the thickness of the aquifer. Optimal steady-state pumpage was obtained assuming an upper limit of pumpage at each well to the rate that was pumped in 1997, a hydraulic-head constraint set at half the thickness of the aquifer, and recharge set to predevelopment rates.

Implementation of the selected plan to import 268,324 acre-ft/yr of water to the Bayou Meto IPA, in conjunction with conservation and storage and the optimized sustainable yield of 148,565 acre-ft/yr from the alluvial aquifer calculated by the U.S. Geological Survey, will provide sufficient water to meet anticipated demand without compromising water levels within the aquifer or streamflow in Bayou Meto Basin or the Arkansas River. By limiting ground water withdrawals to the optimized sustainable yield, water levels within the alluvial aquifer will remain at or above half the original saturated thickness of the Alluvial formation. Details of the water balance model for the project are presented in Volume 2, Appendix A, Natural Resources Plan for On-Farm Portion.

DEMAND & SUPPLY DATA

Water needs for each tract within the IPA were determined by the NRCS utilizing computer models. Irrigation water requirements were determined using an NRCS program called CONUSE. This is a computational program for determining consumptive use for various crops under varying climatic conditions. The results of this analysis were used in the NRCS water budget program to compute individual tract water needs. The water budget program integrates land use, water demands, existing on-farm storage, planned storage, potential tailwater (runoff) capture, groundwater availability, and import needs for each tract of cultivated land in the IPA. This model compares water demand, existing water supplies, and potential water supplies to determine total needs and peak quantities and times for each tract. This analysis included both crop and non-crop water needs and considered evaporation losses for surface water sources. The crop demand data was then assembled into 10-day increments and duration analyses were performed to determine the design flow for each 10-day increment.

As previously discussed the Arkansas Natural Resources Commission (ANRC) has authority for establishing critical groundwater levels, aquifer sustained yields, and water use allocations. Utilizing data from their well monitoring program and groundwater modeling studies the ASWCC has established an annual groundwater pumpage from the alluvial aquifer of 148,565 acre-feet as the safe yield. Groundwater use at a sustained yield was determined by USGS groundwater modeling. The model utilized 1997 pumpage with current (2001) data to determine the sustained yield. Yield and availability results were based on Arkansas Water Law regulations and constraints, which have been implemented to protect and conserve groundwater resources.

Existing (1997) and future with project demands were computed from the same landuse database. Adjustments to future with project conditions were as follows:

- All new on-farm storage would be constructed on cropland, thus reducing the irrigated acres.
- The priority of cropland reduction for reservoir construction is full season soybeans, late soybeans, and rice.
- Small changes in woodland acres will occur.
- Total cropland acres will not increase and crop distributions will remain constant.

- Water would be available to flood 33,382 acres of cropland for waterfowl.

Potential runoff capture is based on the irrigated acres and computed as a percentage of monthly runoff. The volume of existing storage was determined by multiplying the surface acreage by an average depth of 6 feet. With project storage was based on a percentage of demand and varied within the IPA based on current development.

The total unmet need is the reduced demand after conservation less tailwater capture, available storage, and groundwater at the sustained level. Crop water budgets were prepared for 10-day intervals because a ten-day period is critical to crop production in terms of water availability. These results were utilized in computing the required delivery system capacities. A detailed description of these analyses is included in Section I of the Natural Resources Plan for On-Farm Portion, Volume 2, Appendix A and Volume 3, Appendix B, Section I, Part C, Hydraulics.

ANALYSIS AND DATA APPLICATION

Data was assimilated and stored in the GIS for easy access and utilization by all study participants for planning, engineering, and design of the project.

DELIVERY SYSTEM

The delivery system consists of four pumping stations and a network of new canals, existing channels, pipelines, and associated structures to deliver water to the project area.

Layout

Water will be diverted from the Arkansas River immediately north of David D. Terry Lock and Dam No. 6. A pumping station will lift the water into a 480 acre-foot reservoir for gravity flow into the primary artery of the canal system, which extends generally eastward to Bayou Meto. A pumping station at Bayou Meto lifts the water across the bayou into a reservoir for continued gravity flow northward up onto Long Prairie just west of Lonoke crossing Interstate 40. The canal turns east to Two Prairie Bayou where another pumping station lifts the water into a reservoir for feeding the northeastern portion of the project area. The primary canal system feeds secondary canals, existing streams, and pipelines along its entire length. The secondary canals, existing streams, and pipelines feed other delivery system components until water is accessible to every tract of land within the project area. Gravity flow is utilized to the maximum extent practical. The water is controlled by a system of water control structures. Plate 3 provides the general layout of the distribution system. Detailed plots of all systems components are included in Volume 7, Appendix B, Section X, Reference Maps.

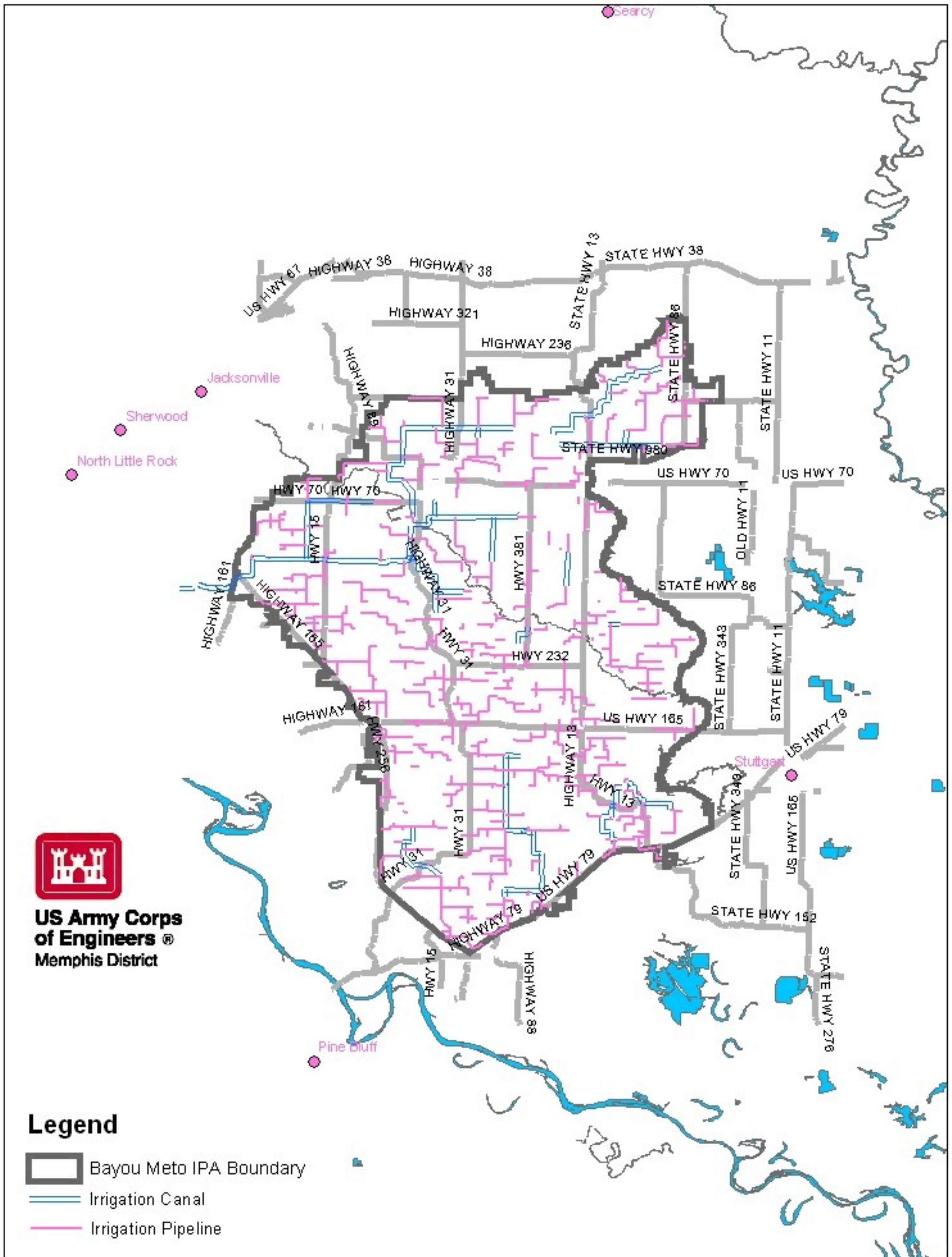


Plate 3
Bayou Meto Basin, Arkansas
DISTRIBUTION SYSTEM

Coordination of the proposed alignment with Federal, state, and local interests and the potential local sponsor; engineering and design, environmental, economic, and institutional considerations; along with other factors; resulted in numerous minor alignment changes throughout the planning of the project. A delivery system numbering system was developed which allowed for easy location and identification of individual components, automated analysis and design of the system, and modification. A detailed discussion of the delivery system layout and network analysis is presented in Volume 3, Appendix B, Section I, Topic C, Hydraulics and in Volume 2, Appendix A, Natural Resources Plan for On-Farm Portion.

Hydraulic Analyses

Initial sizing of the delivery system was based solely on the demand for irrigation water with the assumption that the Arkansas River could provide that demand upon call. Water supply and delivery was evaluated using a water balance approach. Detailed analyses of the delivery system (canals, turnouts, and pipelines) were conducted by steady and unsteady flow methodology. Information contained in the databases for the hydraulic analyses included daily records of Arkansas River discharge and stage, precipitation, rainfall runoff, tailwater capture, crop demands, waterfowl demands, sustainable groundwater yields, seepage, and minimum flow requirements for the Arkansas River.

Analyses for providing import water to the area considered numerous alternative measures and designs. A combination gravity-pumped system was found to be the most economically and engineeringly feasible and environmentally and socially acceptable. This system utilizes a combination of new canals, existing ditches, and pipeline to provide the need water to each farm within the IPA.

Engineering Design

Canals

Calculations to determine excavation and fill quantities were made utilizing Intergraph Inroads Design Software using data obtained through aerial photography. Topographical Triangulated Networks (ttn's) and Digital Terrain Models (dtm's) were used and templates "pushed" along horizontal and vertical alignments to obtain volumes of cut and fill needed to produce the required minimum canal cross section and levee height. In areas where required fill was greater than the quantity of excavation, over excavation of the canal invert was used to provide additional material in order to minimize haul distances and outside borrow areas. On some canals, levee heights were increased to dispose of excess material in reaches where excavation exceeded fill.

Sections were "cut" for mass haul tables and graphs at various intervals. Intervals varied from 100 feet for short canals up to 500 feet for longer canals. The accuracy of the quantities obtained, as compared to a method more accurate than the end area method, varied with the length of the interval with the more accurate information coming from the shorter intervals. The longer section intervals were used to reduce computer processing time and were justified by the accuracy of the design models used to produce the data.

Quantities for existing ditches where channel enlargement is required were computed using the average end area method based on available cross section data and hydraulic design criteria. Excavated material was disposed of along the ditch on the work side.

Typical cross sections for a new canal and an existing ditch are shown in Volume 5, Appendix B, Section III, Civil Design.

Riprap quantities were computed for the inlet canal 500 and 35 bridges on existing ditches, and were based on hydraulic design criteria. Riprap and earthwork quantities are presented in Volume 6, Appendix B, Section IX, Cost Engineering Report.

Rights-Of-Way

The landside toe of levees was used as a basis to calculate acres of right-of-way for the new canals and levee structure. An additional ten feet of right-of-way was added beyond the levee toe for construction purposes to arrive at the final acreage required. The right-of-way requirements for new canals include any additional lands necessary for the disposal of excess excavated material and borrow.

On existing ditches where channel cleanout is necessary, the right-of-way extends from the non-work top bank to 10 feet beyond the excavated material disposal pile.

Rights-of-way may be adjusted during detailed design and coordination with project sponsor.

Relocations

The delivery system layout and model was utilized to identify facilities impacted by project implementation and to identify modifications to reduce impacts and costs. All relocations were input into the GIS system for easy identification, location, and output.

Structures

A complex system of structural features is required to convey water in a controlled manner through the delivery system. The type, dimensions, and locations of the structures required were determined by the hydraulic analyses. Structures were located and identified on the GIS mapping and feature data incorporated into the database. Structure configurations, site plans, and conceptual designs were accomplished using Intergraph software. Volume 5, Appendix B, Section IV contains detailed information on the structural design.

Economic Analyses

Existing landuse, water supply and demand, projected future without and with project conditions and other base economic data was input into the GIS database by the various agencies involved in the collection and assimilation. The GIS was the major source of data for economic analyses to determine project benefits and costs.

Environmental Analyses

Existing conditions wetland determinations were developed using several data types and sources. Period-of-record stage data at six gages in the study area were utilized to determine the 5 percent duration elevation at each gage. A Landstat satellite image with water stages equal or exceeding the 5 percent duration elevation at all gages was used to determine the areal extent of non-farmed wetlands. This data was then ground truthed by personnel from the Vicksburg District Regulatory Branch, the U.S. Fish and Wildlife Service, AGFC, ANHC, ANRC, and ADEQ. Future without- and with-project impacts were projected for all habitat types within the project area. Mitigation requirements necessary to offset losses to wildlife habitat were determined according to Habitat Evaluation System procedures (Volume 10, Appendix D, Environmental Analyses).

A Section 404(b)(1) evaluation was conducted for the total project, except for the on-farm storage and delivery systems (Volume 10 Appendix D, Section VII). It was assumed that farmers would not construct on-farm systems in wetlands. Any farmers that propose to locate irrigation structures in wetlands will have to apply for an individual Section 404(b)(1) permit and be subject to review by the inter-agency environmental team. The evaluation involved a review of the project for compliance with the Clean Water Act by applying Section 404(b)(1) guidelines.

The U.S. Army Corps Engineer Research and Development Center (ERDC) conducted a study to determine baseline conditions of and potential project impacts to fisheries (Volume 10, Appendix D, Section XIV, Part A). This study found that although the fish community in the Bayou Meto Basin reflects the impacts of human disturbance, 55 species of fish were collected in 2001 in the Basin's streams and ditches. Approximately 75% of the total number of fish collected were from species that are tolerant to stressors, and included mosquitofish, bluegill, red and golden shiners, and green sunfish. However, stream reaches remain that are less disturbed and support a more diverse assemblage of species. Human impacts to the fishery include withdrawal of water from the streams and ditches, which reduces water levels and causes stagnant pools with low dissolved oxygen, and cleared stream banks that increase water temperature (through lack of shading) and increase sediment load.

Diversion of water from the Arkansas River to an irrigation delivery system in the Basin will increase water volume in streams, ditches, and canals. There is a potential of larval fish entrainment during pumping, but ichthyoplankton collections in 2000 and 2001 in the Arkansas River indicate that the risk is low during the peak irrigation season (summer). Most of the larval fish susceptible to entrainment are widespread, tolerant taxa including gizzard shad and drum that comprised over 70% of the ichthyoplankton collected. Over 80 miles of bayous and ditches will receive irrigation water diverted from the Arkansas River, and over 100 miles of new canals will be constructed as distributaries.

Habitat models developed from field data collected over several years in the basin predict substantial benefits of irrigation water to fish habitat. Models show that species richness (number of species collected at a site) is expected to double or triple in some reaches, which is similar to the modeling used in the Grand Prairie Water Supply project. Additional benefits from weirs, channel work, and storage reservoirs will also be accrued as part of the irrigation project. Over 60 weirs will be constructed to maintain minimum pool elevations, and channel work to increase flow capacity will remove unconsolidated substrates that degrade fish habitat. Both of these engineering features have been shown to improve species richness and abundance of fishes in delta streams, including collections in Bayou Meto, Grand Prairie, and for an improved reach in Upper Steele Bayou, Mississippi. On-farm storage reservoirs, approximately 1-2 acres in size, will be constructed throughout the basin, and depending on project alternative, will result in 6,000 to 14, 500 acres in additional lacustrine habitat.

Researchers with the Engineer Research and Development Center (ERDC) conducted an intensive search for freshwater mussels in the Bayou Meto Basin and the proposed intake location on the Arkansas River in the spring of 2001. More than 1,000 individuals representing 18 species of mussels were collected from the streams and ditches within the Basin. Over 85% of the mussels collected were found at 2 sites in Indian Bayou Ditch, while 13% of the total number were collected from 7 sites in Salt Bayou Ditch. Density and diversity was low at all sites where mussels were collected, and several streams were completely devoid of mussels.

The high water temperatures and low flows resulting from excessive use of stream water for agriculture create conditions unfavorable to freshwater mussels. No threatened or endangered mussels were found in the Basin. The mussel community was dominated by *Amblema plicata* and *Quadrula quadrula*; two species which are found in a variety of habitat types. The results of the survey are located in Volume 10, Appendix D, Environmental Analyses.

USFWS raised concerns that import Arkansas River could introduce the Zebra mussel (*Dreissena polymorpha*) into Basin streams, which would impact an already stressed freshwater mussel population. ERDC conducted analyses to determine the potential for zebra mussel infestation and found that conditions were likely to be unsuitable for significant numbers of zebra mussels to exist within project waterways.

A geomorphic investigation of Bakers Bayou was conducted by ERDC to the assess waterfowl restoration opportunities and develop alternative water supply and restoration plans. Bakers Bayou is an abandoned Arkansas River course that was active between 6,000 and 8,000 years ago. The maximum width of the channel during this active period was between 600 and 900 feet, while the current width ranges from about 60 to 120 feet. An examination of available data indicates that the typical "channel" in Bakers Bayou circa 1850 (the pre-settlement restoration goal) was probably not a single defined channel, but rather a series of open to forested ponds separated by short and narrow channel segments (Dunbar 2001). Therefore the "restoration" of the channel as a means to supply irrigation water was determined to be unrealistic. Restoration of native vegetation between the natural levees was considered an option, but did not have landowner support.

The Gaylord Memorial Laboratory, University of Missouri at Columbia, and the University of Tennessee at Knoxville performed an assessment of ecosystem restoration opportunities for the Bayou Meto Basin of Arkansas. This report (contained in Volume 10, Appendix D) provides an analysis of options for restoring native ecosystems and habitats in the Bayou Meto Basin. This report identified how the structure and function of the Basin had been altered since the settlement of Europeans, and identified restoration approaches and ecological attributes that would be needed to successfully restore specific habitats and conditions that would be the most economically and ecologically feasible. Several habitat types were recommended as being feasible for waterfowl restoration in this report, including herbaceous wetlands, various elevation bottomland hardwood forests, and slash communities.

ERDC used a hydrogeomorphic approach to classify project area wetlands (according to vegetation, hydrology, and geomorphology) and to characterize the functions of each wetland classification (Volume 10, Appendix D). This study will aid in the restoration of specific sites by predicting the amount of recovery of a restored wetland over time. The NRCS, based on the ERDC wetland classifications, developed and mapped finer plant community types and developed a map of potential natural vegetation that will be extremely useful in project restoration efforts.

Utilizing information in the above studies, the Arkansas Natural Heritage Commission led an inter-agency effort to identify site-specific restoration opportunities in the project area. A copy of this report is included in Volume 10, Appendix D, Environmental Analyses.

A Phase I Hazardous, Toxic, and Radioactive Waste Assessment was performed according to ER 1165-2-132 (Volume 10, Appendix D, Environmental Analyses). As previously discussed, additional sampling and analyses will be conducted during detailed design studies at six (6) sites identified in the investigations to determine their significance and determine what, if any, alternative measures should be taken.

An intensive archaeological survey was conducted for 9,271 acres of a total 62,876 acres estimated for the project's total cultural resources Area of Potential Effect. Of 216 historic and prehistoric sites identified, 14 are interpreted to be potentially eligible for listing in the National Register of Historic Places. While the overall process of identification, evaluation for significance of findings, and assessment of effects for precise project features is not completed (as typical for a project of this size and complexity), project design will strive to avoid impacts to any significant cultural resources sites.

STUDY PARTICIPATION & COORDINATION

PROJECT MANAGEMENT

The Memphis District (MVM) Corps of Engineers had overall management responsibility for the general reevaluation effort. The Vicksburg District (MVK) Corps of Engineers and the Natural Resources Conservation Service (NRCS) had major roles in the planning, engineering and design of the project. A two-tiered management structure consisting of an Executive Committee and a management team was utilized in the managing of the general reevaluation.

EXECUTIVE COMMITTEE

An Executive Committee was established with responsibility for overall study direction and execution of the general reevaluation.

The Executive Committee consisted of the following members:

- Colonel Charles O. Smithers - Memphis District, District Engineer
- Eddie Belk - Memphis District, Deputy for Project Management
- Gary Canada - President, Bayou Meto Water Management District
- Gene Sullivan - Executive Director, Bayou Meto Water Management District
- Kalven Trice - State Conservationist, Natural Resources Conservation Service

PROJECT MANAGEMENT TEAM

The project management team had responsibility for the day-to-day management of the general reevaluation. They worked with and directed the work of the interdisciplinary study team. The project management team was headed by the MVM project manager and consisted of technical representatives from the various disciplines involved in study execution and a representative from the Bayou Meto Water Management District (BMWMD). The responsibilities of the project manager as related to the general reevaluation were: monitor physical and fiscal progress of all work required for completion of the project; prepare budgetary submission data and materials; report study progress monthly through the Project Management Business Process (PMBP) and to the customer; serve as primary point of contact with potential project sponsor on project issues; chair issue resolution conferences, alternative formulation briefings, project team meetings, and other coordination activities; and prepare the PMP. Responsibilities of the project managers and technical managers included: the quality and technical management of all activities including planning, engineering, and real estate products that are a part of the general reevaluation; serving as points-of-contact on technical issues within their expertise;

participation in preparation of the PSP, QCP, PMP, and general reevaluation report (GRR); coordination of all technical issues; monitoring of schedule and expenditure of funds for all activities, work elements, and subproducts for all work necessary within their element for the GRR to assure completion on time and within resources allocated; report progress, issues, and changes through the appropriate channels; coordination of quality control/quality assurance process including technical review and documentation; and submit draft report (main report & EIS, engineering appendices, real estate memos, etc.) for review and processing. The MVK coordinator monitored expenditure of funds and performance on all activities conducted by MVK and reported progress to the MVM project manager at least bi-weekly or as needed for coordination and to assure efficient study execution. The NRCS coordinator oversaw all activities associated with the on-farm portion of the project and coordinates this effort with the MVM project manager. The BMWMD representative was included in all aspects of planning and project development.

INTERDISCIPLINARY STUDY TEAM

An interdisciplinary study team was utilized so that specialists in each discipline would be available to the study effort. The study team included members from the MVM, MVK, NRCS and BMWMD.

ENVIRONMENTAL PLANNING TEAM

Essential to the successful implementation of this project was the environmental coordination of the planning and project development. To facilitate this goal and accelerate the planning process, an Environmental Planning Team was formed early in the planning process. This team represented various Federal, state, and local public agencies along with several conservation groups. Team members included representatives from the U.S. Fish and Wildlife Service (USFWS), Natural Resources Conservation Service (NRCS), Environmental Protection Agency (EPA), Ducks Unlimited, Arkansas Game and Fish Commission (AGFC), Arkansas Natural Heritage Commission (ANHC), Arkansas Natural Resources (ANRC), and The Nature Conservancy. This group met throughout the study to: identify opportunities to protect and restore waterfowl resources, facilitate development of environmentally-sensitive alternative plans related to flood control and agricultural water supply, and design an optimal plan for waterfowl management. Frequent meetings were conducted to ensure that coordinating agencies had the most current information on the overall progress of the project. Many of these meetings were combined with field inspections of various aspects of the study. For example, on 24-25 May 2000, the team was briefed by staff of MVK on baseline conditions for flood control needs along with design of channel improvements, control structures, and other improvements. This included field visits to numerous locations for on-site discussion. Another meeting was held on 19 September 2000 to update the team on alternative plans for providing supplemental agricultural water supply by importing water from the Arkansas River into various combinations of existing streams, new or existing canals, and pipelines. Other team meetings were conducted throughout the study at key points in the development and analysis of alternative plans of improvement and opportunities for flood control, agricultural water supply, and waterfowl management.

STUDY PARTICIPANTS

Coordination with all study participants and key interests was effected upon receipt of the initial work allowance. Early meetings focused on the development of the PSP for study execution and coordination. A scope of studies to achieve the desired study outputs in an efficient and cost effective means was developed with input from all parties.

FEDERAL AGENCIES

(1) The NRCS was a major player throughout the planning process in identification of problems and opportunities, inventory and projection of resources and needs, formulation of alternatives, evaluation of project measures, and planning and design of the on-farm portion of the project.

(2) Recent modeling of the alluvial aquifer to evaluate the regional effects of aquifer and alternative water source development on water level declines by the U. S. Geological Service (USGS) show that conservation measures and use of alternative sources of water could result in considerable recovery of water levels in the aquifer.

(3) Coordination with the U. S. Fish and Wildlife Service (USFWS) has been continuous throughout the study effort. USFWS is a part of the team that developed and formulated alternative plans and measures to be included as an integral part of the plan of improvement for water supply, flood control, and waterfowl management. A Planning Aid Report, Migratory Bird Management Plan, and Fish and Wildlife Coordination Report are included in Volume 10, Appendix D.

STATE AND LOCAL AGENCIES

The Arkansas Natural Resources Commission, Arkansas Game and Fish Commission (AGFC), and Arkansas Natural Heritage Commission provided considerable input and support to the study effort. Other agencies involved in coordination include Arkansas Department of Transportation, Arkansas Department of Health, Arkansas Department of Pollution Control and Ecology, Arkansas Department of Parks and Tourism, Arkansas Geological Commission, and Arkansas Waterways Commission.

POTENTIAL PROJECT SPONSOR

The Arkansas Natural Resources Commission, in partnership with the Bayou Meto Water Management District, is the potential project sponsor and has been an active participant throughout the study effort.

PUBLIC INVOLVEMENT

An extensive public involvement program was initiated with the receipt of the initial work allowance. A Public Involvement Plan was developed and implemented to educate all interests concerning the project and solicit input into the planning process. Public involvement activities included: public information meetings, area shop meetings, individual meetings, state legislative briefings, in-progress reviews and status updates, BMWMD Board of Directors meetings, field trips, news releases, information pamphlets, and videos.

QUALITY CONTROL/QUALITY ASSURANCE

A Quality Control Plan (QCP) was developed to insure that all planning, engineering, and design studies were conducted consistent with Corps guidance and regulations and the final output is a high quality product. The QCP was implemented for independent technical review, consistent with established criteria and procedures, and with policy. The QCP is included in the Bayou Meto Basin, Arkansas Project Study Plan (PSP). Technical review consisted of a single level review performed throughout the course of the study. Quality control records have been consolidated in a technical review package. A plan for quality control/quality assurance for detailed engineering and design and construction activities is being developed as part of the PMP.

PLANNING CONSTRAINTS

GENERAL

This general reevaluation was conducted in accordance with the *Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies*, published in March 1983 by the U. S. Water Resources Council. The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

1. Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

2. Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed.

3. Plan formulation criteria used was in compliance with the National Environmental Policy Act, Executive Orders 11988 and 11990, and other applicable environmental statutes.

STUDY-SPECIFIC

- Minimize impacts to fish and wildlife.
- Minimize impacts to wetlands and forests.
- Maximize waterfowl restoration opportunities.
- Utilize non-structural measures to maximum extent that is economically, engineeringly, environmentally feasible and socially acceptable.

LEGAL AND INSTITUTIONAL

A major factor in project planning and design was the minimum flow and state water resource allocation requirements for the Arkansas River as provided by the current Arkansas State Water Plan (SWP). The requirements of the SWP are presented and discussed in Volume 3, Appendix B, Section I, Part C, Paragraph 3-C-01. Numerous reviews of the existing state legislation, regulations, and case law have been conducted by state and local water law experts in recent years to identify deficiencies in Arkansas Water Law pertaining to groundwater protection and the development and implementation of projects to provide supplemental water supply. As a result of these reviews significant pieces of legislation have been enacted that provide the authority and procedures for groundwater protection by the state and project development and sponsorship by a local entity. The rules for protection and management of groundwater can be found under Title IV of the Arkansas Natural Resources Commission's, Rules and Regulations.

The rules for protection and management of groundwater can be found under Title IV of ANRC's Rules and Regulations. These rules and regulations can be found on the internet at www.anrc.arkansas.gov/CommissionRules.htm. All appropriate legal and institutional constraints and restrictions have been considered when assessing both future without- and future with-project conditions. The ANRC has responsibility for groundwater protection. However, existing laws do not allow them to regulate groundwater withdrawals in the absence of an alternative water source. Therefore, current law cannot significantly reduce groundwater pumping without construction of the project.

PLANNING OBJECTIVES

GENERAL

The planning objectives for the Bayou Meto Basin, Arkansas general reevaluation were developed to formulate plans of improvement consistent with Federal, state and local water and related land resources management needs and goals for the project area. These objectives were developed through problem analysis and in partnership with the Bayou Meto Water Management District and other Federal, state, and local interests.

STUDY-SPECIFIC

The following planning objectives were established consistent with and to be responsive to the identified problems and opportunities. These objectives formed the strategies for development of measures for formulation of alternative plans.

- Reduce flood damages within project area.
- Improve/enhance water management capabilities for waterfowl.
- Protect and preserve the groundwater resources.
- Provide a supplemental water supply to meet the irrigation water needs of the Bayou Meto Basin.
- Maximize the use of conservation.
- Restore/enhance environmental and natural resources.
- Minimize Cost/Maximize Outputs.

ALTERNATIVE PLANS

Alternative plans for the Bayou Meto IPA were formulated to address the planning objectives. Development of the alternative plans for this project was an iterative process that began at study initiation and continued through the evaluation process. Additions and changes were made to accommodate the many complex issues and constraints and to meet the needs and desires of the local interests.

STRATEGIES

Strategies were developed for solving the water resources problems and opportunities identified and to achieve the goals and objectives. These strategies formed the basis for determination of data and analyses needed to conduct the planning and make decisions relative to the assessment and evaluation of alternative plans.

GROUNDWATER PROTECTION AND PRESERVATION

As previously discussed, the most significant problem related to water supply and conservation is the depletion of the alluvial aquifer. Long term stability and prevention of permanent loss of the aquifer were major planning objectives.

AGRICULTURAL WATER SUPPLY

The economy of the Bayou Meto Basin is almost totally agriculture based and without water for irrigation, could not continue to function. A reliable source and supply of water for agricultural irrigation is essential for the future of the region.

CONSERVATION

All available sources of water for agricultural irrigation are limited and must be conserved to the maximum extent feasible. Conservation measures must be an integral part of any plan.

FLOOD CONTROL

Flood damages to crops and other improvements occur throughout the basin. Improvements to existing channels to reduce flooding and eliminate any induced impacts from agricultural water supply improvements will be included.

WATER MANAGEMENT

Measures to enhance water management for fish and wildlife, specifically waterfowl conservation, protect and restore bottomland hardwoods, provide for positive drainage, and restore natural flow regimes must be an integral part of any plan of improvement.

WATERFOWL MANAGEMENT AND RESTORATION

The Bayou Meto Basin is one of the premier duck hunting areas in the world. The project offers significant opportunities to restore fish and wildlife habitat, and enhance waterfowl management.

RIPARRIAN BUFFERS

Opportunities for restoration of riparian corridors along existing streams and landscape areas to provide habitat for area sensitive species have been identified for implementation.

MEASURES

The following measures are the specific actions or features identified to address the planning objectives.

IRRIGATION EFFICIENCIES

The efficiency of delivering and applying water to the crops being irrigated is an important factor in determining the water needed and optimizing project design. Irrigation efficiency is defined as the amount of applied water that benefits the crop divided by the total amount of water leaving the on-farm source. It is an indicator of the water loss due to levee seepage, evaporation, deep percolation, tailwater runoff, and waste. Studies conducted by the Natural Resources Conservation Service (NRCS) have shown that installation of water conservation practices and water management techniques can improve water application efficiencies. These conservation measures include land leveling, soil moisture monitoring and irrigation scheduling programs, tailwater recovery systems, application methods (sprinkler, drip, furrow, etc.), and utilization of pipelines for on-farm water transfer. Also, multiple inlet rice irrigation, where applicable, will be encouraged due to increased efficiencies over cascade irrigation. By increasing the efficiency of getting the water from the on-farm source to the field, conservation measures effectively cut the demand and should be maximized to the extent practical.

Extensive field tests and analyses were conducted by NRCS for the Eastern Arkansas Water Conservation Project (EAWCP) to determine existing and potential irrigation efficiencies of typical farms throughout eastern Arkansas. This project included 20 season long studies on flood rice irrigation and 25 evaluations on other crops using intermittent flood irrigation. An irrigation water needs analysis was performed which determined the irrigation efficiencies of the typical farm for rice and other crops. Findings from these studies showed that current average irrigation efficiencies for the Bayou Meto Basin are approximately 60 percent. Field tests were conducted to determine the achievable efficiencies using conservation practices. Land leveling was not considered for the Bayou Meto Basin IPA due to the fact that most land has or is being leveled to the extent feasible.

Conservation analysis on typical cells and comparison of benefits and costs showed that an improvement of about 10% in irrigation efficiency could realistically be achieved. Economic analyses (Volume 11, Appendix E) confirmed that conservation provides the best return per dollar invested. Therefore, the with-project demands for the Bayou Meto IPA were based on a project wide 70% efficiency in water applications.

GROUNDWATER

Groundwater modeling was performed by USGS. Utilizing a digital groundwater flow model (MODFLOW) of the alluvial aquifer north of the Arkansas River, groundwater conditions for the period 1918 to 2049 were simulated. Conjunctive-use optimization modeling used MODMAN to maximize pumpage without exceeding water-level or streamflow constraints. Results showed that the 1997 pumpage, adjusted to provide a sustainable yield indefinitely without allowing the saturated thickness of the aquifer to drop below 50%, would allow for 148,565 acre-foot/year pumpage. The model maximized available surface water resources in determining sustained groundwater yield.

ON-FARM STORAGE

On-farm storage is a practical means of capturing and storing additional surface water for irrigation purposes. Farmers throughout eastern Arkansas and in the Bayou Meto IPA have depended on their storage reservoirs to provide the irrigation water they needed when all other sources were exhausted. On-farm reservoirs provide the means for capturing runoff throughout the year from existing streams during periods of high flow or storm events and to recapture irrigation water runoff. On-farm storage provides that large volume of water needed for initial flooding of rice fields and timely irrigation of other crops. Studies conducted by Conservation Districts have shown that yields are substantially increased if water is applied at specific points in the plants growth and development cycle. There are currently 4,893 acres of land in the Bayou Meto IPA in storage reservoirs. These reservoirs provide for 30,429 acre-feet of irrigation water storage. The lack of existing sources of available water for capture currently limits on-farm storage.

Analyses were conducted to determine the optimum amount of on-farm storage. These analyses considered: the peak water need periods, the amount of land that a farmer would be willing to take out of production, the availability of import water during peak use times, and the increased available water for capture and storage with the implementation of conservation measures. Numerous storage levels were run and evaluated. Initial storage levels were analyzed to minimize the peak demand on the delivery system. This would minimize the size of the delivery system (pumping station, canals, structures, etc.) and allow a more constant operation for the delivery system. The optimum level of storage was determined to be approximately 25% for the Bayou Meto IPA north and east of Bayou Meto and 10% south and west of Bayou Meto. Storage would provide approximately 16% of the existing irrigation needs or 19% of the with project needs for an average year. The decreased needs are a result of conservation. This level was achieved through balancing the availability of import water, timing of irrigation, filling reservoirs, and providing water for fish and wildlife. This would require 8,832 acres of land and would provide 87,783 acre-feet of additional irrigation water annually. Only approximately 55,289 acre-feet of the new storage could be provided from existing water sources, the remainder would require new irrigation water from the import system. Reservoirs would be placed on cropland, with wooded areas being disturbed as a last resort. Storage acres below the 8,832 acres would require the conversion of irrigated land to dryland farming. This level is recommended based on supply-demand modeling and an economic tradeoff analysis. An increase or decrease in storage reduces the net economic benefits. Storage water is utilized throughout the cropping season on an as-needed and as-available basis, when other sources fail to meet the demands.

IMPORT WATER

The unmet need is the volume of water that could not be met with existing sources: groundwater, surface water, rainfall, storage, etc. This unmet need would have to come from outside sources. 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 sustainable level. The major concern related to import water was a source that could supply this volume of water at the time needed.

The only source of import water within the area that could provide the need was the Arkansas River. Flows in the Arkansas River fluctuate throughout the year but this fluctuation is normalized by the reservoirs for the Arkansas River navigation. Only during periods of very low flow will there be a concern from this source. A water balance analysis (Volume 3, Appendix B, Section I) was conducted which considered all sources and agricultural uses of water. Factors affecting the water balance included water from the Arkansas River, rainfall, evaporation, on-farm storage, groundwater, import system capacity, delivery system losses, and water demand. Determining the amount of water available from the Arkansas River and the delivery system's ability to supply the required water was key in evaluating project functionality and feasibility. The water balance was conducted using CONUSE, a program developed by Natural Resource Conservation Service (NRCS), for a 57-year period of record. Flow was considered available for the diversion when discharges were greater than the minimum requirements for any other use or stop pump level. These minimum instream flow requirements (4645 cfs for fish and wildlife purposes) of the Arkansas State Water Plan (SWP) were the governing constraint for diversion out of the Arkansas River. The water balance model provided the water needed for diversion, storage volume utilization, and water demand met on a daily basis with an average annual maximum withdrawal of 173 billion gallons/year. Water supplied from the Arkansas River was sufficient to meet approximately 95 percent of the area's average demand, with all of the area's demands being met some of those years analyzed.

FLOODING FOR WATERFOWL

The project area is along a major migratory route for ducks and geese. Adequate feeding and resting areas are essential in sustaining waterfowl along this route, particularly in the Bayou Meto Basin. Water is needed from mid-October to the end of November to flood agricultural fields for waterfowl. The project will provide the capability for flooding 33,382 acres of cropland on an average annual basis. In addition, the project will provide a dependable source of water for waterfowl flooding in the Bayou Meto Wildlife Management Area.

FISH HABITAT

Within the project area, only limited fisheries exist in many of the small tributary streams due to desiccation during summer months. The project provides incidental benefits to fisheries in these tributaries and creates fisheries within new canals. Weirs placed in existing streams for irrigation purposes will provide pools of sufficient depth to maintain year round fisheries. New canals and storage reservoirs will also provide additional fish habitat.

FRESHWATER MUSSELS

The high water temperatures and low flows resulting from excessive use of stream water for agriculture have created conditions unfavorable to freshwater mussels. Additionally, large amounts of sediment enter the streams from areas where farming occurs up to the top bank. Species richness and densities are generally low and in some streams mussels have been extirpated. The implementation of such project features as maintaining minimum depths, installing drop-pipe structures and creating riparian buffer strips will largely eliminate these stressors and should aid in the recovery and recolonization of streams with impacted mussel communities.

ALTERNATIVES

Structural and non-structural measures were considered and evaluated in the formulation of alternative plans. Measures that had been determined either not feasible, unacceptable, or did not meet the needs of the area during feasibility studies were not considered in the general reevaluation. These measures included groundwater artificial recharge, intensified mining of deeper aquifers, and construction of large reservoirs. Engineering, environmental, economic, sociological, institutional, acceptability, and other factors were key in the formulation of alternatives to insure that resources were not wasted in the development of unimplementable plans.

The following is a presentation of alternatives developed for the Bayou Meto IPA. Some of the alternatives were carried forward through complete and detailed engineering, economic, and cost analyses. Others were screened or eliminated from detailed studies at various points throughout the planning process. All alternatives were based on groundwater providing approximately 148,565 acre-feet annually, the long-term sustained yield of the alluvial aquifer from groundwater studies that will allow for aquifer recharge.

ALTERNATIVE WS1 - NO ACTION

This alternative is the set of conditions that are expected to occur in the proposed project area in the absence of a project. The supply of irrigation water is decreasing as the groundwater reserves are being depleted. Historical and current trends reaffirmed by well data and field observations in concert with previously discussed groundwater models make obvious the dire seriousness of groundwater depletion. The state of Arkansas recognized the urgency of protecting groundwater resources in 1998 when the area was designated as a Critical Groundwater Area. With this designation withdrawals can be limited to the annual recharge rate. Withdrawals from the aquifer would not be allowed when water levels dropped below 50% of the original saturated thickness. These legal and institutional restrictions become the governing factor in pumpage instead of physical constraints. The desired land use and demand for irrigation water in the future will remain the same as present conditions. However, after 2015, groundwater yields are expected to be limited to the safe yield or recharge rate of 148,565 acre-feet. This level of groundwater, along with existing rainfall runoff capture and on-farm storage reservoirs, can support irrigation on only about 34% of the project area (97,716 acres of cropland and fish ponds) during an average year. The reminder of the area will have to convert to dryland agricultural practices consisting mainly of soybeans. Alternative WS1 was carried through detailed hydrologic and economic analyses and used as the base with which to compare the effects of all other alternatives.

ALTERNATIVE WS2 – CONSERVATION WITH STORAGE

Alternative WS2 consists of additional on-farm storage and conservation measures without any import water. Conservation measures would be implemented to maximize the use of existing water sources to the extent practical. These measures are designed to increase the efficiency or usage of irrigation water. The current 60% efficiency rate would be increased to a maximum of 70% through the installation of conservation measures and storage reservoirs. Three levels of on-farm storage were considered for this alternative 5,954, 8,832, and 14,544 acres. The designation of these levels for this alternative is as follows:

- Alternative WS2A – 5,954 acres of additional storage reservoirs
- Alternative WS2B -- 8,832 acres of additional storage reservoirs
- Alternative WS2C -- 14,544 acres of additional storage reservoirs

This alternative, like Alternative WS1 above, uses 2015 groundwater yields of the expected safe yield or recharge rate of 148,565 acre-feet. This level of groundwater, along with existing and new rainfall runoff capture and on-farm storage reservoirs, can support irrigation on only about 46% to 52% of the project area (132,570 acres for WS2A, 141,573 acres for WS2B, and 151,391 acres for WS2C of cropland and fish ponds) during an average year. The reminder of the area will convert to dryland agricultural practices consisting mainly of soybeans.

ALTERNATIVE WS3 – 1,650 IMPORT SYSTEM PLUS CONSERVATION AND STORAGE

This alternative consists of the conservation measures and on-farm storage reservoirs in Alternative WS2 plus a 1,650 cfs import system. The conservation measures are designed to achieve the optimum level increasing the irrigation efficiencies from 60% to a maximum of 70% for the entire project area. Import water is provided by transfer of excess water from the Arkansas River to the farms through a system of new canals, existing streams, and pipelines. On-farm storage is used to capture existing runoff and to store import water for use during peak demand periods or when other sources cannot provide the need. These three components are not independent or stand alone features. They are related and depend on each other to function properly. The above three combinations are designated as:

- 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

This alternative, like Alternatives WS1 and WS2 above, uses 2015 groundwater yields of the expected safe yield or recharge rate of 148,565 acre-feet. This level of groundwater, along with existing and new rainfall runoff capture and on-farm storage reservoirs, can support irrigation on about 90% to 96% of the project area (260,461 acres for WS3A, 274,546 acres for WS3B, and 277,595 acres for WS3C of cropland and fish ponds) during an average year. The reminder of the area will convert to dryland agricultural practices consisting mainly of soybeans.

ALTERNATIVE WS4 – 1,750 IMPORT SYSTEM PLUS CONSERVATION AND STORAGE

This alternative is identical to Alternative WS3 with the exception of using a 1,750 cfs import system instead of a 1,650 cfs system. It consists of the same combination of conservation measures and on-farm storage reservoirs as Alternative WS3. The conservation measures are set at a maximum of 70% for the project area with on-farm storage reservoirs of 5,954 acres, 8,832 acres, and 14,544 acres of new reservoirs in addition to the existing reservoirs. These combinations are designated as:

- Alternative WS4A – 5,954 acres of additional storage reservoirs
- Alternative WS4B -- 8,832 acres of additional storage reservoirs
- Alternative WS4C -- 14,544 acres of additional storage reservoirs

Alternative WS4, like Alternatives WS1, WS2, and WS3 above, uses 2015 groundwater yields of the expected safe yield or recharge rate of 148,565 acre-feet.

Alternative WS4 can also support irrigation on about 90% to 96% of the project area (261,260 acres for WS4A, 275,376 acres for WS4B, and 278,378 acres for WS4C of cropland and fish ponds) during an average year. The remaining area will convert to dryland agricultural practices consisting mainly of soybeans.

ALTERNATIVE WS5 – 1,850 IMPORT SYSTEM PLUS CONSERVATION AND STORAGE

Alternative WS5 also consists of the conservation features and on-farm storage levels used in Alternatives WS3 and WS4. Alternative WS5 uses a 1,850 cfs import system in addition to the conservation features and on-farm storage reservoirs. These combinations of Alternative WS5 are designated as:

- Alternative WS5A – 5,954 acres of additional storage reservoirs
- Alternative WS5B -- 8,832 acres of additional storage reservoirs
- Alternative WS5C -- 14,544 acres of additional storage reservoirs

Alternative WS5, like Alternatives WS1, WS2, WS3, and WS4 above, uses 2015 groundwater yields of the expected safe yield or recharge rate of 148,565 acre-feet. Alternative WS5 can also support irrigation on about 90% to 96% of the project area (261,278 acres for WS5A, 275,467 acres for WS5B, and 278,860 acres for WS5C of cropland and fish ponds) during an average year. The remaining area will convert to dryland agricultural practices consisting mainly of soybeans.

SCREENING OF ALTERNATIVES

All of the above alternatives were carried into detailed economic analysis. Alternative WS2 (conservation and storage without an import system) yields a higher dollar return for each dollar invested than any of the other alternatives. Alternative WS2B yields the highest return of the three conservation and storage levels studied. Additional conservation and storage measures should always be used to the maximum or optimum extent before adding any other measure since it provides water more cost effectively than any other source. However, additional conservation and storage cannot supply all of the Bayou Meto IPA’s future without-project unmet need. The limiting factor in using conservation measures is that they are effective only when there is available water to recover. A point is quickly reached where the available sources of irrigation water are exhausted and only a small portion of an average year’s unmet need can be satisfied. Conservation practices are recommended for the entire project area in conjunction with the alternative sources provided by other alternatives, since conservation reduces the total amount of water required and is more cost effective. Because of this, the features in Alternative WS2 were incorporated into the design of Alternatives WS3, WS4, and WS5.

REFINEMENT OF ALTERNATIVES

Alternatives WS3, WS4, and WS5 incorporated the conservation measures of Alternative WS2 along with 1,650 cfs, 1,750 cfs, and 1,850 cfs pumping stations and import systems. The 1,750 cfs import system and 8,832 acres of new storage reservoirs in Alternative WS4B is the minimum required to supply an average year's unmet demand based on unlimited withdrawals from the Arkansas River. The 1,650 and 1,850 cfs import systems in Alternatives WS3 and WS5 in conjunction with smaller and larger levels of storage reservoirs were analyzed to identify the NED alternative.

The 8,832 acres of new storage, providing approximately 82,365 acre-feet, is the minimum level of on-farm storage necessary to achieve the desired conservation levels for the entire project area. Any decrease would reduce the conservation efficiencies and cause a corresponding shift from irrigation to dryland practices during an average year. Any cost savings from reducing on-farm storage below this level would be more than offset by the economic losses associated with the lost conservation efficiencies. Also, any increased gain by moving to a larger storage capacity was more that offset by the added construction cost.

Each of the alternatives requires 1,324 acres to mitigate for loss of fish and wildlife habitat. Since mitigation acreage is the same, it was not a factor in determining the selected plan.

FINAL ARRAY OF ALTERNATIVE PLANS

Supporting economic data for the final array of alternatives is presented in Table 6. It shows that all alternatives taken into detailed economic analysis were economically justified with benefit-to-cost ratios greater than unity. It also shows that the conservation and storage only alternatives yield the greatest return per dollar invested. However, significant economic gains were still attainable by adding an import system. The optimum or NED alternative is Alternative WS4B consisting of a 1,750 cfs import system along with 8,832 acres of new storage and additional conservation features necessary to achieve a 70% efficiency of on-farm irrigation water usage.

Table 6
BAYOU METO BASIN, ARKANSAS PROJECT
Bayou Meto IPA
Summary of Annual Benefits, Costs, Excess Benefits, and Benefit-Cost Ratios
(October 2004 Price Levels, 5.375% Discount Rate, $000)

Alternative	Annual Benefit	Annual Cost	Excess Benefit	Benefit-Cost Ratio
WS2A	5,669	4,419	1,250	1.3
WS2B	6,964	5,172	1,792	1.4
WS2C	7,990	6,668	1,322	1.2
WS3A	30,091	28,554	1,537	1.05
WS3B	32,213	29,330	2,883	1.10
WS3C	32,426	30,803	1,623	1.05
WS4A	30,204	28,636	1,568	1.05
WS4B	32,330	29,411	2,919	1.10
WS4C	32,428	30,883	1,545	1.05
WS5A	30,207	28,686	1,521	1.05
WS5B	32,332	29,463	2,869	1.10
WS5C	32,428	30,943	1,485	1.05

TRADE-OFF ANALYSES

This section of the report focuses on the differences between the alternative plans presented in the final array based on the effects in the NED, EQ, RED, and OSE accounts. The plan with the greatest net economic benefits consistent with protecting the nation's environment would be selected, unless deviation is justified on the basis of trading off contributions of the other plans. Several factors were considered as trade-offs during plan formulation. These considerations are discussed in previous sections and include: (1) the amount of on-farm storage and conservation versus import water; (2) the demand for Arkansas River flows by various users; and (3) the short term impacts of construction and the overall net increase in benefits to fish and wildlife habitat and the environment.

NED ACCOUNT

Table 7, System of Accounts, indicates that all of the alternatives in the final array are economically justified. All plans contribute more to the national economy in the way of direct or primary benefits than they would cost to build, operate, and maintain. Alternative WS4B is identified as the NED plan since it maximizes excess benefits over costs. It provides approximately $32.3 million dollars in annual benefits at an annual cost of slightly over $29.4 million. Its excess benefits over costs are in excess of $2.9 million with a benefit-to-cost ratio of 1.1 to 1.

EQ ACCOUNT

Within the project area there are both rural and urban lands. However the project primarily affects rural lands, the majority of which are cleared and intensively farmed. There are significant positive contributions to the EQ account by all alternatives as shown in Section C of Table 7, System of Accounts. They would provide significant wildlife and aquatic habitat, increase the quality of existing habitat, and have no effect on any threatened or endangered species. The most significant adverse effects would result from the clearing of 898 acres of valuable wildlife habitat (woodlands) due to the construction of ditches, canals, pipelines, and on-farm features.

RED ACCOUNT

The System of Accounts shows that all alternatives contribute positively to the RED account. They prevent the erosion of the economy's agricultural base by sustaining irrigation and maintaining employment. They contribute positively to local government finances by preventing widespread declines in property values (tax base). There is a positive contribution to local employment during construction of the project and from operation and maintenance activities over the life of the project. There are also other secondary or spin-off effects which have not been quantified in the account but nevertheless are real, affecting area lending institutions, farm supply retailers, equipment dealerships, and other firms where those employed by the agricultural sector of the local economy spend their wages.

Table 7
BAYOU METO BASIN, ARKANSAS PROJECT
Agricultural Water Supply Component
System of Accounts

Account	Alt WS1	Alt WS2A	Alt WS2B	Alt WS2C	Alt WS3A	Alt WS3B	Alt WS3C	Alt WS4A	Alt WS4B	Alt WS4C	Alt WS5A	Alt WS5B	Alt WS5C
A. PLAN DESCRIPTION	No Action	5,954 Acres of New Storage with No Import System	8,832 Acres of New Storage with No Import System	14,544 Acres of New Storage with No Import System	1,650 cfs Import System with 5,954 Acres of New Storage	1,650 cfs Import System with 8,832 Acres of New Storage	1,650 cfs Import System with 14,544 Acres of New Storage	1,750 cfs Import System with 5,954 Acres of New Storage	1,750 cfs Import System with 8,832 Acres of New Storage	1,750 cfs Import System with 14,544 Acres of New Storage	1,850 cfs Import System with 5,954 Acres of New Storage	1,850 cfs Import System with 8,832 Acres of New Storage	1,850 cfs Import System with 14,544 Acres of New Storage
B. NATIONAL ECONOMIC DEVELOPMENT													
1. First Cost ($000)	n/a	55,333	65,000	84,179	356,114	365,781	384,960	357,104	366,771	385,950	357,825	367,492	386,671
2. Annual Benefits ($000)	n/a	5,669	6,964	7,990	30,091	32,213	32,426	30,204	32,330	32,428	30,207	32,332	32,428
3. Annual Costs ($000)	n/a	4,419	5,172	6,668	28,554	29,330	30,803	28,636	29,411	30,883	28,686	29,463	30,943
4. B/CR	n/a	1.28	1.35	1.20	1.05	1.10	1.05	1.05	1.10	1.05	1.05	1.10	1.05
C. ENVIRONMENTAL QUALITY													
1. Biological Resources													
a. Wildlife Habitat													
(1) Beneficial Effects	No Effect	A Significant Amount of Habitat Would be Created Under the Waterfowl management Opportunities Associated With This Project, Including Restoration of Bottomland Hardwood Forests and Restoring Native Prairie Habitat.			Much Greater Creation of Habitat than Alternative WS2.			Similar to Alternative WS3.			Similar to Alternative WS3.		

Account	Alt WS1	Alt WS2A	Alt WS2B	Alt WS2C	Alt WS3A	Alt WS3B	Alt WS3C	Alt WS4A	Alt WS4B	Alt WS4C	Alt WS5A	Alt WS5B	Alt WS5C
(2) Adverse Effects	No Effect	Approximately 108 Acres of Bottomland Hardwood Forest Would be Directly Impacted by Project Construction			Approximately 296 Acres of Bottomland Hardwood Forest Would be Directly Impacted by Project Construction			Similar to Alternative WS3			Similar to Alternative WS3		
b. Aquatic Resources													
(1) Beneficial Effects	No Effect	Additional Habitat for Amphibians Would be Provided by Reservoir Construction.			Significant Benefits Would be Realized in Both the Fish and Benthic Macroinvertebrate Communities From the Addition of Water From the Arkansas River.			Similar to Alternative WS3			Similar to Alternative WS3		
(2) Adverse Effects	Long Term Adverse Effects as Area Streams Depleted	No Effect			Some Short-term Impacts to the Fish Community Will Result from Channel Improvement work, While Benthic Macroinvertebrate Communities Will Likely be Significantly Impacted in Stream Reaches Scheduled for Channel Improvement			Similar to Alternative WS3			Similar to Alternative WS3		
c. Threatened or Endangered Species													
(1) Beneficial Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
(2) Adverse Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
2. Air Quality													
a. Beneficial Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
b. Adverse Effects		Construction Will Result in a Temporary Decrease in Air Quality due to Dust and Exhaust Emissions			Same as Alternative WS2.			Same as Alternative WS2.			Same as Alternative WS2.		
3. Water Quality													
a. Beneficial Effects		Significant Reductions in Sediment Inputs			Same as Alternative WS2.			Same as Alternative WS2.			Same as Alternative WS2.		
b. Adverse Effects		No Significant Effects			Same as Alternative WS2.			Same as Alternative WS2.			Same as Alternative WS2.		
4. Wooded Land													
a. Beneficial Effects		No Significant Effects			No Significant Effects			No Significant Effects			No Significant Effects.		
b. Adverse Effects		Slight Loss in Lands Required for Construction Rights-Of-Way			Greater than Alternative WS2.			Greater than Alternative WS2.			Greater than Alternative WS2.		

Account	Alt WS1	Alt WS2A	Alt WS2B	Alt WS2C	Alt WS3A	Alt WS3B	Alt WS3C	Alt WS4A	Alt WS4B	Alt WS4C	Alt WS5A	Alt WS5B	Alt WS5C
5. Agricultural Land													
a. Beneficial Effects		Irrigation Will Be Slightly Higher than Under Without-Project Conditions Which Will Prevent a Significant Decrease in Agricultural Production, Land Values, and Tax Base			Irrigation Will Be Maintained Which Will Prevent a Significant Decrease in Agricultural Production, Land Values, and Tax Base			Same as Alternative WS3.			Same as Alternative WS3.		
b. Adverse Effects		Slight Loss in Lands Required for Construction Rights-Of-Way			Greater than Alternative WS2.			Greater than Alternative WS2.			Greater than Alternative WS2.		
6. Prime and Unique Farmlands													
a. Beneficial Effects		No Significant Effect			No Significant Effect			No Significant Effect			No Significant Effect		
b. Adverse Effects		No Significant Effect			No Significant Effect			No Significant Effect			No Significant Effect		
7. Wetlands													
a. Beneficial Effects	No Effect	Could Halt or Slow Desiccation of Groundwater Wetlands Along Tributary Streams			Greater than Alternative WS2.			Greater than Alternative WS2.			Greater than Alternative WS2.		
b. Adverse Effects	No Effect	Slight Loss			810 Acres Adversely Impacted by Construction of the Delivery System			Same as Alternative WS3.			Same as Alternative WS3		
8. Historic Properties													
a. Beneficial Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
b. Adverse Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
D. REGIONAL ECONOMIC DEVELOPMENT													
1. Income													
a. Beneficial Effects ($000)	None	5,669	6,964	7,990	30,091	32,213	32,426	30,204	32,330	32,428	30,207	32,332	32,428
b. Adverse Effects ($000)		4,419	5,172	6,668	28,554	29,330	30,803	28,636	29,411	30,883	28,686	29,463	30,943

Account	Alt WS1	Alt WS2A	Alt WS2B	Alt WS2C	Alt WS3A	Alt WS3B	Alt WS3C	Alt WS4A	Alt WS4B	Alt WS4C	Alt WS5A	Alt WS5B	Alt WS5C
2. Employment													
a. Beneficial Effects	No Effect	Increase in Jobs over Alternative WS1			Greater Than Alternative WS2			Greater Than Alternative WS2			Greater Than Alternative WS2		
b. Adverse Effects	Loss of Local Jobs due to Lost Area Income	No Effect			No Effect			No Effect			No Effect		
3. Regional Growth													
a. Beneficial Effects	No Effect	Partially Prevents Decline When Groundwater Resources are Exhausted			Prevents Decline When Groundwater Resources are Exhausted			Same as Alternative WS3			Same as Alternative WS3		
b. Adverse Effects		No Significant Effect			No Significant Effect			No Significant Effect			No Significant Effect		
4. Local Government Finance													
a. Beneficial Effects	No Effect	Prevents Decrease in Property Values and Tax Base is Maintained			Prevents Decrease in Property Values and Tax Base is Maintained			Same as Alternative WS3			Same as Alternative WS3		
b. Adverse Effects	No Effect	Local Government May Finance Part of Construction Cost			Same as Alternative WS2			Same as Alternative WS2			Same as Alternative WS2		
E. OTHER SOCIAL EFFECTS													
1. Noise													
a. Beneficial Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
b. Adverse Effects	No Effect	Increased Noise Level During Construction			Same as Alternative WS2			Same as Alternative WS2			Same as Alternative WS2		
2. Aesthetics													
a. Beneficial Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
b. Adverse Effects	No Significant Effect	No Significant Effect			No Significant Effect			No Significant Effect			No Significant Effect		
3. Health and Safety													
a. Beneficial Effects	No Effect	Helps Protect and Sustain Groundwater Resources			Greater than Alternative WS2			Greater than Alternative WS2			Greater than Alternative WS2		

Account	Alt WS1	Alt WS2A	Alt WS2B	Alt WS2C	Alt WS3A	Alt WS3B	Alt WS3C	Alt WS4A	Alt WS4B	Alt WS4C	Alt WS5A	Alt WS5B	Alt WS5C
b. Adverse Effects	No Effect	Increased Potential for Injuries During Project Construction and Maintenance			Increased Potential for Injuries During Project Construction and Maintenance			Same as Alternative WS3			Same as Alternative WS3		
4. Displacement of People													
a. Beneficial Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
b. Adverse Effects	Possible Loss of Jobs and People	No Effect			No Effect			No Effect			No Effect		
5. Community Cohesion													
a. Beneficial Effects	No Effect	Will Help Increase Community Cohesion			Greater Than Alternative WS2			Greater Than Alternative WS2			Greater Than Alternative WS2		
b. Adverse Effects	Decreas e with Loss of Jobs and People	No Effect			No Effect			No Effect			No Effect		
6. Emergency Preparedness													
a. Beneficial Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
b. Adverse Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
7. Recreational Opportunities													
a. Beneficial Effects	No Effect	No Significant Effect			Some improvement in game fish populations in the Basin should result from addition of water to the streams and ditches. Waterfowl habitat will increase with additional acres of flooded cropland and restoration of bottomland hardwood forests.			Some improvement in game fish populations in the Basin should result from addition of water to the streams and ditches. Waterfowl habitat will increase with additional acres of flooded cropland and restoration of bottomland hardwood forests.			Some improvement in game fish populations in the Basin should result from addition of water to the streams and ditches. Waterfowl habitat will increase with additional acres of flooded cropland and restoration of bottomland hardwood forests.		
b. Adverse Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
8. Real Income Distribution													
a. Beneficial Effects	No Effect	No Effect			No Effect			No Effect			No Effect		
b. Adverse Effects	No Effect	No Effect			No Effect			No Effect			No Effect		

Account	Alt WS1	Alt WS2A	Alt WS2B	Alt WS2C	Alt WS3A	Alt WS3B	Alt WS3C	Alt WS4A	Alt WS4B	Alt WS4C	Alt WS5A	Alt WS5B	Alt WS5C
F. PLAN EVALUATION													
1. Tangible Benefit ($000)		5,669	6,964	7,990	30,091	32,213	32,426	30,204	32,330	32,428	30,207	32,332	32,428
2. Tangible Costs ($000)		4,419	5,172	6,668	28,554	29,330	30,803	28,636	29,411	30,883	28,686	29,463	30,943
3. Net Benefits ($000)		1,250	1,792	1,322	1,537	2,883	1,623	1,568	2,919	1,545	1,521	2,869	1,485
4. B/C Ratio		1.28	1.35	1.20	1.05	1.10	1.05	1.05	1.10	1.05	1.05	1.10	1.05
G. IMPLEMENTATION RESPONSIBILITY													
1. Financial First Cost ($000)													
a. Non-Federal		19,367	22,750	29,463	124,640	128,023	134,736	124,986	128,370	135,083	125,239	128,622	135,335
b. Federal		35,966	42,250	54,716	231,474	237,758	250,224	232,118	238,401	250,868	232,586	238,870	251,336
c. Total		55,333	65,000	84,179	356,114	365,781	384,960	357,104	366,771	385,950	357,825	367,492	386,671
2. Annual Investment Charge ($000)													
a. Non-Federal		1,300	1,527	1,977	8,661	8,901	9,375	8,686	8,925	9,400	8,686	8,942	9,417
b. Federal		2,414	2,835	3,673	16,086	16,530	17,412	16,130	16,575	17,456	16,130	16,608	17,489
c. Total		3,714	4,362	5,650	24,747	25,431	26,787	24,816	25,500	26,856	24,816	25,550	26,906
3. Annual OM&R ($000)													
a. Non-Federal		705	810	1,018	3,807	3,899	4,016	3,820	3,911	4,027	3,820	3,913	4,037
b. Federal													
c. Total		705	810	1,018	3,807	3,899	4,016	3,820	3,911	4,027	3,820	3,913	4,037
4. Total Annual Costs ($000)													
a. Non-Federal		2,005	2,337	2,995	12,468	12,800	13,391	12,506	12,836	13,427	12,506	12,855	13,454
b. Federal		2,414	2,835	3,673	16,086	16,530	17,412	16,130	16,575	17,456	16,130	16,608	17,489
c. Total		4,419	5,172	6,668	28,554	29,330	30,803	28,636	29,411	30,883	28,686	29,463	30,943

OTHER SIGNIFICANT EFFECTS ACCOUNT

As shown under the OSE account in System of Accounts, noise would increase temporarily during construction for any of the alternatives investigated. There would be no significant impact on community cohesion, aesthetics, or displacement of people. However, there would be a significant increase in recreational opportunities from the additional waterfowl habitat provided for hunting by all alternatives. Fisheries would improve as a result of the improved water quality and minimum water levels in area streams, and the increase in wooded habitat would increase the opportunities to enjoy nature through such activities as bird watching and hiking.

PLAN SELECTION

RATIONALE FOR SELECTION

Selection of the best plan of improvement for the Bayou Meto IPA involved the screening of the alternative plans relative to the formulation and evaluation criteria as previously outlined. Considering the results of impact assessment and evaluation of alternatives, economic benefits and costs, and views and desires of the potential project sponsor, Alternative WS4B was identified as the best plan for meeting the current and future water and related land resources needs of the area. Alternative WS4B maximizes net economic benefits over costs and is the economic optimum or NED plan. It provides approximately $32.3 million dollars in annual benefits at an annual cost of slightly over $29.4 million. Its excess benefits over costs are slightly less than $3.0 million with a benefit-to-cost ratio of 1.1 to 1. The planning objectives are met and constraints are avoided to the maximum extent feasible. Alternative WS4B allows for preservation of the area's groundwater resources by providing an adequate and dependable supplemental source of irrigation water for users in the area by providing 94.9% of an average year's unmet need. This enables the project to meet the objective of protecting and preserving the alluvial and sparta aquifers by minimizing groundwater depletion, thereby allowing the region to maintain its output of agricultural products and its economy. The selected plan maximizes the area's conservation efficiency and provides a source of supplemental irrigation water with additional on-farm storage to meet peak demands. A dependable source of water for flooding cropland throughout the project area and bottomland hardwoods within The Bayou Meto Wildlife Management Area for waterfowl during the migration season is available. The plan also satisfies the objective of restoring and enhancing fisheries habitat by maintaining year round minimum pools in existing streams and providing additional habitat with the new canals and reservoirs. Buffer strips along existing channels significantly increase wildlife habitat and quality of aquatic habitat.

RISK ANALYSIS

Risk analysis provides an estimate of the uncertainty inherent in the economic data used to evaluate the effects of the project. It addresses the areas where risk and uncertainty are known to exist so that the economic performance of the project can be expressed in terms of probability distributions. Risk analysis was performed using Excel spreadsheets in conjunction with an add-on simulation model entitled @Risk. It incorporated the range (maximum and minimum) of possible values for input variables and specified the statistical distribution of likely outcomes over the chosen range. In the case where a normal distribution was assumed, 68% percent of the occurrences of a particular outcome would fall within (plus or minus) one standard deviation, on either side of the mean, and 95% percent within two standard deviations on either side of the mean. Some sources of risk and uncertainty arise from measurement errors, small sample sizes, estimation and forecasting errors, and modeling errors. The variables affecting the benefits, the shape of their distributions, and the amounts they are allowed to vary during the simulation are presented in Table 8 in order of significance. The most significant variable was the 25% variation in crop yield followed by the 15% variation in crop prices. The 2 standard deviations in the input projection factor, 10% variation in crop mix, and variation in interest rate had negligible effect on the analysis.

Table 8
BAYOU METO BASIN, ARKANAS PROJECT
Bayou Meto IPA
Description of Variables Used in Risk Analysis

Item	Variation in Item	Distribution	Rank
Crop Yields	25 Percent	Truncated Normal	1
Crop Prices	15 Percent	Truncated Normal	2
Output Projection Factors	2 Standard Deviations	Truncated Normal	3
Crop Production Cost	5 Percent	Truncated Normal	4
Crop Distribution	10 Percent	Truncated Normal	5
Input Projection Factor	2 Standard Deviations	Truncated Normal	6
Interest Rate	One-Half Percentage Point	Truncated Normal	7

RELIABILITY ANALYSIS

Reliability analysis provides information on how dependable the project will be in providing adequate water to irrigate the project area. The two factors influencing the reliability of the project are: (1) The demand for irrigation water and (2) The amount of water that the project can provide. The mean or average demand before conservation to irrigate the entire 290,061-acre project area is 678,624 acre-feet with a standard deviation of 46,183 acre-feet. After conservation, the demand is effectively reduced by 92,038 acre-feet to 586,586 with a standard deviation of 39,920. The demand varied greatly over the 56-year period of record. After the conservation practices were implemented, it varied from a low of 441,183 acre-feet to a high of 750,599 acre-feet. The wide range between the two extremes is due to the unpredictability of rainfall and wide variation in temperatures from year to year. Lower rainfall and higher temperature levels increase the need for supplemental irrigation water. Higher rainfall and lower temperature levels decrease the need for supplemental irrigation water. The project is also limited by the amount of water that can be imported from the Arkansas River. This amount varies from year to year depending on the precipitation falling upstream of the pumping station. The mean demand met by Alternative WS4B is 644,267 acre-feet (includes 92,038 acre-feet of conservation) with a standard deviation of 42,311 acre-feet, which translates into a mean irrigated acreage of 275,376 acres and a standard deviation of 18,085 acres. This means that on an average year approximately 94.9% of the average demand can be met (644,267 acre-feet/678,624 acre-feet). Table 9 shows the percentage of the area that can be irrigated under each of the alternatives carried into detailed analysis.

Table 9						
BAYOU METO BASIN, ARKANAS PROJECT						
Bayou Meto IPA						
Reliability Data						
Alternative	Demand	Supply	Shortfall	Percent of Area Irrigated	Acres in Irrigation	Acres Shifted to Dryland
WS1	678,624	228,616	450,008	33.69%	97,716	192,345
WS2A	678,624	310,159	368,465	45.70%	132,570	157,491
WS2B	678,624	331,223	347,401	48.81%	141,573	148,488
WS2C	678,624	354,192	324,432	52.19%	151,391	138,670
WS3A	678,624	609,371	69,253	89.80%	260,461	29,600
WS3B	678,624	642,325	36,299	94.65%	274,546	15,515
WS3C	678,624	649,459	29,165	95.70%	277,595	12,466
WS4A	678,624	611,241	67,383	90.07%	261,260	28,801
WS4B	678,624	644,267	34,357	94.94%	275,376	14,685
WS4C	678,624	651,291	27,333	95.97%	278,378	11,683
WS5A	678,624	611,285	67,339	90.08%	261,278	28,783
WS5B	678,624	644,481	34,143	94.97%	275,467	14,594
WS5C	678,624	652,418	26,206	96.14%	278,860	11,201

DESCRIPTION OF SELECTED PLAN OF IMPROVEMENT FOR AGRICULTURAL WATER SUPPLY

The selected plan is the combination of measures which best meets the identified needs and opportunities of the project area consistent with the planning objectives and constraints and addresses the concerns expressed by various interest groups during the course of the general reevaluation. Components of the plan are described in the following sections and presented graphically in Volume 7, Appendix B, Section X - References Maps. A more detailed description of specific project features and designs are contained in Volumes 2 through 11 of the report.

PLAN COMPONENTS

The Bayou Meto IPA agricultural water supply project consists of four major components for supplying supplemental irrigation water to the project area and preserving existing water resources. The identified irrigation water supply components are (1) conservation - increased irrigation efficiencies, (2) groundwater, (3) additional on-farm storage reservoirs, and (4) an import water system. There are some incidental environmental benefits with these components. However, avoiding and minimizing environmental impacts was an integral part of the selected plan. The components of the selected plan are discussed in the following paragraphs.

CONSERVATION - INCREASED IRRIGATION EFFICIENCIES

The first component of the selected plan is implementation of conservation measures. Conservation measures are improvements in the on-farm water distribution system and/or changes in farm management practices such as irrigation application methods and soil moisture monitoring that result in increased irrigation efficiencies. Irrigation or system efficiency is defined as the percentage of water ultimately utilized by the plants as compared to the amount obtained at the source. It is a measurement of not only the effectiveness of the irrigation delivery system itself, but also of farm management practices employed. Conservation measures outlined within this report and recommended for implementation on a project wide basis are presently employed to various extents within the region. Based on historical data analyzed by the NRCS, the average irrigation efficiency of existing farming operations within the project area is 60 percent. Though this level of efficiency indicates that no economic benefits are derived from 40 percent of the water, the 60 percent level is considered to be well within regional and national averages for similar operations.

Significant factors contributing to the 40 percent inefficiencies within the system are application of water in excess of plant needs, evaporation and seepage losses from open distribution systems and the lack of tailwater recovery systems. Within the scope of the selected plan the NRCS will develop a comprehensive "Water Management Plan" for each farm serviced. At present the NRCS has selected approximately 15 % of the farms within the project area and developed specific management plans for projecting costs and determining the maximum achievable efficiency level. These analyses along with extensive field tests show that the average efficiency can be increased to 70%. This 10 % increase in efficiency is equivalent to a 14 % (92,038) reduction in the annual water demand for the project area. Key features of the farm management plans are closed distribution systems (underground pipelines), tailwater recovery systems and monitoring of soil moisture. Approximately 552 miles of new permanent underground pipeline with appurtenances will be installed to replace open canals and inadequate on-farm distribution systems. Utilization of pipelines will allow for better management and control of water at the farm level, will minimize losses from evaporation and seepage and will improve quality of water applied to crops.

Tailwater recovery systems will be an integral part of the water management plan developed for each farm. These systems, are in essence, a method of "recycling water". Tailwater is a term applied to the freestanding water within the fields that is drained by gravity into a system of collection ditches. These ditches, in turn, lead to pumps or diversion structures where the water is placed back into on-farm storage reservoirs. Alternatively, the water may be directly routed to another area for field application. With the selected plan, it is estimated that an additional 234 miles of tailwater recovery ditches will be required to collect, transport, and store rainfall runoff and tailwater. This system of shallow collection ditches is also an integral aspect of the on-farm storage system discussed in subsequent paragraphs. Associated with the collection system are roughly 576 water control structures necessary to control runoff rates and to provide pools for pumping back into reservoirs or for field applications. In addition to these structures, approximately 909 pumps or relifts will be required to move water through the tailwater recovery systems. Only estimated quantities for the water control structures and pumps can be provided prior to completion of all Water Management Plans. Additional information regarding the design of the tailwater recovery systems can be found in Volume 2, Appendix A, Natural Resources Plan for On-Farm Portion.

GROUNDWATER

As important as the alluvial aquifer is to the economy of the Bayou Meto IPA, it, unfortunately, has been mined for agricultural practices at a rate that far exceeds its capacity to replenish itself. Prior to development of the aquifer for rice production at the turn of the century, flows within the aquifer served as a source to the many water courses within the basin and the adjacent rivers such as the White and Arkansas. However, as irrigated acreage increased, the demands placed on the aquifer also increased. Eventually, the demands placed upon the aquifer became such that it no longer served as a source to the rivers. Instead of being a source the alluvial aquifer is now recharged by these rivers. Though the alluvial aquifer is being recharged by the adjacent rivers it is being done at a rate much lower than withdrawals are occurring. This decline will continue until the saturated thickness of the aquifer reaches the point that it can no longer support well development.

Implementation of the selected plan will sustain the alluvial aquifer by establishing a "safe yield" for the aquifer. By definition "safe yield" is a yield that will not result in any additional decline of water levels within the aquifer. Groundwater modeling studies and analyses completed by the USGS in 2002 determined the safe yield to be 148,565 acre-feet annually (22% of demand) for the Bayou Meto IPA. In addition to protecting the aquifer from over pumpage and total depletion, the selected plan of improvement provides a supplemental supply of irrigation water that will allow the aquifer to rebound above the minimum saturated thickness, which will, in turn, benefit the other natural resources of this vast ecosystem.

ON-FARM STORAGE

The on-farm storage system consists of above or below ground earthen reservoirs and tailwater recovery ditches used to capture and store runoff for irrigation. Sources of water in order of preference for use in filling the on farm storage systems are rainfall runoff, tailwater recovery, and groundwater, with the preference being established by economic factors. On-farm storage provides a reliable source for the large volumes of water that are required for the initial flooding of the rice fields and irrigation of other crops at critical times during the growing season. Presently there are 4,893 acres dedicated to storage in the project area. Most reservoirs in the area are in the 40 to 60 acre size range with some being smaller and others as large several hundred acres. Existing reservoirs have a storage capacity of approximately 27,579 acre-feet of water. With the selected plan, an additional 8,832 acres of cropland will be converted to on-farm storage reservoirs. These new reservoirs will provide 55,289 acre-feet of storage capacity. The new reservoirs are assumed to be located on lands identified for soybean production and are equally distributed throughout the project area. Reservoir sites will be identified in the water management plans developed by the NRCS. Reservoirs will be located to avoid impacts to wetlands and cultural resource sites. These new reservoirs when combined with existing storage will provide approximately 12 percent of the with-project needs for an average year. Though assumptions were made in developing the selected plan as to the operation of the reservoirs, the reservoirs will remain in private ownership and the daily management of such will be at the owner's discretion. Assumptions made regarding the operation of the reservoirs, such as the filling schedule, were made to minimize the risk of having an inadequate supply of irrigation water at critical times during the growing season. These assumptions were made based on current operational procedures utilized by farmers throughout eastern Arkansas.

Additional on-farm storage was only considered in conjunction with the implementation of conservation measures. Storage reservoirs were not considered without conservation measures since it was demonstrated that conservation measures provide the greatest return on the investment. Additionally, the construction of new reservoirs cannot meet the total water needs without an additional source of water. Even with the proposed conservation measures, there is not an adequate supply of rainfall runoff, tailwater recovery or groundwater to economically justify the construction of all of the new on-farm storage. With this maximum level of reservoirs, implementation of conservation measures, and withdrawals of groundwater at a safe yield, only 46% to 52% of the existing cropland can remain in irrigation. The remaining area would be required to convert to less profitable dryland farming.

IMPORT WATER

The import system consists of all features necessary to import water from the Arkansas River just upstream of David D. Terry Lock and Dam No. 6 and deliver it to each tract of land within the IPA. Major features comprising the system are pump stations, regulation reservoirs, man-made canals, check structures, existing ditches, pipelines, inverted siphons, pump-type turnouts, gate-well structures, and weirs. The proposed import system will also require an extensive monitoring and control system for directing flows within the system and to prevent the diversion of excessive amounts into natural streams.

PUMPING STATIONS

PUMP STATION NO. 1

Pump Station No. 1 is located in Pool No. 6 of the Arkansas River, just upstream of David D. Terry Lock and Dam (see Plate 4). All import water required by the project passes through this pump station. The pump station contains six pumps driven by electric motors. Four of the pumps are rated at 375 cfs each and two of are rated at 125 cfs each. Each pump will discharge into a steel discharge pipe terminated with a flexible check valve. Pump station design was based on a total station capacity of 1750 cfs, an average low river elevation of 229.0 feet, and a discharge reservoir water surface elevation of 248.0 feet. The pumps will operate against a static head varying between 19 feet at historic low river and 5 feet at historic high river.

The pump station substructure will be a rectangular multi-level reinforced concrete structure 126.5 feet long by 42 feet wide. A control room will be located at elevation 254.0. The control room will contain operating consoles for remote operation of all pumps and motors plus remote monitoring of all major control structures in the distribution system. Principal auxiliary station mechanical equipment will consist of a compressed air system, an overhead traveling crane, a well water supply system, a plumbing system, a sewage disposal system, a ventilation system, an inlet conduit unwatering system, a station floor drainage system, and a HVAC system. The station will also be equipped with a hydraulic elevator for easy access to lower mechanical and electrical equipment rooms.

PUMP STATION NO. 1
Basic Data

Sump Floor	217 Feet NGVD
Operation Floor	254 Feet NGVD
Pump Discharge Centerline	244 Feet NGVD
Historical High Water Elevation	243 Feet NGVD
Historical Low Water Elevation	229 Feet NGVD
Design Regulation Reservoir Water Elevation	248 Feet NGVD
Design Inlet Channel Water Elevation	229 Feet NGVD
100 Year Flood Elevation	234 Feet NGVD
Design Station Flow Rate	1750 CFS
Large Pump Flow Rate (4 Pumps)	375 CFS @ 24 TDH
Small Pump Flow Rate (2 Pumps)	125 CFS @ 24 TDH
Large Motor Horsepower	1500 HP
Small Motor Horsepower	500 HP

Plate 4
Bayou Meto Basin, Arkansas
PUMP STATION NO. 1

PUMP STATION NO. 2

Pump Station No. 2 is located on the north bank of Bayou Meto just south of Lonoke. Water is pumped across Bayou Meto into a regulation reservoir upon Lone Prairie. This 625 cfs pump station provides for continuous gravity flow through the system. This station contains five 56-inch drop-in submersible pumps, each having a 476 horsepower, 510-rpm submersible motor. Pumps have a maximum total dynamic head of 22.85 feet.

PUMP STATION NO. 3

Pump Station No. 3 is used to pump water across Bayou Two prairie and feed the northeastern portion of the project. This relatively small 260 cfs pump station is required for continuous gravity flow in the system. This pump station contains three 48-inch drop-in submersible pumps, each having a 316 horsepower, 505-rpm submersible motor. Pumps have a maximum total dynamic head of 21.56 feet.

PUMP STATION NO. 4

Pump Station No. 4 lifts water from Caney Creek into Canal 2140 for gravity flow to the lower middle portion of the IPA. This pump station has a 100 cfs capacity and contains three 40-inch drop-in submersible pumps, each having a 100 horsepower, 580-rpm submersible motor. Pumps have a maximum total dynamic head of 11.88 feet.

REGULATION RESERVOIRS

Regulations reservoirs are required at Pump Stations No. 1, 2, and 3. These reservoirs serve several purposes. They provide the head for gravity flow and volume for system stabilization. Regulation reservoir locations are shown in Volume 7, Appendix B, Section X, Reference Maps. Site plans and designs are in Volume 5, Appendix B, Section V, Pumping Stations.

CANALS

One of the transportation mechanisms for conveying the import water is 105 miles of new earthen canal. The canal system originates at the outlet structure from the regulation reservoir at Pump Station No. 1. and flows generally eastward before turning north-northeast towards Lonoke. From this point the canal flows north to Bayou Meto where the water is lifted by Pump Station No. 2 across Bayou Meto into a regulation reservoir. Flow from the regulation reservoir continues north along the west side of Lonoke before turning east toward Bayou Two Prairie. Pump Station No. 3. pumps the water across Bayou Two Prairie into a regulation reservoir to feed the northeastern portion of the IPA. Numerous secondary canals are used to provide water distribution to areas off the main canal system, provide water to existing ditches, connect various distributary components, and service adjoining land tracts. Among the factors considered in determining the canal locations were topography; tract boundaries; degree of urbanization; location of roads, utilities, buildings, and other improvements; environment; and proximity to existing streams. Canals were located to maximize gravity flow distribution for the most efficient and cost effective operation to the extent practical. Canal alignments utilized agricultural land to the maximum extent practical and minimized the impact to urban and environmentally sensitive areas. Tract boundaries were utilized in the canal layout process to insure that all areas were serviced and to prevent creation of land remnants that could not be farmed economically. Additionally, canal alignments were selected that maximized the use of existing ditches for conveyance.

The distribution canals range in bottom width from 5 feet to 60 feet with canal embankment heights a maximum of 20 feet above natural ground. Though the levee embankments forming the distribution system are primarily above natural ground, there are reaches where the canals are at or below natural ground levels. The crown width of the levee embankments are 12 feet on both sides and all levees and canals have 1V on 3.0 H inner and outer slopes. A 15-foot berm is provided between top bank and the levee embankments on both sides. This geometric section for the canals was determined based on stability, anticipated construction techniques, and maintenance considerations. It is planned to establish native prairie grasses along the canals in some areas where this type of vegetation grew historically. For access, inspection and maintenance purposes, a 10-foot easement will be obtained along the outer toe of the embankments. A typical section is presented in Volume 5, Appendix B, Section III, Civil Design.

Material used in constructing the above-ground portions of the canals will be obtained by excavating within the limits of the canals. In the event there is not sufficient material within a reach to construct the above ground portion, the canal will be over-excavated to provide the necessary material, or additional material will be transported in from adjoining reaches. Where canal excavation results in an excess of excavated material, the material will be used to widen the levee crowns, raise the embankment heights, and/or flatten the outer slopes. Excavation for the canals may require the removal of the nearly impervious "hardpan" that is conducive to rice production. Removal of this layer will expose the more permeable layers underlying the hardpan and result in infiltration losses to the alluvial aquifer. These losses were computed and accounted for in the water balance model of the system.

EXISTING DITCHES

Existing ditches within the project area were incorporated into the distribution system to the extent possible. Ditches were selected for water conveyance based on existing condition, environmental sensitivity, and location. The Environmental Planning Team reviewed and approved all existing ditch reaches and improvements necessary for the project. Existing ditches used as part of the distribution system include Indian Bayou, Indian Bayou Ditch, Caney Creek, Crooked Creek Ditch, Blue Point Ditch, Skinner Branch, Shumaker Branch, Oak Branch, and Rickey Branch. A total 116 miles of existing ditches will be used to convey the import water. Hydraulic models developed for flood control analyses were run to evaluate the effects of the additional irrigation flows. The models were used to determine frequency flowlines, channel modifications, and weir locations and sizes with the irrigation project. Release of irrigation water into the existing ditches will be fully automated. This will allow for immediate termination of releases, especially in the case of large rainfall events.

Several of the existing ditches used as part of the import water distribution system require enlargement especially in the ditch's upper reaches where the needed volume of flow cannot be transported within these existing ditches. Most ditches require minor channel modifications to accommodate irrigation flows and natural drainage. Ditches to be enlarged range in bottom widths from 10 feet to 60 feet. Other modifications include the removal of shoals and blockages from within the existing channel. Work will be conducted from one side of the ditch only. Excavated material will be placed adjacent to the ditch within the right-of-way along the channel. Side slopes for the enlarged reaches are 1V on 3.0H. There will be a 20-foot berm between top bank and the excavated material embankment and a 10-foot easement along the outer toe of the excavated material embankment for access, inspection and maintenance purposes.

Also, in the case of scheduled water needs not being delivered to farms, additional carrying capacity has been designed in the downstream reaches of the ditches so as not to induce flooding in the lower reaches.

WEIRS

A sufficient depth of water must be maintained at the inlet of each turnout along canals and existing ditches to provide for the design discharge. Weirs have been located throughout the distribution system to create an upstream pool of sufficient depth to allow for diversion. Weir heights were set at the highest elevation possible without increasing the flowline elevation for the existing bankfull discharge. Weir designs include methods to measure the flow of water over the weir. This is essential in system operation and control. Approximately 56 weirs will be required along existing ditches. The proposed locations of these weirs are shown in Volume 7, Appendix B, Section X, Reference Maps.

PIPELINES & PUMPS

The distribution system also utilizes pipelines for conveyance. In many instances it is more efficient to transport the water by pipeline than through open channels. Rights-of-way restrictions, topography, design considerations, volume of flow, environmental sensitivity, and cost are some of the factors that determined the use of pipelines. A total of 472 miles of pipeline will be used in the distribution system. These pipelines are composed of both PVC pipe and reinforced concrete pipe (RCP). Pipelines 27 inches and less in diameter will allow the use of PVC whereas RCP is specified for the larger size pipes. The pipelines are primarily utilized where flow within the system has dropped to a level that makes their use more economical than canals. However, there are reaches where the use of larger size concrete pipes are necessary due to topography and/or other constraints. All of the pipelines will be buried so as to not interfere with farming operations or obstruct traffic. Also, it will be necessary to install 183 pumps in conjunction with the pipelines. Volume 3, Appendix B, Section I, Hydraulics and Hydrology contains a detailed pump and pipe sizing table.

STRUCTURES

A wide range of structures is required to make the distribution system operational. Structure types include bridges, siphons, check structures, turnouts, and weirs. Features such as check structures, turnouts, and weirs are used to physically control the distribution of flows within the system and regulate flow arteries. Other structure types are used to maintain pre-project conditions. A brief description of the function and quantity of the various type structures required are presented in the subsequent paragraphs. The geographical location of the proposed structures is presented in Volume 7, Appendix B, Section X, Reference Maps. Hydraulic design criteria and considerations for all structures are contained in Volume 3, Appendix B, Section I, Hydraulics and Hydrology. Technical aspects relating to the structures such as design criteria, computations and drawings are presented within Volume 5, Appendix B, Section IV, Structural, Electrical & Mechanical.

BRIDGES

The bridges serve to maintain access across the distribution canals and existing ditches at road crossings. Sixty-six bridge sites were identified. All design and construction for the bridges will be in accordance with the applicable Arkansas State Highway Standards.

INVERTED SIPHONS

Inverted siphons are used to address the conveyance of flows within the natural streams and ditches. The distribution system was designed such that delivery system flows would not be induced into existing ditches except where existing ditches are being used as part of the distribution system. This was done so as not to induce any flooding impacts and to maintain natural flow regimes. Siphons are used to preserve the existing drainage patterns that would be impacted by construction of the canals. Typically, the natural drainage patterns will be maintained by conveying the flows of existing streams and ditches beneath the distribution canals. However, there are certain cases where it will be more economical to pass the canals beneath the natural streams. In most cases, the system with the lower flow is passed beneath the higher flow. A total of 74 sites will require siphons. The siphons will be constructed of reinforced concrete pipe having diameters between 24" and 96".

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CHECK STRUCTURES

Check structures are gated type structures placed in line for control purposes. They are used to regulate the water surface elevation in the canal pool upstream and to release flow to the downstream canal pool. The types of gates used are the sluice gate and tainter gate, depending on the type of operation (upstream or downstream control) required at the location. Eleven check structures will be required along the main canal distribution system. Each structure location includes the structure, a stilling basin, and overflow weirs on either side of the gates. These structures have a range of discharges from 228 cfs to 1,750 cfs. **TURNOUTS**

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Turnouts are utilized to divert water from one segment of the delivery system to another for furnishing water to another area. Water may be diverted from a canal, existing ditch, or pipeline. Five types of turnouts are utilized in the distribution system. They are summarized as follows:

- Type 1 - Diversion by gravity flow from the primary canal to the receiving end of a secondary canal.
- Type 2 - Diversion by gravity flow from the primary canal to a buried pipeline.
- Type 3 - Diversion by pumping through a pipeline.
- Type 4 - Diversion by gravity from the end of a canal normally to an existing stream.
- Type 5 - Diversion from pipeline back into an open channel.

LANDOWNER TAKEOFFS

Approximately 1,218 landowner takeoffs are required in the system. These structures include a diversion structure with a shutoff valve and meter for providing water to the individual farms. These are the last component in the main delivery system.

DROP STRUCTURES

Drop structures have been located throughout the system along existing ditches to reduce sediment inflow from adjacent agriculture lands. Farmers have historically utilized these structures to flood agricultural lands for waterfowl during the non-cropping season. Approximately 92 drop structures have been included in the plan.

RETROFIT

The on-farm portion of the project will include the retrofit of existing on-farm irrigation systems to the new import distribution system. Retrofitting will include the installation of new canals, pipelines, and lift stations to efficiently move the water from the on-farm source point to the storage and application areas on the farm. The needs of each individual farm will be identified in an on-farm plan developed by the NRCS.

LANDS

Project construction will require approximately 6,787 acres of land. An estimated 1603 individual ownerships will be impacted by project construction. Project lands are primarily located in rural agricultural areas and are primarily used for agricultural production or woodland purposes. The project has been planned and designed to avoid or minimize relocations. Rights-of-way for the project will be acquired through the use of four estates. The estates are: Fee Simple, Restricted Channel Improvement Easement, Water Pipeline Easement, and Conservation Easement. A fee estate will be used for acquisition of the pumping station sites, mitigation lands, and the locations of the check structures. Approximately 1,178 acres of agricultural cropland will be acquired for mitigation purposes.

A detailed description of the real estate requirements and costs are provided in Volume 11, Appendix G, Real Estate, Agricultural Water Supply Component. The Mitigation and Environmental Features Section of Volume 10, Appendix D provides a discussion on project mitigation requirements.

RELOCATIONS

New bridges at sites where new canals cross existing roads and replacement or modification of bridges across existing ditches will be required at sixty-six crossings to adequately pass the design flows. These sites include 15 state highway bridges (new canals) and 51 (45 on new canals and 6 on existing ditches) county bridges. Bridge designs are based on Arkansas State Highway Department of Transportation standards and current County bridge standards. No railroads will be impacted by the project.

Utilities at 159 locations will be impacted by the project. These utilities include overhead electric lines, telephone cables, waterlines, gas service lines, fiber optic cables, ammonia pipelines, and television cables. The extent of utility alterations necessary to accommodate the project is predicated on providing horizontal and vertical clearance for project construction, operation and maintenance.

A list and description of all relocations required for project implementation is presented in Volume 5, Appendix B, Section VI, Relocations. Relocations costs are included in the project cost data presented in Volume 6, Appendix B, Section IX, Cost Engineering Report.

ENVIRONMENTAL DESIGN AND RELATED INCIDENTAL BENEFITS

Approximately 200 acres of native prairie grasses will be planted within the rights- of-way of canals that traverse the portion of the project area known as Long Prairie, a component of the Grand Prairie Complex (Section III). The remaining canal rights-of-way (approximately 1,700 acres) will be planted in a seed mixture recommended by the Arkansas Game and Fish Commission and will benefit numerous wildlife species. The water supply component will provide the capability of flooding 33,382 acres of agricultural fields for waterfowl. It will also provide a dependable source of water for waterfowl flooding within the Bayou Meto Wildlife Management Area.

Approximately 56 weirs will be constructed in existing ditches at locations throughout the project area. The purpose of these weirs is to provide the necessary pools in the ditches for water diversion. Existing ditches within the project area generally experience extremely low flows, or in most cases, no flow at all during the summer months. The addition of import water and weirs will benefit aquatic organisms. Studies conducted by the U. S. Army Corps of Engineers, ERDC, concluded that the pooled areas and increased velocities over the weirs would significantly improve fishery habitat. The increased flows during the spring and summer months will especially improve habitat quality. Habitat Units for some receiving streams will increase as much as 90% per month. This feature provides significant stream benefits. Removing blockages from streams such as Indian Bayou will provide flow conditions favored by lotic organisms, such as freshwater mussels.

MITIGATION REQUIREMENTS

A mitigation feature is best described as an "on-site" established fish and wildlife resources management procedure, activity, or technique that is designed to offset construction and/or associated impacts. Mitigation acreage has been determined to partially offset terrestrial and aquatic losses and has been incorporated into the project design.

A wide range of alternatives was considered for mitigating the unavoidable wildlife habitat losses associated with project construction. Mitigation needs for the project were determined based on project impacts assessed from a Habitat Evaluation Procedures (HEP) Analysis. Approximately 1,324 acres will be purchased in fee and reforested to mitigate habitat losses. This acreage will be either prior converted or farmed wetland. Identification of the lands in these categories within the project area will be accomplished by the NRCS. Soils delineation to accomplish this activity has been completed for the project area.

Following coordination with the inter-agency team, the priority locations for mitigation lands are in the vicinity of the Bayou Meto Wildlife Management Area, located in the southern portion of the project area. Acquisition of mitigation lands within this area would allow for easier management, provide the opportunity for connectivity with larger blocks of land, and potentially remove some frequently flooded lands from agriculture. Monitoring of mitigation land planting success would be ensured during periodic inspections of project components, and would be the responsibility of the local sponsor. Monitoring protocols, measures of success (e.g. percent planting survival) would be determined through coordination with the inter-agency team.

DESIGN AND CONSTRUCTION CONSIDERATIONS

HYDROLOGIC CONSIDERATIONS

Hydrologic studies were conducted to determine how irrigation flows and how the new canals used to convey these flows might affect the natural drainage within the project area. It was also necessary to determine if selected existing streams could be incorporated into the delivery system. A hydrologic study of the project area provided estimates of the magnitude and frequency of natural flows occurring in the existing streams. The import water distribution system designs and flows were evaluated with the hydrologic model to determine the impacts associated with proposed plan. This analysis determined any channel modifications, structure requirements, and control features necessary for the system to function without inducing flooding.

HYDRAULIC DESIGN

A complex system of hydraulic structures is necessary to convey water in a controlled manner through the delivery system. The types, dimensions, and locations of the structures required for the delivery system were determined based on the desired operation of the system. Volume 3, Appendix B, Section I, Part C, Hydraulics, presents a detailed description of the hydraulic analysis and design of all hydraulic structures.

FOUNDATIONS & GEOLOGY

This project consists of two distinctive geological areas located within the project boundaries. The first geological area encompasses the alluvial floodplain of the Arkansas River where the majority of the irrigation project is located. The other geological area is the Grand Prairie region located in the uplands northeast of the town of Lonoke. The project is located predominately on point bar deposits of the Mississippi-Ohio River complex. The Grand Prairie region of Arkansas is in a subdivision of the Coastal Plain province known as the Mississippi Alluvial Plain. Subsurface investigations confirmed these conditions.

Boring logs along with the corresponding test results were examined to determine appropriate soil stratification and shear strength parameters for the major structures foundation design. Once stratifications and shear strength values were assigned, a variety of foundation analyses were performed, as applicable, to determine liquefaction potential, channel slope stability, structural excavation slope stability, structural sliding and overturning stability, bearing capacity, settlement, uplift analyses, and dewatering requirements. Detailed analyses are presented in Volume 4, Appendix B, Section II, Geology and Soils.

RELOCATIONS

A facility inventory and layout of all facilities affected by project construction was prepared. Canals were routed to avoid residences and other major structures. An Attorney's Opinion of Compensability will be done prior to execution of the PCA. Canal alignments were modified throughout the planning and design process to minimize facility relocations to the extent feasible. Volume 5, Appendix B, Section VI, Relocations and Volume 7, Appendix B, Section X, Reference Maps, provides relocations data.

CANALS AND LEVEES

Canal design considerations used in the development of the delivery system for the Bayou Meto IPA were as follows:

- Provide service to all irrigated tracts within the project area.
- Maximize gravity flow distribution.
- Determine stable canal proportions required to convey the design discharge.
- Obtain balanced earthwork quantities.

In determining canal alignments, preliminary alignments were established in the early phases of the project design considering the following:

- Location of irrigation tracts.
- Topography.
- Location of roads, utilities, building, and other improvements.
- Environmental considerations.
- Existing natural and man made streams and ditches.
- Tract boundaries, minimize division of properties.

Man-made canals were designed so that water could be moved from one location to the next, utilizing gravity flow wherever possible. This meant that man-made canals were placed on the highest ground to allow for gravity flow and withdrawals. Also, certain alignments were selected to minimize impacts to existing infrastructure or to avoid areas of environmental interest.

The project was initially laid out using the ideas of an inlet gravity structure and all existing streams in the project area. However, streams not having the capacity to deliver needed water, and a pool on the Arkansas River not high enough to dependably provide a source of irrigation water, gave this alternative very little merit. Costs analyses confirmed that a pump station system would be cheaper than a gravity structure system.

The next thing looked at was how water would get to tracts in the project area. Because the initial design used almost every stream in the area, the design team looked at the practicality of this design. Based on demands for tracts and the conveyance capability of the streams, almost all of the streams needed some work, cleaning out or enlargement, to conveyance necessary irrigation flows and flood flows. Environmental interests were not receptive to that idea and other design considerations were addressed.

Because of the flexibility of a man-made canal system and benefit of keeping irrigation water separate from runoff, this system was analyzed. Although it would have the functionality necessary for the area's water needs and do it in a timely, more precise manner, it takes land out of production, and farmers didn't support this alternative.

An alternative that would come to some middle ground between the two alternatives seemed to be the way to proceed. Because, some of the streams in the project area were, in fact, man-made ditches for flood control and seemed acceptable for enlargement to carry irrigation water. So, by using as many existing ditches as possible, along with connector man-made canals and a lot of pipeline, the system resembles something like the system that was first envisioned, and is acceptable to both farmers and environmental concerns.

During the detailed engineering and design phase field, verification of the preliminary alignments were made and reviewed in light of comments provided by local interests throughout the project area. As a result of this review, some changes in the alignments were made, but, generally, the preliminary canal alignments were found to be the most practical and feasible and were adopted for the basis of the project design and cost estimate. As design efforts continue and detailed plans and specifications are developed, additional minor modifications may be required.

Design considerations concerning the use of pipelines in lieu of open canals were based on the following:

- Topography.
- Rights-of-way restrictions.
- Relocation of major facilities.
- Highly developed areas.
- Flow volumes to be conveyed.

Generally at certain locations within the project area, it was more practical and/or efficient to deliver water through pipelines than open canals. In some instances, pipelines fit into right-of-way restrictions better than open canals. Also, some reaches had unfavorable depths of cut for an open channel and some reaches had adverse grades, requiring a pumped conduit flow in order to deliver water to the demand site. Pipelines were also typically used near the end of a branch in the delivery system where discharges were low enough to be readily conveyed through a conduit or economical size. However, in some cases, pipelines were substituted for segments that had been originally planned for canals, due to right-of-way limitations.

STRUCTURES

The Bayou Meto agricultural water supply component is unlike the normal civil works project where life and property are being protected from some natural, unpredictable, uncontrollable event where failure can be devastating. This project is providing water in specific volumes into a controlled system for use as needed for agricultural irrigation. During the conduct of the Grand Prairie Area Demonstration Project, a project very similar to this component of the Bayou Meto project, the Memphis District proposed the use of United States Bureau of Reclamation (USBR) design criteria to minimize costs, without jeopardizing design integrity. Designs based on these criteria offered significant potential for savings both in time and dollars over Corps criteria. Coordination with the USBR and a detailed evaluation of their criteria found that the major difference between Corp's criteria and USBR criteria was the factor of safety on precast concrete pipe and that the USBR makes a distinction between a water containing and a water conveying structure. This distinction is applicable when leakage from a system is critical. The proposal to use the USBR design criteria in the design of structures for the project was coordinated with higher level Corps representatives. It was agreed that USBR design criteria was indeed applicable to the Grand Prairie Project as long as it was interpreted correctly. This approach has also been utilized in the design of pipelines and water control structures for the Bayou Meto IPA, resulting in significant cost savings.

FIRST COSTS OF SELECTED PLAN

Table 10 is a summary of the M-CACES cost estimate for the agricultural water supply component of the Bayou Meto Basin, Arkansas project and the NRCS cost estimate for the on-farm component, indexed to October 2005 price levels. Project costs for the water supply component ($402,690,000) including the on-farm component ($70,388,000) is based on October 2005 price levels and are assumed to be end of year expenditures. Project costs include 12% contingency.

Table 10
BAYOU METO BASIN, ARKANSAS PROJECT
Bayou Meto IPA
Project Cost Summary of the Water Supply Component
(October 2005 Price Levels)

ACCOUNT NUMBER	DESCRIPTION	TOTAL PROJECT COST
01	Land and Damages	$18,804,000
02	Relocations	$34,593,000
03	Reservoirs	$1,897,000
09	Channels and Canals*	$262,281,000
13	Pump Stations	$35,683,000
19	Building, Grounds, & Utilities	$6,246,000
30	Planning, Engineering, and Design	$27,048,000
31	Construction Management	$16,138,000
	TOTAL PROJECT COST	**$402,690,000**

* Channels and canals include costs for channel enlargement necessary in the flood control component of the project.

IMPACTS DURING CONSTRUCTION

A plan will be developed which identifies procedures to avoid and/or minimize adverse construction impacts to the region and the environment.

NOISE

Measures will include contract provisions that limit noise to a certain level within a given distance from the construction site. Restrictions will vary depending on the proximity to an urban area and hours of construction.

TRANSPORTATION

Specific routes away from residential and commercial areas will be designated for construction related traffic and remote locations for constructing staging areas. Detour signage will be erected when roads are closed due to utility relocations or other project construction activity.

AESTHETICS

Structural design will maintain the architectural integrity of the area where the structures are located. Embankments near public roads will be finished in a manner consistent with the surrounding.

SAFETY

Measure will include signage, lighting, and access control during and after construction. Media notices will be released for certain construction activities.

CULTURAL RESOURCES

Cultural resources identification and evaluation of cultural sites' significance remain ongoing. As this study effort is completed, and as specific engineering and other project-related construction becomes designed, it is expected most if not all significant cultural sites can be protected via avoidance. For example, the water delivery system alignment may be adjusted.

OPERATION PLAN

A general operation plan and schedule for the agricultural water supply system was developed during the planning process. Delivery system planning, layout, and design was conducted in consideration of institutional factors, available water sources, water demands, and the desired delivery system operations, control, and monitoring. The operations procedures for the various project components are included in the draft operation manual, Volume 3, Appendix B, Section I, Part III.

OPERATIONS AND MAINTENANCE REQUIREMENTS

The entire canal system of pump stations, gates, and system pumps (excluding the Pump Station No. 1) will be controlled by a Supervisory Control and Data Acquisition (SCADA) system operated by the *Watermaster*. This system will allow fully automative or operator assisted (manual) operation. The central monitoring station for the distribution system will be located in the Administration Building/Control Center located just south of Lonoke and will be separate from the controls of Pump Station No. 1. The controls systems for Pump Station No. 1 and the rest of the distribution system will interface with each other for total system automatic control.

Pump Station No. 1 will operate as a supply type station with upstream control. This pump station is a supply/demand-oriented system. During times when the amount of water available from the Arkansas River determines withdrawal levels, the system is supply driven, and during times when water availability is not the governing factor, demand will determine the operation schedule of the pump station and the canal flow schedule. The control structures and turnouts having gravity flow or pumps located in the canal system will be operated as a supply-type system. The existing ditches within the distribution system will operate under the upstream control philosophy of delivering water to the upstream end of the delivery system and letting it route down to the user before it can be pumped out. This type of operation calls for more scheduling to occur to anticipate the need for irrigation water. The system will be controlled by the Watermaster based on real time information of water levels upstream of the structures and a flow depth over weirs to determine flow rates. This ensures that enough water is passing downstream to satisfy the demands of those users and helps in monitoring the efficiency of the system. The control systems for the pump stations and the canal system will be designed with components requiring low maintenance ease of operation. Volume 5, Section IV, Part B, Electrical, Power, Control Systems and Operations Conditions provides information on the operations of the individual system components and the overall system. Volume 6, Appendix, Section V, Part C and Part D, Mechanical Design Development and Electrical Design Development, respectively, present design, operation and maintenance information of the various components and systems of the pumping stations.

Operation and maintenance played a major role in the design of the concept plan for the four (4) pump stations. Stated goals of the design were that the end product should have good architectural appeal, be easy to maintain, and have operational features that will allow the Watermaster to control pumps, valves, and accessories from a central operation control room consistent with the operation of Pump Station No. 1.

The control and monitoring system for the delivery system operation will be further developed during the preparation of plans and specifications.

Individual farmers will do operation and maintenance of the on-farm components of the project. They will enter into water contracts that will clearly define their obligation to operate and maintain the on-farm project features necessary to deliver water to their farm.

The delivery system includes features that require various levels of maintenance. Pumping units, gates, and other mechanical and/or electrical devices require maintenance at prescribed intervals for the proper operation and life of the component. Maintenance will include structure upkeep and replacement, pumping unit upkeep and replacement, canal and stream cleanout, and bank stabilization for any slides or erosion that may occur as well as maintenance and repair of the levee embankments.

Canal maintenance includes excavation of sediment, removal of aquatic growth, selective vegetative clearing and slide repairs. Stream maintenance consists of repairs to the low water weirs and selective vegetative clearing. Canal and stream maintenance is estimated on a 20-year frequency at a cost of $5,000 per mile of canal and stream maintenance. An annual mowing cost is based on mowing 70 percent of the canal rights-of-way three times a year at a cost of $300/mile of canal mowed. The remaining 30 percent of canal rights-of-way will be utilized for prairie restoration, and burning is the preferred method of control.

The operations and maintenance costs uses present day cost data. Operation and maintenance costs by construction item are presented in Table 11.

Table 11
BAYOU METO BASIN, ARKANSAS PROJECT
Agricultural Water Supply Component
O&M Costs
October 2005 Price Levels

PROJECT FEATURE	COST
Operations/Maintenance Building	
Maintenance	$5,880
Labor Operation Cost	$416,674
Electricity Cost	$4,711
Bayou Meto Irrigation Project CA01	
Pump Station No. 1	
Maintenance Control Structures	$1,747
Maintenance of Pumping Stations	$18,552
Electricity Cost	$1,512,963
Labor Operation Cost for One Major Pumping Station	$416,674
Canals & Streams	$1,071
Bayou Meto Irrigation Project CA02	
Maintenance Control Structures	$4,631
Pumps, Motor and Accessories	$1,371
Electricity Cost	$2,827
Canals & Streams	$14,848
Bayou Meto Irrigation Project CA03A	
Pumps, Motor and Accessories	$2,339
Electricity Cost	$22,131
Canals & Streams	$4,061
Bayou Meto Irrigation Project CA03B	
Pumps, Motor and Accessories	$953
Electricity Cost	$9,016
Canal & Streams	$7,363
Bayou Meto Irrigation Project CA04	
Pumps, Motor and Accessories	$1,667
Electricity Cost	$11,126
Canals & Streams	$7,330
Bayou Meto Irrigation Project CA05	
Pump Station No. 4	
Maintenance Control Structures	$2,654
Maintenance of Pumping Stations	$1,805
Electricity Cost	$47,595
Pumps, Motor and Accessories	$4,579
Electricity Cost	$47,595
Canals & Streams	$24,846
Bayou Meto Irrigation Project CA06	
Pumps, Motor and Accessories	$4,716
Electricity Cost	$31,483
Canals & Streams	$10,882

Table 11 (cont.)
BAYOU METO BASIN, ARKANSAS PROJECT
Agricultural Water Supply Component
O&M Costs
October 2005 Price Levels

Bayou Meto Irrigation Project CA07A	
Pumps, Motor and Accessories	$2,073
Electricity Cost	$13,831
Canals & Streams	$8,560
Bayou Meto Irrigation Project CA07B	
Pumps, Motor and Accessories	$2,960
Electricity Cost	$19,757
Canals & Streams	$14,550
Bayou Meto Irrigation Project CA08	
Pump Station No. 2	
Maintenance Control Structures	$486
Maintenance of Pumping Stations	$3,150
Electricity Cost	$542,096
Bayou Meto Irrigation Project CA09	
Maintenance Control Structures	$1,608
Canals & Streams	$2,535
Bayou Meto Irrigation Project CA010	
Maintenance Control Structures	$1,236
Canals & Streams	$9,121
Bayou Meto Irrigation Project CA011	
Canals & Streams	$4,061
Bayou Meto Irrigation Project CA012	
Pumps, Motor and Accessories	$112
Electricity Cost	$745
Bayou Meto Irrigation Project CA013	$0
Pumps, Motor and Accessories	$269
Electricity Cost	$1,792
Bayou Meto Irrigation Project CA014	
Pump Station No. 3	
Maintenance Control Structures	$1,119
Maintenance of Pumping Stations	$469
Electricity Cost	$108,622
Bayou Meto Irrigation Project CA015	
Canals & Streams	$2,888

Table 11 (cont.)
BAYOU METO BASIN, ARKANSAS PROJECT
Agricultural Water Supply Component
O&M Costs
October 2005 Price Levels

Bayou Meto Irrigation Project CA016	
Pumps, Motor and Accessories	$500
Electricity Cost	$3,344
Bayou Meto Irrigation Project CA017	
Maintenance Control Structures	$1,081
Pumps, Motor and Accessories	$2,976
Electricity Cost	$56,805
Canals & Streams	$20,274
ANNUAL O&M @ 5.125% (IMPORT SYSTEM)	**$3,315,000**
ANNUAL O&M @5.125% (ON-FARM)	**$920,000**

PLAN ACCOMPLISHMENTS

The selected water supply plan for the IPA achieves the goals and objectives of the study by providing the best combination of measures for solving the identified water resources problems, realizing possible opportunities, and meeting the current and future needs of the area.

The agricultural water supply component of the project was designed to accomplish the following:

- Protect and preserve the groundwater resources;
- Increase conservation through efficient use and management of all water resources;
- Provide a supplemental supply of water for agricultural to meet the needs of the area and sustain the economic viability of the region;
- Provide a dependable water supply for flooding waterfowl feeding and resting areas;

SUMMARY OF ECONOMIC, ENVIRONMENTAL, AND OTHER SOCIAL EFFECTS

ECONOMIC ANALYSIS

No project has been identified which provides 100 percent of the irrigation water demands all of the time, due to restrictions on withdrawals from the Arkansas River. However, the selected plan consistently provides a majority of the area's water needs. The selected plan can provide an average of 268,324 additional acre-feet of water per year for a total available supply of 644,267 acre-feet per year. This level will provide approximately 95 percent of an average year's needs. An unmet need or shortage of 34,357 acre-feet remains, which means that a portion of the area will convert to dryland practices, and some of the desired winter waterfowl acreage cannot be flooded.

Presently, approximately 88 percent of irrigation water comes from groundwater and 12 percent from surface water in the Bayou Meto Basin. With the project, approximately 78 percent of the water will come from surface water (existing runoff capture and import) and only 22 percent from groundwater.

BENEFITS

All project benefits are based on current (2005) price levels, estimated over a 50-year period of analysis plus the installation period, and discounted to the end of the project installation period using the current Federal discount rate of 5.125%. The project benefits consist solely of irrigation benefits. Irrigation benefits consist of the difference between with- and without-project revenue streams. They are comprised of the increased crop production of maintaining irrigation practices versus dryland practices and any efficiencies or cost savings of using surface water in place of groundwater. The following sections present the methodologies used to calculate each of the benefit categories in this analysis.

a. Economic Projections. The methodology to project future revenues under without- and with-project conditions is different than the methodology used in prior Memphis District studies. This study is a very large and complex study that was conducted by two Corps of Engineers districts, Memphis and Vicksburg. Memphis District conducted the irrigation water study while Vicksburg District conducted the flood protection study. The two districts employ somewhat different methods to estimate future conditions. It was decided for consistency purposes that the same method should be used by both Districts. The projection factors used in this analysis are presented in Table 11a. A detailed description of how these factors were derived can be found in Appendix F prepared by the Vicksburg District.

This methodology was reviewed by Agricultural Economists from the University of Arkansas, Louisiana State University, and Mississippi State University to determine if it yielded reasonable results. All of the Agricultural Economists view that the results of the process are indeed reasonable. In fact, the Agricultural Economist from the University of Arkansas felt that the process may have yielded low or conservative results. The letters provided by the three above are attached to this addendum.

Table 11a
Projection Factors
Bayou Meto, Arkansas

Year	Crop Yield Projection Factor	Production Input Projection Factor
2000	1.00000	1.0000
2006	1.00000	1.0000
2007	1.01410	1.0082
2008	1.02820	1.0164
2009	1.04230	1.0246
2010	1.05640	1.0328
2011	1.07050	1.0410
2012	1.08460	1.0492
2013	1.09870	1.0574
2019	1.18330	1.1066
2027	1.29610	1.1721
2029	1.32430	1.1885
2039	1.46530	1.2705
2049	1.60630	1.3525
2062	1.78960	1.4590

b. Benefit Streams. The irrigation benefits were derived from maintaining as high a level of irrigation practices as possible and from lower irrigation costs due to reduced pumping costs as surface water is substituted for groundwater. Without the project, the aquifer is expected be depleted to such a point that a large portion of the presently irrigated crops will shift to dryland practices. As the groundwater available without the project declines, the irrigated acres will shift to dryland crops. With the project, import water is provided to replace the lost groundwater. This allows irrigation practices to continue to the level at which the import sources can sustain. Irrigation benefits are the difference in total net revenues between the with- and without-project conditions. Total revenues for Alternative WS4B and without-project conditions and project benefits during the project implementation period and by decade throughout the period of analysis are presented in Table 11a. The benefits begin in 2007 as conservation measures and on-farm storage reservoirs are constructed. Average annual equivalent revenues and benefits are also presented in Table 11c. Benefits under traditional methods are estimated at $45.9 million.

Table 11c
Without- and With Project Revenue Streams
Selected Plan -- WS4B
Bayou Meto, Arkansas
October 2005 Price Levels, 5.125% Discount Rate 1/

N	Year	Without-Project	With-Project	Benefit	Present Value Factor	PV Benefit
-5	2007	5,445,567	14,329,096	8,883,529	1.28390	11,405,563
-4	2008	5,477,411	15,836,489	10,359,079	1.22130	12,651,543
-3	2009	5,509,255	17,355,069	11,845,814	1.16176	13,761,993
-2	2010	5,397,803	18,445,378	13,047,575	1.10513	14,419,267
-1	2011	5,286,351	28,810,701	23,524,350	1.05125	24,729,973
0	2012	5,174,899	29,726,592	24,551,693	1.00000	24,551,693
1	2013	4,827,936	30,996,029	26,168,093	0.95125	24,892,398
7	2019	2,746,157	36,529,226	33,783,069	0.70479	23,809,969
15	2027	4,721,463	43,923,111	39,201,648	0.47251	18,523,171
17	2029	4,641,313	45,774,491	41,133,178	0.42756	17,586,902
27	2039	5,936,167	55,048,845	49,112,678	0.25938	12,738,846
37	2049	6,455,121	64,352,287	57,897,167	0.15735	9,110,119
50	2062	7,723,099	76,490,249	68,767,150	0.08217	5,650,597
Total Present Value						822,147,104
Amortization Factor 5.125%, 50 Years						0.05584
Annual Benefit						45,908,694
Rounded Use						45,909,000

1/ FY 2005 Current Normalized Prices.

COSTS

The project costs like the annual benefits are based on current (2005) price levels, estimated over a 50-year period of analysis plus the installation period, and discounted to the end of the project installation period using the current Federal discount rate of 5.125%. The annual costs consist of interest, sinking fund, operation, maintenance, and replacement charges.

Table 12.
BAYOU METO BASIN, ARKANSAS PROJECT
Bayou Meto IPA
Selected Plan for Water Supply Component
Summary of First Costs and Average Annual Equivalent (AAE) Benefits, Costs, Excess Benefits, and Benefit-to-Cost (BCR) Ratio
(October 2005 Price Levels, 5.125% Discount Rate)

BENEFIT/COST CATEGORY	BENEFIT/COST ($)
FIRST COST	
Import System	$332,302,000
On-Farm	$70,388,000
Total (First Cost + Mitigation)	**$402,690,000**
ANNUAL BENEFITS	
Irrigation Benefits	$45,909,000
Waterfowl Benefits	$0
Total	**$45,909,000**
ANNUAL COSTS	
Interest	
Import System	$20,189,000
On-Farm	$4,360,000
Sinking Fund	
Import System	$1,808,000
On-Farm	$391,000
Operation & Maintenance	
Import System	$3,315,000
On-Farm	$920,,000
Total	**$30,983,000**
EXCESS BENEFITS	**$14,926,000**
BCR	**1.5**

NAVIGATION

The selected plan of improvement has no impact to navigation on the Arkansas River. Surplus water on the Arkansas River is that water in excess of the needs for navigation. The minimum pool for navigation will be maintained with the project. No withdrawals will occur when water levels are below 231.2 feet NGVD**.**

SUMMARY

Table 12 presents a summary of the benefits and costs for the selected plan. The selected plan (NED plan) is the plan preferred by the potential project sponsor. A comparison of the average annual equivalent (AAE) benefits with AAE costs indicates that the selected plan for the Bayou Meto IPA has a benefit-to-cost ratio of 1.54 to 1, with excess benefits of $14,926,000.

ENVIRONMENTAL EFFECTS OF THE SELECTED PLAN

The selected plan includes components for restoration of bottomland hardwood forest, and other waterfowl habitats, and an available water supply to flood an additional 33,382 acres of harvested rice fields for waterfowl on an average annual basis. To compensate for impacts associated with construction of the import system and on-farm features, 1,324 acres of agricultural land would be acquired and planted in bottomland hardwood trees. Adverse impacts to Arkansas River aquatic resources will be minimal, and benefits to aquatic resources in tributary streams will be substantial. Table 13 shows the effects of the selected plan on nationally recognized resources. A detailed description of project-induced environmental impacts and benefits is presented in the accompanying Environmental Impact Statement (EIS). The U. S. Fish and Wildlife Service has provided a Coordination Act Report included in Volume 10, Appendix D.

Table 13
BAYOU METO BASIN, ARKANSAS PROJECT
Bayou Meto IPA
Effects of the Selected Plan on National and Cultural Resources

TYPES OF RESOURCES	AUTHORITIES	MEASUREMENT OF EFFECTS
Archaeological and Historical	National Historic Preservation Act of 1966, as amended (16 USE 470) and the Archaeological and Historic Preservation Act of 1974, as amended (16 U.S.C. 469a).	Unknown at this time; any significant cultural resources sites will be avoided or mitigated.
Air Quality	Clean Air Act, as amended, 42 U.S.C. 185h-7, et seq.	Very minor impacts during project construction.
Endangered and Threatened Species	Endangered Species Act, as amended, 16 U.S.C. 469a).	No adverse impacts anticipated.
Fish and Wildlife Habitat	Fish and Wildlife Coordination Act, as amended, U.S.C. 661, et seq.	Some short-term degradation during construction; increase in both quality and quantity of aquatic habitats over time.

Table 13 BAYOU METO BASIN, ARKANSAS PROJECT Bayou Meto IPA Effects of the Selected Plan on National and Cultural Resources		
TYPES OF RESOURCES	AUTHORITIES	MEASUREMENT OF EFFECTS
Prime and Unique Farmland	Farmland Protection Policy Act, Subtitle I of Title XV of the Agriculture and Food Act of 1981 (7 U.S.C. 4201 et seq.) CEQ Memorandum of August 1, 1980; Analysis of Impacts on Prime and Unique Agricultural Lands in Implementing NEPA.	A total of 5366 acres of Prime and Unique farmland will be impacted by this project.
Floodplains	Executive Order 11988 Floodplain.	Some project features constructed in floodplains; no significant impacts.
Water Quality	Clean Water Act of 1977, as amended, 42 U.S.C. 1857h-7, et seq. Water Quality Act of 1987.	Some short-term degradation during construction; addition of Arkansas River water will improve water quality in the Basin.
Wetlands	EQ 11990, Protection of Wetlands; Clean Water Act of 1977, as amended (42 U.S.C. 1857h-7 et seq.)	A total of 810 acres of wetlands will be impacted by the delivery system. 200 acres by on-farm construction.
Wild and Scenic Rivers	Wild and Scenic Rivers Act, as amended (16 U.S.C. 1271 et seq.).	None present.

FUNDING/CONSTRUCTION SCHEDULE

The construction schedule was developed to maximize the national economic development benefits and to initiate project operation at the earliest possible time to protect the groundwater resources from further depletion. The schedule presents a sequenced construction approach, which allows areas to begin receiving benefits, as that reach is complete, once Pump Station No. 1 comes on line. The local sponsor and the state of Arkansas have stated that they desire the most expeditious schedule possible. The construction schedule, as presented, is the quickest reasonable time to initiate the proposed phased project operation. However, project funding is at the discretion of Congress, and, therefore, any construction scheduling is tentative. Tables 14 and 15 show the proposed construction schedule and provide summaries of the total project costs by construction item and fiscal year. The Project Management Plan (PMP) provides a detailed schedule of future work and necessary funding.

SCHEDULE DEVELOPMENT

A team consisting of representatives from all functional elements was assembled to develop the construction schedule and determine the total time necessary for project implementation, including the development of design documents and plans and specifications, relocations, rights-of-way acquisition, and construction time.

CONSTRUCTION PHASING

The Bayou Meto IPA project component was divided into nineteen construction items (see below and Plate 5). Two of the initial items (Item 3 and Item 7) were subdivided into A and B items to identify existing ditches being utilized as part of the distribution system that were also included in the flood control component plan of improvement. Each of these nineteen items is a complete unit and when constructed in the proposed sequence, will be available for operation. The construction contracts will consist of all work within an item to eliminate potential problems with scheduling different contractors to work on different components within an item. It is anticipated that the main contractor for an item will subcontract work on various components to specialized contractors. Item 1 includes the 1,750 pump station which will supply the project with water from the Arkansas River. The inlet channel to the pump station, regulation reservoir, and outlet structure are also included in Item 1. The pumps, inlet canal, regulation reservoir and outlet structure, and the access road to Pump Station No. 1 may be constructed in separate contracts to allow for earlier contract awards. Items 2-17 consists of the construction of additional pump stations, canals, existing ditches, pipelines, check structures, bridges and culverts, turnout structures, siphons, pump structures, and weirs to move the water through the system for delivery at the farm. Some items may be combined for contracting in order to expedite construction. However, for design purposes, the items will be kept separate. This will provide options to minimize any delays resulting from rights-of-way acquisition, relocations, cultural resources mitigation, or other occurrences. The design and construction of all components for each pumping station will be accomplished in concert to insure functionality. A description of the items of work in by item number is presented below. Numbering sequence does not reflect construction sequence. Scheduling of items is presented in detail in the Project Management Plan (PMP). A summarized funding schedule is presented in Tables 14 and 15.

- Item 1 – Canal 500, Pump Station No. 1 (1750 cfs) and regulation reservoir with outlet structure.

- Item 2 – Canals 1000 and 2000, and pipelines with associated structures.

- Item 3A – Indian Bayou Ditch (1500) to confluence of Indian Bayou Proper; ditches 1510, 1520, and 1521; pipelines and miscellaneous structures.

- Item 3B – Structures associated with Indian Bayou Ditch (1500) from confluence of Indian Bayou Proper, Canal 1530, pipelines and associated structures.

- Item 4 – Canals 1400 and 1410, pipelines and associated structures.

- Item 5 – Canals 2100, 2140, and 2160, Caney Creek (2120), pipelines, Pump Station No. 4 (125 cfs), and associated structures.

- Item 6 – Canals 2520, 2531, and 2533; Fish Trap Slough (2521), Skinner Branch (2530), Blue Point Ditch (2532), Ditches 2533 and 2534; pipelines and associated structures

- Item 7A – Canals 2110 and 2220, Crooked Creek (2200) upstream of mi. 10.0,
  Big Ditch (2240), pipelines and associated structures.

- Item 7B – Canals 2260 and 2280, structures associated with Crooked Creek (2200) downstream of mi. 10.0, pipelines and associated structures.

- Item 8 – Pump Station No. 2 (625 cfs) regulation reservoir, and outlet structure.

- Item 9 – Canals 2500 and 2510 with associated structures.

- Item 10 – Canal 3000 and pipelines with associated structures.

- Item 11 – Oak Branch (2511), Shumaker Branch (2540), pipelines and associated structures.

- Item 12 – Pipelines with associated structures.

- Item 13 – Pipelines with associated structures.

- Item 14 – Pump Station No. 3 (260 cfs), regulation reservoir, and outlet structure

- Item 15 – Canals 4000 and 4100 with associated structures.

- Item 16 – Pipelines with associated structures.

- Item 17 – Canals 4111, 4112, and 4113; Brooks Branch (4200); Rickey Branch (4110); pipelines; and associated structures.

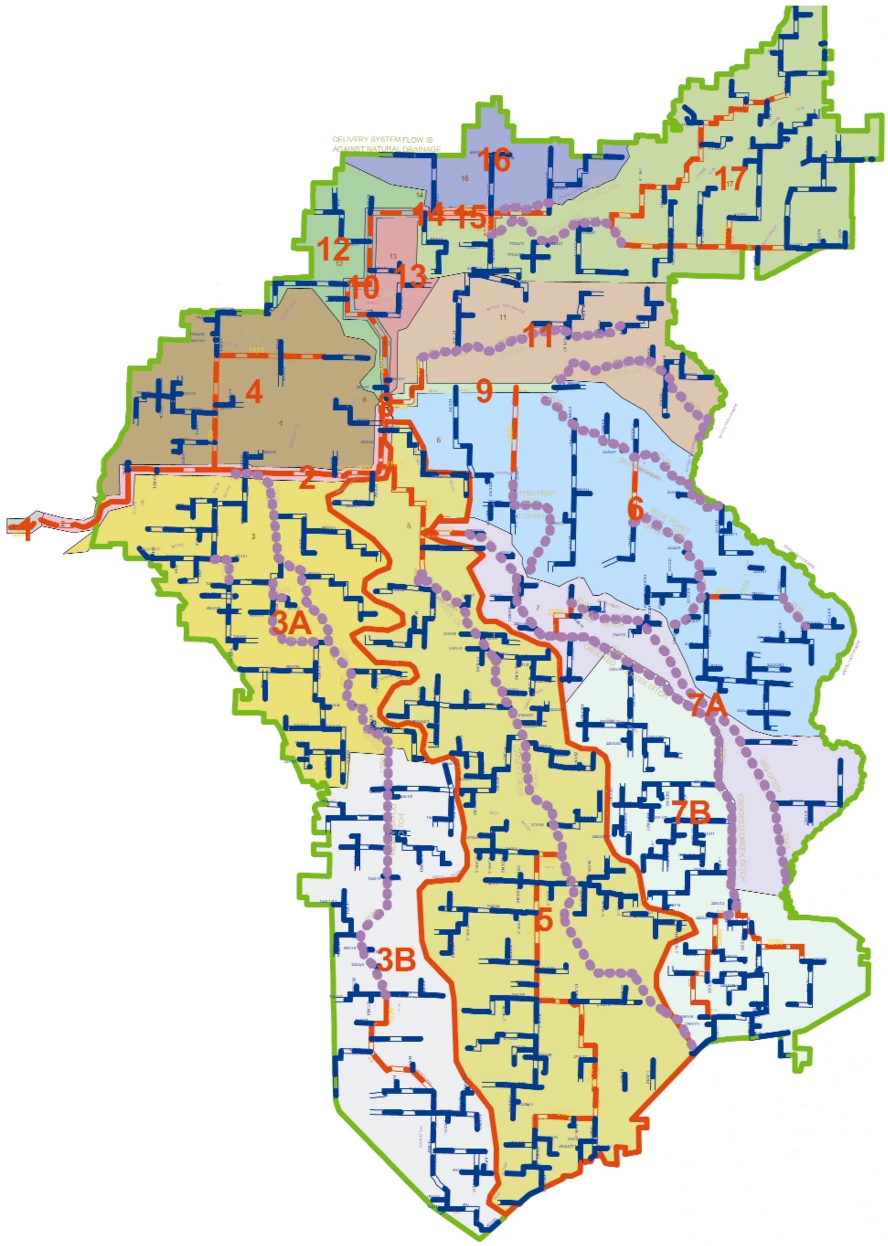


Plate 5
Bayou Meto Basin, Arkansas
CONSTRUCTION ITEMS

DESIGN DOCUMENTS

Design documentation reports for the project will include the design for the control system, detailed design of the pump stations, and standard designs for the structures.

The control system design will involve hydraulic and mechanical and electrical design and modeling. This will be accomplished by an A-E contractor experienced in these type systems. The results will determine the type of control system selected and the mechanical and electrical equipment necessary for operation. The detailed design and preparation of plans and specifications for the pump stations and standard designs for the project structures will be performed by an A-E contractor or in-house in order to minimize the time to construction. Pump stations designs will be done in accordance with Corps of Engineers criteria. Design memoranda will be prepared in accordance with the provisions of ER 1110-2-1150. Standard designs for the project structures will be completed as part of the work order for the first item encountered in which a given structure is found. The standard design will serve for the remainder of the project. Standard designs will be used to simplify preparation of plans and specifications and will result in cost saving during construction.

PLANS AND SPECIFICATIONS

Plans and specifications will be prepared for all components for each construction item. Initiation of the design work will be scheduled sufficiently in advance to meet the construction schedule presented in Tables 14 and 15. Indefinite delivery, indefinite quantity A/E contracts will be utilized to supplement in-house design resources. In addition to initiating the design to meet the construction schedule, the development of plans must begin in sufficient time to provide rights-of-way requirements and relocation requirements to meet this construction schedule.

CONSTRUCTION SCHEDULE

The requirement for each item of work was evaluated to determine a reasonable estimate of time for completion. The contractor was assumed to work six, ten-hour days to project completion. Time for weather delays were included in the estimate. From these estimates, the construction schedule was estimated. The construction schedule is presented in detail in the PMP. The time to complete the project is estimated to be six years. This schedule will require the local sponsor to acquire the real estate and perform the required relocations in an expeditious manner.

Table 14
BAYOU METO BASIN, ARKANSAS PROJECT
Total of All Accounts
Project Cost Schedule*
(October 2005 Price Levels)

Item	2007 ($)	2008 ($)	2009 ($)	2010 ($)	2011 ($)	2012 ($)	2013 ($)	Total ($)
1	$2,054,000	$1,190,000	$9,682,000	$17,453,000	$2,690,000			$33,070,000
2	$9,163,000	$2,482,000	$17,052,000	$150,000				$28,848,000
3A	$272,000	$2,258,000	$19,849,000	$11,576,000	$38,000			$33,993,000
3B	$751,000	$673,000	$335,000	$35,000	$1,658,000	$24,000		$3,476,000
4	$3,364,000	$1,014,000	$283,000	$7,895,000	$212,000			$12,769,000
5	$5,122,000	$4,770,000	$19,915,000	$19,226,000	$511,000			$49,544,000
6		$3,871,000	$1,380,000	$28,744,000	$23,000			$34,018,000
7A	$1,325,000	$2,397,000	$12,529,000	$11,925,000	$157,000			$28,333,000
7B	$1,764,000	$1,044,000	$183,000	$129,000	$2,389,000	$19,000		$5,529,000
8	$405,000	$793,000	$285,000	$6,477,000	$223,000			$8,182,000
9		$4,607,000	$435,000	$2,840,000	$31,000			$7,912,000
10		$614,000	$7,940,000	$978,000	$4,533,000	$37,000		$14,101,000
11		$1,153,000	$705,000	$815,000	$10,501,000	$3,718,000	$2,000	$16,894,000
12		$298,000	$258,000	$80,000	$2,127,000	$8,000		$2,770,000
13		$473,000	$99,000	$552,000				$1,123,000
14			$1,383,000	$108,000	$3,788,000	$39,000	$10,000	$5,327,000
15			$2,098,000	$132,000	$71,000	$848,000		$3,149,000
16			$361,000	$327,000	$91,000	$4,496,000		$5,274,000
17			$949,000	$7,764,000	$2,472,000	$13,238,000	$11,613,000	$36,036,000
Mitigation	$391,000	$391,000	$391,000	$391,000	$390,000			$1,955,000
Import	$24,611,000	$28,028,000	$96,112,000	$117,597,000	$31,905,000	$22,427,000	$11,625,000	$332,303,000
On-Farm	$7,039,000	$15,837,000	$15,837,000	$15,837,000	$15,837,000			$70,388,000
Total	$31,649,000	$43,865,000	$111,950,000	$133,434,000	$47,742,000	$22,426,000	$11,624,000	$402,690,000

Notes: 1) Does not include $19,665,000 in sunk PED costs.

* Schedule assumes new start construction in FY06. No new start construction were received in FY06. Earliest new start construction could occur in FY07.

Table 15
BAYOU METO BASIN, ARKANSAS PROJECT
Bayou Meto IPA
Project Cost Schedule
Total of All Accounts
(Fully Funded – CWCCIS Index – October 2005)

Item	2007 ($)	2008 ($)	2009 ($)	2010 ($)	2011 ($)	2012 ($)	2013 ($)	Total ($)
1	$2,151,000	$1,301,000	$10,365,000	$18,949,000	$3,008,000			$35,774,000
2	$9,447,000	$2,728,000	$18,142,000	$166,000				$30,483,000
3A	$280,000	$2,492,000	$21,274,000	$13,645,000	$53,000			$37,744,000
3B	$773,000	$834,000	$389,000	$40,000	$1,830,000	$27,000		$3,893,000
4	$3,457,000	$1,092,000	$325,000	$8,638,000	$267,000			$13,779,000
5	$5,264,000	$5,114,000	$21,459,000	$20,958,000	$643,000			$53,438,000
6		$4,187,000	$1,600,000	$31,311,000	$29,000			$37,127,000
7A	$1,362,000	$2,581,000	$13,493,000	$13,016,000	$198,000			$30,650,000
7B	$1,816,000	$1,105,000	$213,000	$155,000	$2,647,000	$24,000		$5,960,000
8	$416,000	$847,000	$331,000	$7,044,000	$280,000			$8,918,000
9		$4,853,000	$481,000	$3,103,000	$38,000			$8,475,000
10		$685,000	$8,481,000	$1,098,000	$5,088,000	$49,000		$15,401,000
11		$1,249,000	$817,000	$919,000	$11,700,000	$4,191,000	$2,000	$18,878,000
12		$327,000	$284,000	$90,000	$2,355,000	$10,000		$3,066,000
13		$511,000	$107,000	$598,000				$1,216,000
14			$1,514,000	$122,000	$4,203,000	$51,000	$13,000	$5,903,000
15			$2,255,000	$147,000	$85,000	$975,000		$3,462,000
16			$407,000	$374,000	$111,000	$5,118,000		$6,010,000
17			$1,101,000	$8,658,000	$2,829,000	$15,094,000	$13,511,000	$41,193,000
Mitigation	$403,000	$415,000	$427,000	$440,000	$452,000			$2,137,000
Import	$25,369,000	$30,321,000	$103,465,000	$129,471,000	$35,816,000	$25,539,000	$13,526,000	$363,507,000
On-Farm	$7,229,000	$16,509,000	$16,806,000	$17,142,000	$17,485,000			$75,171,000
Total	$32,598,000	$46,830,000	$120,271,000	$146,613,000	$53,301,000	$25,539,000	$13,526,000	$438,678,000

Notes: 1) Does not include $17,775,000 in sunk PED costs.

SECTION II
FLOOD CONTROL COMPONENT

PLAN FORMULATION

INVENTORY AND FORECASTING

Critical to the determination of flood control problems and opportunities is the examination of what conditions are now and what they are anticipated to be in the future. This is the inventory and forecasting phase of the study and is described in the following paragraphs.

EXISTING CONDITIONS

HYDROLOGIC SETTING

The Bayou Meto Basin is a hydrologically complex area. Very few areas within the basin are unaltered from a hydrologic standpoint. The basin drains from north to south with flows eventually entering the Arkansas River through floodgates on Little Bayou Meto and Big Bayou Meto. Backwater flooding from the Arkansas River is prevented by the Arkansas River Levees in conjunction with the floodgates mentioned above. The locks and dams making up the McClellan-Kerr Navigation Project control stages on the Arkansas River. Minimum stages on the Arkansas River are therefore higher than they would be absent the navigation project. This impacts the evacuation of floodwater from the Bayou Meto Basin during spring storm events and partially contributes to the flooding problems in the lower portion of the basin.

Over time, the majority of flows from Little Bayou Meto have been diverted to Big Bayou Meto through manmade ditches below the Cannon Brake Structure on the Bayou Meto Wildlife Management Area. The Little Bayou Meto channel below this point has silted in and become clogged with vegetation as a result. This channel has very little capacity for evacuation of flood flows and renders the Little Bayou Meto Floodgate somewhat functionally obsolete. The majority of water from Little Bayou Meto therefore combines with flows on Big Bayou Meto and continues downstream to the Arkansas River.

The Bayou Meto Wildlife Management Area, owned and operated by the Arkansas Game and Fish Commission, lies within the lower portion of the basin and accepts drainage from Little Bayou Meto and its tributaries. This area is managed for waterfowl during the winter months, which further complicates the hydrology of the basin. Numerous structures have been built within the management area to hold water on approximately 13,000 acres of land during the winter waterfowl migration season. Surrounded by agricultural lands, the WMA has a difficult time evacuating water, once the waterfowl have left, in time for spring planting. Again, this is complicated by navigation pool requirements on the Arkansas River.

With a few exceptions, tributary streams originating in the upper portion of the basin are typically well defined and capable of carrying the more frequent storm events. These streams are generally found to have some areas where sedimentation is a problem, however, many of them have accompanying ditches that reduce the need for additional carrying capacity. All of the tributaries eventually combine with Little Bayou Meto or Big Bayou Meto by the time they reach the WMA. The majority of Little Bayou Meto flows are then routed to Big Bayou Meto, as discussed above.

In the Bayou Meto Basin, floods generally occur during the first and second quarters of the year (January through June) but can occur at any time. Depending on the location, flood events are frequent and relatively large as indicated by the approximately 121,400 total acres flooded annually (1-year frequency event). The 5-year frequency event is projected to inundate about 204,400 total acres, while the 288,600 acres are subject to flooding by the 100-year event.

SOCIOECONOMIC SETTING

A socioeconomic profile for the study area was presented previously. The flood control evaluation was developed based on a period of analysis of 50 years and a Federal discount rate of 5.375 percent. The economic base area is represented by Lonoke and Jefferson Counties, which are within or mostly within the Bayou Meto hydrologic boundary.

Agriculture continues to be the most important sector of the economy even though urbanization and industrial growth have increased in recent years. Demographic changes have been primarily from rural to urban settings since the 1930s. Frequent flooding impacts farming operations, especially in the lower portion of the watershed, and any reduction in the risk of flooding will create opportunities for farmers to achieve the production potential of existing agricultural tracts.

ENVIRONMENTAL SETTING

The study area includes the Big Bayou Meto and Little Bayou Meto watersheds. It begins above Interstate Highway 40 near the community of Jacksonville, AR and includes approximately 1,050 square miles, emptying into the Arkansas River below the Bayou Meto

WMA. Alluvial lands make up the majority of the study area with the exception of limited upland areas in the extreme northern portions of the watershed. The study area was initially forested with varying combinations of upland and bottomland species of hardwood timber. A limited amount of prairie was found in presettlement times in the northeastern portions of the study area. Drainage and flood control improvements throughout the watershed resulted in land clearing for agriculture over most of the 20th century. As crop prices increased and mechanization improved, additional lands were cleared for agricultural production.

This scenario contributed to environmental problems in the form of sheet erosion, sedimentation, and herbicide and pesticide contamination, which resulted in degraded water quality and the loss of fish and wildlife habitat. Affected resources include waterfowl, terrestrial resources, wetlands, fishery resources, and fresh water mussels. Existing conditions will be defined by describing the current state of these affected resources as well as overall water quality, threatened and endangered species, and cultural resources within the study area.

WETLANDS

Wetland resources are abundant in the Bayou Meto study area with approximately 64,000 acres of forested wetlands. The majority of these resources are concentrated in the portion of the basin influenced by the flood control aspects of this project. Wetland resources have changed over time with development in the region. The clearing and draining of wooded tracts for agriculture, along with related flood control features, have brought about some of the changes; other changes have resulted from manipulation of water resources for purposes such as waterfowl management. Navigation features on the Arkansas River have influenced wetlands in the lower portion of the basin by raising the minimum pool elevation on the river.

The most significant remaining tract of wooded wetlands is in the Bayou Meto Wildlife Management Area south of U.S. Highway 79. This area is targeted primarily for wintering waterfowl and, as such, includes water management strategies to flood approximately 13,000 acres during the November to February timeframe. While increasing wetland functions, this has had the negative effect of stressing timber resources within the WMA. In fact, the Arkansas Game and Fish Commission has identified two areas of dead timber totaling about 550 acres within the WMA. Timber stress is related to the duration of flooding in the spring following the dormant period that coincides with waterfowl migration; and timely evacuation of areas flooded for waterfowl is dependent on an adequate outlet to the Arkansas River. Arkansas River stages are managed for navigation; therefore, the outlets for Big and Little Bayou Meto are subject to minimum pool requirements on the river. The conclusion that can be drawn from this scenario is that the navigation project on the Arkansas River artificially raises outlet elevations for Big and Little Bayou Meto, thereby increasing the duration of flooding in and below he WMA, especially when gates are opened to release water pooled for waterfowl. While this increases the size of areas that fit the classification of wetlands, it also results in stress on timber resources in these same areas. This scenario is unlikely to change for the foreseeable future in the absence of structural changes to water management strategies.

WATERFOWL

Historically, the Mississippi Alluvial Valley (MAV) has served as a major wintering area for waterfowl. Waterfowl populations began to decline in the 1960s as a result of extensive drought, loss of nesting habitat in the prairie pothole region of North America, and conversion of bottomland hardwoods in the MAV to agricultural production. Several species of waterfowl, including mallards, have shown signs of recovery over the last decade; however, overall populations tend to fluctuate due to a variety of factors including breeding ground conditions, temperature extremes, above or below normal rainfall, etc.

Due in part to its location at the heart of the wintering range within the Mississippi Flyway and its historically abundant wetland resources, Arkansas rates as one of the most important wintering areas for mallards and other waterfowl in the MAV. Total duck harvest in Arkansas in 2001 was approximately 1,113,800 birds, with an average annual bag of 14.4 ducks per adult hunter. In the Bayou Meto Study Area, waterfowl utilize both managed areas, such as the Bayou Meto Wildlife Management Area and private lands that are flooded independently or through other federal and state programs, as well as lands that are flooded naturally by winter rainfall and high river stages. The abundance of habitat and its waterfowl traditions will continue to make the Bayou Meto watershed an important target area for waterfowl resource related activity.

TERRESTRIAL RESOURCES

The land use within the study area boundary includes a total of 863,712 acres of land and water, which contains farmland; irrigated cropland; fish ponds; and woodlands, lakes, and streams, of which approximately 32,000 acres are managed for fish and wildlife. Within the category labeled woodlands, forested areas can be broken down further into bottomland hardwoods, cypress/tupelo swamps, and forested riparian areas.

A significant portion of the project area includes bottomland hardwoods within and adjacent to the Bayou Meto WMA. These terrestrial resources are utilized by many game and non-game species but are specifically managed for waterfowl. Winter flooding of bottomland hardwoods and cropland managed by the Arkansas Game and Fish Commission and private landowners makes this area a magnet for wintering waterfowl. Following the migration period, standing water must be removed from bottomland hardwood stands to prevent stress on mast producing species that are intolerant of long periods of inundation. Evacuation of water from bottomland hardwood communitities has been and continues to be a problem for resource managers in this area and thus was an important guiding objective for the flood control evaluation.

Fishery Resources

Many streams in the Bayou Meto Basin are characterized by persistent low flows during the summer and fall that result in stagnant hypoxic conditions with increased temperatures and high turbidity. This is partly the result of withdrawals for irrigation and a lack of recharge from the alluvial aquifer. The fish community reflects the impacts of these conditions with tolerant species such as mosquitofish, bluegill, red shiner, green sunfish, orangespotted sunfish, and golden shiner present in these conditions. However, stream reaches remain that are less disturbed and support a more diverse assemblage of species. Overall, 43 species of fish have been documented in the streams and canals of the basin. These include minnows and darters that prefer stable substrates, wetland species that dominate pools and backwaters, and exploitable fishes in the larger streams.

Water Quality

The Arkansas Department of Environmental Quality (ADEQ) has designated the waters within the project area to be suitable for the propagation of fish and wildlife; primary and secondary contact recreation; and public, industrial, and agricultural water supplies. Surface water quality is primarily influenced by the area's topography, soils, and land use. Concentrations of chemical parameters within the waters and sediments of the project area exhibit patterns generally expected within historic agricultural regions. Urban areas generally showed lower turbidity and chloride/sulfate concentrations than agricultural areas. Concentrations of dissolved solids, conductivity, sulfate and chloride usually peaked during late summer when water levels were at their lowest. Nutrient levels, fecal coliform, and turbidity generally peaked in late winter and spring, coinciding with larger rainfall events. These parameters, along with metals, generally exceeded their designated criterion at least once during the period of record; however, these occasions were temporary and concentrations did not remain elevated for long periods of time.

Bayou Meto and Wabbaseka Bayou were reported by ADEQ in 2002 to have the highest number of pesticide detections per sampling event in the basin. The Corps also found evidence of pesticides such as aldrin, BHC, and endrin aldehyde in these and other streams. DDT and its derivatives were reported by ADEQ in water samples from Bayou Meto and Two Prairie Bayou; however, the Corps only found it in sediment samples. Herbicides were reported in low concentrations throughout the project area and appeared to be seasonal in proportion to their use.

Dioxin contamination from the Vertac Chemical Corporation site continues to be monitored even though the Vertac site is considered to be 100% remediated. Fish consumption advisories have been in place on Bayou Meto since 1980 because of the dioxin contamination. This advisory extends to the Highway 13 Bridge but may be extended downstream in the future for certain species. Sediment concentrations range from 46 ppt at the Highway 15 bridge to 1.4 ppt at the Highway 11 Bridge below the Bayou Meto WMA.

FUTURE WITHOUT-PROJECT CONDITIONS

HYDROLOGIC SETTING

Some channel maintenance has recently been accomplished within the study area by local drainage districts. However, maintenance work alone will not relieve the flooding in the basin. Development throughout the watershed, particularly in the upper reaches, continues to aggravate existing problems and results in additional areas being subject to regular inundation. The evacuation of flood flows below the Bayou Meto WMA will continue to be a problem due to limitations in channel capacity and stage requirements for navigation on the Arkansas River. Future growth in the vicinity of Jacksonville will increase runoff and raise stages in Bayou Meto. This will contribute to increased flooding, especially in the area above U.S. Highway 70 where constrictions already are causing problems.

SOCIOECONOMIC SETTING

Future land use is not expected to change significantly with or without the project, i.e., agriculture will continue to dominate the landscape. Urbanization in the upper reaches of the basin is expected to continue, which will increase runoff and add to existing downstream flooding. The impact of groundwater declines on agriculture is expected to worsen as the aquifers are depleted. Current projections by the USGS and ASWCC indicate that the alluvial aquifer will no longer be a reliable source of water for irrigation by the year 2015 if current trends continue and alternative sources of water are not developed. Since the economy of eastern Arkansas and the Bayou Meto Basin are agriculture based, it is unlikely that further development would occur in the absence of a stable economy. Flooding will continue to impact agricultural production, especially in the lower portion of the watershed, and will become even more critical as areas to the north decrease rice production due to inadequate supplies of water.

ENVIRONMENTAL SETTING

Environmental conditions will continue to reflect the agricultural based economy with the exception that irrigated cropland will begin to be replaced by dryland crops, especially in the central and northern portions of the watershed. Some changes to fish and wildlife resources will result since the absence of rice production will significantly reduce forage for wintering waterfowl. There will also be a reduction in stream base flows during the summer because of the absence of irrigation tailwater. Conservation programs administered by the Department of Agriculture will return some cropland to natural/forested conditions; however, wholesale changes to natural conditions throughout the watershed are not anticipated due to limited resources within these programs. Bottomland hardwood communities making up the Bayou Meto WMA will continue to regress toward more water tolerant species, with associated reductions in timber health and mast production.

PLAN FORMULATION

PROBLEMS AND OPPORTUNITIES

FLOODING PROBLEMS

Flooding problems are predominantly found in the lower portion of the basin; however, additional flooding occurs in various locations due to channel sedimentation, flood plain encroachment, or other factors. Commercial and residential structures, roads, bridges, and agricultural lands experience flood damages as streambanks overtop due to insufficient channel capacity or restrictions downstream. Average annual flood damages total $13.0 million, with damages generally heavier during the winter and spring months; however, significant damage from isolated storm events can occur at any time of the year. Particularly damaging are floods that result in delayed land preparation and planting, or damage to crops already on the ground. Average annual cleared acres flooded totals 164,885 for the study area. Cleared acres flooded by reach are shown in Table 16.

Table 16
AVERAGE ANNUAL ACRES FLOODED
BASE (WITHOUT-PROJECT) CONDITIONS

Reach	Cleared (acres)	Wooded (acres)	Total (acres)
1 Big Bayou Meto-1	15,355	20,573	35,928
2 Big Bayou Meto -2	17,441	20,862	38,303
3 Big Bayou Meto -3	8,850	4,522	13,372
4 Caney Creek	6,797	1,264	8,061
5 Caney Creek Ditch	1,034	16,900	17,934
6 Two Prairie Bayou	12,062	11,953	24,015
7 Little Bayou Meto-1	4,100	5,816	9,916
8 Little Bayou Meto -2	43,098	68,247	111,345
9 Wabbeseka/Indian Bayou-3	6,385	730	7,115
10 Salt Bayou/Caney Creek -BB	3,190	19,003	22,193
11 Indian Bayou Ditch	1,375	23,155	24,530
TOTAL	119,687	193,025	312,712

SOURCE: Current area-frequency data.

Flooding problems in the lower portion of the basin are complicated by the fact that the Bayou Meto WMA intercepts agricultural drainage. This area is flooded for waterfowl during the winter through the use of water control structures. The structures are opened in the spring to facilitate drainage and flood damage reduction; however, complaints from adjacent landowners indicate early spring flooding is impacting farming operations. This is corroborated by the fact that the Arkansas Game and Fish Commission regularly awards flood damage payments to adjacent landowners.

ENVIRONMENTAL PROBLEMS

The Bayou Meto basin, like many areas in the alluvial plain of the Mississippi River, is considered to be an important resource area by environmental groups and resource agencies. Flood-prone lands have drawn the attention of those who seek to conserve or restore bottomland hardwood wetland habitat. Fisheries biologists are concerned with the health of area streams and lakes and the aquatic life they support. The study area is known for the abundant waterfowl resources present during the winter migration period. This is somewhat in contrast to the farming community, which depends on area resources to yield an abundance of grain, fiber, and fish. Problems thus created are the natural result of conflicting resource demands. Based on the extensive studies undertaken as part of this effort, the following environmental problems have been identified for the study area.

WETLANDS AND TERRESTRIAL RESOURCES

Over time, wetlands and terrestrial resources have diminished throughout the study area. Conversion of bottomland hardwood timberland to cropland resulted as crop prices escalated and flood control measures were instituted. Typical wetland functions such as water storage, water velocity reduction, sediment retention, erosion control, contaminant removal, and organic carbon export have been diminished accordingly. Problems resulting on area streams include head cutting, siltation, high turbidity, and higher levels of nutrients and pesticides. The remaining bottomland hardwood timberland, especially the Bayou Meto WMA, is considered to be a significant natural resource. Minimizing damage to the WMA habitat is critical in this analysis. Over the course of this and previous studies, special emphasis has been placed on the health of timber resources in the Bayou Meto WMA. Resource specialists have indicated that the bottomland hardwood community is being transformed into a plant community dominated by water tolerant species of less value to waterfowl and native terrestrial species. The reasons for this transformation can be traced to changes in floodwater evacuation capability as a result of the Arkansas River Levees in combination with the McClellan-Kerr Navigation Project. The navigation pool on the Arkansas River dictates the minimum riverside water surface elevation at the floodgates in the Arkansas River Levees. The maximum slope of water leaving the Bayou Meto Basin is therefore dictated by the elevation of the navigation pool. This change has over time resulted in channel aggradations and a reduction in drainage capability at the lower end of the basin, which has in turn induced changes to the plant community as described above. These are significant problems that need to be addressed at a watershed level in order to maximize the benefits to the entire ecosystem.

Water Quality and Aquatics

The problems discussed previously directly impact water quality in area streams and lakes and the aquatic resources they support. Suspended sediments result in high turbidity and contribute to degraded conditions because of contaminants bonded to the soil particles. Deposition occurs as sediment drops out of the water column once the carrying capacity of the stream is exceeded. This leads potentially to contamination of the food chain, beginning with invertebrates living in the bottom sediments. It also reduces habitat value for mussels, which prefer more substantial substrate.

Chemical contaminants such as pesticides and herbicides can be found in varying concentrations in the water column of area streams and in sediments as a result of agricultural runoff. Dioxin remains trapped in sediments in decreasing concentrations moving downstream from the Vertac Chemical Corporation Site.

Low steam base flows are also a concern for the aquatic environment. Groundwater and surface water pumpage for irrigation and aquaculture, as well as drainage improvements on area streams, have contributed to this problem. As base flows decline during periods of low rainfall and high temperature, water temperatures rise and dissolved oxygen levels fall. Aquatic resources are driven to any remaining pools of water with the associated temperature and oxygen problems.

Waterfowl

The study area is traditionally known for its waterfowl habitat and the significant number of birds that populate the region during the winter migration period. Beginning in the late 1970s, waterfowl populations declined to the point that the United States and its neighbors formulated a plan to encourage habitat preservation and restoration throughout North America. The North American Waterfowl Management Plan targeted nesting areas and wintering habitat as critical to the restoration of migratory waterfowl populations. Federal and state agencies cooperated with private organizations and landowners to develop waterfowl habitat in critical flyway zones. Combined with above average snow and rainfall in nesting areas during recent years, these efforts have resulted in significant waterfowl population increases. Problems facing waterfowl managers today and in the future include the availability of high caloric value foods required to sustain successful breeding and the return to nesting areas in the spring. Flooded lands, whether natural or intentionally flooded, must supply an adequate amount of grains, weed seeds, nuts, or other material to fulfill the nutritional requirements of wintering waterfowl. Portions of this habitat should be remote to the extent that they can serve as resting areas free from human disturbance.

Problems within the study area are limited to the quality of feeding and resting habitat available. Rice production continues to provide a major source of grain for the waterfowl that utilize the area. Resting areas within the basin, specifically the Bayou Meto WMA bottomland hardwood community, have been the focus of discussions related to timber quality and mast production in recent years. Problems related to timber stress, discussed previously, have the added impact to waterfowl of a reduction in higher caloric value mast production. Addressing these problems will improve the overall habitat for migratory waterfowl and stimulate higher quality bottomland hardwood communities.

OPPORTUNITIES

Opportunities exist to reduce flood damages to cropland and urban infrastructure through structural flood damage reduction measures. These same features have the potential to reduce flooding in and around the Bayou Meto WMA following waterfowl season in order to reduce timber stress in the bottomland hardwood community. Waterfowl habitat maybe improved in the area through structural measures to reduce flood damage, having a reliable source of water available from the water supply portion of the project, and the implementation of a waterfowl management plan for the WMA that will govern how water will be applied and removed from the WMA. This waterfowl management plan will decrease damage from early fall flooding as well as damage from spring inundation of bottomland hardwoods. There is also an opportunity to increase wetland and terrestrial resources through the reforestation of frequently flooded marginal farmland. Removal of contaminated sediments to increase channel capacity provides an opportunity to decrease aquatic resource exposure to chemical contaminants and provide a firmer substrate, which would benefit fisheries and mussel resources.

ALTERNATIVES CONSIDERED

During the early stages of this study, extensive data gathering and inspection techniques were used to guide the preliminary activities leading up to our modeling of the streams and waterways that make up the Bayou Meto Basin. The data that resulted from these models, along with input from the environmental resource agencies represented as part of the environmental team and the water supply proponents of the project, helped to guide our initial attempts to develop coherent alternatives for flood damage reduction. Our initial array of alternatives included FC1 through FC5 in Table 17 below, which required extensive modeling and evaluation to determine both the economic benefits and the environmental impacts. Alternative FC6, the Non-Structural Plan was added along with the No-Action Plan, Alternative FC7, to complete the array.

Table 17
FLOOD CONTROL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	STATUS
FC1	Selective Channel Clearing	Screened Out (H&H)
FC2	Channel Cleanout/Enlargement	Carried Forward
FC2A	Alternative 2 With Water Supply Adjustments	Carried Forward
FC3A	Alternative 2A With 1000 cfs Pump on LBM	Carried Forward
FC3B	Alternative 2A With 3000 cfs Pump on LBM	Carried Forward
FC3C	Alternative 2A With 5000 cfs Pump on LBM	Screened Out (H&H)
FC4A	Alternative 2A With 3000 cfs Pump on BBM	Screened Out (H&H)
FC4B	Alternative 2A With 5000 cfs Pump on BBM	Screened Out (H&H)
FC4C	Alternative 2A With 8000 cfs Pump on BBM	Screened Out (H&H)
FC4D	Alternative 2A With 10,000 cfs Pump on BBM	Screened Out (H&H)
FC5	Waterfowl Features - Bayou Meto WMA	Carried Forward
FC6	Non-Structural Plan	Carried Forward
FC7	No-Action Plan	Carried Forward

Alternative FC6 has always been envisioned as a substitute for structural measures to address flood damage reduction; which, in this case, is reasonably limited to reforestation of agricultural property that would otherwise benefit from structural features. Alternative FC7 is, obviously, the status quo alternative against which every other alternative is measured. It should be noted that Alternative FC5 is the direct result of coordination with the Arkansas Game and Fish Commission and represents the desires of the agency to enhance water management capability within the Bayou Meto WMA for more efficient inundation of areas designated as waterfowl habitat.

ALTERNATIVE FC1 – SELECTIVE CHANNEL CLEARING

Alternative FC1 was developed to be the most limited flood control plan in terms of work required and environmental impact. It consists of selective clearing on Indian Bayou, Indian Bayou Ditch, Wabbaseka Bayou, Boggy Slough, Salt Bayou, Two Prairie Creek, and portions of Big Bayou Meto; and enlargement of Crooked Creek Ditch for about 9.6 miles. The type of work involved in selective clearing includes removal of stream obstructions such as thick woody vegetation while leaving mature trees at intervals that do not impact stream flow significantly.

ALTERNATIVE FC2 – CHANNEL CLEANOUT/ENLARGEMENT

Alternative FC2 was developed to be the next logical step in size that would make a difference hydraulically. It includes the enlargement of Indian Bayou Ditch with work primarily on the left descending bank and limited work on the original Indian Bayou channel to restore flows through the old meandering stream and provide some degree of drainage while protecting the ecosystem that has developed (Figure 15). The original Indian Bayou channel has been subject to silt deposition and the growth of woody vegetation over the years as flows have been diverted through Indian Bayou Ditch. Structures at the northern confluence of these channels are required to sustain minimum flows for Indian Bayou while diverting flood flows primarily through Indian Bayou Ditch.

Indian Bayou and Indian Bayou Ditch combine near Tucker, AR to form Wabbaseka Bayou (Figure 16). Since this stream was designated by the environmental team as significant from an ecosystem perspective, flood control plans were limited to the amount of work necessary to carry upstream flows without inducing damage to the surrounding landowners. The upper 11 miles and lower 3 miles of this work were limited to cleanout of the existing channel. The remaining 18 miles in-between were targeted for selective clearing. Although this work does not significantly reduce flooding in the surrounding areas, it provides conveyance for the flows received from Indian Bayou.

The existing route within Bayou Meto Wildlife Management Area for conveyance below Wabbaseka Bayou includes Boggy Slough and Little Bayou Meto (Figure 17). Although undesirable from an environmental standpoint, conveyance through Boggy Slough and Little Bayou Meto was presumed to be the most effective means to transfer flows through this system into Big Bayou Meto via the double ditches adjacent to the Cannon Brake structure. This work consists of excavating 1 to 3 feet of material in Little Bayou Meto (including one of the double ditches) and 1 to 2 feet in Boggy Slough. The primary impact is related to clearing on one bank for equipment operation and material disposal.

Salt Bayou intersects Little Bayou Meto less than 2 miles above the Cannon Brake structure. This channel follows a natural meander for about 5 miles before entering another set of double channels that were excavated for drainage many years ago (Figure 18). Excavation of 1 to 2 feet is planned on the lower portion of the channel along with selective clearing of the west twin channel for about 8.7 miles.

Crooked Creek converges with Big Bayou Meto above the WMA and meanders for about 16.6 miles before intersecting with Crooked Creek Ditch, another manmade channel built many years ago for local drainage (Figure 19). To provide some flood relief in this reach, 2 to 3 feet of excavation is required for approximately 9.6 miles of Crooked Creek Ditch along with excavation of 1 to 3 feet of material on about 8.6 miles of Crooked Creek below the confluence with Crooked Creek Ditch. Two existing weirs on Crooked Creek also need to be modified to accommodate this work.

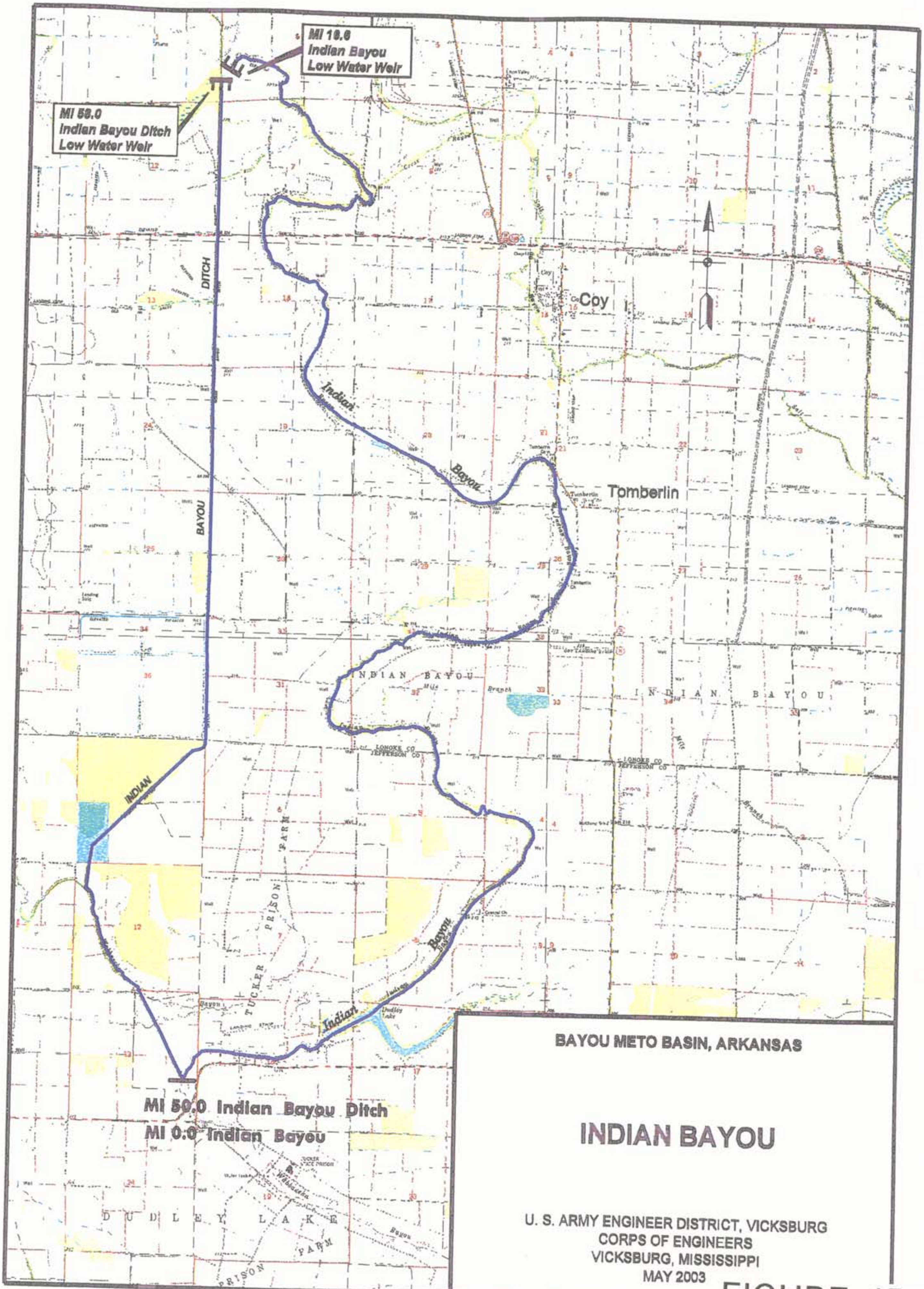
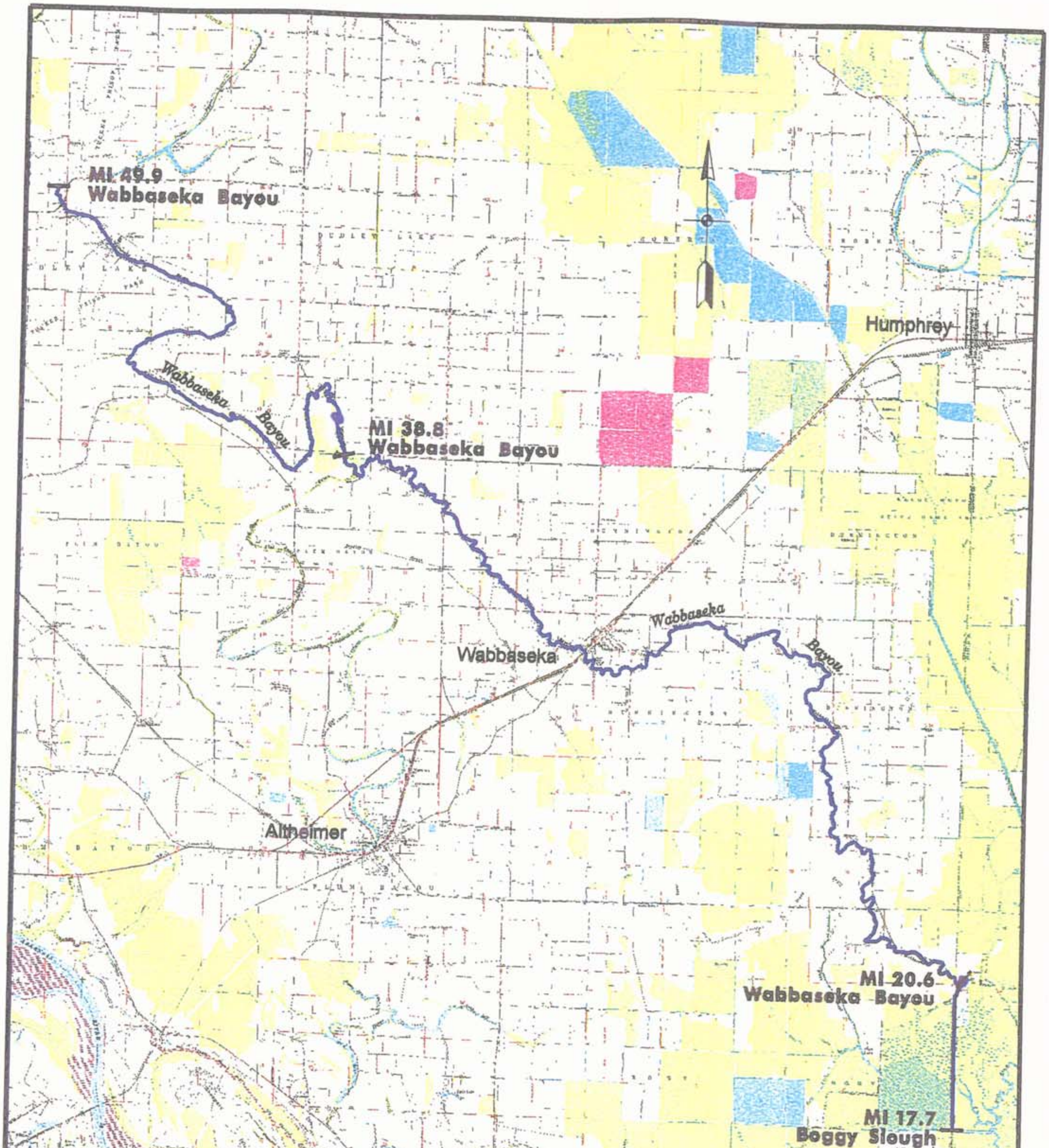

MI 18.6
Indian Bayou
Low Water Weir
MI 58.0
Indian Bayou Ditch
Low Water Weir
DITCH
BAYOU
INDIAN
Coy
Tomberlin
Indian
Bayou
INDIAN BAYOU
INDIAN BAYOU
LONOKE CO
JEFFERSON CO
TUCKER PRISON FARM
Bayou
Indian
Dudley Lake
DUDLEY LAKE
PRISON
FARM
MI 50.0 Indian Bayou Ditch
MI 0.0 Indian Bayou
BAYOU METO BASIN, ARKANSAS
INDIAN BAYOU
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI
MAY 2003

FIGURE 15



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WABBASEKA BAYOU

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FIGURE 16

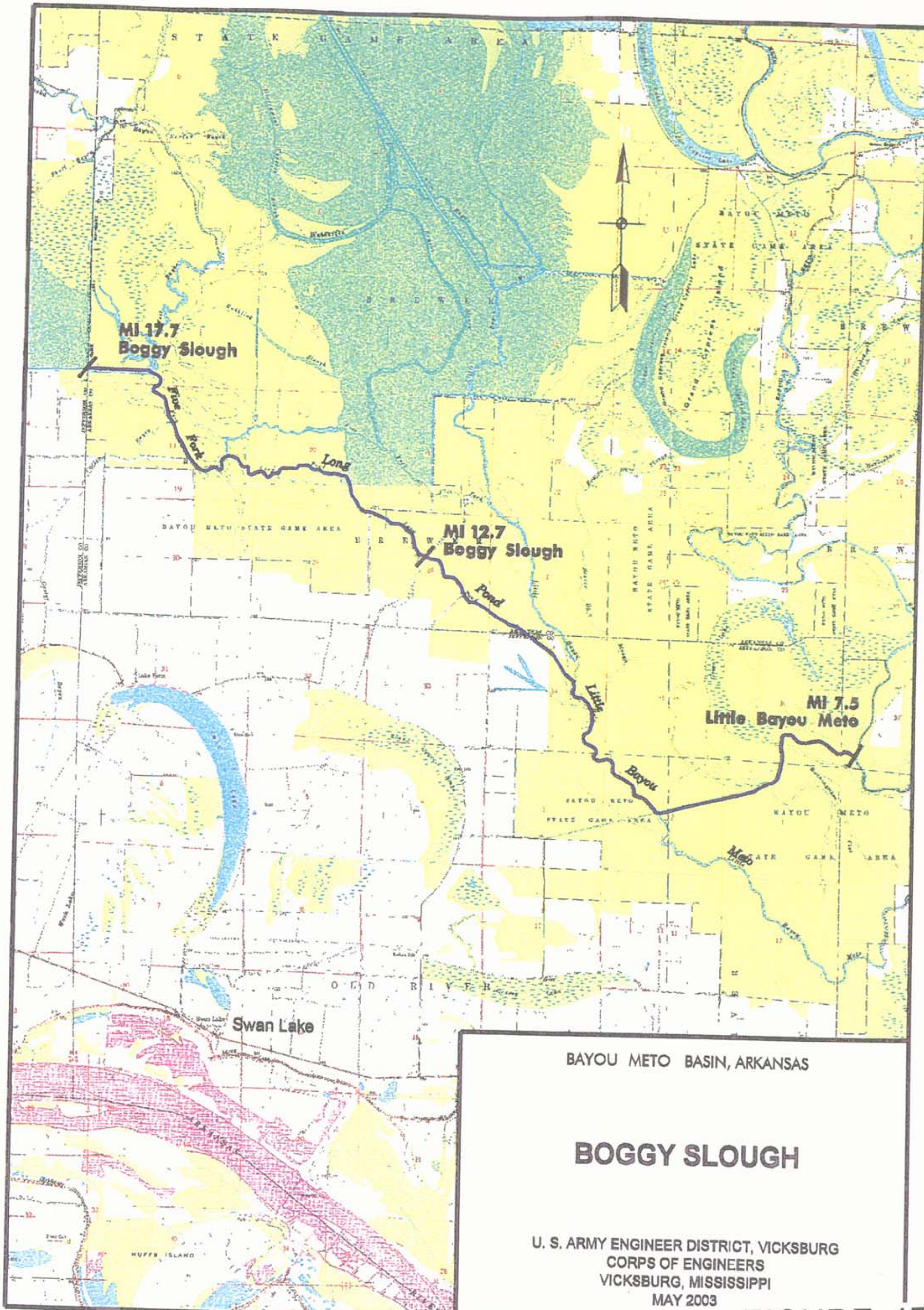
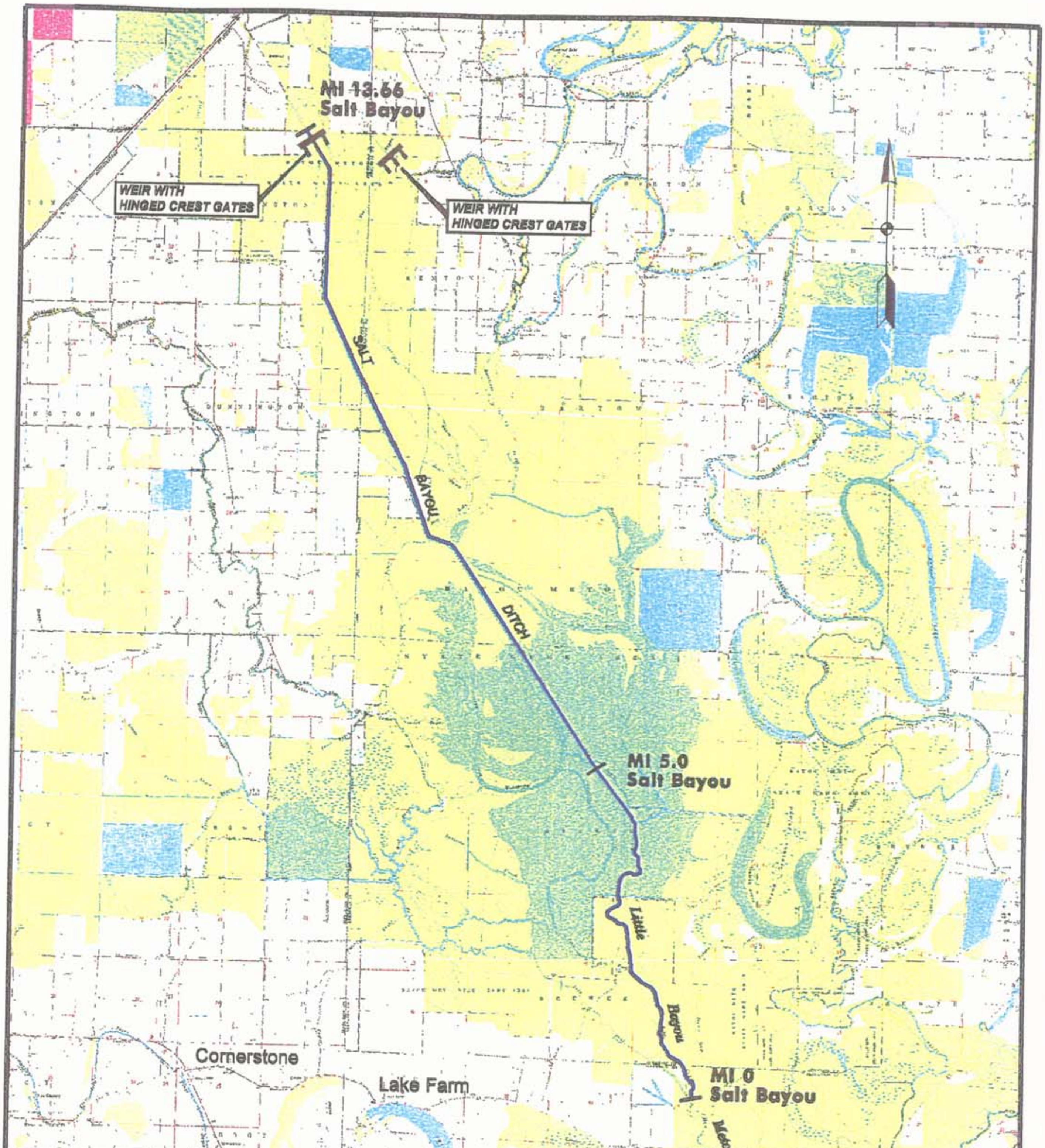

STATE GAME AREA
Mi 17.7
Boggy Slough
Mi 12.7
Boggy Slough
Mi 7.5
Little Bayou Meto
BAYOU METO STATE GAME AREA
Long
Pond
Little
Bayou
OLD RIVER
Swan Lake
HUFFS ISLAND
BAYOU METO BASIN, ARKANSAS
BOGGY SLOUGH
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI
MAY 2003

FIGURE 17



BAYOU METO BASIN, ARKANSAS

SALT BAYOU

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VICKSBURG, MISSISSIPPI
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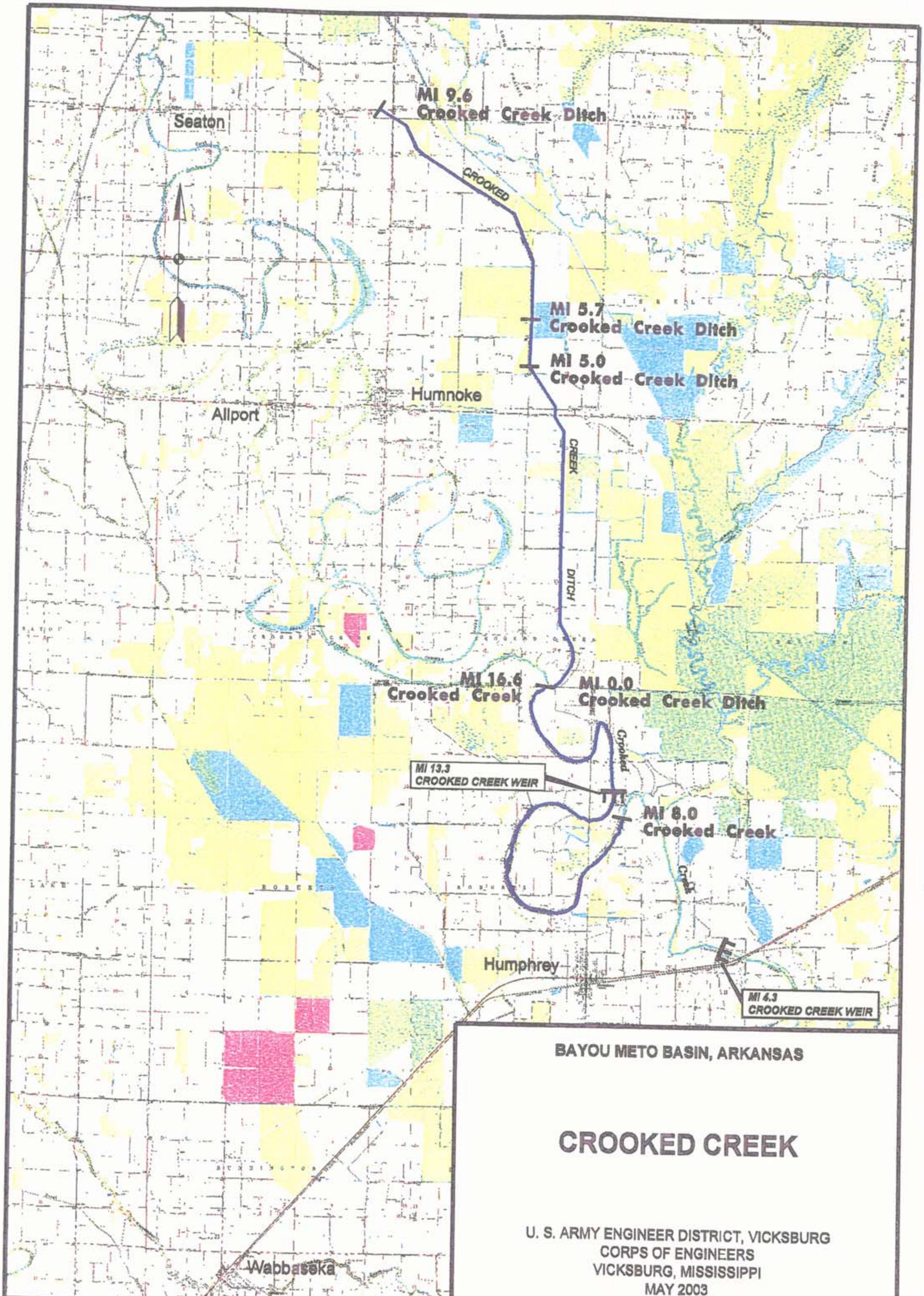
MI 9.6
Crooked Creek Ditch
Seaton
CROOKED
MI 5.7
Crooked Creek Ditch
MI 5.0
Crooked Creek Ditch
Humnoke
Allport
CREEK
DITCH
MI 16.6
Crooked Creek
MI 0.0
Crooked Creek Ditch
Crooked
MI 13.3
CROOKED CREEK WEIR
MI 8.0
Crooked Creek
Creek
Humphrey
MI 4.3
CROOKED CREEK WEIR
Wabbaseka
BAYOU METO BASIN, ARKANSAS
CROOKED CREEK
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
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VICKSBURG, MISSISSIPPI
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FIGURE 19

Two Prairie Creek (Bayou Two Prairie) begins above Lonoke and empties into Big Bayou Meto northwest of Stuttgart (Figure 20). This stream is characteristically wide and shallow with significant obstructions both in terms of deposition and vegetation. Flood damage reduction measures for this stream include excavation of 1 to 6 feet of material for the first 7 miles to develop a 25-foot bottom width channel, which would narrow to 20 feet for the next 12 miles requiring excavation of approximately 1 to 4 feet of material. Channel cleanout on Big Bayou Meto is necessary for about 6.7 miles below this point to accommodate the increased discharge from Two Prairie Creek. That work would require removal of 1 to 3 feet of material resulting in a bottom width of approximately 25 feet.

The last remaining item in this alternative is a bypass channel on Big Bayou Meto, which would lower flood stages near Interstate 40 (Figure 21). Two railroad bridges and a highway bridge cross the channel in this reach and the natural floodway has been reduced by encroachment of fishpond levees and vegetation growth. The bypass channel would be 5 miles in length with a bottom width of 10 feet and a depth of about 12 to 18 feet. This channel will have levees on both sides to prevent flooding of adjacent properties. Existing fishpond levees would serve as the levees for the left descending bank while the right descending levee would have to be constructed. A bridge will be required where the channel crosses Hwy 70 and two low water weirs will be constructed in the channel for maintenance purposes.

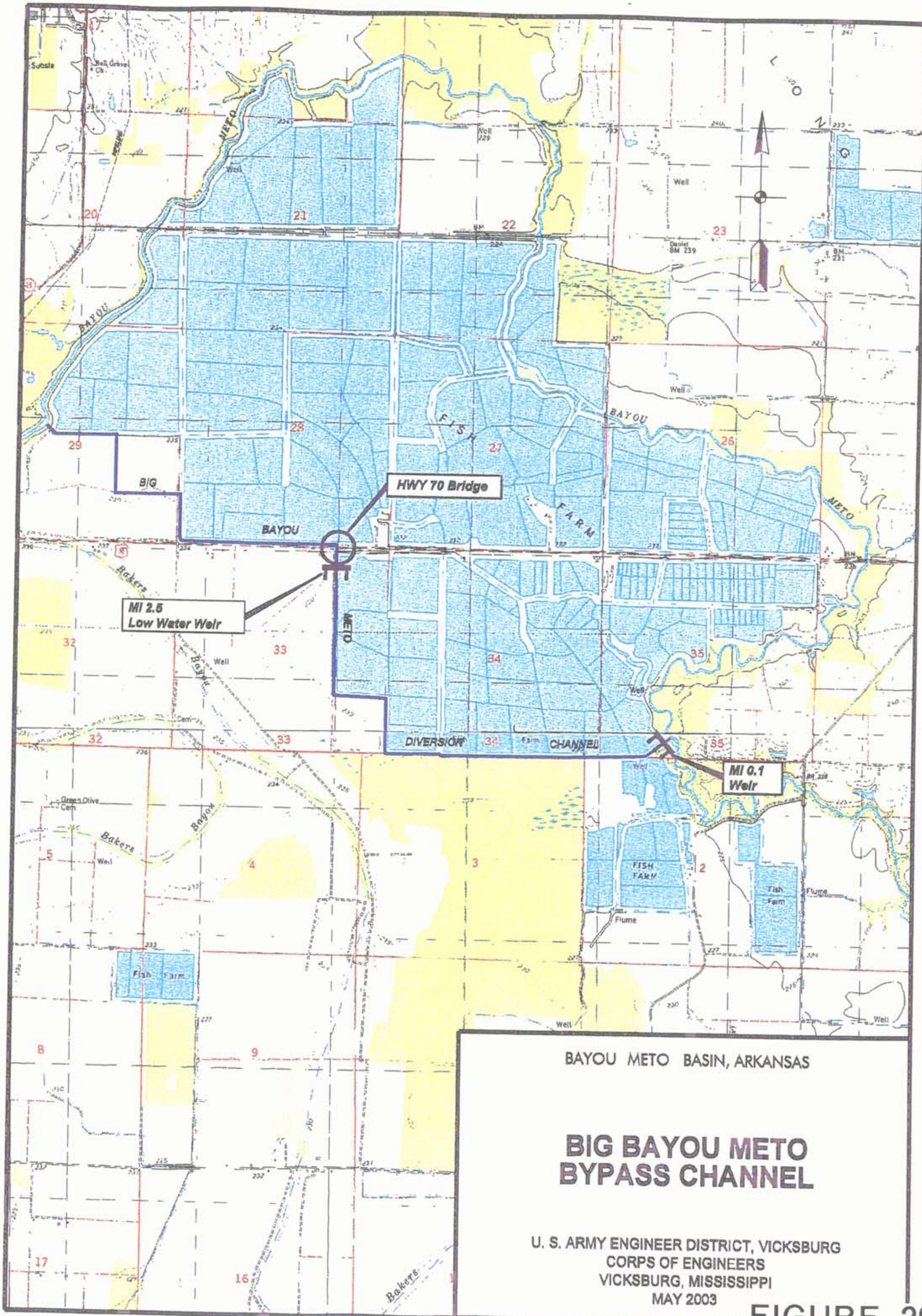
ALTERNATIVE FC2A – ALTERNATIVE FC2 WITH WATER SUPPLY

Alternative FC2A was developed once the configuration of water supply features had reached the point that channels could be defined that would carry water throughout the system. In two cases, flood control channels had to be enlarged to accommodate increased discharges resulting from the water supply plans. These costs were accounted for in the Water Supply Component (Section I).

Indian Bayou Ditch was modified to pass the 1-year frequency flow plus the design irrigation flow without increasing flood stages. The channel was increased for approximately 8 miles by cutting the left descending bank to a 1 on 3 slope in addition to the excavation described in Alternative FC2

Crooked Creek Ditch was also modified from the work described in Alternative FC2 to accommodate the addition of irrigation water as follows. The bottom of the channel will not be lowered as proposed in Alternative FC2; however, bottom widths will be increased and banks will be cut back to 1 on 3 slopes. Channel bottom widths will increase to 35, 45 and 55 feet for miles 0 to 5.0, 5.0 to 5.7, and 5.7 to 9.6, respectively.

The channel bottom width of Crooked Creek will increase for this alternative from 50 to 60 feet in the 8.6 mile reach below Crooked Creek Ditch. The existing weirs that were discussed in Alternative FC2 will be modified for this alternative also.



BAYOU METO BASIN, ARKANSAS

BIG BAYOU METO BYPASS CHANNEL

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MAY 2003

FIGURE 20


MI 19.1
Bayou Two Prairie
MI 12.64
Bayou Two Prairie
Bayou
Two
Parkers Corner
MI 6.8
Bayou Two Prairie
Slovak
Prairie
Hamilton
MI 100.8
Big Bayou Meto
MI 0.0
Bayou Two Prairie
Humnoke
Meto
Bayou
MI 92.9
Big Bayou Meto
STUTTGART
BAYOU METO BASIN, ARKANSAS
BAYOU TWO PRAIRIE
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI
MAY 2003

FIGURE 21

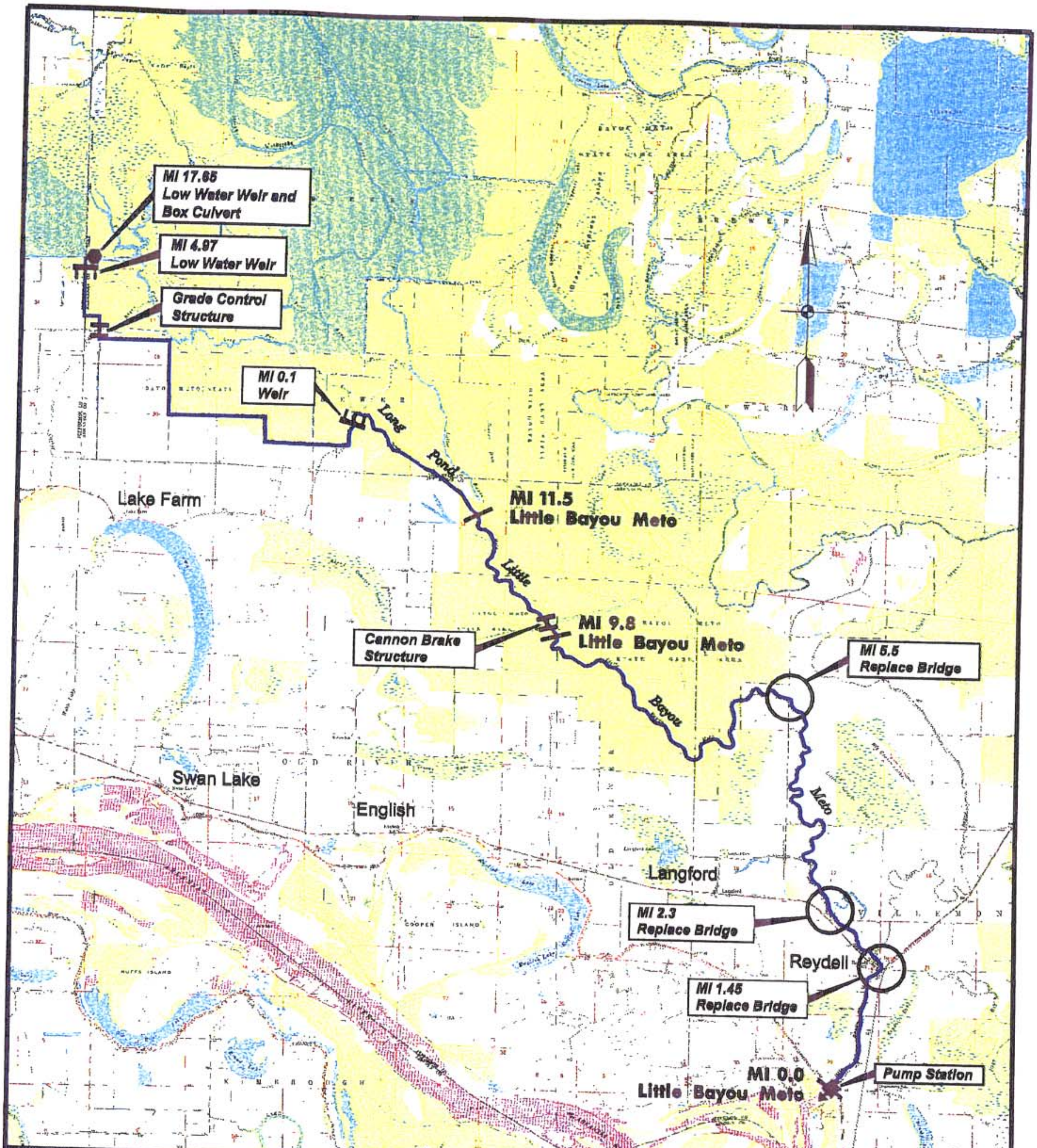
ALTERNATIVE FC3A – ALTERNATIVE FC2A WITH 1000 CFS PUMP STATION ON LITTLE BAYOU METO

Alternative FC3A incorporates the addition of a 1000 cfs pump station at the outlet of Little Bayou Meto to remove water from behind the Arkansas River Levees. This plan also includes channel work on 10 miles of Little Bayou Meto above the pump station to convey water from the Cannon Brake Structure to the pump station (Figure 22). The channel will have a 30-foot bottom width and would essentially be a new channel since the old channel has silted in following the diversion of Little Bayou Meto flows to Big Bayou Meto.

An additional water control structure is required adjacent to the existing Cannon Brake Structure to control flows in Little Bayou Meto. This structure would include three- 10x10 foot gates and would be managed in combination with the original Cannon Brake structure. This structure, in combination with a guide levee separating flows between Little Bayou Meto and Big Bayou Meto, will facilitate proper water management to maximize flood damage reduction and limit environmental impacts.

Above the water control structure on Little Bayou Meto and Boggy Slough, a channel cleanout of 1 to 2 feet is needed for approximately 3 miles, with a bottom width of about 40 feet.

To avoid additional major channel work on Boggy Slough in the WMA, a bypass channel was proposed which would convey water from Indian Bayou and Wabbaseka Bayou around the southwest corner of the WMA and into the channel just described (Fig 22). This channel would be 5 miles long with a 30-foot bottom width and would include a levee on the left descending bank. The levee would help to prevent flooding of agricultural lands when water is being managed for waterfowl in the WMA and would provide access to areas in the WMA that are currently hard to reach by personnel with the Arkansas Game and Fish Commission. This channel will cross Castor Bayou where a grade control structure will be placed to prevent head cutting upstream. A low water weir will be constructed at the lower end of the bypass channel for maintenance purposes. A combination of weirs and a gated culvert will be provided where the bypass channel intersects the existing Boggy Slough channel to provide low flows into Boggy Slough and ensure a balanced flow between the two channels during higher flow conditions. One of the weirs will be constructed at the upper end of the diversion and another weir with gated culvert will be constructed in the existing Boggy Slough channel immediately downstream from the junction with the bypass channel.



BAYOU METO BASIN, ARKANSAS

LITTLE BAYOU METO

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VICKSBURG, MISSISSIPPI
MAY 2003

FIGURE 22

ALTERNATIVE FC3B - ALTERNATIVE 2A WITH 3000 CFS PUMP STATION ON LITTLE BAYOU METO

Alternative 3B essentially replicates Alternative 3A except the pump station is increased in size to 3000 cfs. This necessitates the enlargement of the Little Bayou Meto channel downstream of the new Cannon Brake structure to a bottom width of 60 feet. The additional Cannon Brake structure would also be increased in size to five - 10x10 foot gates to pass the flow to the pump.

ALTERNATIVES FC4A, FC4B, FC4C, AND FC4D – ALTERNATIVE 2A WITH VARIOUS SIZE PUMP STATIONS ON BIG BAYOU METO

Alternatives FC4A, FC4B, FC4C, and FC4D represent alternatives that include pump stations at the outlet of Big Bayou Meto with capacities of 3000 cfs, 5000 cfs, 8000 cfs, and 10,000 cfs, respectively. These pump stations would replace the pumps on Little Bayou Meto and would require extensive channel excavation upstream for 20 miles on Big Bayou Meto and 10 miles on Little Bayou Meto. Upstream of this point, these alternatives would mimic alternative FC3A.

ALTERNATIVE FC5 – WATERFOWL FEATURES ON BAYOU METO WMA

Alternative FC5 is essentially the construction of two hinged-crest gated structures that would divert flow from the Salt Bayou channel into Dry Bayou then into waterfowl management areas located between Salt Bayou and Big Bayou Meto (Fig. 18). The structures would be controlled to enhance waterfowl management capability without impacting flood stages on Salt Bayou and Dry Bayou. The structure on Salt Bayou would consist of a 100-foot hinged crest gate that would be constructed immediately downstream from the junction of Salt Bayou and Dry Bayou. In the raised position it would divert flow to Dry Bayou and in a lowered position would pass flood flows down Salt Bayou without affecting stages. A smaller 25-foot hinged crest gate would be constructed in Dry Bayou near mile 1.1 that would divert flows into the Bear Bayou Impoundment on the WMA. This would make it possible to flood several areas in the WMA from the upstream side instead of backing water into them from existing downstream structures. Flooding would take place more quickly and could be done without placing downstream structures and levees at risk due to the higher elevations of ponding required. In combination with the water supply features of the project, this alternative would provide a reliable source of water for the Bear Bayou Impoundment and related areas on a consistent basis.

ALTERNATIVE FC6 – NON-STRUCTURAL PLAN

Alternative FC6 is the Non-Structural Plan that would replace structural measures for flood damage reduction. Looking at the flood control measures proposed previously, without consideration of the water supply portion of the project, this plan would necessarily involve reforestation of cropland in the lower part of the basin adjacent to and perhaps above the WMA. Agricultural areas flooded by the 2-year frequency event that benefit from alternative 2 total 4,850 acres. Reforestation of this amount of cropland would be done similarly to the way that is anticipated for the non-structural measures that are included in the recommended plan. Costs would include a permanent flood easement that would restrict development; planting, replanting, and management of the property to ensure the health of the plant communities that are recommended, and monitoring to ensure that deed restrictions are enforced.

The remaining alternatives that were carried forward include flood damage reduction measures that are independent of the water supply plans as well as measures on which the water supply plans depend. For Alternative FC2A, the increase in benefited acres for agricultural areas flooded by the 2-year frequency event represents changes necessitated by inclusion of the water supply features of the project. It is difficult to formulate a Non-Structural Plan for this situation since induced flooding from water supply features would probably limit the benefits of these features in the first place. However for the purposes of this analysis, the benefited acres within the 2-year frequency event for this plan total 7,320 acres, which is an increase of 2,470 acres over Alternative FC2. The benefited areas within the 2-year frequency event for Alternatives 3A and 3B total 15,140 and 19,240 acres respectively.

Reforestation of property in the areas described above would probably be difficult at this point, in light of the fact that many areas in the WMA are already showing signs of stress due to the length of inundation during the growing season. The Vicksburg District has reforested over 20,000 acres in Mississippi as part of mitigation for other projects. These areas are frequently flooded which has a negative impact on the survival of small hardwood seedlings. It will be necessary to apply some of the techniques used on these tracts to ensure that the seedlings are able to grow big enough to withstand the greater durations of flooding that will be expected without channel maintenance or the capacity to remove water through pumping.

ALTERNATIVE FC7 – NO ACTION PLAN

Alternative FC7 is the No-Action Plan. Farming would continue, with some cropping pattern and land use changes throughout the basin due to flooding or lack of available irrigation water. In the lower part of the basin near the WMA, water supply would not be a problem due to recharge from the Arkansas River; therefore, the only reason for land use changes would be the threat of flooding. Since flooding is presumed to continue at about the current level in the future, it is assumed that agricultural production will continue in areas that are currently farmed. This is especially true for areas where rice is grown and then flooded for waterfowl after the harvest.

PRELIMINARY SCREENING

Once existing hydrologic conditions were established for the Bayou Meto Basin, the alternatives listed above were input to hydrologic models and evaluated for effectiveness. Alternative FC1 yielded an insignificant reduction in stages and was screened out early in the evaluation phase. Alternative FC2 provided significant stage reduction and was carried forward to be evaluated in detail. Alternative FC2A was necessary to account for changes in stages as a result of the water supply features and was also carried forward. Alternative FC3A, the plan that includes a 1,000 cfs pump station at the outlet for Little Bayou Meto, provided a greater reduction in stages and the opportunity to remove excess water from the Bayou Meto WMA following waterfowl season. This, in turn, would reduce stresses to timber resources that have plagued the WMA for many years. This plan was carried forward along with alternative FC3B, which substituted a 3,000 cfs pump station for the 1,000 cfs pump station in Alternative FC3A along with adjustments to channel and structure sizes. Alternative FC3C included a 5,000 cfs pump station and additional channel enlargement. The station capacity and channel requirements to render this pump station effective did not provide significantly greater flood damage reduction to merit further evaluation of this alternative. It was screened out prior to the detailed evaluation of alternatives.

Alternatives FC4A, FC4B, FC4C, and FC4D include pump stations at the outlet of Big Bayou Meto with capacities of 3000 cfs, 5000 cfs, 8000 cfs, and 10,000 cfs, respectively, along with significant channel enlargement on Big Bayou Meto and Little Bayou Meto. The stage reduction for these alternatives was controlled by upstream channels and did not prove to be effective for the amount of construction required. These alternatives were dropped from further consideration at that point. Other possible alternatives that included pump stations on both Big and Little Bayou Meto were discussed; however, the limitations described for alternatives FC4A through FC4D precluded additional evaluations of these measures.

Although FC5 was evaluated for waterfowl benefits that it would provide in combination with the water supply features of the project, it was eliminated from detailed analysis as a flood control plan. It was however, evaluated as part of the Waterfowl Management Plan (Section III).

Alternative FC6 is the Non-Structural Plan and would essentially result in reforestation of areas within the 2-year frequency event that would benefit from structural flood control measures. This plan was carried forward and considered in a similar way to the non-structural measures that will accompany the recommended plan. For purposes of comparison, the reforested acres that are carried forward are those that coincide with the benefited acres from the recommended plan. The no action plan is also carried forward for comparison purposes.

PLANS EVALUATED IN DETAIL

The plans listed below were evaluated in detail so that comparisons could be made to determine the recommended plan based on the criteria and objectives described previously.

ALTERNATIVE FC2 - CLEANOUT/ENLARGEMENT OF EXISTING STREAMS

This plan, described previously, consists of the minimum amount of channel cleanout/enlargement possible that would result in potentially feasible flood damage reduction benefits.

ALTERNATIVE FC2A - ADDITIONAL CHANNEL WORK TO ACCOMMODATE AGRICULTURAL WATER SUPPLY

Alternative FC2A is a modification of Alternative FC2 to accommodate the agricultural water supply portion of the project. Additional channel enlargement was required on Indian Bayou/Indian Bayou Ditch and Crooked Creek/Crooked Creek Ditch.

ALTERNATIVE FC3A - CHANNEL WORK PLUS 1000 CFS PUMP ON LITTLE BAYOU METO

This alternative included the added increment of a 1000 cfs pump station at the outlet of Little Bayou Meto along with necessary channel work and structural features to support the pump station.

ALTERNATIVE FC3B - CHANNEL WORK PLUS 3000CFS PUMP ON LITTLE BAYOU METO

Alternative FC3B includes a 3000 cfs pump station on Little Bayou Meto resulting in further increases of channel dimensions and structure capacities upstream of the pump station.

ALTERNATIVE FC6 - NON-STRUCTURAL PLAN

This plan was developed as an alternative to structural flood control measures for the Bayou Meto area and consists of reforestation within the area flooded at the 2-year frequency.

ALTERNATIVE FC7 - NO-ACTION PLAN

This plan was carried forward and used as the basis for evaluation of the effects of other plans.

PLAN SELECTION

ECONOMIC EVALUATION OF PLANS

The economic evaluation of flood damage reduction alternatives is based on hydrologic analyses, land use information, cost estimates, engineering and economic technical data, and other information developed as part of the Bayou Meto General Reevaluation Study. Detailed information can be found in Appendix G. As stated previously, the economic analysis is based on an assumed 50-year growth period, an expected 50-year period of analysis, a Federal discount rate of 5.375 percent, and an estimated project completion date of 2012. Project costs were developed based on (April) 2004 price levels. Costs and benefits of Alternative FC6, the Non-Structural Plan, were not fully developed since it would be superseded by the waterfowl management component of the project, which includes reforestation and waterfowl features that are much more significant.

FLOOD DAMAGE ANALYSIS

As discussed previously, the majority of lands in the project area are dedicated to agriculture. Of the approximately 641,000 acres contained within 11 hydrologic reaches, approximately 72 percent are made up of cleared agricultural land. Urban and built-up areas make up about 0.6 percent of the project area. It is understandable, therefore, that the primary benefits of a flood damage reduction project will be attributable to crop production, non-crop agricultural infrastructure, and rural development.

AGRICULTURAL FLOOD DAMAGES

Approximately 312,700 acres are inundated on an average annual basis in the Bayou Meto Area under base conditions. Of this, 53 percent (164,900 acres) is cleared agricultural land. Ninety-one percent of the average annual cleared acres flooded are located at or below the 2-year frequency flood event. Table 18 shows cleared and wooded acres flooded at various frequencies from the 1-year to the 100-year frequency event. Agricultural flood damage calculations are based on three factors, frequency of flooding, duration of flooding, and the time of year that flooding occurs. Flood control plans were developed to reduce the frequency and duration of flooding during the growing season in order to maximize benefits to agricultural production. Crop distributions and yield data were used to determine flood damages using the Computerized Agricultural Crop Flood Damage Assessment System (CACFDAS) developed by Mississippi State University. Crop returns were based on FY 00 current normalized prices.

Table 18
AREA FLOODED BY SELECTED FLOOD FREQUENCIES
BASE (WITHOUT-PROJECT) CONDITIONS
(Thousands of Acres)

Frequency		Area Flooded				
Percent Chance of Occurrence	Year	Cleared		Wooded		Total
		Acres	Percent	Acres	Percent	Acres
.01	100	182	63	107	37	289
.02	50	171	62	105	38	276
.04	25	157	61	101	39	258
.10	10	138	59	96	41	234
.20	5	116	56	89	44	205
.50	2	84	53	74	47	158
1.00	1	62	51	59	49	121

SOURCE: Stage-area/stage-frequency data. Excludes acreages in catfish farms.

Results from the CACFDAS program indicate that for without-project conditions, the estimated crop damages per acre for irrigated crops ranged from $34.53 per acre to $116.55 per acre. The estimated crop damage per acre for non-irrigated crops ranged from $12.91 per acre to $73.16 per acre. Total annual crop damages for without-project conditions, including both irrigated and non-irrigated crops of all reaches, are estimated at $11.3 million annually.

Agricultural noncrop damages include damages to farm supplies, farm roads, drainage ditches, fences, irrigation systems, and land forming and leveling. Data developed by Mississippi State University was used to calculate noncrop damages based on an indexed value of damage per cleared acre flooded throughout the project area. Noncrop damages totaled $1.659 million annually for base conditions.

The remaining category of agricultural flood damage is to baitfish operations. An estimated 15,950 acres of baitfish ponds are found within the project area, with a gross production value of approximately $17.5 million annually. Damages occur when pond levees are overtopped and include losses for escaped fish, shortened growing season, restocking costs, draining and refilling ponds, and damages to pond levees, drainage systems, and water supply systems. Under existing conditions, pond levees overtop at frequencies equal or greater than the 100-year event. Total annual damages are estimated to be $298, 000 for existing conditions. This brings the total agricultural damages to $16.5 million annually.

NONAGRICULTURAL FLOOD DAMAGES

Flood damages to public roads and bridges were identified based on the number of miles of roads inundated during flood events. Repair and replacement costs were determined and total damages for the Bayou Meto area under existing conditions were estimated to be $126,000 annually.

BENEFITS

Project benefits were derived based on the reduction in damages for each alternative during the period of analysis. Table 19 shows the existing damages and damages remaining with implementation of each alternative. Benefits are projected to accrue throughout the life of the project and include benefits during construction. Average annual benefits are shown in Table 20 for each flood control plan and range from $2.4 million for Alternative FC2 to $6.3 million for Alternative FC3B.

Table 19
SUMMARY, AVERAGE ANNUAL FLOOD DAMAGES
BASE (WITHOUT-PROJECT) DAMAGES AND DAMAGES WITH DETAILED ALTERNATIVE STRUCTURAL PLANS CONSIDERED
(Current Year, 2002 Values)

Flood Damage Category	Base (Without-Project) Conditions a/	Flood Damages with Alternative Plans c/			
		Plan FC2	Plan FC2A	Plan FC3A	Plan FC3B
Nonagricultural ($000)					
Residences, Commercial					
Buildings, Etc.					
Urban	b/	b/	b/	b/	b/
Rural	b/	b/	b/	b/	b/
Emergency Costs					
Urban	b/	b/	b/	b/	b/
Rural	b/	b/	b/	b/	b/
Public Roads and Bridges	126	125	125	124	124
Subtotal	126	125	125	124	124
Agricultural ($000)					
Crops	14,406	12,280	12,136	10,259	8,184
Noncrop	1,659	1,528	1,509	1,320	1,241
Baitfish Operations	298	81	81	32	32
Subtotal	16,363	13,889	13,726	11,611	9,457
TOTAL FLOOD DAMAGES	16,489	14,014	13,851	11,735	9,581

a/ Exist. Cond. b/ Negligible damages/costs. c/ Does not include benefits during construction

Table 20
SUMMARY, TOTAL ANNUAL BENEFITS
ALL INITIAL DETAILED STRUCTURAL ALTERNATIVE PLANS CONSIDERED
(5-3/8 Percent Discount Rate Analysis)
($000)

Item	Alternative Structural Plans			
	FC2	FC2A	FC3A	FC3B
INUNDATION				
Nonagricultural				
Public Roads and Bridges	1	2	2	2
Subtotal	1	2	2	2
Agricultural				
Crops	2,012	2,150	4,507	5,455
Noncrop	194	220	522	594
Baitfish Operations	216	216	265	265
Subtotal	2,422	2,586	5,261	6,314
SUBTOTAL INUNDATION	2,423	2,588	5,263	6,316
TOTAL BENEFITS	2,423	2,588	5,263	6,316

COSTS

Preliminary first costs for construction for each plan are shown in Table 21 and range from $20.9 million for Alternative FC2 to $90 million for Alternative FC3B. Costs were annualized using a 50-year period of analysis and an interest rate of 5-3/8 percent. The resulting average annual costs along with operation and maintenance costs and major rehabilitation costs are also shown in Table 21. Total average annual costs for the alternatives range from $1.4 million for Alternative FC2 to $6.5 million for Alternative FC3B. For these initial analyses, mitigation requirements were not available. And, it was also apparent at this time that the NER component of the project would involve reforestation of many more acres than were anticipated to be required for mitigation of the flood control component. In addition, non-structural flood damage reduction benefits for the reforested lands in the waterfowl management component would have to be included in the flood control analysis. For these reasons, the absence of mitigation costs were not considered critical for comparison of flood control plans at this point.

Table 21
FIRST COSTS AND ANNUAL COSTS
INITIAL DETAILED STRUCTURAL ALTERNATIVE PLANS a/
(5.375 Percent Discount Rate Analysis)
($000)

Item	Plan FC2	Plan FC2A	Plan FC3A	Plan FC3B
First Costs a/				
First Costs	20,882	22,957	58,211	90,041
Interest During Construction (IDC) b/	2,662	2,927	6,409	9,914
Total Investment	23,544	25,884	64,620	99,995
Annual Costs a/				
Interest and Sinking Fund	1,365	1,501	3,747	5,795
Operation and Maintenance	56	56	444	697
Major Rehabilitation Channels	8	8	8	8
Fish and Wildlife Losses c/	c/	c/	c/	c/
Total	1,429	1,565	4,199	6,500

a/ Costs reflect price levels of April 2004 (revised costs).
b/ Based on use of estimated construction schedule of expenditures for each plan and appropriate interest rate.
c/ Not available.
Note: For this initial analyze, mitigation requirements were not available.

BENEFIT/COST COMPARISON (SELECTION OF NED PLAN)

Average annual benefits were compared to average annual costs to determine which plans were most likely to have excess benefits. Table 22 gives the average annual benefits and average annual costs of each plan, along with excess benefits over costs and the benefit-cost ratio. Excess benefits range from $0.99 million annually for Plan FC2 to $1.06 million annually for Plan FC3A. Plan FC3B is not economically feasible with costs exceeding benefits by $0.18 million annually. Benefit cost ratios for Alternatives FC2, FC2A, and FC3A are 1.7, 1.7, and 1.3, respectively with FC3A having the most excess benefits.

TABLE 22
ECONOMIC ANALYSIS, INITIAL DETAILED STRUCTURAL PLANS
(5-3/8 Percent Discount Rate Analysis)

Item	Plan FC2	Plan FC2A	Plan FC3A	Plan FC3B
First Costs ($000) a/	20,882	22,957	58,211	90,041
Annual Costs ($000) a/b/	1,429	1,565	4,199	6,500
Annual Benefits ($000) b/				
All Categories	2,423	2,588	5,263	6,316
Excess Benefits over Costs ($000) c/	994	1,023	1,064	-184
Benefit-Cost Ratio (%)				
Benefit-Cost Ratio with All Benefit Categories	1.7	1.7	1.3	0.97

a/ April 2004 price levels (revised costs).
b/ Annualized with appropriate discount rate factors and 50-year project period of analysis.
c/ Calculated using all benefits except employment benefits.
Note: For this initial analyze, mitigation requirements were not available.

Following the initial plan comparison, work on Two Prairie Bayou was singled out for evaluation since it was independent of the other flood control items and involved construction in areas felt to be environmentally sensitive. Two Prairie Bayou was not incrementally justified and therefore it was deleted from the flood control alternatives. Salt Bayou was deleted from the flood control alternatives because it was more suitable for waterfowl management improvements. Also, Habit Evaluation Procedures (HEP) were completed and mitigation costs were included for each alternative. Table 23 gives revised benefit cost figures for each plan including mitigation first costs but without Two Prairie Bayou. Although plans FC2, FC2A, and FC3A are still justified, FC2A is the NED plan because it maximizes excess benefits.

Table 23
PLAN SELECTION/ECONOMIC ANALYSIS,
DETAILED STRUCTURAL PLANS
WITHOUT TWO PRAIRIE BAYOU (REACH 6) WORK COSTS
(5-3/8 Percent Discount Rate Analysis)

Item	Plan FC2	Plan FC2A	Plan FC3A	Plan FC3B
First Costs ($000) a/	19,204	21,364	58,628	90,852
Annual Costs ($000) a/b/	1,310	1,450	4,217	6,544
Annual Benefits ($000) b/				
All Categories	2,423	2,588	5,263	6,316
Excess Benefits over Costs ($000) c/	1,113	1,138	1,046	-228
Benefit-Cost Ratio (%)				
Benefit-Cost Ratio with All Benefit Categories	1.9	1.8	1.3	0.97

a/ April 2004 price levels (revised costs).
b/ Annualized with appropriate discount rate factors and 50-year project period of analysis.
c/ Calculated using all benefits except employment benefits.
Note: Habitat Evaluation Procedures (HEP) costs are included in the alternative plans costs.

ENVIRONMENTAL IMPACTS

WETLAND IMPACTS

There are estimated to be 78,919 total acres of forested wetlands and 56,667 total acres of cleared farmlands having wetland hydrology in the entire study area, of which 65,012 acres of forested wetlands and 40,417 acres of cleared farmlands are in the flood damage reduction project area. Approximately 2,000 additional acres are anticipated to be reforested in the study area within the next 5 years under the Wetlands Reserve Program (WRP). Wetland areas affected by flood damage reduction measures were determined through hydrologic modeling based on accepted wetland criteria and verified using satellite imagery, groundtruthing, and other information provided by resource agency personnel.

Wetland impacts associated with alternatives FC2, FC2A, FC3A, and FC3B were initially identified strictly through the use of hydraulic models and GIS mapping. Pre-project and post-project wetland scenes were generated that approximated jurisdictional wetland boundaries. The acreage differences between the pre-project scene and alternative wetland scenes were used as estimates of the areal extent of wetland impacts for each alternative. FC2 and FC2A have relatively limited hydrologic impacts in comparison to FC3A and FC3B because FC3A and FC3B include 1,000-cfs and 3,000-cfs pump stations, respectively. During initial review of alternative impacts, the inter-agency team discovered that adverse effects on bottomland hardwood forests (BLH) were likely overstated

TERRESTRIAL IMPACTS

Habitat evaluation procedures (HEP) were originally used to determine impacts of each flood control alternative on terrestrial resources (Volume 10, Appendix D, Section XIII). The HEP team selected the gray squirrel, mink, barred owl, wood duck, Carolina chickadee, and pileated woodpecker for evaluation species. Sample plots in bottomland hardwood and cypress/tupelo stands were evaluated for habitat suitability. Results indicate that, in general, available habitat is favorable for the Carolina chickadee and mink with average HSI values of .68 and .76, respectively. Habitat for the barred owl was fair with HSI values averaging .49. Habitat conditions for the pileated woodpecker, wood duck, and gray squirrel appear to be less favorable with average HSI values ranging from .06 to .38.

The terrestrial mitigation acres for the Flood Damage Reduction features are as follows: FC2 is 2,527 acres, FC2A is 2,993 acres, FC3A is 5,367, and FC3B is 5,827.

(Mitigation values are from Volume X, Appendix D, Section 13 – "Terrestrial Habitat Evaluation", Table 3 on page 10.)

FISHERIES IMPACTS

Hydraulic models and GIS landuse classifications were used to determine changes in impacts to fish habitat. Currently 38,840 acres of functional, reproductive habitat is flooded at least once every two years. Cultivated agricultural land and bottomland hardwood forests are the dominant landuse categories within this 2-year floodplain. An aquatic HEP analysis was performed to determine fishery impacts associated with flood control alternatives (Volume 10, Appendix D, Section XIV, Part A). Table 26 shows the acres and habitat units lost for each flood control alternative along with reforestation requirements for both direct (construction) and indirect (hydrologic) impacts.

Table 26
FISHERIES IMPACTS AND MITIGATION REQUIREMENTS

Direct and indirect impacts and mitigation requirements for structural flood control measures.								
Indirect Impacts						Direct Impacts		
Alternative	Total Acres	Total Habitat Units	Acres Lost	Habitat Units Lost	Reforestation Requirements	Acres Lost	Habitat Units Lost	Reforestation Requirements
Baseline	15689	11405	0	0	0	0	0	0
FC2	14665	10717	1024	688	894	642	527	685
FC2A	14634	10699	1055	706	918	735	582	756
FC3A	14472	10530	1217	875	1138	1058	765	995
FC3B	14283	10399	1406	1006	1307	1216	912	1186

WATERFOWL IMPACTS

Hydrologic impacts to waterfowl foraging habitat were analyzed for the flood control alternatives (Volume 10, Appendix D, Section X). Impact determinations were developed based on available food (energy) as an index of the carrying capacity of winter foraging habitat for dabbling ducks in the MAV. This methodology was developed by the US Fish and Wildlife Service and has been used in previous studies to determine project impacts to waterfowl in the lower MAV.

GIS data were used to identify the types of foraging habitat available under existing conditions and with the various project alternatives. General land use categories that provided foraging habitat included soybeans, rice, moist soil, bottomland hardwood forested wetlands, and other (pasture, open water, etc.). Carrying capacity was determined in terms of duck-use-days (DUD) during the November through February migration season.

Seasonally flooded habitats total 9,472 acres under existing conditions and provide 3,523,197 DUDs annually. Impacts for flood control alternatives range from 334 to 911 acres of frequently flooded forest and 431 to 863 acres of frequently flooded cleared land. Winter waterfowl foraging habitat carrying capacity would be reduced annually by 267,817; 269,929; 482,948; and 626,375 DUDs for Alternatives FC2, FC2A, FC3A, and FC3B respectively. Table 27 provides a summary of baseline conditions and alternative impacts.

Table 27
WATERFOWL IMPACTS IN DUCK-USE-DAYS BY ALTERNATIVE

Alternative	Acres Available	DUD's	Change in DUD's
Base Conditions	9,427	3,523,197	0
FC2	8,658	3,255,380	-267,817
FC2A	8,652	3,253,268	-269,929
FC3A	8,055	3,040,249	-482,948
FC3B	7,653	2,896,822	-626,375

Reforestation is the preferred method of compensation for mitigating waterfowl losses by the U.S. Fish and Wildlife Service. It requires less maintenance than other techniques such as moist soil management areas and addresses all the habitat requirements for waterfowl such as courtship sites, protection from predators, roosting areas, and isolation from human disturbance. Table 28 shows DUD losses and the amount of BLH restoration required (assuming at least 30% red oak composition) to mitigate impacts associated with each alternative.

Table 28
WATERFOWL MITIGATION ACRES REQUIRED BY ALTERNATIVE

Alternative	DUD's Lost	BLH Restoration (acres)
FC2	267,817	532
FC2A	269,929	537
FC3A	482,948	960
FC3B	626,375	1,245

WATER QUALITY IMPACTS

Water quality impacts are discussed by project feature, for the affected alternatives. For levee construction, which is included in all the alternatives, no direct impacts are likely to occur. There will be increased turbidity temporarily during construction from runoff at the construction site. A storm water management plan for each activity will be in place to minimize these impacts, most of which will disappear once vegetation is reestablished.

Channel and bank excavation will also produce short-term direct impacts that are localized at the construction site. This includes increased turbidity from resuspension of sediment and removal of aquatic habitat. These impacts will decrease as vegetative cover is reestablished. Long-term indirect impacts such as increased turbidity from bank erosion associated with the loss of vegetative cover and the erosion protection it provides during storm events are also possible. Redistribution of pollutants is possible, depending on the amount of work involved. Excavation quantities were kept to the minimum amount possible for each alternative, to reduce these impacts. Effects could be longer term for dioxin-contaminated material in upper Bayou Meto.

Channel excavation associated with the Bayou Meto Bypass Channel is likely to cut into an area with known contamination of dioxin in the sediment. Any excavation in this reach will be done in a manner that minimizes the movement of dioxin downstream into other parts of the basin. Excavated sediment will be treated as contaminated and placed in capped, upland disposal sites where it cannot be reintroduced into the system. Two weirs planned for this item of work have the potential to collect dioxin-contaminated sediment. Measures to prevent the banks or streambed from head cutting or erosion will be implemented above the bypass channel to prevent contaminated sediment from moving downstream.

Weirs are included in each alternative and will induce short-term direct impacts as mentioned previously. They also have the potential to trap contaminated sediments, which should, therefore, be monitored for depth and chemical composition.

Pumping plants associated with Alternatives FC3A and FC3B will have no direct impacts to the streams and localized erosion problems will be addressed through the state required storm water management plan. Operation of the pumping plants could introduce point source discharge of water with higher turbidity to the Arkansas River; however, it is anticipated that these discharges will not result in higher turbidity values than currently exist for ambient conditions when discharges are released through the Bayou Meto drainage structures.

Mitigation requirements for the flood control component were based on project impacts assessed through habitat evaluation procedures (HEP) analyses. Since the terrestrial impacts are larger than the wetland, fisheries, waterfowl and water quality impacts, 2,993 acres will be purchased in fee and planted in bottomland hardwoods to mitigate for the terrestrial project impacts. Agricultural tracts within the with-project 2-year flood plain will be targeted for acquisition.

DESCRIPTION OF RECOMMENDED PLAN OF IMPROVEMENT FOR FLOOD CONTROL

The recommended plan is the combination of measures that best meets the identified needs and opportunities of the project area consistent with the planning objectives and constraints, incorporates the ideas and revisions suggested during higher level reviews, and addresses the concerns expressed by various interest groups during the course of the general reevaluation.

PLAN COMPONENTS

The Bayou Meto Flood control project is designed to reduce agricultural flooding, especially in the lower portion of the watershed, and to ensure compatibility with the Waterfowl Management and Agricultural Water Supply components of the project.

CONSTRUCTION ITEMS

<u>Item 1 - Little Bayou Meto Pump Station</u>. Item 1 is not part of the NED plan and was deleted from the recommended plan.

<u>Item 2 - Little Bayou Meto Connecting Channel</u>. Item 2 is not part of the NED plan and was deleted from the recommended plan.

<u>Item 3 - Boggy Slough</u>. This item of work consists of excavating 1 to 2 feet of material.

<u>Item 4 - Wabbaseka Bayou Channel Cleanout and Restoration</u>. This item consists of approximately 32 miles of channel cleanout with a bottom width of 20 ft. and approximately 18 miles of selective clearing. This is the minimum amount of work possible to preserve the character of this ecosystem while passing flood flows downstream.

<u>Item 5 - Indian Bayou Ditch</u>. This item includes 1 to 2 ft. of channel excavation for approximately 8 miles with a bottom width of 15 ft. Work will be accomplished from the left descending bank, which will have a 1 on 3-side slope. A weir will be placed at the upper end of the channel to reduce flooding along Indian Bayou Ditch by putting low flows down the old Indian Bayou channel.

Item 6 - Indian Bayou Channel Cleanout. This item is designed to restore flows to the old Indian Bayou channel. Approximately 2 to 3 ft. of material will be removed from the upper 3 miles of the channel and selective clearing will be used on the remaining 13.5 miles. A weir will be placed at the upstream end near the intersection with Indian Bayou ditch to work in concert with the weir on that channel for flow management to reduce flood damage.

Item 7 - Salt Bayou Cleanout and Restoration. This item is included in the waterfowl management plan since it provides drainage improvements to the Bayou Meto WMA and will reduce stress on bottomland hardwoods from extensive inundation. Costs and benefits for this feature were adjusted accordingly in the flood control alternatives and did not change the selection of the NED plan.

Item 8 - Crooked Creek and Crooked Creek Ditch Cleanout. Crooked Creek Ditch will be modified to accommodate the water supply component by increasing the bottom width in increments from 35 ft. to 55 ft. moving upstream for a total of approximately 10 miles. These costs were accounted for in the Water Supply Component (Section I). Approximately 1 to 3 feet of excavation with a 60 ft. bottom width is planned for about 8.6 miles on Crooked Creek. Two existing weirs on Crooked Creek will be modified to accommodate increased flows.

Item 9 - Big Bayou Meto Diversion. This item includes a diversion of Big Bayou Meto approximately 5 miles long with a 10 ft. bottom width and a levee on the right descending bank. Weirs will be placed at the lower end and midway up the channel. A bridge will also be required where the channel crosses U.S. Highway 70.

LANDS

Project construction will require approximately 2,710 acres of land and with 2,993 acres of mitigation. An estimated 239 individual ownerships will be impacted by project construction. Project lands are primarily located in rural agricultural areas and used for agricultural production or woodland purposes. The project has been planned and designed to avoid or minimize relocations. Rights-of-way for the project will be acquired through the use of three main estates. The estates are: Fee Simple, Non-Standard Channel and Levee Improvement Easement, and Non-Standard Clearing and Snagging Easement. Additional easements to construct, operate, and maintain public utilities and/or pipelines will be required in those tracts or portions thereof needed to meet relocation requirements, if relocation of any such facilities is determined necessary. A detailed description of the real estate requirements and costs are provided in Volume 11, Appendix H, Real Estate Plan, Flood Control Component.

RELOCATIONS

A new bridge with adjacent utility line relocations will be required for Item 9 where the Big Bayou Meto diversion channel crosses U.S. Highway 70.

A list and description of all relocations required for project implementation is presented in Volume 9, Appendix C, Section V, Relocations. Relocations costs are included in the project cost data presented in Volume 9, Appendix C, Section VIII, Cost Engineering Report.

MITIGATION REQUIREMENTS

A mitigation feature is best described as an "on-site" established fish and wildlife resources management procedure, activity, or technique that is designed to offset construction and/or associated impacts. Impacts are avoided whenever possible and minimized through project design if they cannot be avoided. Features designed to replace habitat value must be used to mitigate any remaining impacts.

Original mitigation requirements for the flood control component were based on project impacts assessed through habitat evaluation analyses. From these requirements, 2,993 acres will be purchased in fee and planted in bottomland hardwoods to mitigate for project impacts. Agricultural tracts within the with-project 2-year flood plain will be targeted for acquisition. Acquisition of lands for the waterfowl management and restoration component and mitigation will be assumed to complement one another.

Following coordination with the inter-agency team, the priority locations for mitigation lands are in the vicinity of the Bayou Meto Wildlife Management Area, located in the southern portion of the project area. Acquisition of mitigation lands within this area would allow for easier management, provide the opportunity for connectivity with larger blocks of land, and potentially remove some frequently flooded lands from agriculture. Monitoring of mitigation land planting success would be ensured during periodic inspections of project components, and would be the responsibility of the local sponsor. Monitoring protocols, measures of success (e.g. percent planting survival) would be determined through coordination with the inter-agency team.

IMPACTS DURING CONSTRUCTION

A plan will be developed which identifies procedures to avoid and/or minimize adverse construction impacts to the region and the environment.

NOISE

Measures will include contract provisions that limit noise to a certain level within a given distance from the construction site. Restrictions will vary depending on the proximity to an urban area and hours of construction.

TRANSPORTATION

Specific routes away from residential and commercial areas will be designated for construction related traffic and remote locations for constructing staging areas.

Detour signage will be erected when roads are closed due to utility relocations or other project construction activity.

AESTHETICS

Structural design will maintain the architectural integrity of the area where the structures are located. Embankments near public roads will be finished in a manner consistent with the surrounding.

SAFETY

Measures will include signage, lighting, and access control during and after construction. Media notices will be released for certain construction activities.

CULTURAL RESOURCES

Cultural resources identification and evaluation of cultural sites' significance remain ongoing. As this study effort is completed, and as specific engineering and other project-related construction becomes designed, it is expected that the final design efforts can be implemented to avoid most if not all significant cultural sites. Adverse impacts to any significant cultural sites that cannot be avoided would be mitigated through treatment such as specified in a Programmatic Agreement.

FIRST COSTS OF THE RECOMMENDED PLAN

Table 29 is a summary of the M-CACES cost estimate for the flood control component of the Bayou Meto Basin, Arkansas project, indexed to October 2005 price levels. Project costs for the flood control component ($28,610,000) is based on October 2005 price levels and are assumed to be end of year expenditures.

Table 29
BAYOU METO BASIN, ARKANSAS PROJECT
Recommended Plan – Flood Control Component
Project First Cost Summary
(October 2005 Price Levels)

ACCOUNT NUMBER	DESCRIPTION	TOTAL PROJECT COST
01	Land and Damages	$5,749,000
02	Relocations	$840,000
03	Reservoirs	$0
06	Fish and Wildlife Facilities	$715,000
09	Channels and Canals	$8,855,000
11	Levees and Floodwalls	$531,000
13	Pump Stations	$0
15	Floodway Control and Diversion Str.	$534,000
19	Building, Grounds, & Utilities	$0
30	Planning, Engineering, and Design	$5,725,000
31	Construction Management	$1,290,000
	TOTAL PROJECT COST	**$24,239,000**

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan for the Flood Control Component is outlined in Table 31. O&M includes channel maintenance (dragline and aerial herbicide application), weir maintenance (concrete or riprap rehab), and levee maintenance (mowing and slide repair, if necessary). Monitoring of mitigation land would be ensured during periodic inspections of project components, and would be the responsibility of the local sponsor. Monitoring protocols would be determined through coordination with the inter-agency team.

OPERATIONS AND MAINTENANCE REQUIREMENTS

Table 31
Operations and Maintenance Requirements for the Recommended Plan
(October 2005 Price Levels)

Item	Units	Unit Cost	Cost	Frequency	Total Cost Period of Analysis
Channel Maintenance:					
Channel Cleanout (Dragline)	60 miles	$2,100	$126,000	every 20 years	$3,542
Herbicide Treatment (aerial app.)	60 miles	$420	$25,200	annual	$25,200
Weir Maintenance:					
6 weirs					
Rip-rap or Sheet pile with concrete cap	6	$14,000	$84,000	every 25 years	$1,344
Levee Maintenance:					
Bayou Meto Diversion Ditch Levee 5 M	40 Acres	$20/acre cut	$800	twice yearly	$1,600
Includes Mowing and Minor fill of washes					
				Total	**$31,687**

PLAN ACCOMPLISHMENTS

The recommended plan for the Bayou Meto Flood Control Component achieves the goals and objectives of the study by providing the best combination of measures for solving the identified water resources problems, realizing possible opportunities, and meeting the current and future needs of the area.

The flood control component of the project was designed to accomplish the following:

- Reduce flood damages to agricultural property;
- Relieve stress on bottomland hardwood communities in the vicinity of the Bayou Meto WMA;
- Restore stream flow to old channel meanders; and
- Reduce exposure of aquatic species to contaminated sediment through channel excavation activities.

SUMMARY OF ECONOMIC, ENVIRONMENTAL, AND OTHER SOCIAL EFFECTS

ECONOMIC ANALYSIS

The recommended plan provides flood damage reduction benefits that are commensurate with the level of flooding experienced in the project area. The flood control component is balanced with the other components of the project and addresses the flood damages while supporting the recommended plans for agricultural water supply and waterfowl management.

BENEFITS

All project benefits are based on current (October 2005) price levels, estimated over a 50-year period of analysis plus the installation period, and discounted to the end of the project installation period using the current Federal discount rate (5-1/8%). The project benefits result primarily from flood damage reduction on agricultural properties.

COSTS

The project costs, like the annual benefits, are based on current price levels, estimated over a 50-year period of analysis plus the installation period, and discounted to the end of the project installation period using the current Federal discount rate. The annual cost consists of interest, sinking fund, operation, maintenance and replacement charges.

SUMMARY

Table 32 presents a summary of the benefits and costs for the recommended plan. The recommended plan is the plan preferred by the potential project sponsor. A comparison of the average annual equivalent (AAE) benefits with AAE costs indicates that the recommended plan for the Bayou Meto Flood Control Component has a benefit-to-cost ratio of 1.7 to 1, with excess benefits of $1.13 million.

Table 32 BAYOU METO BASIN, ARKANSAS PROJECT Bayou Meto Flood Control Component, Recommended Plan Summary of First Costs and Average Annual Equivalent (AAE) Benefits, Costs, Excess Benefits, and Benefit-to-Cost (BCR) Ratio (October 2005 Price Levels, 5.125% Discount Rate)	
BENEFIT/COST CATEGORY	**BENEFIT/COST ($000)**
FIRST COST (With Mitigation)	$24,239,000
ANNUAL BENEFITS	$2,794,000
ANNUAL COSTS	$1,663,000
EXCESS BENEFITS	$1,131,000
BCR	1.7

ENVIRONMENTAL EFFECTS OF THE RECOMMENDED PLAN

The recommended plan includes features designed to reduce flooding on cleared lands and to minimize impacts to significant habitat as much as possible. Some reductions in flooding to bottomland hardwoods in the vicinity of the Bayou Meto WMA will reduce stress on these important resources. Incidentally, restoration of flows to the Indian Bayou Channel will restore aquatic habitat to this degraded system. To compensate for impacts associated with construction of the flood control project, 2,993 cleared lands would be acquired in fee title and planted in bottomland hardwoods. Adverse impacts to terrestrial habitat, waterfowl habitat, and aquatic resources have been accounted for and minimized as much as possible. A detailed description of project-induced environmental impacts and benefits is presented in the accompanying Environmental Impact Statement (EIS). The U. S. Fish and Wildlife Service have provided a Coordination Act Report included in Volume 10, Appendix D.

CONSTRUCTION SCHEDULE AND PHASING

The construction schedule was developed to maximize the national economic development benefits and to initiate project operation at the earliest possible time. The schedule presents a sequenced construction approach, which allows areas to begin receiving benefits as that reach is complete. The local sponsor has stated that they desire the most expeditious schedule possible. The construction schedule as presented in the combined plan description is the quickest reasonable time to initiate the proposed phased project operation. However, project funding is at the discretion of Congress, and, therefore, any construction scheduling is tentative. The Project Management Plan (PMP) provides a detailed schedule of future work and necessary funding.

SCHEDULE DEVELOPMENT

A team consisting of representatives from all functional elements was assembled to develop the construction schedule and determine the total time necessary for project implementation including the development of design documents and plans and specifications, relocations, rights-of-way acquisition, and construction time.

CONSTRUCTION PHASING

The Bayou Meto Flood Control component was divided into 8 construction items. Each of these 8 items is a complete unit and when constructed in the proposed sequence will be available for operation. The construction contracts will consist of all work within an item to eliminate potential problems with scheduling different contractors to work on different components within an item. It is anticipated that the main contractor for an item will subcontract work on various components to specialized contractors. Some items may be combined for contracting in order to expedite construction. However, for design purposes the items will be kept separate. This will provide options to minimize any delays resulting from rights-of-way acquisition, relocations, cultural resources mitigation, or other occurrences. A description of the items of work by item number is presented above. Scheduling of items is presented in detail in the Project Management Plan (PMP).

DESIGN DOCUMENTS

The detailed design and preparation of plans and specifications for the pump station and standard designs for the project structures will be performed by an A-E contractor or in-house in order to minimize the time to construction. Pump stations design will be done in accordance with Corps of Engineers criteria. Design memoranda will be prepared in accordance with the provisions of ER 1110-2-1150. Standard designs for the project structures will be completed as part of the work order for the first item encountered in which a given structure is found. The standard design will serve for the remainder of the project. Standard designs will be used to simplify preparation of plans and specifications and will result in cost saving during construction.

PLANS AND SPECIFICATIONS

Plans and specifications will be prepared for all components for each construction item. Initiation of the design work will be scheduled sufficiently in advance to meet the construction schedule. Indefinite delivery, indefinite quantity A/E contracts will be utilized to supplement in-house design resources. In addition to initiating the design to meet the construction schedule, the development of plans must begin in sufficient time to provide rights-of-way requirements and relocation requirements to meet this construction schedule.

CONSTRUCTION SCHEDULE

The requirement for each item of work was evaluated to determine a reasonable estimate of time for completion. The contractor was assumed to work six, ten-hour days to project completion. Time for weather delays were included in the estimate. From these estimates, the construction schedule was estimated. The construction schedule is presented in detail in the PMP. The time to complete the project is estimated to be six years. This schedule will require the local sponsor to acquire the real estate and perform the required relocations in an expeditious manner.

SECTION III WATERFOWL MANAGEMENT AND RESTORATION PLAN

INTRODUCTION

The Water Resources Development Act (WRDA) of 1996 specifically authorized the Corps of Engineers to develop a waterfowl management plan for the Bayou Meto Basin in east-central Arkansas. The primary purpose of this effort was to develop a plan that provided substantial waterfowl benefits primarily through rehabilitation, creation, and preservation of sustainable habitats.

Although not authorized as an ecosystem project, the determination of a National Ecosystem Restoration (NER) plan using costs effectiveness/incremental cost analyses can be carried in a similar manner, resulting in a Waterfowl Management Plan that can contribute national ecosystem benefits in a cost-effective manner. Once formulated, this plan is then compared both separately and in combination with the National Economic Development plans arising from the flood control and agricultural water supply purposes also authorized project in WRDA 1996 (see Section IV).

WATERFOWL MANAGEMENT AND ECOSYSTEM RESTORATION NEEDS

A study (Heitmeyer et al. 2002) was conducted to assess the landscape-scale restoration needs and opportunities within the Bayou Meto Basin; the subsequent report is contained in Volume 10, Appendix D, Section III. The specific objectives of the study 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."

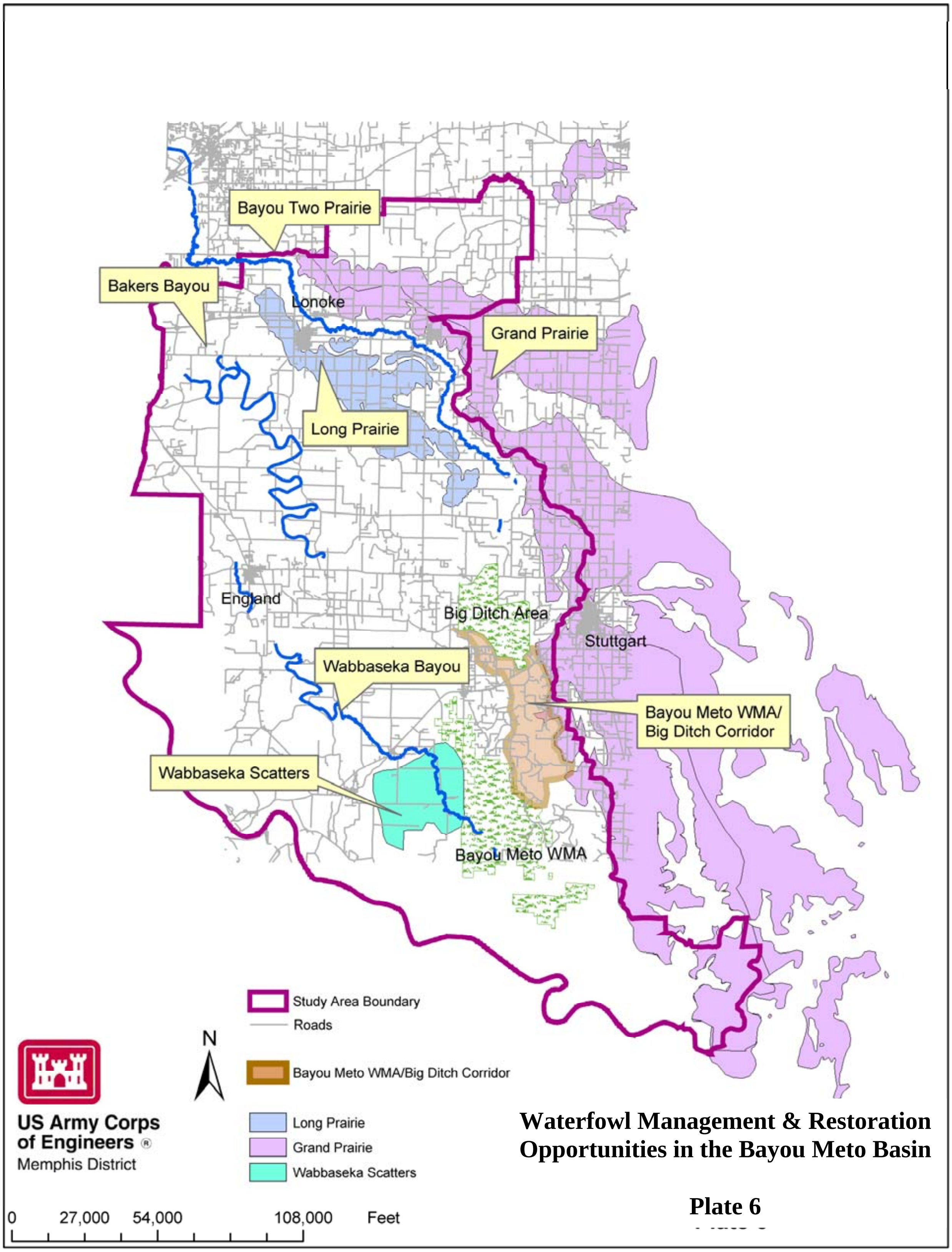
The project area contains three distinct geologic regions. A portion of the Grand Prairie Terrace extends into the northeastern section of the project area. The Deweyville

Complex, a second terrace region, is located along the western edge of the Grand Prairie. The remainder of the project area is considered Arkansas River Lowland.

Historically, two distinct areas of grassland occupied the project area portion of the Grand Prairie Terrace and part of the Deweyville Complex (Plate 6). Several patches of prairie, collectively known as the Long Prairie, were located west and south of Bayou Two Prairie. The Long Prairie was a unit of prairie in the Grand Prairie grassland complex. A portion of the Grand Prairie, the largest prairie unit, was located within the project area, east and north of Bayou Two Prairie. Dominant vegetation included prairie grasses, flowers, and shrubs. Other vegetative communities existed within this prairie ecosystem as well. Slash (a habitat type comprised of pioneer species of trees, shrubs, and forbs) occurred in narrow corridors along the upper ends of drainages that extended into the prairie terraces. Savannas were present along the edges of the prairie grassland. Savannas are comprised of grassland with scattered or clumped trees. Seasonal herbaceous wetland or wet prairie occurred within topographic depressions of two types—small, isolated "potholes" and ancient Arkansas River channels, typically about 200 yards wide by several feet deep and miles long. More water tolerant herbaceous species, such as grasses, sedges, buttonbush, spikerush, smartweed, and cattail occupied herbaceous wetlands. This herbaceous wetland complex (HWC), composed of wetlands and adjacent drier grassland, provided substantial food and resting habitat for waterfowl, including ducks, rails, bitterns, and gallinules. Post oak flats occurred in scattered locations along the edges of the Deweyville and Grand Prairie terraces.

The Arkansas River Lowland consists of highly connected drainages that follow relatively minor changes in elevation gradient. Even small floods inundate large areas. Bottomland hardwood (BLH) forest historically occupied most of the Arkansas River Lowland. These BLH forests provided a critical habitat for many animal species including large numbers of wintering and migrating waterfowl. Dominant bottomland tree species range from bald cypress and tupelo on the lowest sites to willow oak, cherrybark oak, and shagbark hickory on higher sites. Post oak flats were present on high elevation point-bar deposits and areas adjacent to natural levees; tree species found on these flats include delta post oak, cherrybark oak, water oak, and willow oak.

Destruction of presettlement habitats in the Bayou Meto Basin began as early as the mid-1800s, and only about 15% of the native presettlement vegetation communities remain. Much of the BLH forest and almost the entire HWC have been cleared and cultivated for agricultural use. This greatly reduced waterfowl, as well as fish and wildlife populations, in the project area. Diversity of fish has decreased from 79 species in the 1960s to 64 species in 1992. Recent mussel surveys revealed only



Waterfowl Management & Restoration Opportunities in the Bayou Meto Basin

Plate 6

limited populations of mussels. The bison, mountain lion, greater prairie chicken, and red wolf have been extirpated from the Bayou Meto Basin; and the Carolina parakeet and passenger pigeon are now extinct. Only a few black bears remain in the bottomland forests of the southern project area, and waterbird populations have been greatly reduced, except when rice fields are flooded after harvest to provide winter waterfowl habitat.

Nonetheless, compared to other areas of the Mississippi Alluvial Valley, the southern portion of the project area contains a relatively large expanse of BLH, including the ca. 32,000-acre Bayou Meto Wildlife Management Area (WMA). These bottomland hardwoods provide habitat for a large number of waterfowl and offer some of the best waterfowl hunting in the nation. However, during the last 50 years, stresses on this WMA have substantially reduced its productivity and value to waterfowl.

Despite changes in historic conditions, the Heitmeyer et al. (2002) study concluded that many ecosystem restoration opportunities exist in the project area. The study did not attempt to prioritize habitat restoration opportunities; but identified landscape and ecological characteristics needed for restoring specific habitat types. The project's inter-agency planning team had the responsibility of identifying and prioritizing site-specific restoration features.

The U.S. Fish and Wildlife Service (USFWS) and Arkansas Game and Fish Commission (AGFC) developed a migratory bird management plan for the project area (Volume 10, Appendix D, Section XI). Bottomland hardwood restoration and the creation of moist-soil habitat were among the recommendations provided to benefit waterfowl and other migratory birds. The plan specifically discussed the need to reforest cleared lands within the two-year floodplain and within the Big Ditch Area (Plate 6); the Big Ditch Area has been designated a Forest Bird Conservation Area by the Mississippi Alluvial Valley Migratory Bird Initiative.

WATERFOWL MANAGEMENT PLAN GOALS

An inter-agency planning team comprised of federal and state agencies, conservation groups, and the local sponsors established goals for the waterfowl management features. These included:

1. Restore sufficient amounts of herbaceous wetland complex to allow recovery of waterfowl, including ducks, rails, herons, and gallinules that require herbaceous wetlands for breeding, migratory, and/or wintering habitat.
2. Create riparian forest buffers on project area streams to reduce sedimentation and provide waterfowl, fisheries, and terrestrial wildlife habitat.
3. Restore forests in critical areas to benefit waterfowl, forest breeding songbirds, and other fish and wildlife.
4. Provide an overall increase in waterfowl habitat acreages within the project area.
5. Restore, rehabilitate, create, and preserve habitat for sensitive species, including king rail, forest breeding birds, and black bear.

WATERFOWL MANAGEMENT CONSIDERATIONS

The Arkansas Natural Heritage Commission (ANHC), in coordination with the project inter-agency team, utilized information obtained in the Heitmeyer et al. (2002) study and the migratory bird management plan to identify critical, site-specific restoration needs within the project area (Volume 10, Appendix D, Section IV). The herbaceous wetland complex and forest restoration features described below were identified in the ANHC report. The moist-soil habitat feature was identified in the migratory bird management plan, and the AGFC identified the Bayou Meto WMA features. Target restoration areas are shown on Plate 6.

HERBACEOUS WETLAND COMPLEX (HWC) RESTORATION

Historically, ca. 108,500 acres of prairie, including herbaceous wetlands and marsh, existed within the project area boundaries. The Long Prairie was located entirely within the project area, and it comprised 36,000 acres. The project area portion of the Grand Prairie totaled 72,500 acres. These prairie ecosystems contained prairie grassland, slash (successional woody species at the heads of water courses), herbaceous wetlands or wet prairie, and savanna (grassland with scattered trees). No remnants of native prairie grassland are known to exist within the former extent of Long Prairie (ANHC file data), and more than 99% of the prairie grassland has been destroyed in the project area portion of Grand Prairie. Some slash is found along streams, and a few small patches of savanna remain.

HWC restoration is a project priority since this important habitat has been so heavily degraded. Restored HWC would provide valuable habitat for many waterfowl species. Although wetlands comprised approximately 15% of the Grand Prairie, much of the remaining prairie was seasonally saturated and intermittently flooded, providing some wetland functions. Wet prairie or herbaceous wetlands were of two general types, one being isolated depressions or “potholes” of perhaps ¼ acre to several acres in size and the other being relict stream channels ranging from less than a hundred feet wide to 150 yards wide and up to tens of miles long. Typical depth was a few feet.

These wetlands and their associated waterfowl were different from bottomland hardwood wetlands in the region. Species such as pintail and teal were much more common in the HWC. Although food resources (red oak acorns) are a strong attraction to bottomland hardwood wetlands for other waterfowl such as mallards, these species likely made extensive use of HWC during periods when streams were not flooded.

Waterfowl other than ducks prefer or are restricted to herbaceous wetlands as well. Rails, gallinules and bitterns are species of these habitats. Of particular importance in the Grand Prairie is the king rail. The king rail was once abundant in the region, which was its preferred habitat in the central US. However, it is now rare in the Grand Prairie. Waterbird Conservation for the Americas (an international, broad-based partnership) lists the king rail as a species in need of immediate management, which is the highest conservation priority level. The inter-agency team decided to use king rail as the focal species for establishing the HWC restoration goal.

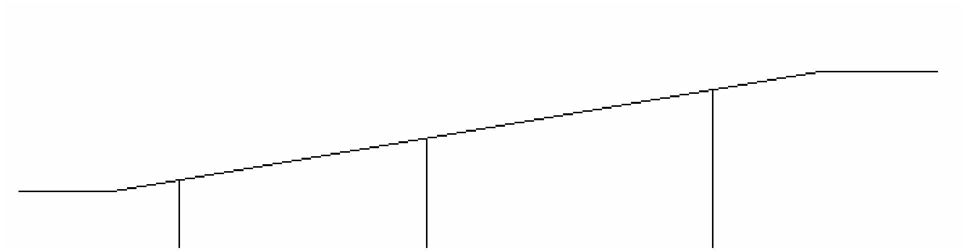
The king rail was historically a common breeding bird in herbaceous wetlands from Canada to the Gulf Coast of North America (Eddleman et al. 1988; Meanley 1992). Historical accounts reveal that the Grand Prairie region of Arkansas contained dense populations in the 1950's (Meanley 1953, 1956). The population there was the primary subject of the many field observations that led to the publication of the definitive review of king rail natural history (Meanley 1969). During the pre-European settlement time period, king rails presumably nested and foraged in the natural depressional herbaceous wetlands that composed a portion of the tallgrass prairie ecosystem that was dominant in the Grand Prairie and Long Prairie regions. As settlers converted much of this region to agriculture in the early 20th century, king rails and other waterfowl adapted to the use of surrogate habitats such as flooded rice fields and road ditches to fulfill nesting and foraging requirements. Individuals in the 1950's were observed using densely vegetated road ditches for primary nesting cover and nearby flooded rice fields for foraging habitat (Meanley 1953). Re-nesting pairs also used the rice fields in the spring after the rice had reached a height sufficient to provide cover.

Researchers have noted a decline in king rail numbers throughout most of the historic range over the last 30 years (Meanley 1969; Eddleman et al. 1988; Meanley 1992). Most authors attribute this decline to a loss of herbaceous wetlands. Preliminary surveys for king rails in the Grand Prairie reveal densities much reduced from those observed in the 1950's (Krementz 2004, pers. comm.). The reasons for the local decline of this species in Arkansas are not clear, but several possibilities exist. It may be that the high densities of nesting birds observed during the 1950's associated with road ditches were the concentrated remnants of a population that historically nested in the more widespread natural wetlands. These isolated, linear areas of nesting habitat contained dense concentrations of nesting pairs but may have actually been population sinks due to predation. Also, for indeterminate reasons rice fields in the Grand Prairie area no longer support large populations of burrowing crayfishes (Eddleman et al. 1988; Meisch 2004, pers. comm.; Deron 2004, pers. comm.). Interestingly, rice fields in southern Louisiana continue to support substantial crayfish populations. Crayfishes are a crucial food item for king rails, constituting 23 percent (by volume) of the diet on an annual basis and 61 percent of the diet in the spring months (Meanley 1956).

Several explanations for the lack of crayfishes in Arkansas rice fields have been offered. Eddleman et al. (1988) suggested that the pesticides used in intensively farmed areas have led to the decline. However, modern pesticides used in rice culture are not known to have significant impacts to crayfishes (Warren 2004, pers. comm.). The organochloride based pesticides that were heavily used in the early and mid-20th century could have impacted crayfishes and may still be present in some levels in the soils of areas where they were applied. However, these chemicals received widespread use in the farmed areas of both Louisiana and Arkansas. The disproportionate decline of crayfishes in Arkansas rice fields probably has more to do with the modern differences in crop rotations and water management between farms in Arkansas and Louisiana as well as differences in crop rotations and the timing of rice harvests between modern Arkansas farms and those present in the 1950's (Deron 2004, pers. comm.; Meisch 2004, pers. comm.). Rice farmers in south Louisiana often "double crop" rice fields, which entails harvesting the rice and allowing the crop to resprout and flood well into the fall before a second harvest. Arkansas farmers often begin harvesting rice in mid-August and burn, roll, or disc the fields prior to planting soybeans the next spring. This conversion from a permanently flooded summer crop to furrow irrigated soybeans on an annual or semi-annual basis probably impacts the ability of burrowing crayfishes to establish large populations. The development of earlier maturing rice varieties has also allowed the harvest of Arkansas rice fields much earlier than in the 1950's. This has further lessened the attractiveness of rice fields to many crayfishes in Arkansas.

An opportunity exists through the Bayou Meto Basin Project to restore some areas of the Grand Prairie and Long Prairie regions to HWC to benefit king rails and other waterfowl species. Waterfowl management planners for the proposed project have determined through a literature review that the king rail requires a nesting area of approximately four acres of wetlands containing emergent vegetation per breeding pair (Meanley 1953; Meanley 1969; Meanley 1992). A review of the literature and expert opinion reveals that a minimum of 250 breeding pairs of birds are required to maintain a genetically diverse source population (Franklin 1980; Shaffer and Samson 1985; USFWS 1985; Soule 1987; Thiollay 1989; Thomas 1990; Wenny et al. 1993; Mueller et al. 2000; Mueller 2004, pers. comm.). The inter-agency planning team determined that it would be appropriate to manage for 500 pairs (1,000 breeding birds) in order to maintain more than the minimum viable population size. Theoretically, success in this management goal would require the establishment of 2,000 acres of herbaceous wetlands made up of smaller units that average four acres in size.

Natural prairie wetlands are more complex in plant composition and structure than the road ditches studied by Meanley (1953, 1956, 1959). With lower elevations and increasing moisture, prairie gradually becomes herbaceous wetland and eventually marsh. These are displayed schematically in Figure 23, with some representative plant species and characteristics shown. Species range boundaries are not rigid. Multiple species can occur in each wetland zone, and individual species



Marsh Herbaceous Wetland Prairie

Wetter Drier

cattail prairie cordgrass gammagrass ----switchgrass----
spikerushes big bluestem
sedges little bluestem
smartweed Indiangrass
willow
------------------------------mallow------------------------------------
----------------------------buttonbush----------------------------------

Typical maximum two-three feet deep

semi-permanently flooded seasonally flooded or saturated seasonally saturated
--------------------------------hydric soil-----------------------------------

Figure 23 - Cross-Section of HWC

can occupy more than one zone. For example, switchgrass has a particularly broad tolerance to moisture. The relative area occupied by these types changes during wet and dry cycles with the marsh and herbaceous wetland advancing upslope during wet years and retreating during dry years.

It is important to have the full gradation in sites present to assure viability during all conditions. In order to manage wetlands for the maximum benefit of nesting king rails, each prairie wetland should generally range in size from one to ten acres. Larger wetland areas would also be beneficial to king rails and other waterfowl, but they would contain large areas of water that would be too deep to provide preferred nesting and foraging habitat for rails (Meanley 1953, 1956). The smaller wetlands would also more closely mimic the habitats that were present in the Grand Prairie region before agricultural conversion.

The successful management of these wetland units for the king rail would also require the establishment of upland buffers of native prairie grasses. The herbaceous wetlands would provide relatively stable nesting and foraging habitats (in comparison with road ditches and modern rice fields) for king rails. However, these habitat inclusions cannot function properly as wetlands or productive king rail breeding/foraging habitat without associated buffers. The reasons for this are discussed below.

Riparian buffers around streams and wetlands serve many functions. Chief among these is maintenance of water quality through the filtering, uptake, or conversion of sediment, nutrients, and other chemical contaminants. These buffers can also serve as important habitat for animals that provide forage for king rails. One study showed that terrestrial beetles, grasshoppers, and amphibians (mostly frogs) can constitute as much as 17 percent of the summer diet of king rails (Meanley 1956). Additionally, buffers around the proposed wetland sites would reduce the concentration of nest predators. The use of buffers around nesting areas to reduce the concentration of nesting pairs has been shown to reduce predation rates in other bird species (Keyser et al. 1998; Brice 2004).

The guidance on buffer widths needed to perform the above functions is wide ranging. One common theme among the recommendations is that wider and more continuous buffers always outperform narrow, intermittent ones and that buffers should be as wide as practically possible. Following are examples of minimum buffer widths or wetland/buffer ratios needed to perform various functions as compiled in literature reviews by Wenger (1999) and Fischer and Fischenich (2000) and a study by Brice (2004):

- Sediment reduction: 15 ft. - ≥200 ft.
- Nutrient reduction (phosphorus and nitrogen): 15 ft. - ≥100 ft.
- Chemical (pesticide and herbicide) reduction: 50 ft. - undefined much larger width.
- Maintenance of healthy/diverse reptile and amphibian populations: 100 ft. - 3,280 ft.
- Reduction of nest predation: 3:2 grassland buffer to wetland ratio

In order to be conservative and to ensure that the above functions remain viable for the life of the project, the inter-agency team concluded that no HWC restoration alternative should contain less than 75% buffer. The team also decided that 15% herbaceous wetland, in scattered small patches, would be within the upper percentage range of herbaceous wetland that could have occurred within the Grand Prairie ecosystem historically. Therefore, since creation of waterfowl habitat (not upland habitat) is the primary goal, it was concluded that no HWC alternative should contain more than 85% buffer. Three prairie buffer percentages were considered—85%, 80%, and 75%. Although actual herbaceous wetland restoration units would vary in size, it was assumed that the average unit would be approximately four acres, the area of nesting habitat required by one breeding pair of king rails. Therefore, the approximate widths of the 85%, 80%, and 75% buffers are 350 feet, 270 feet, and 220 feet, respectively (Figure 24). The inter-agency team decided that the waterfowl

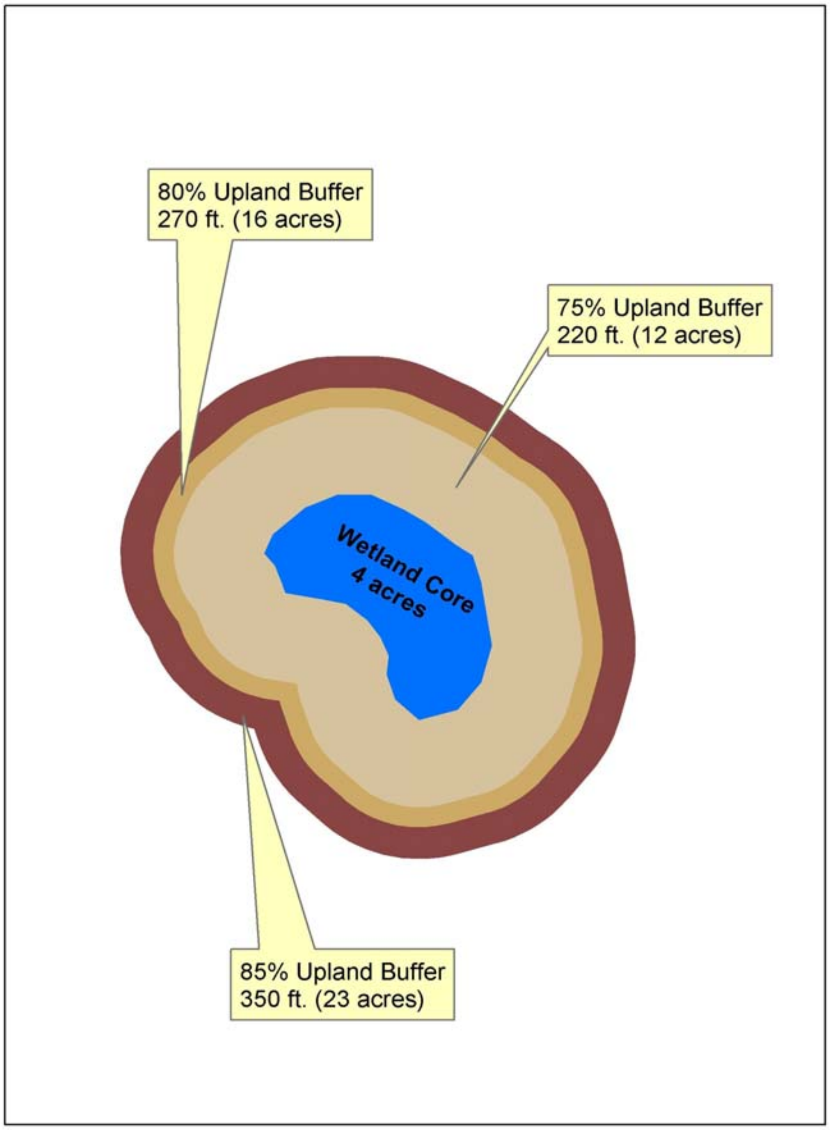


Figure 24 - Various buffer percentages and widths around a four-acre core wetland

management plan should be comprised primarily of features that restored native habitats and embrace the Corps' "Environmental Operating Principles." Although environmental planning efforts focused on the development of features that would provide substantial waterfowl benefits, no feature could be selected that jeopardized ecosystem integrity. HWC containing 15% herbaceous wetland and 85% tallgrass prairie buffer would be more similar in composition to the historic prairie ecosystem; however, the same waterfowl benefits would be provided at a significantly higher cost due to the amount of buffer. A restoration scenario of 25% herbaceous wetland/75% buffer would provide waterfowl benefits for the least cost, but would be well above the historic percentage of herbaceous wetland. This high proportion of herbaceous wetland could adversely impact ecosystem integrity, and the selected wetland-to-buffer mix should maintain the total prairie ecosystem and not substantially shift natural variability. Any major increase in the percentage of herbaceous wetland disproportionately shifts prairie habitat compositions to the detriment of upland wildlife species. Also, many wetland species require uplands during some part of their life cycle. A relatively moderate proportion of upland prairie would reduce predation by providing protective cover and dispersing waterfowl and other wetland species throughout the prairie complex. Moreover, upland prairie would support wetlands through water transport, collection, and purification. After all factors were considered, the inter-agency team decided that HWC should contain 20% herbaceous wetland and 80% buffer because it provides the waterfowl benefits at a reasonable cost, and this plan would ensure maintenance of a healthy ecosystem.

Restoration of HWC would have relatively high construction costs due to the required excavation. Spoil material would be randomly placed around each wetland to recreate prairie pimple mounds, a historically prominent feature of Arkansas prairies. The origin of these small, earthen mounds is uncertain. Many scientists believe that pimple mounds were formed thousands of years ago by wind blown soils that accumulated around the root systems of scattered plants. Each constructed mound would be about three feet tall with a diameter of 30 to 50 feet. Restoration of prairie buffers would require seeding with native prairie species from locally endemic seed sources. Prairie restoration would also require restoration of micro-topography in areas that have been land leveled for agricultural purposes. This would be necessary in order to recreate the hydrology that historically existed within the HWC.

FOREST RESTORATION

The inter-agency team also considered restoration of BLH forest types an extremely high priority. The Heitmeyer et al. (2002) study identified six BLH forest types in the Bayou Meto Basin: cypress/tupelo; low, intermediate, and high (flat) BLH; riparian forest; and natural levee forest. BLH losses in the basin range from >95% for high elevation forest types to <50% for cypress/tupelo. Only isolated remnants of post oak flats remain. The Big Ditch Area, Bayou Meto WMA/Big Ditch Connector, and Wabbaseka Scatters were identified by the inter-agency team as high-priority BLH restoration areas. A total of 85,535 acres of cleared land are well-suited for forest restoration. The following descriptions of BLH habitat, needs and opportunities are taken primarily from Heitmeyer et al (2002).

BLH RESTORATION WITHIN POST PROJECT TWO-YEAR FLOODPLAIN

Low elevation BLH covered about 208,000 acres in the 2-year flood frequency zone during pre-settlement times. Today, acreage has been reduced to about 54,000 acres. Remaining BLH acreage is located primarily in the lower half of the basin; the largest of which is the ca. 32,000-acre Bayou Meto Wildlife Management Area. Following construction of the selected flood-control plan (see Section IV), 71,479 acres of cleared land would remain in the post project two-year floodplain. Cleared land sites within the projected post project two-year floodplain are primarily suited for restoration of cypress/tupelo swamps and low bottomland forest types. Dominant vegetation in the low bottomland forests consists of green ash; cedar elm; water hickory; overcup, Nuttal, and willow oak; swamp privet; and water locust. Of the 71,479 acres, 65,560 acres of privately owned cleared land would be available for restoration. In addition to providing tremendous waterfowl habitat, restoration of the post project two-year floodplain would provide substantial fishery benefits. A diverse group of fishes would utilize restored forests in the two-year floodplain for spawning, rearing, and foraging; and some species are year-round residents. Forested riparian zones benefit fishes and other aquatic organisms by filtering sediments during runoff and increasing bank stability, food availability, and structural complexity of stream channels. Moreover, restoration of the post-project floodplain would provide flood-control benefits. Land would be reforested in appropriate tree species. Micro-topography would have to be restored on many sites for hydrologic purposes.

BLH RESTORATION ABOVE THE POST-PROJECT 2-YEAR FLOODPLAIN

Intermediate BLH has decreased by 86% from 262,000 acres in pre-settlement times to 36,500 acres today and high BLH has decreased 95%- from 220,000 acres to 11,000 acres. Most intermediate BLH sites occur between the 2- and 5-year flood frequency zones and some of the sites do not flood on an annual basis. Flooding of intermediate BLH typically occurs in late winter and spring but may occur at any time of the year depending on the occurrence of large flood events. Dominant vegetation includes sugarberry, American elm, Nuttal oak, willow oak and sweetgum. Small depressions such as vernal pools that are interspersed in intermediate BLH usually contain overcup oak. High BLH habitats occupy areas that are flooded for up to a few weeks during some years but may go several years between flooding events. Generally, the dividing point between intermediate and high BLH is the 5-year flood frequency. Dominant tree species include water oak, willow oak, cherrybark oak, shagbark hickory, and sweetgum. Restoration of intermediate and high BLH areas can provide substantial waterfowl benefits. Although these areas do not flood at the frequency of low BLH sites, when flooding does occur it provides a substantial food source for waterfowl, primarily in the form of red oak mast that does not occur at as high a level in low BLH areas. There are thousands of acres within the Bayou Meto Basin that would be suitable for conversion to intermediate or high BLH; two areas in particular are the Big Ditch, area between Big Ditch and Bayou Meto WMA, and the Wabbaseka Scatters (Plate 6).

The Mississippi Alluvial Valley Migratory Bird Initiative identified the Big Ditch Area and the Bayou Meto WMA, and areas immediately adjacent to the WMA, as Forest Bird Conservation Areas (FBCAs) see Volume 10, Appendix D, Section XI. The USFWS and AGFC recommended reforesting cleared lands within the Big Ditch FBCA; this would benefit forest-breeding birds by reducing forest fragmentation and cowbird nest depredation. The ANHC report (Volume 10, Appendix D, Section IV) suggests forest restoration within an approximate 2.5-mile wide by 10-mile long connector from the Bayou Meto WMA to the Big Ditch Area to benefit sensitive species, such as forest breeding birds and black bear. This measure also would provide substantial waterfowl benefits.

The inter-agency team selected the Big Ditch Area and the Bayou Meto WMA/Big Ditch connector as BLH restoration priority areas (Plate 6). The connector encompasses 14,150 acres of cleared land that is available for restoration, plus 500 acres of cleared land are scattered within the Big Ditch Area forest. About 2,555 acres of cleared land within the connector would be in the post-project two-year floodplain. Conversely, about 12,095 acres are primarily suitable for establishment of intermediate or high BLH development. Restoration of micro-topography would be necessary on many sites in order to recreate appropriate hydrology, particularly to benefit waterfowl.

Wabbaseka Bayou is an extension of Indian Bayou that starts at Tucker State Penitentiary and flows southward to join Little Bayou Meto. The Wabbaseka Scatters is the name give to a 20,333-acre area located southwest of the Bayou Meto WMA (Plate 6). There are 15,863 acres of privately owned cleared land and 4,470 acres of privately owned BLH located within the Scatters. The ANHC report lists BLH restoration in the Scatters as a priority, and the inter-agency team selected the Wabbaseka Scatters as another high-priority BLH restoration area. About 7,880 acres have primarily intermediate and high BLH restoration capability; the remaining 7,983 acres of cleared land in this area is within the post project two-year floodplain. Restoration of the entire 15,863 acres would provide substantial habitat for waterfowl and a myriad of wildlife species.

BAKERS BAYOU RESTORATION

Bakers Bayou is located in Lonoke County, approximately 16 miles due east of Little Rock and 6 miles due south of Interstate 40. The opportunity of restoring a 15-mile section of the meandering bayou to its historic condition was evaluated as both an environmental/waterfowl feature and as a means for supplying irrigation water to adjacent agricultural lands. The inter-agency team made initial recommendations relating to riparian buffer strips to reduce sedimentation in the restored channel; benefit waterfowl, fish, and wildlife; and increase esthetic value. Based on conversations with local landowners, it was initially believed by some team members that the Bakers Bayou channel might have been much deeper and better defined historically than in its present condition and that a restored channel would be sufficient to carry irrigation water to local farms. Other team members believed that the channel was always shallow and not well defined because the first land survey in the 1800s described such a channel. Therefore, it was decided that a geomorphic study should be conducted in order to determine the historic channel configuration. The information derived would be critical in determining if a restored channel would have the capacity for water supply and, if so, would also be important in determining the appropriate channel design.

The Corps' Engineer Research and Development Center (ERDC) conducted the geomorphic study of Bakers Bayou (Volume 10, Appendix D, Section V). This study revealed that the channel was always shallow and poorly defined. Therefore, a restored channel would not be adequate for agricultural water supply. A channel with additional capacity could have been constructed for irrigation purposes and to provide fishery benefits. However, this could not be considered channel restoration and, in fact, would have destroyed what was determined to be the natural, historic channel. Also, it is more economically feasible to use pipelines to supply irrigation water to the local farms. Based all of the above information, it was decided that Bakers Bayou should not be used for water supply.

The inter-agency team recommended that the riparian corridor along Bakers Bayou be restored. The high natural levees adjacent to the bayou are some of the least flood prone areas in the Basin; therefore, they have been cleared and in row-crop agriculture production for many years. The high levees adjacent to the bayou restrict the size of the watershed and amount of surface water inflow, which contributes to the low-flow conditions. This has enabled farmers to clear the native vegetation from within the levees and extend their fields across the bayou in many areas. The native vegetation that still remains indicates that a bottomland forest community consisting of overcup oak and water hickory was the primary forest type, with the adjacent natural levees probably occupied by a forest consisting of water oak, cherrybark oak, and other species typical of the highest bottomlands. Also, a small lake at the lower end of Bakers Bayou has been drained by a relatively small ditch, and would be relatively easy to restore. However, after it was determined that the channel could not be modified to supply irrigation water, local landowners were no longer interested in restoring woodland along the bayou. Therefore, this feature was dropped from further consideration.

RIPARIAN BUFFER RESTORATION

The inter-agency team recommended restoration of riparian forest buffers along all streams in the project area that are affected by the flood-control or water supply components of the project. These buffers would filter pollutants as well as provide important waterfowl and terrestrial habitat and stream shade. As part of the water-supply component of the project, 92 drop-pipe structures would be installed in tributaries and farm drains to further reduce sedimentation and facilitate waterfowl flooding on cropland. Sediment reduction would not only have environmental benefits, but it would also reduce channel maintenance for water supply and flood control. Low, intermediate and high bottomland forest types; riparian forest; and natural levee forest would be restored within these buffers.

MOIST-SOIL HABITAT

The U.S. Fish and Wildlife Service and Arkansas Game and Fish Commission recommended that 240 acres of moist-soil habitat be created (Volume 10, Appendix D, Section XI). This would fully meet the moist-soil habitat goal for the project area. The inter-agency team concurred with this recommendation.

RESTORATION OF BAYOU METO WILDLIFE MANAGEMENT AREA

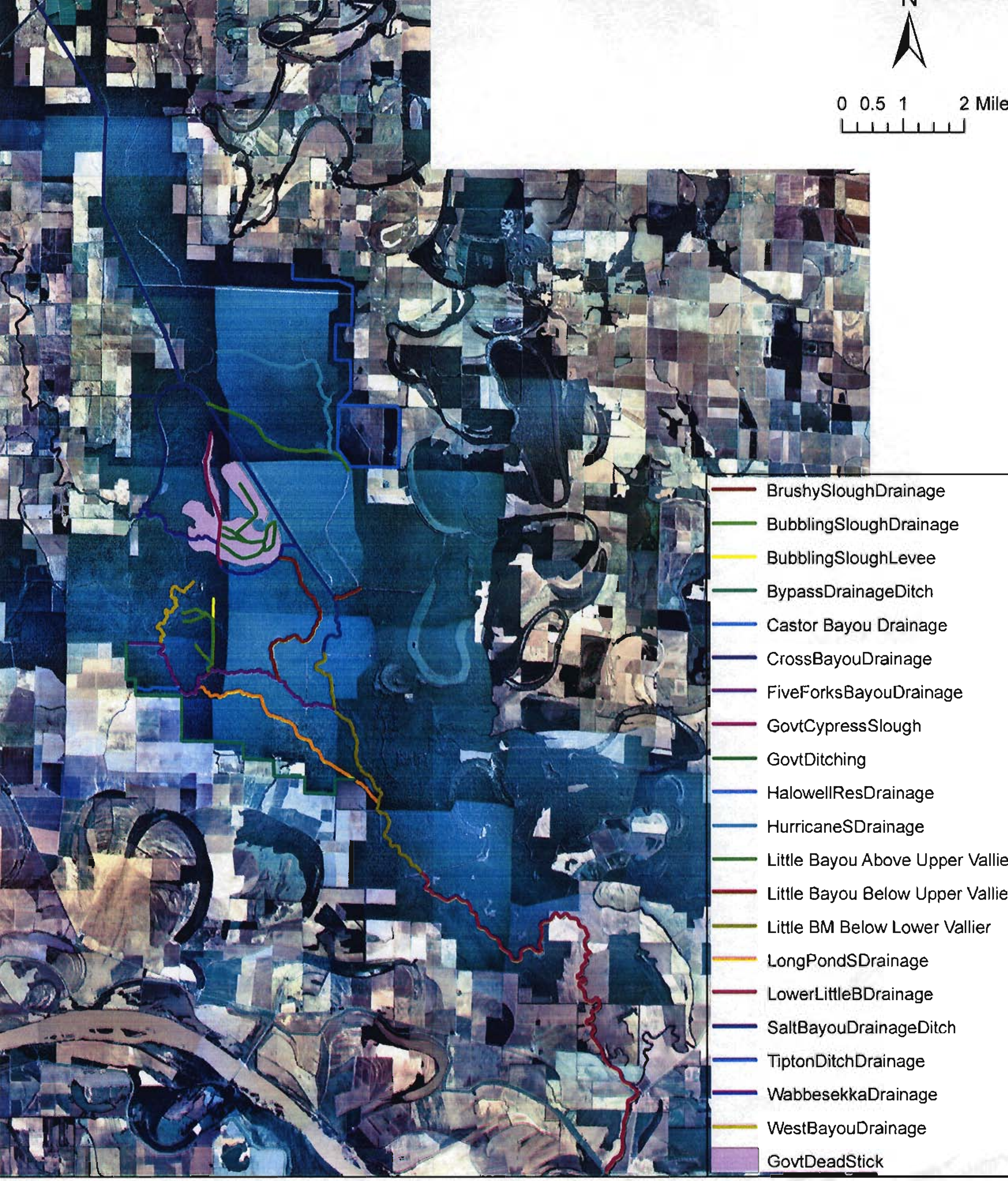
The ca. 32,000-acre Bayou Meto WMA is the largest management area operated by the Arkansas Game and Fish Commission. It is managed primarily for waterfowl hunting and, as such, is the largest public use waterfowl hunting area in the State. Well over 90 percent of the area is in BLH; 13,600 acres are contained in green tree reservoirs (GTRs). The WMA contains one of the largest contiguous areas of BLH in the Upper Mississippi Alluvial Valley and is one of the most important wintering areas for mallards and other waterfowl in the Valley.

Heitmeyer et al. published The *Bayou Meto Wildlife Management Area Wetland Management Plan* in March of 2004 (Volume 10, Appendix D, Section XV). This study/plan was undertaken to document the vitality of the WMA and recommend remedial measures for stressors that have affected the productivity of the WMA for many years. The plan noted that the topography and hydrology of the WMA have been extensively altered by many factors that have increased water flows into and through the WMA and prolonged flooding from fall through early summer. These changes have created extended and unnatural water regimes within the WMA, damaged BLH stands, and reduced resources used by waterfowl and other wildlife species. Most GTR impoundments do not have independent flood and drain capabilities and the interconnectedness of impoundments complicate their management. One of the serious consequences of this prolonged and unnatural flooding is the significant decline in red oak composition. Red oak acorns (willow and Nuttall) are very significant in the diet of mallard, wood duck, and other waterfowl species. As a result of the study, the plan recommended that water regimes be regulated to 1) more closely emulate natural timing, depth, duration, and extent of flooding; 2) improve water flow across, and drainage of, GTR impoundments in late winter and spring; 3) curtail construction of additional levees or further compartmentalization; 4) improve red oak regeneration by reducing flood duration to a more natural regime; and 5) monitor forest/water management measures.

The AGFC, in coordination with the Corps and other resource interests, developed 38 features for the WMA to assist in implementation of the recommendations of the Heitmeyer et al. (2004) wetland management plan. The intent of most features is to improve the capability of the WMA managers to control the hydrology to improve habitat for waterfowl. Some features would only be done in conjunction with others and are combined for analyses of costs and benefits. The following is a list of features proposed:

0. Remove Bubbling Slough Levee (5,571 ft)- Restore hydrology to dead stick area to benefit 417 acres.
1. Ditching on Bubbling Slough (12,002 ft)- Restore hydrology to benefit same 417 acres.
2. Channel cleanout on Five Forks Bayou (25,915 ft)- Restore hydrology on 4,293 acres of WMA and benefit adjacent landowners.
3. Channel cleanout on Government Slough (11,676 ft)- Restore hydrology on 2,157 acres.
4. Ditching on Government Impoundment (22,159 ft)- Restore hydrology and reclaim Dead Stick Area to benefit 611 acres.
5. Clear noxious woody vegetation on Government Impoundment to reclaim Dead Stick Area (941 acres).
6. Replant desirable vegetation on same area (941 acres).
7. Channel cleanout on Brushy Slough (16,102 ft)- Restore hydrology to benefit 1,746 acres.
8. Channel cleanout on Beaver Dam Slough (13,445 ft)- Restore hydrology to benefit 1,869 acres.
9. Channel cleanout on Little Bayou behind Hallowell (14,177 ft)- Restore hydrology to benefit 5,071 acres.
10. Channel cleanout on Little Bayou between Salt Ditch and Upper Vallier (2,375 ft)- Improve drainage on 7,829 acres.
11. Channel cleanout on Halowell Reservoir perimeter ditch (21,120 ft)- Restore hydrology on 615 acres of WMA and reduce flooding on adjacent landowners.
12. Channel cleanout on Tipton Ditch (19,774 ft)- Restore hydrology on 764 acres of WMA and reduce flooding on adjacent landowners.
13. Channel cleanout on Hurricane Slough behind Halowell (17,875 ft)- Restore hydrology to benefit 3,235 acres.
14. Channel cleanout on Marshall Ditch (19,006 ft)- Restore hydrology to benefit 695 acres.
15. Ditching on northeast corner of dead timber area (7,453 ft)- Restore hydrology to benefit 108 acres.
16. Channel cleanout on Bear Bayou above power line (12,109 ft)- Restore hydrology to benefit 779 acres.
17. Remove Marshall Ditch spoil bank (7,459 ft)- Restore hydrology to benefit 137 acres.
18. Deleted as a separable measure. Incorporated into measure 19.
19. Ditching between Bear Bayou Levee and Marshall Ditch and ditching along interior of Bear Bayou Levee (9,101 ft)- Restore hydrology to benefit 112 acres.
20. Channel cleanout on Newton Bayou (8,583 ft)- Restore hydrology to benefit 128 acres.
21. Channel cleanout on West Bayou (9,738 ft)- Restore hydrology to benefit 982 acres.
22. Channel cleanout on Little Bayou below Lower Vallier structure (24,626 ft)- Restore hydrology to benefit 29,103 acres.
23. Ditching in Buckingham Flats impoundment (18,706 ft)- Restore hydrology to benefit 1,039 acres.

24. Channel cleanout west of Gray's Reservoir (6,600 ft)- Reduce flooding conflicts with adjacent landowners.
25. Channel cleanout on Long Pond Slough (20,935 ft)- Hydrology restoration to benefit 1,207 acres.
26. Channel cleanout on Castor Bayou (3,829 ft)- Restore hydrology on 96 acres and reduce flooding conflicts with adjacent landowners.
27. Channel cleanout on Wabbaseka Bayou on west side of Salt Ditch (20,311 ft)- Hydrology restoration on 2,337 acres and reduce conflicts with adjacent landowners.
28. Channel cleanout on Wabbaseka Bayou east side of Salt Ditch (4,130 ft)- Hydrology restoration on 137 acres.
29. Channel cleanout on Cross Bayou in Government Slough (16,014 ft)- Restore hydrology on 1,045 acres of WMA and reduce flood problems on adjacent landowners.
30. Remove Swan Lake levee (2,616 ft)- Restore hydrology to benefit 1,869 acres.
31. Pump station at confluence of Arkansas River and Little Bayou Meto (1,000 cfs) and channel cleanout on Little Bayou Meto between Cannon Brake Control Structure and Arkansas River (51,806 ft) required to get water to the pump- Restore hydrology to most of WMA plus some adjacent woodlands; about 33,000 acres in total.
32. By-pass channel from southwest corner of the WMA to connect with Little Bayou Meto (33,301 ft). Benefits a total of 36,000 acres in terms of hydrological restoration including the 33,000 acres above.
33. Salt Ditch water control structure- Restore hydrology to 1,850 acres. Dependent on item 34.
34. Dry Bayou Ditch water control structure- Works in conjunction with item 33 to restore hydrology to 1,850 acres.
35. East of Cannon Brake water control structure- Restore hydrology to 555 acres.
36. Channel cleanout on Salt Ditch from Hwy 79 to Lower Vallier structure (64,808 ft)- Restore hydrology to 22,629 acres.
37. Widen Dry Bayou Ditch from Big Bayou Meto to Salt Ditch (10,514 ft)- Restore hydrology to benefit 1,850 acres of WMA and reduce flooding on adjacent landowners.
38. Channel cleanout the old slough on Temple Island (2,419 ft)- Restore hydrology to benefit 48 acres.



US Army Corps of Engineers

Plate 6a. Bayou Meto Wildlife Management Area Waterfowl Features

EVALUATION OF FEATURES

All of the aforementioned waterfowl/habitat restoration features were analyzed in detail with the exception of Bakers Bayou Restoration. There was not sufficient local landowner support for this feature and waterfowl outputs were considered to be minimal.

The U.S. Army Research and Development Center's Environmental Laboratory (ERDC-EL), in coordination with the inter-agency team, employed incremental analysis to help evaluate and determine which waterfowl management features should be implemented based on waterfowl and associated habitat outputs that meet established goals and on cost effectiveness. The incremental analysis followed three basic steps: (1) the environmental benefits of each feature were calculated; (2) a cost estimate was developed for each feature, and (3) features were combined to evaluate the best overall Waterfowl Management and Restoration Plan based on outputs and costs. Although costs and quantifiable benefits are important factors, other factors such as intangible benefits and meeting the goals and objectives of the inter-agency team and local sponsor were important in deciding the final plan.

The interagency team also decided that, although the focus of restoration efforts would be for waterfowl, it was also important to determine the other wildlife or fishery benefits that could be derived from specific restoration features.

HABITAT BENEFIT ANALYSES

Four methods or techniques were originally used to generate ecological benefits for the proposed Waterfowl Management Plan designs. These techniques were:

1. Generation of "Duck-Use-Days" or DUDs - an index of wintering waterfowl carrying capacity (Heitmeyer 2005a). Using estimates of current food production compared to optimal levels, the potential increased DUDs associated with each feature was calculated as:

$$\text{DUD} = \Sigma \frac{\text{(acres affected in each area) (food deficit in each area)}}{\text{Daily food consumption of a mallard in winter}}$$

   Where daily food consumption of a mallard was estimated at 0.44 lbs food/day (Heitmeyer 2005b). The DUD methodology and calculations for project features are explained in Volume 10, Appendix D, Section XVII.

2. Habitat Evaluation Procedures (HEP) on riparian communities (i.e., forested cover types) – Species-based Habitat Suitability Index (HSI) models were used to assess terrestrial conditions for the following animals: Wood Duck, Pileated Woodpecker, Mink, Barred Owl, Gray

Squirrel, and Carolina Chickadee. Details regarding the HEP process can be found in the next section of this paper.

3. HEP on herbaceous wetland communities (i.e., pond and wet prairie cover types) – Species-based HSI models were used to assess the additional terrestrial conditions for the following animals: Prairie Chicken, Bobwhite Quail, Dickcissel, and Cottontail Rabbit.

4. HEP on aquatic communities (i.e., riverine and stream buffer cover types) – Species-based HSI models were extrapolated from previous studies, and were used to assess the fish habitat (in-channel and spawning/rearing) within the riparian and bottomland hardwood communities of the post-project two-year floodplain.

As an aside, qualitative descriptions of king rail habitat "needs" were not modeled or quantified per se, but the potential restoration of this bird's habitat was considered a high priority by the team, and the concerns of this species carried a distinct weight in the formulation and selection of the recommended plan.

HEP METHODOLOGY

Because the predominant number of analyses used in the Bayou Meto Basin study were HEP-based already, and the results of the DUD analysis could be easily converted to a HEP-like application, all analysis results were converted to a standard HEP output – namely average annual habitat units (AAHUs). A basic HEP discussion is provided in the next section to set the stage for details regarding the standardization of the study's outputs.

The HEP methodology is an environmental accounting process developed to appraise habitat suitability for fish and wildlife species in the face of potential change [U.S. Fish and Wildlife Service (USFWS) 1980a-c]. Designed to predict the response of habitat parameters in a quantifiable fashion, HEP is an objective, reliable, and well-documented process used nationwide to generate environmental outputs for all levels of proposed projects and monitoring operations in the natural resources arena (USFWS 1980a-c). When applied correctly, HEP provides an impartial look at environmental effects, and delivers measurable products to the decision-maker for comparative analysis.

Habitat Suitability in HEP

A Suitability Index (SI) is a mathematical relationship that reflects a species' or community's sensitivity to a change in a limiting factor (i.e., variable) within the habitat type. These suitability relationships are depicted using scatter plots and bar charts (i.e., suitability curves). The SI value (Y-axis) ranges from 0.0 to 1.0, where an SI = 0.0 represents a variable that is extremely limiting, and an SI = 1.0 represents a variable in abundance (not limiting) for the species or community. In HEP, an HSI model is a quantitative estimate of habitat conditions for an evaluation species or community. HSI models combine the SIs of measurable variables into a formula depicting the limiting characteristics of the site for the species/community on a scale of 0.0 (unsuitable) to 1.0 (optimal).

Habitat Units in HEP

HSI models can be tailored to a particular situation or application and adapted to meet the level of effort desired by the user. Thus, a single model (or a series of inter-related models) can be adapted to reflect a site's response to a particular design at any scale (e.g., species, community, ecosystem, regional, or global dimensions). Several agencies and organizations have adapted the basic HEP methodology for their specific needs in this manner. HEP combines both the habitat quality (HSI) and quantity of a site (measured in acres) to generate a measure of change referred to as Habitat Units (HUs). Once the HSI and habitat quantities have been determined, the HU values can be derived with the following equation: HU = HSI x Area (acres). Under the HEP methodology, one HU is equivalent to one acre of optimal habitat for a given species or community.

Capturing Changes Over Time in HEP Applications

Most federal agencies use annualization as a means to display benefits and costs, and ecosystem restoration analyses should provide data that can be directly compared to the traditional benefit/cost analyses typically portrayed in standard evaluations of this nature. Federal projects are evaluated over a period of time that is referred to as the "life of the project" and is defined as that period of time between the time that the project becomes operational and the end of the period of analysis as dictated by the construction effort or lead agency. However, in many cases, gains or losses in wildlife habitat may occur before the project becomes operational and these changes should be considered in the assessment. Examples of such changes include construction impacts, implementation and compensation plans, and/or other land-use impacts. Ecosystem restoration analyses incorporate these changes into their evaluations by using a "period of analysis" that includes pre-start impacts. However, if no pre-start changes are evident, then the "life of the project" and the "period of analysis" are the same. In HEP, HUs are annualized by summing HUs across all years in the period of analysis and dividing the total (cumulative HU) by the number of years in the life of the project. In this manner, pre-start changes can be considered in the analysis. The results of this calculation are referred to as AAHUs, and can be expressed mathematically in the following fashion:

AAHUs = ∑Cumulative HUs ÷ Number of years in the life of the project

where:

$$\text{Cumulative HUs} = \sum (T_2 - T_1)[((A_1 H_1 + A_2 H_2) \div 3) + ((A_2 H_1 + A_1 H_2) \div 6)]$$

and where:

T_1 = First Target Year time interval
T_2 = Second Target Year time interval
A_1 = Area of available wetlands at beginning of T_1
A_2 = Area of available wetlands at end of T_2
H_1 = HSI at beginning of T_1
H_2 = HSI at end of T_2

This is a generalized formula and requires the HSI and area of the available habitat for each increment of time. The numbers "3" and "6" are constants derived from the integration of HSI x Area for the interval between any two time periods. This formula is applied to the time intervals between periods. The formula was developed to precisely calculate cumulative HUs when either HSI or area or both change over a time interval. The rate of change of HUs may be linear (either HSI or area change over the time interval) – the formula will work in either case. The shaded area in the curve below represents the cumulative HUs for all years in the period of analysis, and is calculated by summing the products of HSI and area of available habitat for all years in the period of analysis (Table 25).

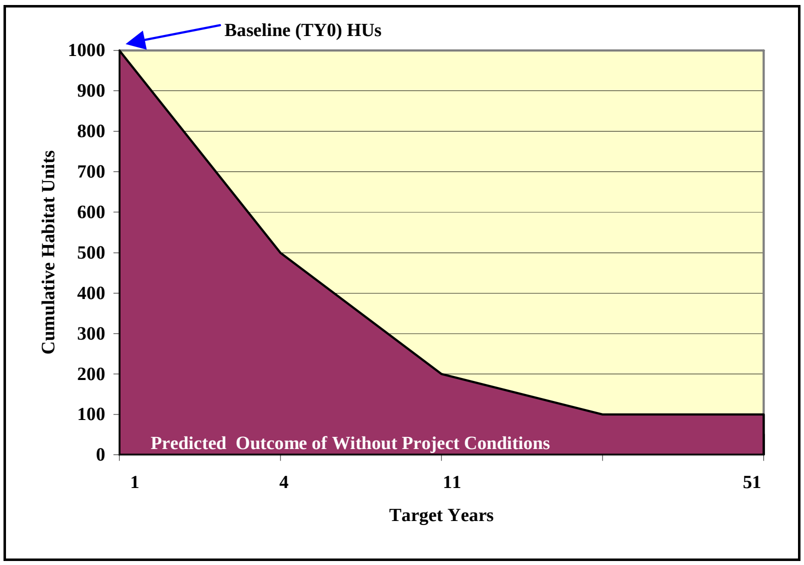


Figure 25. Example of cumulative HU availability under a Without-project (WOP) scenario

Target Years

In studies spanning several years, Target Years (TYs) must be identified early in the process. Target Years are units of time measurement used in HEP that allow users to anticipate and identify significant changes (in area or quality) within the project (or site). As a rule, the baseline TY is always TY = 0, where the baseline year is defined as a point in time before proposed changes would be implemented. As a second rule, there must always be at least a TY = 1 and a TY = X_2. TY1 is the first year land- and water-use conditions are expected to deviate from baseline conditions. TYX_2 designates the ending target year. A new target year must be assigned for each year the user intends to develop or evaluate change within the site or project. The habitat conditions (quality and quantity) described for each TY are the expected conditions at the end of that year. It is important to maintain the same target years in both the environmental and economic analyses, and between the baseline and future analyses. In studies focused on long-term effects, HUs generated for indicator species/communities are estimated for several TYs to reflect the period of analysis. In such analyses, future habitat conditions are estimated for both the Without-project (WOP) (e.g., No Action Plan) and With-project conditions (WP). Thus, projected long-term effects of the project are reported in terms of AAHU values. Based on the AAHU outcomes, alternative designs can be formulated and trade-off analyses can be simulated to promote environmental optimization.

A "Period of analysis" of 50 years was designated for the Bayou Meto study, and a series of TYs was developed within this 50-year setting to guide the projections of both Without-project (WOP) and With-project (WP) activities. Five TYs were defined by the Districts:

1. TY = "0" refers to the baseline condition, or the 2004 calendar year.

2. TY = "1" refers to the last year of construction and planting activities, or the 2013 calendar year.[1]

3. TY = "10" was chosen to capture 9 full years of vegetative growth under the proposed WP conditions (e.g., the 2022 calendar year).

4. TY = "25" was selected to capture 15 additional years of vegetative growth under the WP conditions (e.g., the 2037 calendar year).

5. TY = "40" was selected to capture 15 additional years of vegetative growth under the WP conditions (e.g., the 2052 calendar year).

6. TY = "51" was chosen to capture 50 full years of vegetative growth under WP conditions (e.g., the 2063 calendar year).

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1 The Corps expects construction will span a period of 6 years, 2006 -2012.

RESULT TRADEOFFS

The "best" alternatives cannot be selected from among a set of "good" alternatives unless there is a means in which to compare them. It is only by comparison that an alternative is no longer "good enough," or that a "good" alternative becomes the "best" alternative. The purpose of the comparison step is to identify the most important criteria upon which alternatives can be evaluated against, and compare the various alternatives across those criteria. Ideally, the comparison of alternatives concludes with a ranking of alternatives or some identification of the best course of action for the decision-makers. The comparison can be simple when all the important alternative designs are measured in the same units (e.g., habitat units, acres, dollars, etc.). More realistically, alternative designs are measured in a combination of dollars, ecological units, acres, housing relocations, water quality changes, noise levels, navigation safety, changed erosion rates, or a host of other tangible or intangible units. When this occurs, planners have to advise decision-makers about trade-offs (i.e., value judgments). Trade-offs are made throughout the planning process, throughout all screening activities, but they take on special significance as the study team, decision-makers and other stakeholders move toward selecting the best, most likely alternative future for a society. These trade-offs are first made regarding the individual alternatives under evaluation. The question is asked: "Is it good enough to warrant further consideration?" Alternative designs can be dropped from further analysis for a variety of reasons including cost ineffectiveness, design inconsistencies, and biological unproductiveness to name a few. Afterwards, trade-offs are considered across, and among, all the alternatives. Trade-offs are undertaken when contrasting outputs are encountered. For example, Alternative 1 may be less costly, but restores fewer wetlands than Alternative 2, a more costly design that restores significantly more wetland acres.

Trade-off analysis is a multi-criteria evaluation method commonly used by USACE when it is impossible (or not desirable) to express all alternative effects in a single metric - more than one evaluation metric can be considered (i.e., acres, HEP, and costs together) in a trade-offs analysis (Edmunds and Letey 1973). Trade-offs enable planners to account for the entire gamut of differing (but relevant) criteria when comparing alternatives. Trade-offs can be as simple, or as complex, as necessary to afford the greatest suite of comparisons. In a simple application, trade-offs can frequently rely on professional judgment. Planners "trade-off" alternative contributions to objectives based on the their own accumulated technical expertise, general experience, and specific knowledge of the study area (including stakeholder views and values). In essence, planners sit down and develop an alternative with "a little more of this" and "a little more of that", where the trade-offs made tend to be of a subjective nature. However, more quantifiable approaches exist to conduct trade-off analyses in a controlled environment.

Simple weighting is a sophisticated and simple approach to trade-offs that can be used when there are no apparent "winning" or dominant alternatives among those compared. In HEP, models are selected to emphasize the importance of specific functions, and can be "traded-off" by incorporating a weighting scheme into the calculation of final HUs. By applying Relative Value Indices or RVIs to the resultant outputs, priorities can be characterized, and mathematical "weights" can be applied to HEP activities accordingly. In the overall scheme of project design, RVIs serve as prisms to concentrate attention on those changes that will impact the area's significant resources. The determination of "value" is a somewhat subjective exercise in the HEP process, but the HEP methodology provides avenues of documentation and justification necessary to support decisions in this arena (USFWS 1980b). Thus, RVIs can be used to perform trade-offs among outputs, or simply to "level" the playing field. The final sections of this report document the ERDC-EL's development of a trade-off strategy for the successive annualized outputs generated by the suite of proposed measures.

EXTRAPOLATION OF DUDS IN THE WILDLIFE MANAGEMENT AREA

During the plan formulation process, the decision was made to focus on addressing issues across the basin, but specifically within the Bayou Meto Wildlife Management Area (WMA). To begin, the conditions within the WMA were described in terms of acres that could be restored hydrologically, and the quality of those restored acres in terms of Duck-Use-Days or DUDs. Later, ERDC-EL was tasked with consolidating all data into a single compatible format that would in turn be used to assess cost effectiveness. Again, because the predominant number of analyses used in the Bayou Meto Basin study were HEP-based, and the results of the DUD analysis could be easily converted to a HEP-like application, ERDC-EL converted all analysis results to a standard HEP output – namely AAHUs. In the WMA area, this process required three steps:

1. Develop the Baseline HSIs for each feature,
2. Develop the Baseline HUs for each feature, and
3. Develop Future Conditions (WOP and WP) for each feature.

The details of this process are presented below.

Step 1: Develop Baseline HSIs

Table 35 provides the basic information the inter-agency team developed as assessment results of the WMA features for the Bayou Meto Study on a feature-by-feature basis.

Table 35. Baseline Duck-Use-Day Calculations and Acreages for the WMA Study Area

Feature Number	Feature Description	Baseline Acres	Net Increase in Duck-Use Days (DUDs)
0/1	Remove Bubbling Slough Levee (5,571 ft) (restore hydrology) to Dead Stick Area and Ditching on Bubbling Slough (12,002 ft) (restore hydrology)	417	46,818
2	Channel cleanout on Five Forks Bayou (25,915 ft) (restore hydrology)	4,293	481,987
3	Channel cleanout on Government Slough (11,676 ft) (restore hydrology)	2,157	467,187
4	Ditching on Government Impoundment (22,159 ft) and reclaim Dead Stick Area (restore hydrology)	611	132,337
5/6	Clear noxious woody vegetation on Government Impoundment to reclaim Dead Stick Area and replant desirable vegetation	941	203,812
7	Channel cleanout on Brushy Slough (16,102 ft) (restore hydrology)	1,746	196,028
8/30	Channel cleanout on Beaver Dam Slough (13,445 ft) and remove Swan Lake levee (2,616 ft) (restore hydrology)	1,869	138,901
9	Channel cleanout on Little Bayou behind Hallowell (14,177 ft) (restore hydrology)	5,071	948,942
10	Channel cleanout on Little Bayou between Salt Ditch and Upper Vallier (2,375 ft) - (improve drainage)	7,829	1,449,770
11	Channel cleanout on Halowell Reservoir perimeter ditch (21,120 ft) (restore hydrology and reduce flooding on adjacent landowners)	615	139,772
12	Channel cleanout on Tipton Ditch (19,774 ft) (restore hydrology and reduce flooding on adjacent landowners)	764	138,735
13	Channel cleanout on Hurricane Slough behind Halowell (17,875 ft) (restore hydrology)	3,235	587,447
14	Channel cleanout on Marshall Ditch (19,006 ft) (restore hydrology)	695	30,643
15	Ditching on northeast corner of dead timber area (7,453 ft) (restore hydrology)	108	4,762
16	Channel cleanout on Bear Bayou above power line (12,109 ft) (restore hydrology)	779	34,347
17	Remove Marshall Ditch spoil bank (7,459 ft) (restore hydrology)	137	6,040
19	Ditching between Bear Bayou Levee and Marshall Ditch and ditching along interior of Bear Bayou Levee (9,101 ft) (restore hydrology)	112	4,938
20	Channel cleanout on Newton Bayou (8,583 ft) (restore hydrology)	128	14,371
21	Channel cleanout on West Bayou (9,738 ft) (restore hydrology)	982	110,252
22	Channel cleanout on Little Bayou below Lower Vallier structure (24,626 ft) (restore hydrology)	29,103	3,579,219
23	Ditching in Buckingham Flats impoundment (18,706 ft) (restore hydrology)	1,039	38,254
25	Channel cleanout on Long Pond Slough (20,935 ft) (restore hydrology)	1,207	127,922
(Continued)			

Table 35. (Concluded)

Feature Number	Feature Description	Baseline Acres	Net Increase in Duck-Use Days (DUDs)
26	Channel cleanout on Castor Bayou (3,829 ft) (restore hydrology and reduce flooding conflicts with adjacent landowners)	96	10,778
27	Channel cleanout on Wabbaseka Bayou on west side of Salt Ditch (20,311 ft) (restore hydrology and reduce conflicts with adjacent landowners)	2,337	487,709
28	Channel cleanout on Wabbaseka Bayou east side of Salt Ditch (4,130 ft) (restore hydrology)	137	24,878
29	Channel cleanout on Cross Bayou in Government Slough (16,014 ft) (restore hydrology reduce flood problems on adjacent landowners)	1,045	226,338
31/32	Pump station at confluence of Arkansas River and Little Bayou Meto (1,000 cfs); channel cleanout on Little Bayou Meto between Cannon Brake Control Structure and Arkansas River (51,806 ft); flood control by-pass channel from southwest corner of the WMA to connect with Little Bayou Meto (33,301 ft)	36,000	4,244,557
33/34/37	Salt Ditch water control structure; Dry Bayou Ditch water control structure; and widen Dry Bayou Ditch from Big Bayou Meto to Salt Ditch (10,514 ft) (restore hydrology)	1,850	81,568
35	East of Cannon Brake water control structure (restore hydrology)	555	41,247
36	Channel cleanout on Salt Ditch from Hwy 79 to Lower Vallier structure (64,808 ft) (restore hydrology)	22,629	3,169,232
38	Channel cleanout the old slough on Temple Island (2,419 ft) (restore hydrology)	48	8,542
Totals:		**128,535**	**17,177,333**

After this initial analysis, it was decided to form combinations of these various measures. An unexpected complication of this approach was the potential for double counting of the values of each measure when they were joined in combinations. To address this concern, a weighting factor was developed to reduce the overall value of measures in combination. The weighting factor was derived by taking the total number of acres affected by the combination of alternatives (e.g., 128,535 acres) and dividing this by the total number of acres on the WMA (e.g., 32,000). The result was a factor that was then used to reduce (by division) the total number of DUDs allotted to each measure:

$$\text{Double Counting Factor} = \frac{128{,}535}{32{,}000}$$

$$= \mathbf{4.0}$$

The DUDs were reduced by these factors, and the data in Table 36 was carried forward into the analysis.

Table 36. Modified Baseline Duck-Use-Day Calculations and Acreages for the WMA Study Area to Handle Potential Double Counting Issues

Feature Number	Feature Description	Baseline Acres	Net Increase in Duck-Use Days (DUDs)	Weighted Duck-Use-Days (DUDs)
0/1	Remove Bubbling Slough Levee (5,571 ft) (restore hydrology) to Dead Stick Area and Ditching on Bubbling Slough (12,002 ft) (restore hydrology)	417	46,818	11,705
2	Channel cleanout on Five Forks Bayou (25,915 ft) (restore hydrology)	4,293	481,987	120,497
3	Channel cleanout on Government Slough (11,676 ft) (restore hydrology)	2,157	467,187	116,797
4	Ditching on Government Impoundment (22,159 ft) and reclaim Dead Stick Area (restore hydrology)	611	132,337	33,084
5/6	Clear noxious woody vegetation on Government Impoundment to reclaim Dead Stick Area and replant desirable vegetation	941	203,812	50,953
7	Channel cleanout on Brushy Slough (16,102 ft) (restore hydrology)	1,746	196,028	49,007
8/30	Channel cleanout on Beaver Dam Slough (13,445 ft) and remove Swan Lake levee (2,616 ft) (restore hydrology)	1,869	138,901	34,725
9	Channel cleanout on Little Bayou behind Hallowell (14,177 ft) (restore hydrology)	5,071	948,942	237,236
10	Channel cleanout on Little Bayou between Salt Ditch and Upper Vallier (2,375 ft) - (improve drainage)	7,829	1,449,770	362,443
11	Channel cleanout on Halowell Reservoir perimeter ditch (21,120 ft) (restore hydrology and reduce flooding on adjacent landowners)	615	139,772	34,943
12	Channel cleanout on Tipton Ditch (19,774 ft) (restore hydrology and reduce flooding on adjacent landowners)	764	138,735	34,684
13	Channel cleanout on Hurricane Slough behind Halowell (17,875 ft) (restore hydrology)	3,235	587,447	146,862
14	Channel cleanout on Marshall Ditch (19,006 ft) (restore hydrology)	695	30,643	7,661
15	Ditching on northeast corner of dead timber area (7,453 ft) (restore hydrology)	108	4,762	1,191
16	Channel cleanout on Bear Bayou above power line (12,109 ft) (restore hydrology)	779	34,347	8,587
17	Remove Marshall Ditch spoil bank (7,459 ft) (restore hydrology)	137	6,040	1,510
19	Ditching between Bear Bayou Levee and Marshall Ditch and ditching along interior of Bear Bayou Levee (9,101 ft) (restore hydrology)	112	4,938	1,235
20	Channel cleanout on Newton Bayou (8,583 ft) (restore hydrology)	128	14,371	3,593
21	Channel cleanout on West Bayou (9,738 ft) (restore hydrology)	982	110,252	27,563

(Continued)

Table 36. (Concluded)

Feature Number	Feature Description	Baseline Acres	Net Increase in Duck-Use Days (DUDs)	Weighted Duck-Use-Days (DUDs)
22	Channel cleanout on Little Bayou below Lower Vallier structure (24,626 ft) (restore hydrology)	29,103	3,579,219	894,805
23	Ditching in Buckingham Flats impoundment (18,706 ft) (restore hydrology)	1,039	38,254	9,564
25	Channel cleanout on Long Pond Slough (20,935 ft) (restore hydrology)	1,207	127,922	31,981
26	Channel cleanout on Castor Bayou (3,829 ft) (restore hydrology and reduce flooding conflicts with adjacent landowners)	96	10,778	2,695
27	Channel cleanout on Wabbaseka Bayou on west side of Salt Ditch (20,311 ft) (restore hydrology and reduce conflicts with adjacent landowners)	2,337	487,709	121,927
28	Channel cleanout on Wabbaseka Bayou east side of Salt Ditch (4,130 ft) (restore hydrology)	137	24,878	6,220
29	Channel cleanout on Cross Bayou in Government Slough (16,014 ft) (restore hydrology reduce flood problems on adjacent landowners)	1,045	226,338	56,585
31/32	Pump station at confluence of Arkansas River and Little Bayou Meto (1,000 cfs); channel cleanout on Little Bayou Meto between Cannon Brake Control Structure and Arkansas River (51,806 ft); flood control by-pass channel from southwest corner of the WMA to connect with Little Bayou Meto (33,301 ft)	36,000	4,244,557	1,061,139
33/34/37	Salt Ditch water control structure; Dry Bayou Ditch water control structure; and widen Dry Bayou Ditch from Big Bayou Meto to Salt Ditch (10,514 ft) (restore hydrology)	1,850	81,568	20,392
35	East of Cannon Brake water control structure (restore hydrology)	555	41,247	10,312
36	Channel cleanout on Salt Ditch from Hwy 79 to Lower Vallier structure (64,808 ft) (restore hydrology)	22,629	3,169,232	792,308
38	Channel cleanout the old slough on Temple Island (2,419 ft) (restore hydrology)	48	8,542	2,136
	Totals:	**128,535**	**17,177,333**	**4,294,340**

To convert the net increase in DUDs into HSI values (and ultimately into HUs and AAHUs), the DUD calculation was used in reverse to generate the net increase in food deficit per feature. Again, the DUD calculation was:

$$\text{DUD} = \frac{\Sigma\ \text{(acres affected in each area) (food deficit in each area)}}{\text{Daily food consumption of a mallard in winter}}$$

Where daily food consumption of a mallard was estimated at 0.44 lbs food/day (Heitmeyer 2005b). Thus, the net increase in DUDs, the acres affected and 0.44 lbs food/day food consumption estimate were entered into this formula, and the net increase in food deficit per area for each feature was generated. For example, Feature 0/1, “Remove Bubbling Slough Levee (5,571 ft) (restore hydrology) to Dead Stick Area and Ditching on Bubbling Slough (12,002 ft)” affected 417 acres, and provided an increase of 46,818 DUDs. The calculations were made as follows:

$$46{,}818 = \boldsymbol{\Sigma}\ \frac{(417 \text{ acres affected}) \text{ X } (\textbf{Increased Food Deficit})}{0.44 \text{ lbs/day}}$$

$$\textbf{Increased Food Deficit} = \frac{0.44 \text{ X } 46{,}818}{417}$$

Increased Food Deficit = 49.40.

Thus the net increase in food deficit gained for Feature 0/1 was 49.40 lbs/day. The same math was used to derive increases in Food Deficits for the remaining WMA features.

Food deficits for the forested cover types in the region were shown to be optimized at 172.3 lbs/day (Heitmeyer 2005a). By definition, HSIs are generated by comparing the conditions of the site to that of optimum. Thus, an optimum HSI in this region (i.e., scoring 1.0) would be found on a site providing a food deficit equal to 172.3lbs/day. The District made the assumption that all proposed features met this optimum condition, and thus With-project conditions produced the maximum output attainable. Given this assumption, generating the baseline food deficit for each feature is merely a process of subtracting the increase in food deficit from the optimum condition. For example, Feature 0/1 contributed 49.40 lbs/day. The baseline food deficit is derived as follows:

Baseline Food Deficit = Optimum Food Deficit – Net Increase in Food Deficit

Baseline Food Deficit = 172.3 – 49.4

Baseline Food Deficit = 122.90.

The same math was used to derive increases in Food Deficits for the remaining WMA features.

The key to converting these values into HEP-compatible values (i.e., HSIs, HUs, and AAHUs) is re-setting these Food Deficit values to the 0 to 1 scale. To do this, ERDC-EL simply divided the Baseline Food Deficits by the Optimum Food Deficits. For example, at baseline, Feature 0/1 contributed 122.90 lbs/day. The baseline HSI is derived as follows:

$$\textbf{Baseline HSI} = \frac{\text{Baseline Food Deficit}}{\text{Optimum Food Deficit}}$$

Baseline HSI = $\frac{122.90}{172.30}$

Baseline HSI = 0.713.

The same math was used to derive HSIs for the remaining WMA features.

Step 2: Develop Baseline HUs

Continuing along this line of logic, ERDC-EL completed the baseline extrapolations for the WMA features by generating Baseline HUs by multiplying the Baseline HSIs by the Baseline Acres provided in Table 37. These in turn were weighted down by the same factor described above (e.g., 4.0) to account for potential double-counting issues.

Step 3: Develop Without-project and With-project Outputs. If we assume that under the "No Action" scenario, the system remains in a status quo state, then the WOP conditions mimic that of the baseline conditions. Thus, the average annual WOP habitat units are equal to that at baseline. Furthermore, if we assume the maximum output is achieved under the WP scenarios, the total number of WP AAHUs that can be generated by each feature is equal to that of the total number of acres on the site (i.e., if HSI = 1, then 1.0 x acres of site = WP HUs for the site). Therefore, the only thing left to do is calculate the net increase in AAHUs over the life of the project for each feature by subtracting the Baseline/WOP AAHUs from the WP AAHUs. For example, Feature 0/1 had 297 HUs (unweighted) at baseline (e.g., 297 = 417 acres X 0.713 HSI), and has 417 acres that could achieve a 1.0 HSI by TY51. These in turn must be weighted down by a factor of 4.0 (just as we did above) to account for potential double-counting issues. The net AAHUs are derived as follows:

Net AAHUs = WP AAHUs – WOP HUs

Where ; and

WP AAHUs = WP HSI X WP Acres; and

WOP AAHUs = Baseline HSI X Baseline Acres

Net AAHUs = (417 X 1.0) - (417 X 0.713)

Net AAHUs = 120

Weighted Net AAHUs = 120 ÷ 4

Weighted Net AAHUs = 30

The same math was used to derive HSIs for the remaining WMA features.

Table 37. Baseline Habitat Units Generated for the WMA Study Area

Feature Number	Feature Description	Baseline Acres	Baseline HSIs	Baseline HUs	Weighted Baseline HUs
0/1	Remove Bubbling Slough Levee (5,571 ft) (restore hydrology) to Dead Stick Area and Ditching on Bubbling Slough (12,002 ft) (restore hydrology)	417	0.713	297	74
2	Channel cleanout on Five Forks Bayou (25,915 ft) (restore hydrology)	4,293	0.713	3,062	766
3	Channel cleanout on Government Slough (11,676 ft) (restore hydrology)	2,157	0.447	964	241
4	Ditching on Government Impoundment (22,159 ft) and reclaim Dead Stick Area (restore hydrology)	611	0.447	273	68
5/6	Clear noxious woody vegetation on Government Impoundment to reclaim Dead Stick Area and replant desirable vegetation	941	0.447	421	105
7	Channel cleanout on Brushy Slough (16,102 ft) (restore hydrology)	1,746	0.713	1,245	311
8/30	Channel cleanout on Beaver Dam Slough (13,445 ft) and remove Swan Lake levee (2,616 ft) (restore hydrology)	1,869	0.810	1,514	379
9	Channel cleanout on Little Bayou behind Hallowell (14,177 ft) (restore hydrology)	5,071	0.522	2,648	662
10	Channel cleanout on Little Bayou between Salt Ditch and Upper Vallier (2,375 ft) - (improve drainage)	7,829	0.527	4,127	1,032
11	Channel cleanout on Halowell Reservoir perimeter ditch (21,120 ft) (restore hydrology and reduce flooding on adjacent landowners)	615	0.420	258	65
12	Channel cleanout on Tipton Ditch (19,774 ft) (restore hydrology and reduce flooding on adjacent landowners)	764	0.536	410	102
13	Channel cleanout on Hurricane Slough behind Halowell (17,875 ft) (restore hydrology)	3,235	0.536	1,735	434
14	Channel cleanout on Marshall Ditch (19,006 ft) (restore hydrology)	695	0.887	617	154
15	Ditching on northeast corner of dead timber area (7,453 ft) (restore hydrology)	108	0.887	96	24
16	Channel cleanout on Bear Bayou above power line (12,109 ft) (restore hydrology)	779	0.887	691	173
17	Remove Marshall Ditch spoil bank (7,459 ft) (restore hydrology)	137	0.887	122	30
19	Ditching between Bear Bayou Levee and Marshall Ditch and ditching along interior of Bear Bayou Levee (9,101 ft) (restore hydrology)	112	0.887	99	25

(Continued)

Table 37. (Concluded)

Feature Number	Feature Description	Baseline Acres	Baseline HSIs	Baseline HUs	Weighted Baseline HUs
20	Channel cleanout on Newton Bayou (8,583 ft) (restore hydrology)	128	0.713	91	23
21	Channel cleanout on West Bayou (9,738 ft) (restore hydrology)	982	0.713	700	175
22	Channel cleanout on Little Bayou below Lower Vallier structure (24,626 ft) (restore hydrology)	29,103	0.686	19,963	4,991
23	Ditching in Buckingham Flats impoundment (18,706 ft) (restore hydrology)	1,039	0.906	941	235
25	Channel cleanout on Long Pond Slough (20,935 ft) (restore hydrology)	1,207	0.729	880	220
26	Channel cleanout on Castor Bayou (3,829 ft) (restore hydrology and reduce flooding conflicts with adjacent landowners)	96	0.713	68	17
27	Channel cleanout on Wabbaseka Bayou on west side of Salt Ditch (20,311 ft) (restore hydrology and reduce conflicts with adjacent landowners)	2,337	0.467	1,092	273
28	Channel cleanout on Wabbaseka Bayou east side of Salt Ditch (4,130 ft) (restore hydrology)	137	0.536	73	18
29	Channel cleanout on Cross Bayou in Government Slough (16,014 ft) (restore hydrology reduce flood problems on adjacent landowners)	1,045	0.447	467	117
31/32	Pump station at confluence of Arkansas River and Little Bayou Meto (1,000 cfs); channel cleanout on Little Bayou Meto between Cannon Brake Control Structure and Arkansas River (51,806 ft); flood control by-pass channel from southwest corner of the WMA to connect with Little Bayou Meto (33,301 ft)	36,000	0.699	25,161	6,290
33/34/37	Salt Ditch water control structure; Dry Bayou Ditch water control structure; and widen Dry Bayou Ditch from Big Bayou Meto to Salt Ditch (10,514 ft) (restore hydrology)	1,850	0.887	1,642	410
35	East of Cannon Brake water control structure (restore hydrology)	555	0.810	450	112
36	Channel cleanout on Salt Ditch from Hwy 79 to Lower Vallier structure (64,808 ft) (restore hydrology)	22,629	0.642	14,536	3,634
38	Channel cleanout the old slough on Temple Island (2,419 ft) (restore hydrology)	48	0.546	26	7
	Totals:	**128,535**		**84,669**	**21,167**

Results of the DUD conversion to AAHU outputs

In many cases, the net AAHU increases for the proposed features were very low, e.g., less than 50 AAHUs gained over the life of the project (Table 38). However, three features (e.g., Feature 31/32, 22 and 36) provided enormous gains due to their large sizes (in excess of 20,000 acres affected) and significant increases in quality (e.g., HSIs are lifted from ~0.6 to 1.0).

Table 38. WMA Features Ranked by Net AAHU Gains

Rank	Feature Number	Feature Description	Weighted Net AAHU Gain With-project
1	31/32	Pump station at confluence of Arkansas River and Little Bayou Meto (1,000 cfs); channel cleanout on Little Bayou Meto between Cannon Brake Control Structure and Arkansas River (51,806 ft); flood control by-pass channel from southwest corner of the WMA to connect with Little Bayou Meto (33,301 ft)	2,710
2	22	Channel cleanout on Little Bayou below Lower Vallier structure (24,626 ft) (restore hydrology)	2,285
3	36	Channel cleanout on Salt Ditch from Hwy 79 to Lower Vallier structure (64,808 ft) (restore hydrology)	2,023
4	10	Channel cleanout on Little Bayou between Salt Ditch and Upper Vallier (2,375 ft) - (improve drainage)	926
5	9	Channel cleanout on Little Bayou behind Hallowell (14,177 ft) (restore hydrology)	606
6	13	Channel cleanout on Hurricane Slough behind Halowell (17,875 ft) (restore hydrology)	375
7	27	Channel cleanout on Wabbaseka Bayou on west side of Salt Ditch (20,311 ft) (restore hydrology and reduce conflicts with adjacent landowners)	311
8	2	Channel cleanout on Five Forks Bayou (25,915 ft) (restore hydrology)	308
9	3	Channel cleanout on Government Slough (11,676 ft) (restore hydrology)	298
10	29	Channel cleanout on Cross Bayou in Government Slough (16,014 ft) (restore hydrology reduce flood problems on adjacent landowners)	144
11	5/6	Clear noxious woody vegetation on Government Impoundment to reclaim Dead Stick Area and replant desirable vegetation	130
12	7	Channel cleanout on Brushy Slough (16,102 ft) (restore hydrology)	125
13	11	Channel cleanout on Halowell Reservoir perimeter ditch (21,120 ft) (restore hydrology and reduce flooding on adjacent landowners)	89
14	8/30	Channel cleanout on Beaver Dam Slough (13,445 ft) and remove Swan Lake levee (2,616 ft) (restore hydrology)	89
15	12	Channel cleanout on Tipton Ditch (19,774 ft) (restore hydrology and reduce flooding on adjacent landowners)	89
16	4	Ditching on Government Impoundment (22,159 ft) and reclaim Dead Stick Area (restore hydrology)	84
17	25	Channel cleanout on Long Pond Slough (20,935 ft) (restore hydrology)	82
18	21	Channel cleanout on West Bayou (9,738 ft) (restore hydrology)	70
19	33/34/37	Salt Ditch water control structure; Dry Bayou Ditch water control structure; and widen Dry Bayou Ditch from Big Bayou Meto to Salt Ditch (10,514 ft) (restore hydrology)	52
20	0/1	Remove Bubbling Slough Levee (5,571 ft) (restore hydrology) to Dead Stick Area and Ditching on Bubbling Slough (12,002 ft) (restore hydrology)	30

(Continued)

Table 38. (Concluded)

Rank	Feature Number	Feature Description	Weighted Net AAHU Gain With-project
21	35	East of Cannon Brake water control structure (restore hydrology)	26
22	23	Ditching in Buckingham Flats impoundment (18,706 ft) (restore hydrology)	24
23	16	Channel cleanout on Bear Bayou above power line (12,109 ft) (restore hydrology)	22
24	14	Channel cleanout on Marshall Ditch (19,006 ft) (restore hydrology)	20
25	28	Channel cleanout on Wabbaseka Bayou east side of Salt Ditch (4,130 ft) (restore hydrology)	16
26	20	Channel cleanout on Newton Bayou (8,583 ft) (restore hydrology)	9
27	26	Channel cleanout on Castor Bayou (3,829 ft) (restore hydrology and reduce flooding conflicts with adjacent landowners)	7
28	38	Channel cleanout the old slough on Temple Island (2,419 ft) (restore hydrology)	5
29	17	Remove Marshall Ditch spoil bank (7,459 ft) (restore hydrology)	4
30	15	Ditching on northeast corner of dead timber area (7,453 ft) (restore hydrology)	3
31	19	Ditching between Bear Bayou Levee and Marshall Ditch and ditching along interior of Bear Bayou Levee (9,101 ft) (restore hydrology)	3

When affected area is taken into consideration, and we look at the amount of "lift" or net increase in outputs in relation to size, we find that several features provide significant outputs (Figure 26). For example, Feature 11, "Clear noxious woody vegetation on Government Impoundment to reclaim Dead Stick Area and replant desirable vegetation" affects a mere 520 acres, yet we expect to see an increase of more than 58 percent. In fact, six features (i.e., 11, 4, 29, 3, 5/6, and 27) are expected to demonstrate a greater than 50 percent increase in overall productivity.

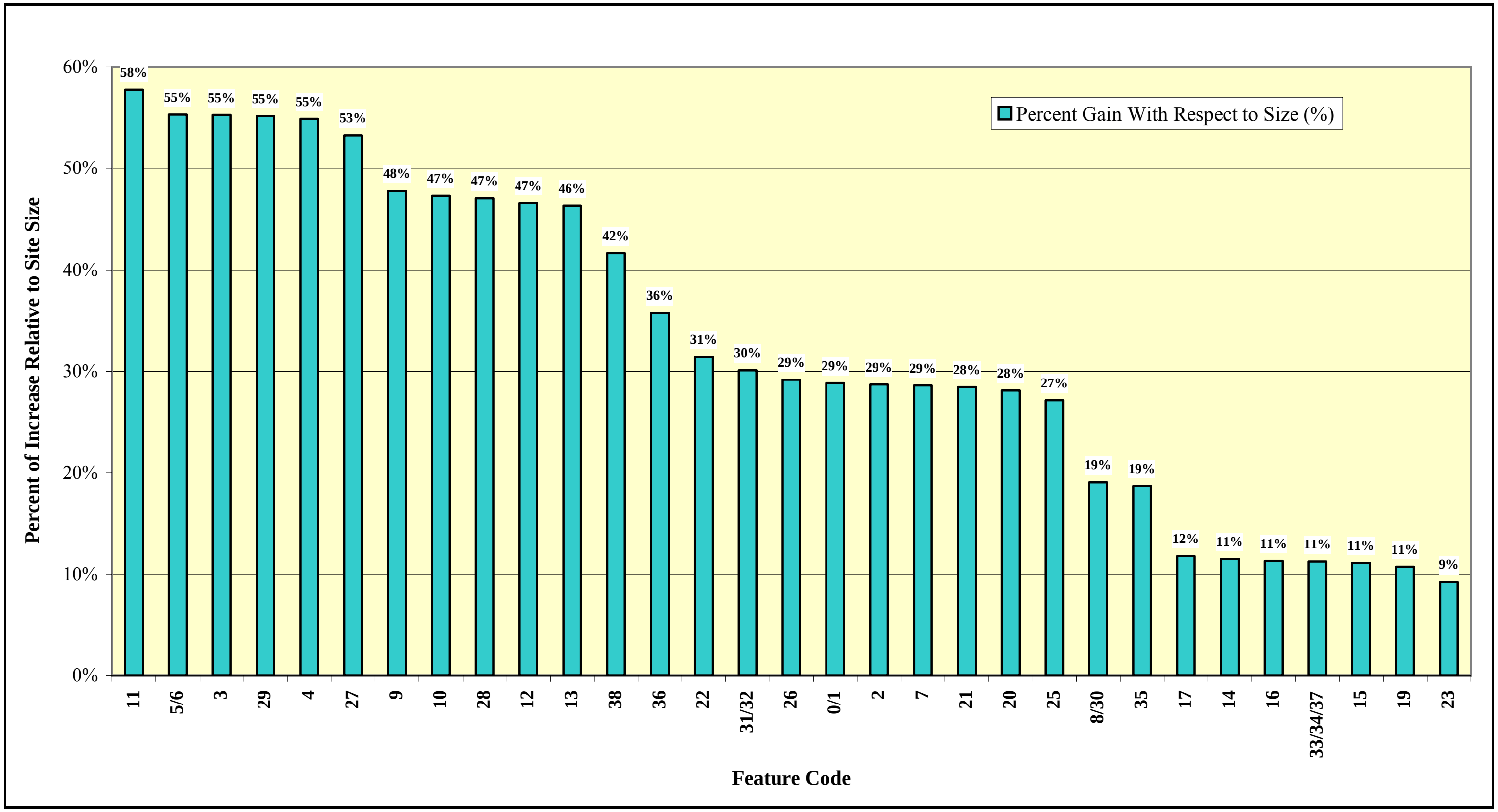

Figure 26. Relative output production for the WMA features of the Bayou Meto study

Dependent Relationships Among Features

Interestingly enough, the interdependency of key activities across the various features was also recognized. By formulating these in a series of dependent alternatives, a more realistic assessment of mobilization costs and operation/maintenance costs was depicted while taking into consideration the cumulative hydrological and ecological benefits of implementing dependant features in a true "alternative plan" approach. Simply put, the following combinations of features are considered dependent upon one another, and thus their HEP outputs must be combined to generate outputs for each alternative design (Table 39).

Table 39. Alternative Plans Formulated Based on Dependant Features

Alternative Plan Code	Alternative Plan Description	Features Combined	With-project Acres Affected	Weighted With-project Acres Affected	Net AAHU Gain With-project	Weighted Net AAHU Gain With-project
A	Lower impoundments	0/1, 2, 7, 21, 25, 26, 27	11,078	2,770	3,734	933
B	Upper impoundments	9, 10, 11, 12, 13, 28	17,651	4,413	8,400	2,101
C	Government impoundments	3, 4, 5/6, 20, 29	4,882	1,221	2,666	665
D	Bear Bayou impoundments	14, 15, 16, 17, 19	1,831	458	206	52
E	Cannon Brake Impoundments	8/30, 35	2,424	606	460	115
F	Ditching in Buckingham Flats impoundment; Pump station; and Channel cleanout on Salt Ditch[1]	22, 31/32, 36	87,732	21,933	28,072	7,018
G	Stand alone	23	1,039	260	98	24
H	Stand alone	33/34/37	1,850	463	208	52
I	Stand alone	38	48	12	22	5

[1]Assumed all plans were dependent upon this alternative plan.

When assessed with this formulation strategy in mind, and with the understanding that all alternatives must be formed in combination with Plan F to succeed, one finds that the most productive alternative design produced in excess of 7,000 AAHUs (Figure 27).

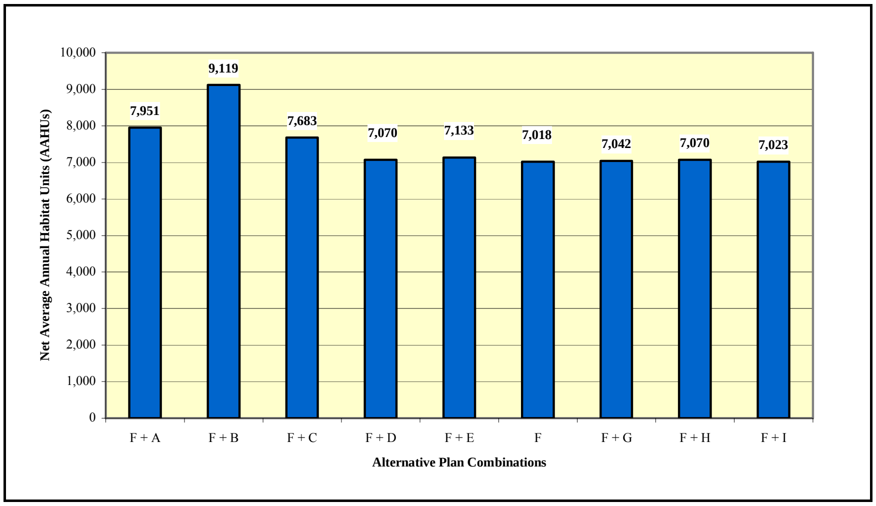

Figure 27. Net AAHU output for the alternative designs on the WMA in the Bayou Meto study

PLAN FORMULATION AND AAHU EXTRAPOLATION

The remainder of this report focuses on the formulation of alternatives for the areas outside the WMA area, but inside the Bayou Meto project boundary. The steps to calculate AAHUs are provided in detail, and the subsequent extrapolation of these AAHU outputs to each measure are then described.

Alternative Development

The project delivery team consulted with ERDC-EL and the inter-agency team during plan formulation. During meetings, ERDC-EL facilitated a plan formulation brainstorming process that resulted in the development of 20 independent measures that, when combined in various fashions, became alternative plans designed to meet the goals and objectives of the study. Below, the formulation process that generated these designs is described in greater detail.

Selection Criteria for Screening Proposed Measures

The inter-agency team was tasked with the development of a series of measures to restore, protect and create waterfowl habitat in the study area. Several functional problems either exist in the baseline condition, or will arise in the future as urban areas and agricultural activities squeeze out the remnant wetland pockets in the study area.

The Bayou Meto re-evaluation study process involved successive formulation iterations that developed and refined solutions to the identified problems. Measures were selected based on the degree to which they addressed study objectives and could take advantage of identified opportunities while remaining within the limitations imposed by the identified constraints. The criteria that are required to be met under Federal planning guidelines are as follows:

- **Technical Feasibility.** Solutions must be technically capable of performing the intended function, have the ability to address the problem, and conform to Corps of Engineers technical standards, regulations, and policies.
- **Environmental Feasibility.** Solutions must comply with all applicable environmental laws, including the National Environmental Policy Act (NEPA).
- **Economic Feasibility.** Solutions must be economically justifiable in that the economic benefits or, in the case of waterfowl habitat ecosystem restoration, non-monetary benefits, must exceed the economic costs, in accordance with applicable regulations, policies, and procedures.
- **Public Feasibility.** Solutions must be acceptable to the public as evidenced by a willing cost-sharing non-Federal sponsor, and further, documented through an open public involvement process that incorporates the public's input into the formulation of the solutions.

In a hierarchical fashion, the study team developed lists of proposed features, measures, and ultimately combinations of measures (i.e., alternatives) to address the study's needs. Measures were evaluated with HEP (and converted DUDs), and both HEP outputs and costs were used for comparisons.

Specific Measures Under Consideration

Measures were actions or stand-alone features that addressed the study's specific problems. There were numerous measures hypothesized to solve problems or improve waterfowl habitat given the site's location, technical considerations, environmental conditions, and a host of other factors. Examples of typical measures developed in this study included "rehabilitating existing bottomland hardwood forest," and "creating 100-foot wide forested buffers," not to mention addressing the WMA issues discussed in the earlier chapters via pump installation and various channel cleanouts. Given the extensive list of design measures proposed, the study team proceeded to screen and eliminate those measures that were: (1) not appropriate for Federal participation, or (2) obviously had low potential for waterfowl habitat restoration benefits. The measures proposed were presented in terms of five broad categories:

1. Wildlife Management Area (WMA) Activities,
2. Herbaceous Wetland Complex Development and Management,
3. Bottomland Hardwood Rehabilitation,
4. Riparian Buffer Creation, and
5. Moist Soil Treatments.

These measures were in turn, scaled to capture the extent and magnitude of potential effort that could be undertaken to create and restore waterfowl habitat in the area. The details of the WMA scaling activities have been described in the previous chapters. The remaining measures were scaled as follows:

1. **Herbaceous Wetland Complex Development and Management**
    a. 5,000 acres of Herbaceous Wetland Complex
        i. Scattered, Disjunct Parcels of Land
        ii. 1 or 2 Contiguous Tracts of Land
    b. 10,000 acres of Herbaceous Wetland Complex
        i. Scattered, Disjunct Parcels of Land
        ii. 1 or 2 Contiguous Tracts of Land
    c. 36,000 acres of Herbaceous Wetland Complex
        i. Scattered, Disjunct Parcels of Land
        ii. 1 or 2 Contiguous Tracts of Land
    d. 100,000 acres of Herbaceous Wetland Complex
2. **Bottomland Hardwood Rehabilitation**
    a. 85,535 acres of Bottomland Hardwood Forest Rehabilitation
        i. Rehabilitation Approach: Natural Succession
        ii. Rehabilitation Approach: Plant 1-2 year old Seedlings
        iii. Rehabilitation Approach: Plant Root Production Method (RPM)[2] Trees
    b. 23,000 acres of Bottomland Hardwood Forest Rehabilitation
        i. Rehabilitation Approach: Natural Succession
        ii. Rehabilitation Approach: Plant 1-2 year old Seedlings
        iii. Rehabilitation Approach: Plant RPM Trees
3. **Riparian Buffer Creation**
    a. 50-foot Buffer Widths
        i. 100 Percent Connected
        ii. 50 Percent Connected
    b. 100-foot Buffer Widths
        i. 100 Percent Connected
        ii. 50 Percent Connected
    c. 300-foot Buffer Widths
        i. 100 Percent Connected
        ii. 50 Percent Connected
4. **Moist Soil Treatments**
    a. Minimum Treatment (120 acres)
    b. Moderate Treatment (240 acres)
    c. Extensive Treatment (480 acres).

Details regarding these various measures can be found in Table 40.

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2 The RPM method was developed by Forest Keeling Nursery in Elsberry, MO (Grossman, Gold and Dey 2003), where the specific nursery culture technique produces a large container-grown seedling that has a dense, fibrous root system. Trees are grown in 3- or 5-gallon containers and attain heights greater than 1.5 meters tall in one or two years in the nursery.

Table 40. The Bayou Meto's Alternative Matrix

Measure Description	Incremental Scale Description	Increment (Scale) Code	Net Acres Gained or Rehabilitated
Wildlife Management Area Pump and Channel Cleanout	Pump Installation and Channel Cleanout at the Wildlife Management Area Site	A	36,000
Herbaceous Wetland Complex Development and Management	5,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C1a	5,000
	5,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C1b	5,000
	10,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C2a	10,000
	10,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C2b	10,000
	36,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C3a	36,000
	36,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C3b	36,000
	100,000 acres of Herbaceous Wetland Complex	C4	100,000
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation - 65,560 acres in the Low Elevations - 19,975 acres in the Intermediate Elevations Rehabilitation Approach: Natural Succession 48,345 acres of Aquatic Habitat	D1a	133,880
	85,535 acres of Bottomland Hardwood Forest Rehabilitation - 65,560 acres in the Low Elevations - 19,975 acres in the Intermediate Elevations Rehabilitation Approach: Plant 1-2 year old Seedlings 48,345 acres of Aquatic Habitat	D1b	133,880

(Continued)

Table 40. (Continued)

Measure Description	Incremental Scale Description	Increment (Scale)	Net Acres Gained or

		Code	Rehabilitated
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation - 65,560 acres in the Low Elevations - 19,975 acres in the Intermediate Elevations Rehabilitation Approach: Plant RPM Trees 48,345 acres of Aquatic Habitat	D1c	133,880
	23,000 acres of Bottomland Hardwood Forest Rehabilitation - 13,000 acres in the Low Elevations - 10,000 acres in the Intermediate Elevations Rehabilitation Approach: Natural Succession 13,000 acres of Aquatic Habitat	D2a	36,000
	23,000 acres of Bottomland Hardwood Forest Rehabilitation - 13,000 acres in the Low Elevations - 10,000 acres in the Intermediate Elevations Rehabilitation Approach: Plant 1-2 year old Seedlings 13,000 acres of Aquatic Habitat	D2b	36,000
	23,000 acres of Bottomland Hardwood Forest Rehabilitation - 13,000 acres in the Low Elevations - 10,000 acres in the Intermediate Elevations Rehabilitation Approach: Plant RPM Trees 13,000 acres of Aquatic Habitat	D2c	36,000
Riparian Buffer Creation	50-foot Buffer Widths	E1a	1,322
	100-foot Buffer Widths	E1b	2,643
	300-foot Buffer Widths	E1c	7,929
	50-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors	E2a	661
	100-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors	E2b	1,322
(Continued)			

Table 40. (Concluded)

Measure Description	Incremental Scale Description	Increment (Scale) Code	Net Acres Gained or Rehabilitated
Riparian Buffer Creation	300-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors	E2c	3,965
Moist Soil Habitats	Minimum Treatment (120 acres)	H1	120
	Moderate Treatment (240 acres)	H2	240
	Extensive Treatment (480 acres)	H3	480

By combining one or more of these 23 measures together, the study team generated a series of 3,136 possible combinations referred to as potential restoration alternatives. These were subsequently screened based on inefficiencies and redundancies, and a final list of 189 alternatives was carried forward into the cost evaluation.

FUTURE CONDITIONS

It was the general consensus of the inter-agency team that the existing conditions of the study area were at an all time low, and that any remaining wetland presence (i.e., quantity) and habitat suitability (i.e., quality) would not change under the predicted future WOP conditions (i.e., the "No Action" plan). With this static trend in mind, the inter-agency team proceeded to develop acreage and HSI projections for the 20 measures proposed by the District (i.e., the WP plans). When possible, the inter-agency team offered suggestions to improve the alternative designs given the goals and objectives developed earlier in the process. As a general rule, the inter-agency team assumed that available barren areas with appropriate topography and soils would be converted to productive wetland settings with flow augmentation, and the existing bottomland hardwood forests would be rehabilitated and protected into perpetuity. In general, measures that maximized potential habitat in terms of area, provided adequate wet-to-dry ratios of complexity, restored hydrology, and were buffered to the greatest extent were assumed to have higher habitat quality than those measures that opted for minimal restoration effort. Native vegetative plantings and aggressive management would further enhance wetland quality.

Calculation and Extrapolation of AAHUs for the Measures

To begin the process of assessing the various measures, ERDC-EL sorted the methods used to assess benefits into categories: waterfowl, terrestrial and aquatics. The following matrix describes the conversions necessary on a measure-by-measure basis (Table 41).

Table 41. Calculations and Extrapolations Needed for the Bayou Meto HEP Assessment

Measure Description	Incremental Scale Description	Increment (Scale) Code	Waterfowl Outputs		Terrestrial Outputs	Aquatic Outputs
			Convert Duck Use Days	Convert King Rail User Days	Average Herbaceous and Terrestrial AAHUs	Sum Aquatic AAHUs
Wildlife Management Area Pump and Channel Cleanout	Pump Installation and Channel Cleanout at the Wildlife Management Area Site	A	X			
Herbaceous Wetland Complex Development and Management	5,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C1a		X	X	
	5,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C1b		X	X	
	10,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C2a		X	X	
	10,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C2b		X	X	
	36,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C3a		X	X	
	36,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C3b		X	X	
	100,000 acres of Herbaceous Wetland Complex	C4		X	X	
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation - 65,560 acres in the Low Elevations - 19,975 acres in the Intermediate Elevations Rehabilitation Approach: Natural Succession 48,345 acres of Aquatic Habitat	D1a	X		X	X

(Continued)

Table 41. (Continued)

Measure Description	Incremental Scale Description	Increment (Scale) Code	Waterfowl Outputs: Convert Duck Use Days	Waterfowl Outputs: Convert King Rail User Days	Terrestrial Outputs: Average Herbaceous and Terrestrial AAHUs	Aquatic Outputs: Sum Aquatic AAHUs
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation - 65,560 acres in the Low Elevations - 19,975 acres in the Intermediate Elevations Rehabilitation Approach: Plant 1-2 year old Seedlings 48,345 acres of Aquatic Habitat	D1b	X		X	X
	85,535 acres of Bottomland Hardwood Forest Rehabilitation - 65,560 acres in the Low Elevations - 19,975 acres in the Intermediate Elevations Rehabilitation Approach: Plant RPM Trees 48,345 acres of Aquatic Habitat	D1c	X		X	X
	23,000 acres of Bottomland Hardwood Forest Rehabilitation - 13,000 acres in the Low Elevations - 10,000 acres in the Intermediate Elevations Rehabilitation Approach: Natural Succession 13,000 acres of Aquatic Habitat	D2a	X		X	X
	23,000 acres of Bottomland Hardwood Forest Rehabilitation - 13,000 acres in the Low Elevations - 10,000 acres in the Intermediate Elevations Rehabilitation Approach: Plant 1-2 year old Seedlings 13,000 acres of Aquatic Habitat	D2b	X		X	X

(Continued)

Table 41. (Concluded)

Measure Description	Incremental Scale Description	Increment (Scale) Code	Waterfowl Outputs: Convert Duck Use Days	Waterfowl Outputs: Convert King Rail User Days	Terrestrial Outputs: Average Herbaceous and Terrestrial AAHUs	Aquatic Outputs: Sum Aquatic AAHUs
Bottomland Hardwood Rehabilitation	23,000 acres of Bottomland Hardwood Forest Rehabilitation - 13,000 acres in the Low Elevations - 10,000 acres in the Intermediate Elevations Rehabilitation Approach: Plant RPM Trees 13,000 acres of Aquatic Habitat	D2c	X		X	X
Riparian Buffer Creation	50-foot Buffer Widths	E1a	X		X	X
	100-foot Buffer Widths	E1b	X		X	X
	300-foot Buffer Widths	E1c	X		X	X
	50-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors	E2a	X		X	X
	100-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors	E2b	X		X	X
	300-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors	E2c	X		X	X
Moist Soil Habitats	Minimum Treatment (120 acres)	H1	X			
	Moderate Treatment (240 acres)	H2	X			
	Extensive Treatment (480 acres)	H3	X			

The following sections describe the various methods to develop AAHUs for each suite of measures.

Measures C1a Through C4: Benefits Gained

CONVERSION OF DUDS TO AAHUS FOR KING RAIL. No king rail HSI model was found for the region; however, this species in particular played a key role in the decision making process. Therefore, ERDC-EL used DUD data to generate a pseudo-model that could be used to alternatively assess the benefits of developing herbaceous wetland complexes (i.e., king rail habitat) for the plan formulation and assessment process. It was assumed that measure C2b would generate optimum conditions for ducks, and one could assume that these conditions would also provide optimum conditions for king rails. ERDC-EL then extrapolated the outputs to generate DUDs for the remaining measures (Table 42).

Table 42. DUD Calculations and Conversions to King Rail TY51 HSIs for Measures C1a Through C4

Increment (Scale) Code	WP Acres	Annualized DUDs	TY51 HSI	Assumptions
C1a	5,000	1,278,409	0.750	Assume fragmentation and fewer acres produce 75 percent of C1b's outputs.
C1b	5,000	1,704,546	1.000	Assume ½ the acreage produces 50 percent of C2b's outputs.
C2a	10,000	2,556,818	0.750	Assume fragmentation and fewer acres produce 75 percent of C2b's outputs.
C2b	10,000	3,409,090	1.000	DUD outputs provided by Corps contractor.
C3a	36,000	9,204,546	0.750	Assume fragmentation and fewer acres produce 75 percent of C3b's outputs.
C3b	36,000	12,272,728	1.000	Comparable to C2b's outputs, but three times the acreage.
C4	100,000	34,090,910	1.000	Comparable to C2b's outputs, but ten times the acreage.

ERDC-EL assumed the smaller measures (i.e., 5,000 acres) would produce only 50 percent of the outputs generated by the optimum conditions (i.e., Measure C1b was 50 percent as productive as C2b). ERDC-EL further assumed that fragmentation would reduce any outputs by 25 percent (i.e., Measure C1a was 75 percent as productive as C1b because it was the same size, but fragmented). These trends were reapplied to the C2a, C3a, and C3b measures. The C4 measure was assumed to be optimal and comparable to the C2b measure, but just larger in size. It was assumed that the maximum HSIs were generated as early as TY10 and continued throughout the period of analysis. Given these assumptions, ERDC-EL developed HSI trends over the period of analysis (Table 43).

Table 43. HSI Trends for Measures C1a Through C4

Increment (Scale) Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
C1a	0.000	**0.188**	**0.375**	**0.375**	**0.375**	**0.375**	Assume fragmentation and fewer acres produce 75 percent of C1b's outputs.
C1b	0.000	**0.250**	**0.500**	**0.500**	**0.500**	**0.500**	Assume ½ the acreage produces 50 percent of C2b's outputs.
C2a	0.000	**0.375**	**0.750**	**0.750**	**0.750**	**0.750**	Assume fragmentation and fewer acres produce 75 percent of C2b's outputs.
C2b	0.000	**0.500**	**1.000**	**1.000**	**1.000**	**1.000**	HSI trends developed by ERDC-EL.
C3a	0.000	**0.375**	**0.750**	**0.750**	**0.750**	**0.750**	Assume fragmentation and fewer acres produce 75 percent of C3b's outputs.
C3b	0.000	**0.500**	**1.000**	**1.000**	**1.000**	**1.000**	Comparable to C2b's outputs, but three times the acreage.
C4	0.000	**0.500**	**1.000**	**1.000**	**1.000**	**1.000**	Comparable to C2b's outputs, but ten times the acreage.

Now, using these HSI trends, the acreages provided in Table 43, and following the AAHU calculation protocol:

$$\textbf{AAHUs} = \sum \textbf{Cumulative HUs} \div \textbf{Number of years in the period of analysis}$$

where:

Cumulative HUs =

$$\sum (T_2 - T_1)\Big[\big((A_1 H_1 + A_2 H_2) \div 3\big) + \big((A_2 H_1 + A_1 H_2) \div 6\big)\Big]$$

and where:

T_1 = First Target Year time interval
T_2 = Second Target Year time interval
A_1 = Area of available wetlands at beginning of T_1
A_2 = Area of available wetlands at end of T_2
H_1 = HSI at beginning of T_1
H_2 = HSI at end of T_2

ERDC-EL developed AAHUs for each measures (Table 44).

Table 44. Net AAHU Gains for Measures C1a Through C4 Based on the DUD Conversions for King Rail

Increment (Scale) Code	WP Acres	Net AAHU Gains
C1a	5,000	1,756
C1b	5,000	2,341
C2a	10,000	7,022
C2b	10,000	9,363
C3a	36,000	25,279
C3b	36,000	33,706
C4	100,000	93,627

CALCULATION AND EXTRAPOLATION OF TERRESTRIAL BENEFITS. The inter-agency team selected a suite of herbaceous-dependant, species-based HSI models to assess the gains generated as a result of the proposed Herbaceous Wetland Complex Measures C1a through C4. The species list included: Prairie Chicken, Bobwhite Quail, Dickcissel, and Cottontail Rabbit. The inter-agency team generated HSIs for Measure C2b, and ERDC-EL based extrapolations of the remaining measures on these values (Table 45).

Table 45. Terrestrial HSI Trends for Measures C1a Through C4

Species Model	Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
Prairie Chicken	C1a	0.000	**0.300**	**0.300**	**0.300**	**0.300**	**0.300**	Assume fragmentation and fewer acres produce 75 percent of C1b's outputs.
	C1b	0.000	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	Assume ½ the acreage produces 50 percent of C2b's outputs.
	C2a	0.000	**0.600**	**0.600**	**0.600**	**0.600**	**0.600**	Assume fragmentation and fewer acres produce 75 percent of C2b's outputs.
	C2b	0.000	**0.800**	**0.800**	**0.800**	**0.800**	**0.800**	Outputs provided by inter-agency team.
	C3a	0.000	**0.600**	**0.600**	**0.600**	**0.600**	**0.600**	Assume fragmentation and fewer acres produce 75 percent of C3b's outputs.
	C3b	0.000	**0.800**	**0.800**	**0.800**	**0.800**	**0.800**	Comparable to C2b's outputs, but three times the acreage.
	C4	0.000	**0.800**	**0.800**	**0.800**	**0.800**	**0.800**	Comparable to C2b's outputs, but ten times the acreage.

(Continued)

Table 45. (Concluded)

Species Model	Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
Bobwhite Quail	C1a	0.000	**0.285**	**0.285**	**0.285**	**0.285**	**0.285**	Assume fragmentation and fewer acres produce 75 percent of C1b's outputs.
	C1b	0.000	**0.380**	**0.380**	**0.380**	**0.380**	**0.380**	Assume ½ the acreage produces 50 percent of C2b's outputs.
	C2a	0.000	**0.570**	**0.570**	**0.570**	**0.570**	**0.570**	Assume fragmentation and fewer acres produce 75 percent of C2b's outputs.
	C2b	0.000	**0.760**	**0.760**	**0.760**	**0.760**	**0.760**	Outputs provided by inter-agency teamr.
	C3a	0.000	**0.570**	**0.570**	**0.570**	**0.570**	**0.570**	Assume fragmentation and fewer acres produce 75 percent of C3b's outputs.
	C3b	0.000	**0.760**	**0.760**	**0.760**	**0.760**	**0.760**	Comparable to C2b's outputs, but three times the acreage.
	C4	0.000	**0.760**	**0.760**	**0.760**	**0.760**	**0.760**	Comparable to C2b's outputs, but ten times the acreage.
Dickcissel	C1a	0.000	**0.334**	**0.334**	**0.334**	**0.334**	**0.334**	Assume fragmentation and fewer acres produce 75 percent of C1b's outputs.
	C1b	0.000	**0.445**	**0.445**	**0.445**	**0.445**	**0.445**	Assume ½ the acreage produces 50 percent of C2b's outputs.
	C2a	0.000	**0.668**	**0.668**	**0.668**	**0.668**	**0.668**	Assume fragmentation and fewer acres produce 75 percent of C2b's outputs.
	C2b	0.000	**0.890**	**0.890**	**0.890**	**0.890**	**0.890**	Outputs provided by inter-agency team.
	C3a	0.000	**0.668**	**0.668**	**0.668**	**0.668**	**0.668**	Assume fragmentation and fewer acres produce 75 percent of C3b's outputs.
	C3b	0.000	**0.890**	**0.890**	**0.890**	**0.890**	**0.890**	Comparable to C2b's outputs, but three times the acreage.
	C4	0.000	**0.890**	**0.890**	**0.890**	**0.890**	**0.890**	Comparable to C2b's outputs, but ten times the acreage.
Cottontail Rabbit	C1a	0.000	**0.195**	**0.195**	**0.195**	**0.195**	**0.195**	Assume fragmentation and fewer acres produce 75 percent of C1b's outputs.
	C1b	0.000	**0.260**	**0.260**	**0.260**	**0.260**	**0.260**	Assume ½ the acreage produces 50 percent of C2b's outputs.
	C2a	0.000	**0.390**	**0.390**	**0.390**	**0.390**	**0.390**	Assume fragmentation and fewer acres produce 75 percent of C2b's outputs.
	C2b	0.000	**0.520**	**0.520**	**0.520**	**0.520**	**0.520**	Outputs provided by inter-agency team.
	C3a	0.000	**0.390**	**0.390**	**0.390**	**0.390**	**0.390**	Assume fragmentation and fewer acres produce 75 percent of C3b's outputs.
	C3b	0.000	**0.520**	**0.520**	**0.520**	**0.520**	**0.520**	Comparable to C2b's outputs, but three times the acreage.
	C4	0.000	**0.520**	**0.520**	**0.520**	**0.520**	**0.520**	Comparable to C2b's outputs, but ten times the acreage.

Again, ERDC-EL assumed the smaller measures (i.e., 5,000 acres) were assumed to produce only 50 percent of the outputs generated by the optimum conditions (i.e., Measure C1b was 50 percent as productive as C2b). ERDC-EL further assumed that fragmentation would reduce any outputs by 25 percent (i.e., Measure C1a was 75 percent as productive as C1b because it was the same size, but fragmented). These trends were reapplied to the C2a, C3a, and C3b measures. The C4 measure was assumed to be optimal and comparable to the C2b measure, but just larger in size. It was assumed that the maximum HSIs were generated as early as TY10 and continued throughout the life of the project.

Using these HSI trends and their associated acreages, and following the AAHU calculation protocol, ERDC-EL developed AAHUs for each species model under each proposed measure (Table 46).

Table 46. Terrestrial Net AAHU Gains for Measures C1a Through C4

Increment (Scale) Code	Prairie Chicken	Bobwhite Quail	Dickcissel	Cottontail Rabbit	Averaged Herbaceous Wetland Complex AAHUs Gained
C1a	1,480	1,406	1,647	962	**1,374**
C1b	1,974	1,875	2,196	1,283	**1,832**
C2a	5,922	5,625	6,588	3,849	**5,496**
C2b	7,895	7,501	8,784	5,132	**7,328**
C3a	21,318	20,252	23,716	13,856	**19,786**
C3b	28,424	27,002	31,621	18,475	**26,381**
C4	78,954	75,007	87,837	51,320	**73,280**

Because the species use the same plot of ground, ERDC-EL averaged their outcomes weighting them equally amongst themselves, and generated a net gain per proposed measure.

<u>Measures D1a Through D2c: Benefits Gained</u>

CONVERSION OF DUDS TO AAHUS FOR WATERFOWL. Just as described in the previous chapters, DUDs were converted to HSIs for the waterfowl habitat generated in Bottomland Hardwood Rehabilitation Measures D1a through Measures D2c (Table 47).

Table 47. DUD Calculations and Conversions to TY51 HSIs for Measures D1a Through D2c

Increment (Scale) Code	WP Acres	Annualized DUDs	Difference Food Deficit	TY51 HSI
D1a	85,535	5,471,407	28.1	0.200
D1b	85,535	43,087,327	221.6	1.000
D1c	85,535	50,926,169	262.0	1.000
D2a	23,000	2,716,132	52.0	0.200
D2b	23,000	11,586,000	221.6	1.000
D2c	23,000	13,693,832	262.0	1.000

The inter-agency team assumed that the majority of measures would achieve a 1.0 HSI by TY50 with 2 exceptions (e.g., D1a and D2a), which would generate no better than a 0.20 HSI under the natural succession scenarios. Given these project TY51 HSIs, ERDC-EL developed HSI trends over the life of the study (Table 48).

Table 48. HSI Trends for Measures D1a Through D2c

Increment (Scale) Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
D1a	0.000	0.000	0.000	**0.100**	**0.200**	**0.200**	Assumed the measure never reached optimal (mast producing) forest.
D1b	0.000	**0.300**	**0.500**	**1.000**	**1.000**	**1.000**	Assumed the measure reached 1.0 later than D1c.
D1c	0.000	**0.600**	**1.000**	**1.000**	**1.000**	**1.000**	Assumed the measure reached 1.0 earlier than D1b.
D2a	0.000	0.000	0.000	**0.100**	**0.200**	**0.200**	Assumed the measure never reached optimal (mast producing) forest.
D2b	0.000	**0.300**	**0.500**	**1.000**	**1.000**	**1.000**	Assumed the measure can achieve a 1.0 by TY51.
D2c	0.000	**0.600**	**1.000**	**1.000**	**1.000**	**1.000**	Assumed the measure reached 1.0 earlier than D2b.

The differences between measures "b" and "c" were the size of trees planted. In the "c" measures, ERDC-EL assumed the forest reached optimum conditions earlier than "b" measures because RPM trees were planted.

Using these HSI trends and their associated acreages, and following the AAHU calculation protocol, ERDC-EL developed AAHUs for each measure (Table 49).

Table 49. Net AAHU Gains for Measures D1a Through D2c Based on the DUD Conversions

Increment (Scale) Code	WP Acres	Net AAHU Gains
D1a	85,535	8,721
D1b	85,535	68,680
D1c	85,535	81,174
D2a	23,000	2,345
D2b	23,000	18,468
D2c	23,000	21,827

CALCULATION AND EXTRAPOLATION OF TERRESTRIAL BENEFITS. The inter-agency team selected a suite of terrestrial, species-based HSI models to assess the gains generated as a result of the proposed Measures D1a through D2c. The species list included: Wood Duck, Pileated Woodpecker, Mink, Barred Owl, Gray Squirrel, and Carolina Chickadee (Table 50).

Table 50. Terrestrial HSI Trends for Measures D1a Through D2c

Species Model	Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
Wood Duck	D1a	0.000	0.000	**0.080**	**0.059**	**0.059**	**0.059**	Assumed 10 percent of potential of D2b
	D1b	0.000	0.000	**0.800**	**0.590**	**0.590**	**0.590**	HSIs from Corps contractor
	D1c	0.000	**0.800**	**1.000**	**0.800**	**0.700**	**0.600**	Assumed HSIs increased overall in a trend similar to that of D2b, but change occurred at a quicker rate and was 0.1 higher.
	D2a	0.000	0.000	**0.080**	**0.059**	**0.059**	**0.059**	Same assumptions as D1a.
	D2b	0.000	0.000	**0.800**	**0.590**	**0.590**	**0.590**	Same assumptions as D1b.
	D2c	0.000	**0.800**	**1.000**	**0.800**	**0.700**	**0.600**	Same assumptions as D1c.
Pileated Woodpecker	D1a	0.000	0.000	0.000	0.000	**0.045**	**0.090**	Assumed 10 percent of potential of D2b
	D1b	0.000	0.000	0.000	0.000	**0.450**	**0.900**	HSIs from Corps contractor
	D1c	0.000	**0.450**	**0.900**	**0.900**	**0.900**	**0.900**	Assumed HSIs increased overall in a trend similar to that of D2b, but change occurred at a quicker rate and was 0.1 higher.
	D2a	0.000	0.000	0.000	0.000	**0.045**	**0.090**	Same assumptions as D1a.
	D2b	0.000	0.000	0.000	0.000	**0.450**	**0.900**	Same assumptions as D1b.
	D2c	0.000	**0.450**	**0.900**	**0.900**	**0.900**	**0.900**	Same assumptions as D1c.
Mink	D1a	0.000	0.000	**0.085**	**0.058**	**0.045**	**0.033**	Assumed 10 percent of potential of D2b
	D1b	0.000	0.000	**0.850**	**0.580**	**0.450**	**0.330**	HSIs from Corps contractor
	D1c	0.000	**0.850**	**0.950**	**0.850**	**0.750**	**0.500**	Assumed HSIs increased overall in a trend similar to that of D2b, but change occurred at a quicker rate and was 0.1 higher.
	D2a	0.000	0.000	**0.085**	**0.058**	**0.045**	**0.033**	Same assumptions as D1a.
	D2b	0.000	0.000	**0.850**	**0.580**	**0.450**	**0.330**	Same assumptions as D1b.
	D2c	0.000	**0.850**	**0.950**	**0.850**	**0.750**	**0.500**	Same assumptions as D1c.

(Continued)

Table 50. (Concluded)

Species Model	Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
Barred Owl	D1a	0.000	0.000	0.000	0.000	**0.070**	**0.090**	Assumed 10 percent of potential of D2b
	D1b	0.000	0.000	0.000	0.000	**0.700**	**0.900**	HSIs from Corps contractor
	D1c	0.000	**0.500**	**0.700**	**0.800**	**0.900**	**0.900**	Assumed HSIs increased overall in a trend similar to that of D2b, but change occurred at a quicker rate and was 0.1 higher.
	D2a	0.000	0.000	0.000	0.000	**0.070**	**0.090**	Same assumptions as D1a.
	D2b	0.000	0.000	0.000	0.000	**0.700**	**0.900**	Same assumptions as D1b.
	D2c	0.000	**0.500**	**0.700**	**0.800**	**0.900**	**0.900**	Same assumptions as D1c.
Gray Squirrel	D1a	0.000	0.000	0.000	**0.045**	**0.070**	**0.085**	Assumed 10 percent of potential of D2b
	D1b	0.000	0.000	0.000	**0.450**	**0.700**	**0.850**	HSIs from Corps contractor
	D1c	0.000	**0.500**	**0.700**	**0.800**	**0.900**	**0.900**	Assumed HSIs increased overall in a trend similar to that of D2b, but change occurred at a quicker rate and was 0.1 higher.
	D2a	0.000	0.000	0.000	**0.045**	**0.070**	**0.085**	Same assumptions as D1a.
	D2b	0.000	0.000	0.000	**0.450**	**0.700**	**0.850**	Same assumptions as D1b.
	D2c	0.000	**0.500**	**0.700**	**0.800**	**0.900**	**0.900**	Same assumptions as D1c.
Carolina Chickadee	D1a	0.000	0.000	**0.020**	**0.050**	**0.060**	**0.060**	Assumed 10 percent of potential of D2b
	D1b	0.000	0.000	**0.200**	**0.500**	**0.600**	**0.600**	HSIs from Corps contractor
	D1c	0.000	**0.500**	**0.600**	**0.700**	**0.800**	**0.800**	Assumed HSIs increased overall in a trend similar to that of D2b, but change occurred at a quicker rate and was 0.1 higher.
	D2a	0.000	0.000	**0.020**	**0.050**	**0.060**	**0.060**	Same assumptions as D1a.
	D2b	0.000	0.000	**0.200**	**0.500**	**0.600**	**0.600**	Same assumptions as D1b.
	D2c	0.000	**0.500**	**0.600**	**0.700**	**0.800**	**0.800**	Same assumptions as D1c.

The inter-agency team and ERDC-EL assumed that the lowest effort (restoration based on natural succession, e.g., D1a and D2a) was not likely to produce optimum conditions, and in fact would only achieve 10 percent of optimum each target year thereafter. The group also assumed that restoration based on RPM tree plantings was likely to be highly successful in a quicker period of time - achieving optimum conditions within 10 years of construction (e.g., measures D1c and D2c), and then emulating the trends prescribed under D1b and D2b. Again, the differences between measures “1” and “2” were strictly acreage variations. Under the “1” scenarios, 85,535 acres were rehabilitated. Under the “2” scenarios, 23,000 acres were rehabilitated.

Using these HSI trends and their associated acreages, and following the AAHU calculation protocol, ERDC-EL developed AAHUs for each species model under each proposed measure (Table 51).

Table 51. Terrestrial Net AAHU Gains for Measures D1a Through D2c

Increment (Scale) Code	Wood Duck	Pileated Woodpecker	Mink	Barred Owl	Gray Squirrel	Carolina Chickadee	Averaged Terrestrial AAHUs Gained
D1a	4,925	1,811	4,455	2,356	3,442	3,522	**3,419**
D1b	49,250	18,113	44,554	23,564	34,424	35,220	**34,188**
D1c	67,534	72,327	68,358	66,192	66,192	58,561	**66,527**
D2a	1,324	487	1,198	634	926	947	**919**
D2b	13,243	4,871	11,980	6,336	9,256	9,471	**9,193**
D2c	18,159	19,449	18,381	17,799	17,799	15,747	**17,889**

Because the species use the same plot of ground, ERDC-EL averaged their outcomes weighting them equally amongst themselves, and generated a net gain per proposed measure.

CALCULATION AND EXTRAPOLATION OF AQUATIC BENEFITS. The inter-agency team selected a suite of aquatic, species-based HSI models to assess the gains generated as a result of the proposed Measures D1a through D2c. These models were based on community associations rather than species indicators. The focus community for the assessment was the spawning and rearing habitats for warm water fish species (Table 52).

Table 52. Aquatic HSI Trends for Measures D1a Through D2c

Species Model	Code	TY0	TY1	TY10	TY25	TY40	TY51
Aquatic Community Improvements for Spawning and Rearing Habitat	D1a	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	D1b	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	D1c	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	D2a	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	D2b	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	D2c	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**

The inter-agency team determined that all measures were equal in terms of the contribution of forest to aquatic habitat. Thus, it was assumed the aquatic habitat quality would gradually improve over time as the fallow fields converted to mature forest, and that no noticeable difference could be discerned between the various proposed measures. Again, the differences between measures "1" and "2" were strictly acreage variations. Under the "1" scenarios, 48,345 acres were rehabilitated to improve spawning and rearing. Under the "2" scenarios, 13,000 acres were rehabilitated to improve spawning and rearing.

Using these HSI trends and their associated acreages, and following the AAHU calculation protocol, ERDC-EL developed AAHUs for each species model under each proposed measure (Table 53).

Table 53. Aquatic Net AAHU Gains for D1a Through D2c

Increment (Scale) Code	Spawning and Rearing Community AAHUs	Summed Aquatic AAHUs Gained
D1a	32,941	32,941
D1b	32,941	32,941
D1c	32,941	32,941
D2a	8,858	8,858
D2b	8,858	8,858
D2c	8,858	8,858

Measures E1a Through E2c: Benefits Gained

CONVERSION OF DUDS TO AAHUS FOR BUFFER BENEFITS. A more straightforward approach was used to generate AAHUs for the proposed buffer measures (e.g., E1a through E2c) than seen previously in the "D" measures. The inter-agency team assumed 300-feet buffers would provide optimum conditions for waterfowl (HSI = 1.0). Thus, 100-feet buffers would only provide 1/3 of this optimum (HSI = 0.30), and 50-feet buffers would provide only 15 percent of the optimum (HSI = 0.15). Using these estimates, ERDC-EL generated the following trends (Table 54).

Table 54. DUD HSI Trends for Measures E1a Through E2c

Increment (Scale) Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
E1a	0.000	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**	Assume 50-ft corridors are equal to 15 percent of optimum.
E1b	0.000	**0.300**	**0.300**	**0.300**	**0.300**	**0.300**	Assume 100-ft corridors are equal to 30 percent of optimum.
E1c	0.000	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	Assume 300-ft corridors are equal to optimum HSI (1.0).
E2a	0.000	**0.075**	**0.075**	**0.075**	**0.075**	**0.075**	Assume 50-ft fragmented corridors are equal to one-half E1a, or 7.5 percent of optimum.
E2b	0.000	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**	Assume 100-ft fragmented corridors are equal to one-half E1b, or 15 percent of optimum.
E2c	0.000	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	Assume 300-ft fragmented corridors are equal to one-half E1c, or 50 percent of optimum.

The difference between measures "1" and "2" was availability of land that could be converted easily to buffer. Rather than connecting all forests along the river, the inter-agency team assumed only fragmented portions of the riparian zone might serve as a less dramatic buffering, and thus the total number of acres purchased and planted as buffers was less (e.g., ½ the acreage). The following acres were used again as the proposed buffers for measures E1a through E2c:

1. E1a = 1,322 acres,
2. E1b = 2,643 acres,
3. E1c = 7,929 acres,
4. E2a = 661 acres,
5. E2b = 1,322 acres, and
6. E2c = 3,965 acres.

Using these HSI trends and their associated acreages, and following the AAHU calculation protocol, ERDC-EL developed AAHUs for each measure (Table 55).

Table 55. Net AAHU Gains for Measures E1a Through E2c Based on the DUD Conversions

Increment (Scale) Code	WP Acres	Net AAHU Gains
E1a	1,322	196
E1b	2,643	783
E1c	7,929	7,825
E2a	661	49
E2b	1,322	196
E2c	3,965	1,956

CALCULATION AND EXTRAPOLATION OF TERRESTRIAL BENEFITS. The inter-agency team used the same species models described above in the "D" measures section to assess the terrestrial benefits of the "E" measures. A contractor generated HSIs for Measure E1b. ERDC-EL based its extrapolations of the remaining measures on these values (Table 56).

Table 56. Terrestrial HSI Trends for Measures E1a through E2c

Species Model	Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
Wood Duck	E1a	0.000	0.000	**0.120**	**0.089**	**0.089**	**0.089**	HSIs are 15 percent of E1b.
	E1b	0.000	0.000	**0.800**	**0.590**	**0.590**	**0.590**	HSIs from Corps contractor
	E1c	0.000	0.000	**1.000**	**1.000**	**1.000**	**1.000**	Assume 300-ft. corridors achieve optimum (HSI = 1.0) sooner than E1b.
	E2a	0.000	0.000	**0.060**	**0.044**	**0.044**	**0.044**	Assume 50-ft. fragmented corridors = 1/2 E1a.
	E2b	0.000	0.000	**0.400**	**0.295**	**0.295**	**0.295**	Assume 100-ft. fragmented corridors = 1/2 E1b.
	E2c	0.000	0.000	**0.500**	**0.500**	**0.500**	**0.500**	Assume 300-ft. fragmented corridors = 1/2 E1c.
Pileated Woodpecker	E1a	0.000	0.000	0.000	0.000	**0.068**	**0.135**	HSIs are 15 percent of E1b.
	E1b	0.000	0.000	0.000	0.000	**0.450**	**0.900**	HSIs from Corps contractor
	E1c	0.000	0.000	0.000	0.000	**1.000**	**1.000**	Assume 300-ft. corridors achieve optimum (HSI = 1.0) sooner than E1b.
	E2a	0.000	0.000	0.000	0.000	**0.034**	**0.068**	Assume 50-ft. fragmented corridors = 1/2 E1a.
	E2b	0.000	0.000	0.000	0.000	**0.225**	**0.450**	Assume 100-ft. fragmented corridors = 1/2 E1b.
	E2c	0.000	0.000	0.000	0.000	**0.500**	**0.500**	Assume 300-ft. fragmented corridors = 1/2 E1c.
Mink	E1a	0.000	0.000	**0.128**	**0.087**	**0.068**	**0.050**	HSIs are 15 percent of E1b.
	E1b	0.000	0.000	**0.850**	**0.580**	**0.450**	**0.330**	HSIs from Corps contractor
	E1c	0.000	0.000	**1.000**	**1.000**	**1.000**	**1.000**	Assume 300-ft. corridors achieve optimum (HSI = 1.0) sooner than E1b.
	E2a	0.000	0.000	**0.064**	**0.044**	**0.034**	**0.025**	Assume 50-ft. fragmented corridors = 1/2 E1a.
	E2b	0.000	0.000	**0.425**	**0.290**	**0.225**	**0.165**	Assume 100-ft. fragmented corridors = 1/2 E1b.
	E2c	0.000	0.000	**0.500**	**0.500**	**0.500**	**0.500**	Assume 300-ft. fragmented corridors = 1/2 E1c.
Barred Owl	E1a	0.000	0.000	0.000	0.000	**0.105**	**0.135**	HSIs are 15 percent of E1b.
	E1b	0.000	0.000	0.000	0.000	**0.700**	**0.900**	HSIs from Corps contractor
	E1c	0.000	0.000	0.000	0.000	**1.000**	**1.000**	Assume 300-ft. corridors achieve optimum (HSI = 1.0) sooner than E1b.
	E2a	0.000	0.000	0.000	0.000	**0.053**	**0.068**	Assume 50-ft. fragmented corridors = 1/2 E1a.
	E2b	0.000	0.000	0.000	0.000	**0.350**	**0.450**	Assume 100-m fragmented corridors = 1/2 E1b.
	E2c	0.000	0.000	0.000	0.000	**0.500**	**0.500**	Assume 300-ft. fragmented corridors = 1/2 E1c.

(Continued)

Table 56. (Concluded)

Species Model	Code	TY0	TY1	TY10	TY25	TY40	TY51	Assumptions
Gray Squirrel	E1a	0.000	0.000	0.000	0.068	0.105	0.128	HSIs are 15 percent of E1b.
	E1b	0.000	0.000	0.000	**0.450**	**0.700**	**0.850**	HSIs from Corps contractor
	E1c	0.000	0.000	0.000	**1.000**	**1.000**	**1.000**	Assume 300-ft. corridors achieve optimum (HSI = 1.0) sooner than E1b.
	E2a	0.000	0.000	0.000	0.034	0.053	0.064	Assume 50-ft. fragmented corridors = 1/2 E1a.
	E2b	0.000	0.000	0.000	**0.225**	**0.350**	**0.425**	Assume 100-ft. fragmented corridors = 1/2 E1b.
	E2c	0.000	0.000	0.000	**0.500**	**0.500**	**0.500**	Assume 300-ft. fragmented corridors = 1/2 E1c.
Carolina Chickadee	E1a	0.000	0.000	0.030	0.075	0.090	0.090	HSIs are 15 percent of E1b.
	E1b	0.000	0.000	**0.200**	**0.500**	**0.600**	**0.600**	HSIs from Corps contractor
	E1c	0.000	0.000	**1.000**	**1.000**	**1.000**	**1.000**	Assume 300-ft. corridors achieve optimum (HSI = 1.0) sooner than E1b.
	E2a	0.000	0.000	0.015	0.038	0.045	0.045	Assume 50-ft. fragmented corridors = 1/2 E1a.
	E2b	0.000	0.000	**0.100**	**0.250**	**0.300**	**0.300**	Assume 100-ft. fragmented corridors = 1/2 E1b.
	E2c	0.000	0.000	**0.500**	**0.500**	**0.500**	**0.500**	Assume 300-ft. fragmented corridors = 1/2 E1c.

Using the same assumptions implemented in the DUD conversion process, ERDC-EL made the assumption that the creation of a 50-foot continuous buffer restoration based on natural succession (e.g., E1a) was not likely to produce optimum conditions, and in fact would only achieve 15 percent of E1b's output on a target year-by-target year basis. ERDC-EL further assumed that the creation of a 300-foot continuous buffer would be highly successful, and would provide protection sooner than the E1b measure. Thus, optimum conditions were achieved as early as TY10.

The difference between measures "1" and "2" was availability of land that could be converted easily to buffer. Rather than connecting all forests along the river, the inter-agency team assumed only fragmented portions of the riparian zone might serve as a less dramatic buffering, and thus the total number of acres purchased and planted as buffers was less (e.g., ½ the acreage). The following acres were proposed as buffer measures E1a through E2c:

1. E1a = 1,322 acres,
2. E1b = 2,643 acres,
3. E1c = 7,929 acres,
4. E2a = 661 acres,
5. E2b = 1,322 acres, and
6. E2c = 3,965 acres.

Using these HSI trends and their associated acreages, and following the AAHU calculation protocol, ERDC-EL developed AAHUs for each species model under each proposed measure (Table 57).

Table 57. Terrestrial Net AAHU Gains for Measures E1a through E2c

Increment (Scale) Code	Wood Duck	Pileated Woodpecker	Mink	Barred Owl	Gray Squirrel	Carolina Chickadee	Averaged Terrestrial AAHUs Gained
E1a	114	42	103	55	80	82	79
E1b	1,522	560	1,377	728	1,064	1,088	1,057
E1c	7,074	2,876	7,074	2,876	5,208	7,074	5,364
E2a	29	10	26	14	20	20	20
E2b	381	140	344	182	266	272	264
E2c	1,769	719	1,769	719	1,302	1,769	1,341

Because the species use the same plot of ground, ERDC-EL averaged their outcomes weighting them equally amongst themselves, and generated a net gain per proposed measure.

CALCULATION AND EXTRAPOLATION OF AQUATIC BENEFITS. The inter-agency team selected a suite of aquatic, species-based HSI models to assess the gains generated as a result of the proposed Measures E1a through E2c. These models were based on community associations rather than species indicators. The communities of focus included: warm water species associated with in-channel habitats and spawning/rearing habitats. Table 58 displays HSI values for Measures E1a through E2c.

Table 58. Aquatic HSI Trends for Measures E1a Through E2c

Species Model	Code	TY0	TY1	TY10	TY25	TY40	TY51
Aquatic Community Improvements for Spawning and Rearing Habitat	E1a	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	E1b	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	E1c	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	E2a	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	E2b	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
	E2c	0.200	0.500	0.750	**1.000**	**1.000**	**1.000**
In-Channel Aquatic Community Habitat Improvements	E1a	0.250	0.325	**1.000**	**1.000**	**1.000**	**1.000**
	E1b	0.250	0.325	**1.000**	**1.000**	**1.000**	**1.000**
	E1c	0.250	0.325	**1.000**	**1.000**	**1.000**	**1.000**
	E2a	0.250	0.325	**1.000**	**1.000**	**1.000**	**1.000**
	E2b	0.250	0.325	**1.000**	**1.000**	**1.000**	**1.000**
	E2c	0.250	0.325	**1.000**	**1.000**	**1.000**	**1.000**

It was assumed that all scales in this measure achieved optimum results by no later than TY25. Again, the difference between measures "1" and "2" was availability of land that could be converted easily to buffer. Rather than connecting all forests along the river, the inter-agency team assumed only fragmented portions of the riparian zone might serve as a less dramatic buffering, and thus the total number of acres purchased and planted as buffers was less (e.g., ½ the acreage). The following acres were associated with spawning and rearing habitat under the buffer measures E1a through E2c:

1. E1a = 902 acres,
2. E1b = 1,804 acres,
3. E1c = 5,412 acres,
4. E2a = 451 acres,
5. E2b = 902 acres, and
6. E2c = 2,706 acres.

Assuming 218 acres already exist as in-channel habitat pre-project, the following acres were associated with in-channel habitat under the buffer measures E1a through E2c:

1. E1a = 277 acres,
2. E1b = 277 acres,
3. E1c = 277 acres,
4. E2a = 248 acres,
5. E2b = 248 acres, and
6. E2c = 248 acres.

Using these HSI trends and their associated acreages, and following the AAHU calculation protocol, ERDC-EL developed AAHUs for each species model under each proposed measure (Table 59).

Table 59. Aquatic Net AAHU Gains for E1a Through E2c

Increment (Scale) Code	Spawning and Rearing Community AAHUs	In-Channel	Summed Aquatic AAHUs Gained
E1a	615	202	**817**
E1b	1,229	202	**1,431**
E1c	3,688	202	**3,890**
E2a	307	175	**482**
E2b	615	175	**790**
E2c	1,844	175	**2,019**

<u>Measures H1 Through H3: Benefits Gained</u>

CONVERSION OF DUDS TO AAHUS FOR WATERFOWL**.** Just as we described in the previous chapters, DUDs were converted to HSIs for the waterfowl habitat generated in Moist Soil Measures H1 through Measures H3 (Table 60).

Table 60. DUD Calculations and Conversions to TY51 HSIs for Measures H1 Through H3

Increment (Scale) Code	WP Acres	Annualized DUDs	TY51 HSI
H1	120	409,091	1.000
H2	240	818,182	1.000
H3	480	1,431,819	1.000

The inter-agency team assumed that all measures would achieve optimum (HSI = 1.0) by TY1. Given these predictions, ERDC-EL developed HSI trends over the period of analysis (Table 61).

Table 61. DUD HSI Trends for Measures H1 Through H3

Increment (Scale) Code	TY0	TY1	TY10	TY25	TY40	TY51
H1	0.000	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
H2	0.000	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
H3	0.000	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**

Using these HSI trends and their associated acreages, and following the AAHU calculation protocol, ERDC-EL developed AAHUs for each measure (Table 62).

Table 62. Net AAHU Gains for Measures H1 Through H3 Based on the DUD Conversions

Increment (Scale) Code	WP Acres	Net AAHU Gains
H1	120	118
H2	240	237
H3	480	474

Un-weighted Results for All Measures

Overall, one could expect to see the restoration and preservation of 36,000 to 229,464 acres of habitat (predominantly bottomland hardwood forest) under the proposed scenarios (Table 63).

Table 63. Un-weighted Net AAHU Gains In Species per Community for All Measures

Measure Description	Increment Code	Acres	Net AAHU Outputs													
			Waterfowl Outputs		Terrestrial Herbaceous Outputs				Terrestrial Forested Outputs						Aquatic Outputs	
			Duck Use Days	King Rail User Days	Prairie Chicken	Bobwhite Quail	Dickcissel	Cottontail Rabbit	Wood Duck	Pileated Woodpecker	Mink	Barred Owl	Gray Squirrel	Carolina Chickadee	Spawning and Rearing	In-Channel
WMA	A	36,000	10,717													
Herbaceous Wetland Complex	C1a	5,000		1,756	1,480	1,406	1,647	962								
	C1b	5,000		2,341	1,974	1,875	2,196	1,283								
	C2a	10,000		7,022	5,922	5,625	6,588	3,849								
	C2b	10,000		9,363	7,895	7,501	8,784	5,132								
	C3a	36,000		25,279	21,318	20,252	23,716	13,856								
	C3b	36,000		33,706	28,424	27,002	31,621	18,475								
	C4	100,000		93,627	78,954	75,007	87,837	51,320								
Bottomland Hardwood Rehabilitation	D1a	85,535	8,721						4,925	1,811	4,455	2,356	3,442	3,522	32,941	
	D1b	85,535	68,680						49,250	18,113	44,554	23,564	34,424	35,220	32,941	
	D1c	85,535	81,174						67,534	72,327	68,358	66,192	66,192	58,561	32,941	
	D2a	23,000	2,345						1,324	487	1,198	634	926	947	8,858	
	D2b	23,000	18,468						13,243	4,871	11,980	6,336	9,256	9,471	8,858	
	D2c	23,000	21,827						18,159	19,449	18,381	17,799	17,799	15,747	8,858	
Riparian Buffer Creation	E1a	1,322	196						114	42	103	55	80	82	615	202
	E1b	2,643	783						1,522	560	1,377	728	1,064	1,088	1,229	202
	E1c	7,929	7,825						7,074	2,876	7,074	2,876	5,208	7,074	3,688	202
	E2a	661	49						29	10	26	14	20	20	307	175
	E2b	1,322	196						381	140	344	182	266	272	615	175

(Continued)

Table 63. (Concluded)

Measure Description	Increment Code	Acres	Net AAHU Outputs													
			Waterfowl Outputs		Terrestrial Herbaceous Outputs				Terrestrial Forested Outputs						Aquatic Outputs	
			Duck Use Days	King Rail User Days	Prairie Chicken	Bobwhite Quail	Dickcissel	Cottontail Rabbit	Wood Duck	Pileated Woodpecker	Mink	Barred Owl	Gray Squirrel	Carolina Chickadee	Spawning and Rearing	In-Channel
Riparian Buffer Creation	E2c	3,965	1,956						1,769	719	1,769	719	1,302	1,769	1,844	175
Moist Soil Treatment	H1	120	118													
	H2	240	237													
	H3	480	474													

Relative Value Indexing and Final Results

The complexity of the Bayou Meto study's analyses led to a suite of results, on many levels spanning guild species within a community, multiple communities, and various levels of measures. To assess both the biological productivity of any given scenario, and take into account the potential cost of constructing, operating and maintaining the project over 50 years, a single output must be derived from the myriad of results generated. To accomplish this, a commonly used and accepted practice of relative value indexing the results at three separate levels was implemented to capture the comprehensive nature of the study and its effects. By definition, a relative value index (RVI) is a value that is used to adjust AAHUs to accommodate social, economic, ecological and political considerations (USFWS 1980b). Below, the protocols used to generate these indices are described, as well as their affect on the overall ecological results that led up to the cost analyses activities.

Level I RVIs

As mentioned previously, a simple averaging approach was used to combine guild species together within communities (i.e., all forested species outputs were averaged to generate a single score per measure for the community). This approach served as the Level I relative value index for the study, and guaranteed the analysis did not double count outputs on the same plot of land under Measures D1a through D2c and E1a through E2c. ERDC-EL applied a similar technique when combining the species within the herbaceous wetland complex measures (i.e., Measures C1a through C4). It was unnecessary to perform the same mathematical weighting on the aquatic community representatives, as they were not assessed on the same plot of land (Table 64).

Table 64. Level I Weighted Net AAHU Gains In Each Community for All Measures

				Net AAHU Outputs				
				Waterfowl		Terrestrial		Aquatic
				Duck Use Days	King Rail User Days	Averaged Herbaceous Community AAHUs	Averaged Forest Community AAHUs	Summed Community AAHUs
WMA	A	36,000	10,717	10,717				
Herbaceous Wetland Complex	C1a	5,000	3,130		1,756	1,374		
	C1b	5,000	4,173		2,341	1,832		
	C2a	10,000	12,518		7,022	5,496		
	C2b	10,000	16,691		9,363	7,328		
	C3a	36,000	45,065		25,279	19,786		
	C3b	36,000	60,087		33,706	26,381		
	C4	100,000	166,907		93,627	73,280		
Bottomland Hardwood Rehabilitation	D1a	85,535	45,081	8,721			3,419	32,941
	D1b	85,535	135,809	68,680			34,188	32,941
	D1c	85,535	180,642	81,174			66,527	32,941
	D2a	23,000	12,122	2,345			919	8,858
	D2b	23,000	36,519	18,468			9,193	8,858
	D2c	23,000	48,574	21,827			17,889	8,858
Riparian Buffer Creation	E1a	1,322	1,092	196			79	817
	E1b	2,643	3,271	783			1,057	1,431
	E1c	7,929	17,079	7,825			5,364	3,890
	E2a	661	551	49			20	482
	E2b	1,322	1,250	196			264	790

(Continued)

Table 64. (Concluded)

				Net AAHU Outputs				
				Waterfowl		Terrestrial		Aquatic
				Duck Use Days	King Rail User Days	Averaged Herbaceous Community AAHUs	Averaged Forest Community AAHUs	Summed Community AAHUs
Riparian Buffer Creation	E2c	3,965	5,316	1,956			1,341	2,019
Moist Soil Treatment	H1	120	118	118				
	H2	240	237	237				
	H3	480	474	474				

Level II RVIs

A Level II relative value index was developed to combine the various community outputs (i.e., Waterfowl, Terrestrial and Aquatic communities) in a fashion that captured the inter-agency team's valuation of their contribution to the overall ecosystem. Once weighted, the results could then be summed across communities. The following RVIs were developed for the models contributing to the assessment of each measure (Table 65) and used to weight and generate the various community outputs for the study (Table 66).

Table 65. Level II Relative Value Indices Across Communities for Each Measure

		Waterfowl		Terrestrial		Aquatic	
Measure Code and Description	**Increment (Scale) Code**	**DUD**	**King Rail**	**Herbaceous**	**Forest**	**Spawning and In-Channel**	**Total**
Wildlife Management Area Pump and Channel Cleanout	A	1.000					1.000
Herbaceous Wetland Complex Development and Management	C1a		0.900	0.100			1.000
	C1b		0.900	0.100			1.000
	C2a		0.900	0.100			1.000
	C2b		0.900	0.100			1.000
	C3a		0.900	0.100			1.000
	C3b		0.900	0.100			1.000
	C4		0.900	0.100			1.000
Bottomland Hardwood Rehabilitation	D1a	0.900			0.050	0.050	1.000
	D1b	0.900			0.050	0.050	1.000
	D1c	0.900			0.050	0.050	1.000
	D2a	0.900			0.050	0.050	1.000
	D2b	0.900			0.050	0.050	1.000
	D2c	0.900			0.050	0.050	1.000
Riparian Buffer Creation	E1a	0.900			0.050	0.050	1.000
	E1b	0.900			0.050	0.050	1.000
	E1c	0.900			0.050	0.050	1.000
	E2a	0.900			0.050	0.050	1.000
	E2b	0.900			0.050	0.050	1.000
	E2c	0.900			0.050	0.050	1.000

(Continued)

Table 65. (Concluded)

Measure Code and Description	Increment (Scale) Code	Waterfowl		Terrestrial		Aquatic	Total
		DUD	King Rail	Herbaceous	Forest	Spawning and In-Channel	
Moist Soil Treatment	H1	1.000					1.000
	H2	1.000					1.000
	H3	1.000					1.000

Table 66. Level II Outputs for the Bayou Meto Study

Measure Description	Incremental Scale Description	Code	Net Acres Gained or Rehabilitated	Weighted AAHUs Gained	Net AAHU Benefits			
					Waterfowl Outputs		Terrestrial Outputs	Aquatic Outputs
					Converted Duck User Days	Converted King Rail User Days	Forest and Herbaceous Communities	Aquatic Community
Wildlife Management Area Pump and Channel Cleanout	Pump Installation and Channel Cleanout at the Wildlife Management Area Site	A	36,000	10,717	10,717			
Herbaceous Wetland Complex Development and Management	5,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C1a	5,000	1,717		1,580	137	
	5,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C1b	5,000	2,290		2,107	183	
	10,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C2a	10,000	6,870		6,320	550	
	10,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C2b	10,000	9,159		8,426	733	
	36,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C3a	36,000	24,730		22,751	1,979	
	36,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C3b	36,000	32,973		30,335	2,638	
	100,000 acres of Herbaceous Wetland Complex	C4	100,000	91,593		84,265	7,328	
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Natural Succession 48,345 acres of Aquatic Habitat	D1a	85,535	9,667	7,849		171	1,647
	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant 1-2 year old Seedlings 48,345 acres of Aquatic Habitat	D1b	85,535	65,168	61,812		1,709	1,647

(Continued)

Table 66. (Continued)

Measure Description	Incremental Scale Description	Code	Net Acres Gained or Rehabilitated	Weighted AAHUs Gained	Net AAHU Benefits			
					Waterfowl Outputs		Terrestrial Outputs	Aquatic Outputs
					Converted Duck User Days	Converted King Rail User Days	Forest and Herbaceous Communities	Aquatic Community
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant RPM Trees 48,345 acres of Aquatic Habitat	D1c	85,535	78,030	73,057	[redacted]	3,326	1,647
	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Natural Succession 13,000 acres of Aquatic Habitat	D2a	23,000	2,600	2,111	[redacted]	46	443
	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant 1-2 year old Seedlings 13,000 acres of Aquatic Habitat	D2b	23,000	17,524	16,621	[redacted]	460	443
	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant RPM Trees 13,000 acres of Aquatic Habitat	D2c	23,000	21,982	19,645	[redacted]	894	443
Riparian Buffer Creation	50-foot Buffer Widths and 902 acres of Aquatic Habitat	E1a	1,322	221	176	[redacted]	4	41
	100-foot Buffer Widths and 1,804 acres of Aquatic Habitat	E1b	2,643	829	704	[redacted]	53	72
	300-foot Buffer Widths and 5,412 acres of Aquatic Habitat	E1c	7,929	7,506	7,043	[redacted]	268	195
	50-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 451 acres of Aquatic Habitat	E2a	661	69	44	[redacted]	1	24

(Continued)

Table 66. (Concluded)

Measure Description	Incremental Scale Description	Code	Net Acres Gained or Rehabilitated	Weighted AAHUs Gained	Net AAHU Benefits: Waterfowl Outputs		Terrestrial Outputs	Aquatic Outputs
					Converted Duck User Days	Converted King Rail User Days	Forest and Herbaceous Communities	Aquatic Community
Riparian Buffer Creation	100-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 902 acres of Aquatic Habitat	E2b	1,322	229	176		13	40
	300-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 2,706 acres of Aquatic Habitat	E2c	3,965	1,929	1,761		67	101
Moist Soil Habitats	Minimum Treatment (120 acres)	H1	120	118	118			
	Moderate Treatment (240 acres)	H2	240	237	237			
	Extensive Treatment (480 acres)	H3	480	474	474			

Level III RVIs

Lastly, the standard of comparison for the majority of this study rested on the DUD analysis and its conversion to AAHUs. The generation of DUDs for the various measures did not address the relative differences in DUD productivity across the various treatments and communities. Thus, DUDs generated under the Bottomland Hardwood Rehabilitation measures (Measure D1a through D2c) were not equal to those generated by Moist Soil Treatments or Herbaceous Wetland creation. To overcome this problem, ERDC developed a Level III relative value index to compensate for these differences. The index was based on the original derivation of DUDs for one scale of each measure evaluated (i.e., C2b, D2b, E1b, and H2). The contribution of acreage was used to derive the number of DUDs generated per acre within each measure. For example, Measure C2b affected 10,000 acres and generated a total of 3,409,090 DUDs. By dividing 3,409,090 by 10,000, a score of 341 was calculated. This result was then divided by 1000 to generate a base index. The lowest index (e.g., C2b = 0.341) was in turn used to generate a comparison index across the remaining measures by dividing their base indices by 0.341. Finally, the WMA features had already been weighted to handle potential over counting issues. Because of this, the Level III weighting factor approach was no longer a valid system to define the productivity of the WMA features. After numerous discussions with the inter-agency team, ERDC was directed to use the maximum weighting factor of the three most similar systems (i.e., Herbaceous Wetland Complex Development and Management (C's), Bottomland Hardwood Rehabilitation (D's) and Riparian Buffer Creation (E's) to generate a weighting factor for the WMA. In this manner and based on intense management for waterfowl, ERDC assigned a factor of 1.5 to the WMA results for the Level III RVI. The resulting Level III RVIs are presented below in Table 67.

Table 67. Level III Relative Value Indices for DUDs Across Measures

Measure Code and Description	Code	Acreages	Unweighted DUDs	Number of DUDs per Acres		Initial Factor	Final RVI
				King Rail	DUD		
Wildlife Management Area Pump and Channel Cleanout	A	36,000	4,197,027	-	-	-	**1.5**
Herbaceous Wetland Complex Development and Management	C2b	10,000	3,409,090	341		0.341	**1.0**
Bottomland Hardwood Rehabilitation	D2b	23,000	11,590,908		504	0.504	**1.5**
Riparian Buffer Creation	E1b	2,643	1,201,363		455	0.455	**1.3**
Moist Soil Treatments	H2	240	818,182		3,409	3.409	**10.0**

These RVIs were then extrapolated to the remaining scales within each measure. For example, all DUDs within the C Measures were multiplied by 1.0, and by a factor of 1.5 in the D Measures, and so on. The results of the Level III RVI exercise are presented in Table 68, and are presented in graphical format in Figure 28 and Figure 29. These numbers were carried forward into the cost analysis as the final ecological array of outputs.

Table 68. Level III Final Array of Outputs for the Bayou Meto Study

Measure Description	Incremental Scale Description	Code	Net Acres Gained or Rehabilitated	Weighted AAHUs Gained	Net AAHU Benefits			
					Waterfowl Outputs		Terrestrial Outputs	Aquatic Outputs
					Converted Duck User Days	Converted King Rail User Days	Forest and Herbaceous Communities	Aquatic Community
Wildlife Management Area Pump and Channel Cleanout	Pump Installation and Channel Cleanout at the Wildlife Management Area Site	A	36,000	16,076	16,076			
Herbaceous Wetland Complex Development and Management	5,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C1a	5,000	1,717		1,580	137	
	5,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C1b	5,000	2,290		2,107	183	
	10,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C2a	10,000	6,870		6,320	550	
	10,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C2b	10,000	9,159		8,426	733	
	36,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C3a	36,000	24,730		22,751	1,979	
	36,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C3b	36,000	32,973		30,335	2,638	
	100,000 acres of Herbaceous Wetland Complex	C4	100,000	91,593		84,265	7,328	
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Natural Succession 1,030 acres of Aquatic Habitat	D1a	85,535	13,592	11,774		171	1,647
	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant 1-2 year old Seedlings	D1b	85,535	96,074	92,718		1,709	1,647

(Continued)

Table 68. (Continued)

Measure Description	Incremental Scale Description	Code	Net Acres Gained or Rehabilitated	Weighted AAHUs Gained	Net AAHU Benefits			
					Waterfowl Outputs		Terrestrial Outputs	Aquatic Outputs
					Converted Duck User Days	Converted King Rail User Days	Forest and Herbaceous Communities	Aquatic Community
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant RPM Trees	D1c	85,535	114,559	109,586	[redacted]	3,326	1,647
	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Natural Succession	D2a	23,000	3,655	3,167	[redacted]	46	443
	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant 1-2 year old	D2b	23,000	25,834	24,932	[redacted]	460	443
	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant RPM Trees	D2c	23,000	30,805	29,468	[redacted]	894	443
Riparian Buffer Creation	50-foot Buffer Widths and 902 acres of Aquatic Habitat	E1a	1,322	274	229	[redacted]	4	41
	100-foot Buffer Widths and 1,804 acres of Aquatic Habitat	E1b	2,643	1,040	915	[redacted]	53	72
	300-foot Buffer Widths and 5,412 acres of Aquatic Habitat	E1c	7,929	9,619	9,156	[redacted]	268	195
	50-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 451 acres of Aquatic Habitat	E2a	661	82	57	[redacted]	1	24

(Continued)

Table 68. (Concluded)

Measure Description	Incremental Scale Description	Code	Net Acres Gained or Rehabilitated	Weighted AAHUs Gained	Net AAHU Benefits: Waterfowl Outputs: Converted Duck User Days	Net AAHU Benefits: Waterfowl Outputs: Converted King Rail User Days	Net AAHU Benefits: Terrestrial Outputs: Forest and Herbaceous Communities	Net AAHU Benefits: Aquatic Outputs: Aquatic Community
Riparian Buffer Creation	100-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 902 acres of Aquatic Habitat	E2b	1,322	282	229		13	40
	300-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 2,706 acres of Aquatic Habitat	E2c	3,965	2,457	2,289		67	101
Moist Soil Habitats	Minimum Treatment (120 acres)	H1	120	1,180	1,180			
	Moderate Treatment (240 acres)	H2	240	2,370	2,370			
	Extensive Treatment (480 acres)	H3	480	4,740	4,740			

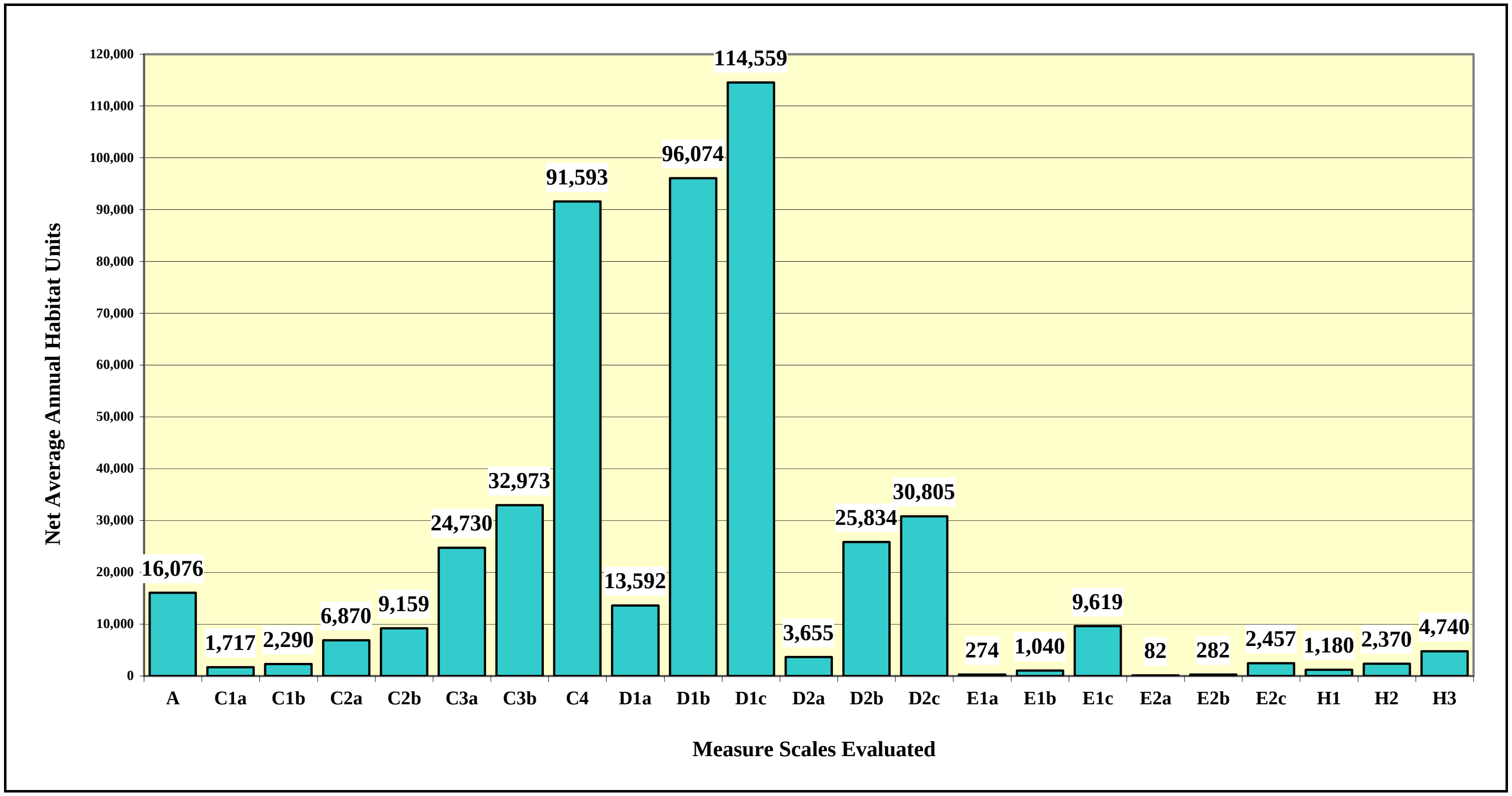

Figure 28. Final array of outputs for the measures in the Bayou Meto Study

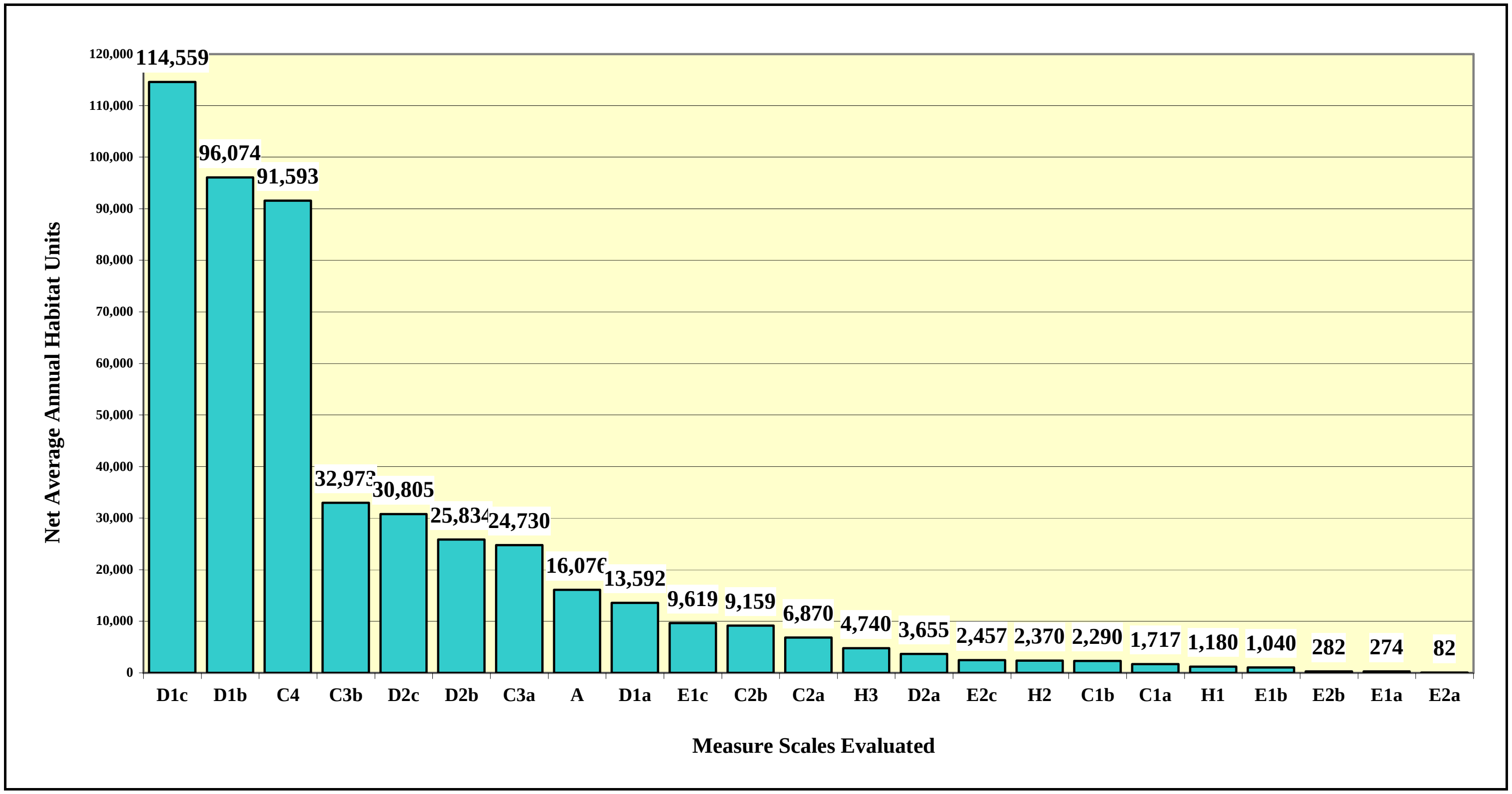

Figure 29. Final array of outputs for the measures in the Bayou Meto Study sorted by productivity

COST ANALYSES

Cost effectiveness (CEA) and incremental cost analyses (ICA) were performed using the IWR-Plan software. CEA/ICA identifies the least-costly solution for each level of output (Robinson, Hansen and Orth 1995). The three criteria used for identifying non-cost effective plans or combinations include: (1) The same level of output could be produced by another plan at less cost; (2) A larger output level could be produced at the same cost; or (3) A larger output level could be produced at the least cost (Orth 1994).

ICA compares the incremental costs for each additional unit of output. The first step in developing "Best Buy" plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental Best Buy plan. Plans that have higher incremental costs per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify large increases in cost relative to output. The sections below summarize the outputs, costs and CEA/ICA results generated as the inter-agency team evaluated the suite of Bayou Meto alternatives.

A two-tiered approach was performed to determine Best Buy plans for Bayou Meto alternatives. First, dependent combinations of features within the Wildlife Management Area (WMA) were evaluated for cost effective and incrementally effective plans. Second, the "Best Buy" plan for the WMA was then combined with alternatives outside the WMA to determine the overall "Best Buy" plan for the project. All alternatives outside the WMA were dependent on the WMA plan.

LEVEL 1 - WMA COST ANALYSIS RESULTS

The interdependency of key activities across the various features was recognized. By formulating these in a series of dependent alternatives, the Corps was able to depict a more realistic assessment of mobilization costs and operation/maintenance costs while taking into consideration the cumulative hydrological and ecological benefits of implementing dependent features in a true "alternative plan" approach.

Project Costs

Costs were determined for each individual feature. The costs and outputs for the dependent alternatives are comprised of the total sum of the individual features (Table 69). The cost per output is also reported by feature and alternative.

Table 69. Cost Table for WMA Alternatives including Annualized Costs and Annualized Outputs

Solution Description	Solution Label	Annualized Cost	Net AAHU Gain	Cost per Output
Lower Impoundment	**A**	**$161,855**	**933**	**$173**
	0/1	$15,870	30	$529
	2	$47,194	308	$153
	7	$14,487	125	$116
	21	$10,761	70	$154
	25	$29,308	82	$357
	26	$8,570	7	$1,224
	27	$35,665	311	$115
Upper Impoundment	**B**	**$104,323**	**2,101**	**$50**
	9	$30,577	606	$50
	10	$8,255	926	$9
	11	$17,925	89	$201
	12	$22,193	89	$249
	13	$15,862	375	$42
	28	$9,511	16	$594
Government Impoundment	**C**	**$115,537**	**665**	**$174**
	3	$15,173	298	$51
	4	$18,068	84	$215
	5/6	$49,811	130	$383
	20	$10,218	9	$1,135
	29	$22,267	144	$155
Bear Bayou Impoundment	**D**	**$58,593**	**52**	**$1,127**
	14	$16,463	20	$823
	15	$9,738	3	$3,246
	16	$18,168	22	$826
	17	$3,970	4	$993
	19	$10,254	3	$3,418
Cannon Brake Impoundment	**E**	**$46,841**	**115**	**$407**
	8/30	$21,528	89	$242
	35	$25,313	26	$974
Pump and Required Control Structures	**F**	**$1,789,243**	**7,018**	**$255**
	22	$45,778	2,285	$20
	31/32	$1,625,000	2,710	$600
	36	$118,465	2,023	$59
Independent Features				
G	23	$15,794	24	$658
H	33/34/37	$344,047	52	$6,616
I	38	$7,685	5	$1,537

Cost Effective Plans

The alternatives (A-I) are dependent upon the installation of the pump and required control structures (F). From the nine alternatives, 512 possible combinations of solutions were formed, however only 257 were actual combinations. Forty-nine combinations were identified as cost-effective (Table 70 and Figure 30).

Table 70. Cost-Effective Solutions - WMA

Solution	Output (AAHU)	Cost ($)	Cost per Output
A0 B0 C0 D0 E0 F0 G0 H0 I0	0	$0	$0
A0 B0 C0 D0 E0 F1 G0 H0 I0	7,018	$1,789,243	$254.9506
A0 B0 C0 D0 E0 F1 G0 H0 I1	7,023	$1,796,928	$255.8633
A0 B0 C0 D0 E0 F1 G1 H0 I0	7,042	$1,805,037	$256.3245
A0 B0 C0 D0 E0 F1 G1 H0 I1	7,047	$1,812,722	$257.2331
A0 B0 C0 D0 E1 F1 G0 H0 I0	7,133	$1,836,084	$257.4070
A0 B0 C0 D0 E1 F1 G0 H0 I1	7,138	$1,843,769	$258.3033
A0 B0 C0 D0 E1 F1 G1 H0 I0	7,157	$1,851,878	$258.7506
A0 B0 C0 D0 E1 F1 G1 H0 I1	7,162	$1,859,563	$259.6430
A0 B1 C0 D0 E0 F1 G0 H0 I0	9,119	$1,893,566	$207.6506
A0 B1 C0 D0 E0 F1 G0 H0 I1	9,124	$1,901,251	$208.3791
A0 B1 C0 D0 E0 F1 G1 H0 I0	9,143	$1,909,360	$208.8330
A0 B1 C0 D0 E0 F1 G1 H0 I1	9,148	$1,917,045	$209.5589
A0 B1 C0 D0 E1 F1 G0 H0 I0	9,234	$1,940,407	$210.1372
A0 B1 C0 D0 E1 F1 G0 H0 I1	9,239	$1,948,092	$210.8553
A0 B1 C0 D0 E1 F1 G1 H0 I0	9,258	$1,956,201	$211.2984
A0 B1 C0 D0 E1 F1 G1 H0 I1	9,263	$1,963,886	$212.0140
A0 B1 C0 D1 E1 F1 G0 H0 I0	9,286	$1,999,000	$215.2703
A0 B1 C0 D1 E1 F1 G0 H0 I1	9,291	$2,006,685	$215.9816
A0 B1 C1 D0 E0 F1 G0 H0 I0	9,784	$2,009,103	$205.3458
A0 B1 C1 D0 E0 F1 G0 H0 I1	9,789	$2,016,788	$206.0259
A0 B1 C1 D0 E0 F1 G1 H0 I0	9,808	$2,024,897	$206.4536
A0 B1 C1 D0 E0 F1 G1 H0 I1	9,813	$2,032,582	$207.1316
A1 B1 C0 D0 E0 F1 G0 H0 I0	10,052	$2,055,421	$204.4788
A1 B1 C0 D0 E0 F1 G0 H0 I1	10,057	$2,063,106	$205.1413
A1 B1 C0 D0 E0 F1 G1 H0 I0	10,076	$2,071,215	$205.5592
A1 B1 C0 D0 E0 F1 G1 H0 I1	10,081	$2,078,900	$206.2196
A1 B1 C0 D0 E1 F1 G0 H0 I0	10,167	$2,102,262	$206.7731
A1 B1 C0 D0 E1 F1 G0 H0 I1	10,172	$2,109,947	$207.4270
A1 B1 C0 D0 E1 F1 G1 H0 I0	10,191	$2,118,056	$207.8359
A1 B1 C0 D0 E1 F1 G1 H0 I1	10,196	$2,125,741	$208.4877
A1 B1 C0 D1 E1 F1 G0 H0 I0	10,219	$2,160,855	$211.4546
A1 B1 C0 D1 E1 F1 G0 H0 I1	10,224	$2,168,540	$212.1029
A1 B1 C1 D0 E0 F1 G0 H0 I0	10,717	$2,170,958	$202.5714
A1 B1 C1 D0 E0 F1 G0 H0 I1	10,722	$2,178,643	$203.1937
A1 B1 C1 D0 E0 F1 G1 H0 I0	10,741	$2,186,752	$203.5892
A1 B1 C1 D0 E0 F1 G1 H0 I1	10,746	$2,194,437	$204.2097
A1 B1 C1 D0 E1 F1 G0 H0 I0	10,832	$2,217,799	$204.7451
A1 B1 C1 D0 E1 F1 G0 H0 I1	10,837	$2,225,484	$205.3598
A1 B1 C1 D0 E1 F1 G1 H0 I0	10,856	$2,233,593	$205.7473
A1 B1 C1 D0 E1 F1 G1 H0 I1	10,861	$2,241,278	$206.3602
A1 B1 C1 D1 E1 F1 G0 H0 I0	10,884	$2,276,392	$209.1503
A1 B1 C1 D1 E1 F1 G0 H0 I1	10,889	$2,284,077	$209.7600
A1 B1 C1 D1 E1 F1 G0 H1 I0	10,936	$2,620,439	$239.6159
A1 B1 C1 D1 E1 F1 G0 H1 I1	10,941	$2,628,124	$240.2088
A1 B1 C1 D1 E1 F1 G1 H0 I0	10,908	$2,292,186	$210.1381
A1 B1 C1 D1 E1 F1 G0 H0 I1	10,913	$2,299,871	$210.7460
A1 B1 C1 D1 E1 F1 G1 H1 I0	10,960	$2,636,233	$240.5322
A1 B1 C1 D1 E1 F1 G1 H1 I1	10,965	$2,643,918	$241.1234

Figure 30. Cost Effective Solutions for WMA alternatives.

Incrementally Effective Plans

Of the cost effective solutions, only seven were incrementally effective, or Best Buy plans, including the No Action plan as shown in Table 71. The highlighted plan below was identified as the overall winner for the WMA alternatives. The Best Buy plans are also represented graphically in Figure 31.

Table 71. Best Buy Plans - WMA

Plan	Output (AAHU)	Cost ($)	($/AAHU)	Increment $	Increment AAHU	Increment ($/AAHU)
No Action A0B0C0D0E0F0G0H0I0	0	0	0	0	0	0
Impoundments: Lower, Upper, Government with Pump and Required Control Structures A1B1C1D0E0F1G0H0I0	10,717	2,170,958	202.57	2,170,958	10,717	202.57
Impoundments: Lower, Upper, Government, Cannon Brake with Pump and Required Control Structures A1B1C1D0E1F1G0H0I0	10,832	2,217,799	204.75	46,841	115	407.31
Impoundments: Lower, Upper, Government, Cannon Brake and Independent Feature #23 with Pump and Required Control Structures A1B1C1D0E1F1G1H0I0	10,856	2,233,593	205.75	15,794	24	658.08
Impoundments: Lower, Upper, Government, Cannon Brake, Bear Bayou and Independent Feature #23 with Pump and Required Control Structures A1B1C1D1E1F1G1H0I0	10,908	2,292,186	210.14	58,593	52	1126.79
Impoundments: Lower, Upper, Government, Cannon Brake, Bear Bayou and Independent Features: #23, #38 with Pump and Required Control Structures A1B1C1D1E1F1G1H0I1	10,913	2,299,871	210.75	7,685	5	1537.00
Impoundments: Lower, Upper, Government, Cannon Brake, Bear Bayou and Independent Features: #23, #38, #33/34/37 with Pump and Required Control Structures A1B1C1D1E1F1G1H1I1	10,965	2,643,918	241.12	344,047	52	6616.29

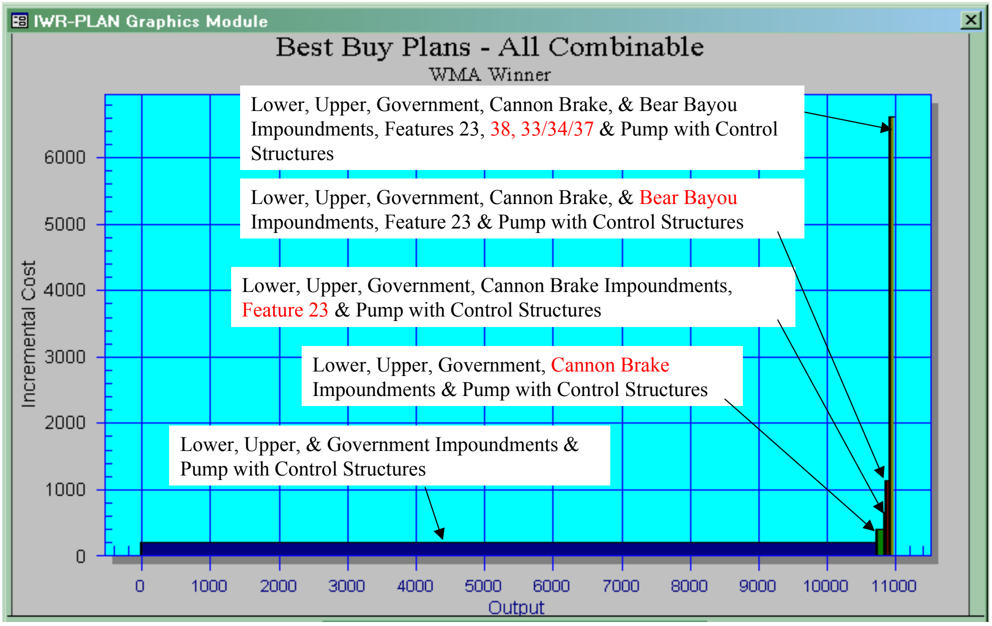

Figure 31. Best Buy Plans for Waterfowl Management Area (WMA).

The Best Buy Plan for the WMA that was carried forward into Level 2 analysis was the overall winner comprised of the following combined solutions: Lower, Upper, and Government impoundments with the pump and required control structures (A1B1C1D0E0F1G0H0I0).

LEVEL 2 - MEASURES OUTSIDE WMA COST ANALYSIS RESULTS

The second level cost analysis considered restoration in areas outside of the WMA. All 23 measures are identified in Table 39, including the overall winner for the WMA. Two dependency factors were applied for this second level cost analysis. First, the Bottomland Hardwood Rehabilitation measures (D1a-D2c) are dependent on the presence of a Riparian Buffer measure (E1a-E2c) for the simple reason that the interior BLH forest would not be planted without buffer protection along the streambanks. However, the riparian buffer could be planted without planting interior BLH forest. The second factor is that all measures are dependent on the development and management of a Herbaceous Wetland Complex (HWC) measure (C1a-C4). This is a rare and disappearing significant resource in the region. HWC has been almost completely eliminated from the study area, and its rehabilitation is absolutely critical for recovery of rare and sensitive waterfowl species such as king rail.

Project Costs

Costs were determined for one representative of each suite of potential measures on a habitat-by-habitat basis (Herbaceous Wetland Complex, Bottomland Hardwood, Riparian Buffer, and Moist Soil). Costs were then extrapolated to the remaining scales of measures within each habitat type. The annualized costs and outputs for the proposed 23 measures are found in Table 72.

Measure Description	Incremental Scale Description	Increment (Scale) Code	Net Acres Gain ed or Rehabilitated	Total Annualized Costs	Sum of AAHUs Gained
Wildlife Management Area Pump and Channel Cleanout	Pump Installation and Channel Cleanout at the Wildlife Management Area Site	A	36,000	$2,170,958	16,076
Herbaceous Wetland Complex Development and Management	5,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C1a	5,000	$1,135,440	1,717
	5,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C1b	5,000	$788,500	2,290
	10,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C2a	10,000	$1,892,400	6,870
	10,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C2b	10,000	$1,577,000	9,159
	36,000 acres of Herbaceous Wetland Complex - Scattered, Disjunct Parcels of Land	C3a	36,000	$8,436,319	24,730
	36,000 acres of Herbaceous Wetland Complex - 1 or 2 Contiguous Tracts of Land	C3b	36,000	$7,030,266	32,973
	100,000 acres of Herbaceous Wetland Complex	C4	100,000	$58,349,000	91,593
Bottomland Hardwood Rehabilitation	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Natural Succession 1,030 acres of Aquatic Habitat	D1a	85,535	$6,522,626	13,592
	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant 1-2 year old Seedlings 1,030 acres of Aquatic Habitat	D1b	85,535	$13,045,252	96,074
	85,535 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant RPM Trees 1,030 acres of Aquatic Habitat	D1c	85,535	$19,567,878	114,559

Table 72. (Concluded)

Measure Description	Incremental Scale Description	Increment (Scale) Code	Net Acres Gained or Rehabilitated	Total Annualized Costs	Sum of AAHUs Gained
Bottomland Hardwood Rehabilitation	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Natural Succession 277 acres of Aquatic Habitat	D2a	23,000	$1,413,000	3,655
	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant 1-2 year old Seedlings 277 acres of Aquatic Habitat	D2b	23,000	$2,826,000	25,834
	23,000 acres of Bottomland Hardwood Forest Rehabilitation Rehabilitation Approach: Plant RPM Trees 277 acres of Aquatic Habitat	D2c	23,000	$4,239,000	30,805
Riparian Buffer Creation	50-foot Buffer Widths and 902 acres of Aquatic Habitat	E1a	1,322	$120,500	274
	100-foot Buffer Widths and 1,804 acres of Aquatic Habitat	E1b	2,643	$241,000	1,040
	300-foot Buffer Widths and 5,412 acres of Aquatic Habitat	E1c	7,929	$942,384	9,619
	50-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 451 acres of Aquatic Habitat	E2a	661	$72,300	82
	100-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 902 acres of Aquatic Habitat	E2b	1,322	$144,600	282
	300-foot Buffer Widths - Connect 50 percent of the Fragmented Corridors 2,706 acres of Aquatic Habitat	E2c	3,965	$565,431	2,457
Moist Soil Habitats	Minimum Treatment (120 acres)	H1	120	$48,500	1,180
	Moderate Treatment (240 acres)	H2	240	$97,000	2,370
	Extensive Treatment (480 acres)	H3	480	$194,000	4,740

Cost Effective Plans

By combining one or more of these 23 measures together with dependencies identified, 3,136 possible combinations were formed as potential alternatives. These were subsequently screened based on inefficiencies and redundancies, and a final list of 2,409 alternatives was carried forward into the cost evaluation. However, only 197 were identified as cost-effective plans as listed in Table 73.

Table 73. Cost-Effective Solutions for Proposed Measures

Solution	Output (AAHU)	Cost ($)	Cost per Output
A0C0D0E0H0	0	$0	$0.00
A0C2D0E0H0	2,290	$788,500	$344.32
A0C2D0E0H1	3,470	$837,000	$241.21
A0C2D0E0H2	4,660	$885,500	$190.02
A0C2D0E0H3	7,030	$982,500	$139.76
A0C2D0E1H3	7,304	$1,103,000	$151.01
A0C2D0E2H3	8,070	$1,223,500	$151.61
A0C2D0E3H0	11,909	$1,730,884	$145.34
A0C2D0E3H2	14,279	$1,827,884	$128.01
A0C2D0E3H3	16,649	$1,924,884	$115.62
A0C2D0E4H2	4,742	$957,800	$201.98
A0C2D0E4H3	7,112	$1,054,800	$148.31
A0C2D0E5H3	7,312	$1,127,100	$154.14
A0C2D0E6H3	9,487	$1,547,931	$163.16
A0C2D2E1H0	98,638	$13,954,252	$141.47
A0C2D2E1H1	99,818	$14,002,752	$140.28
A0C2D2E1H2	101,008	$14,051,252	$139.11
A0C2D2E1H3	103,378	$14,148,252	$136.86
A0C2D2E2H3	104,144	$14,268,752	$137.01
A0C2D2E3H0	107,983	$14,776,136	$136.84
A0C2D2E3H1	109,163	$14,824,636	$135.80
A0C2D2E3H2	110,353	$14,873,136	$134.78
A0C2D2E3H3	112,723	$14,970,136	$132.80
A0C2D2E4H0	98,446	$13,906,052	$141.26
A0C2D2E4H1	99,626	$13,954,552	$140.07
A0C2D2E4H2	100,816	$14,003,052	$138.90
A0C2D2E4H3	103,186	$14,100,052	$136.65
A0C2D2E5H2	101,016	$14,075,352	$139.34
A0C2D2E5H3	103,386	$14,172,352	$137.08
A0C2D2E6H3	105,561	$14,593,183	$138.24
A0C2D5E1H0	28,398	$3,735,000	$131.52
A0C2D5E1H1	39,578	$3,783,500	$95.60
A0C2D5E1H2	30,768	$3,832,000	$124.54
A0C2D5E1H3	33,138	$3,929,000	$118.56
A0C2D5E2H3	33,904	$4,049,500	$119.44
A0C2D5E3H0	37,743	$4,556,884	$120.73
A0C2D5E3H1	38,923	$4,605,384	$118.32
A0C2D5E3H2	40,113	$4,653,884	$116.02
A0C2D5E3H3	42,483	$475,084	$11.18
A0C2D5E4H0	28,206	$3,686,800	$130.71
A0C2D5E4H1	29,386	$3,735,300	$127.11
A0C2D5E4H2	30,576	$3,783,800	$123.75
A0C2D5E4H3	32,946	$3,880,800	$117.79
A0C2D5E5H2	30,776	$3,856,100	$125.30
A0C2D5E5H3	33,146	$3,953,100	$119.26
A0C2D5E6H3	35,321	$4,373,931	$123.83
			(Continued)

Table 73. (Continued)

Solution	Output (AAHU)	Cost ($)	Cost per Output
A0C4D0E0H1	10,339	$1,625,500	$157.22
A0C4D0E0H2	11,529	$1,674,000	$145.20
A0C4D0E0H3	13,899	$1,771,000	$127.42
A0C4D0E3H0	18778	$2,519,384	$134.17
A0C4D0E3H1	19958	$2,567,884	$128.66
A0C4D0E3H2	21148	$2,616,384	$123.72
A0C4D0E3H3	23518	$27,133,884	$1,153.75
A0C4D2E3H0	114852	$15,564,636	$135.52
A0C4D2E3H1	116032	$15,613,136	$134.56
A0C4D2E3H2	117222	$15,661,636	$133.61
A0C4D2E3H3	119592	$15,758,636	$131.77
A0C4D2E4H1	106495	$14,743,052	$138.44
A0C4D5E3H0	44612	$5,345,384	$119.82
A0C4D5E3H1	45792	$5,393,884	$117.79
A0C4D5E3H2	46982	$5,442,384	$115.84
A0C4D5E3H3	49352	$5,539,384	$112.24
A0C4D5E4H1	36255	$4,523,800	$124.78
A0C6D2E3H0	138666	$21,017,902	$151.57
A0C6D2E3H1	139846	$21,066,402	$150.64
A0C6D2E3H2	141036	$21,114,902	$149.71
A0C6D2E3H3	143406	$21,211,902	$147.92
A0C6D2E6H3	136244	$20,834,949	$152.92
A0C6D3E3H2	159521	$27,367,528	$171.56
A0C6D3E3H3	161891	$27,734,528	$171.32
A0C6D5E3H2	70796	$10,895,650	$153.90
A0C6D5E3H3	73166	$10,992,650	$150.24
A0C7D2E1H0	187941	$71,514,752	$380.52
A0C7D2E1H1	189121	$71,563,252	$378.40
A0C7D2E1H2	190311	$71,611,752	$376.29
A0C7D2E1H3	192681	$71,708,752	$372.16
A0C7D2E2H3	193447	$71,829,252	$371.31
A0C7D2E3H0	197286	$72,336,636	$366.66
A0C7D2E3H1	198466	$72,385,136	$364.72
A0C7D2E3H2	199656	$72,433,636	$362.79
A0C7D2E3H3	202026	$72,530,636	$359.02
A0C7D2E4H0	187749	$71,466,552	$380.65
A0C7D2E4H1	188929	$71,515,052	$378.53
A0C7D2E4H2	190119	$71,563,552	$376.41
A0C7D2E4H3	192489	$71,660,552	$372.28
A0C7D2E5H2	190319	$71,635,852	$376.40
A0C7D2E5H3	192689	$71,732,852	$372.27
A0C7D2E6H3	194864	$72,153,683	$370.28
A0C7D3E3H2	218141	$78,956,262	$361.95
A0C7D3E3H3	220511	$79,053,262	$358.50
A1C2D0E2H3	24146	$3,394,458	$140.58
A1C2D2E2H3	120220	$16,439,710	$136.75
A1C2D2E3H0	124059	$16,947,094	$136.61
A1C2D2E3H1	125239	$16,995,594	$135.71
A1C2D2E3H2	126429	$17,044,094	$134.81
A1C2D2E3H3	128799	$17,141,094	$133.08
A1C2D2E6H3	121637	$16,764,141	$137.82
A1C2D5E2H3	49980	$6,220,458	$124.46
A1C2D5E3H0	53819	$6,727,842	$125.01
A1C2D5E3H1	54999	$6,776,342	$123.21
A1C2D5E3H2	56189	$6,824,842	$121.46
A1C2D5E3H3	58559	$6,921,842	$118.20
A1C2D5E6H3	51397	$6,544,889	$127.34

(Continued)

Table 73. (Continued)

Solution	Output (AAHU)	Cost ($)	Cost per Output
A1C4D2E3H0	130928	$17,735,594	$135.46
A1C4D2E3H1	132108	$17,784,094	$134.62
A1C4D2E3H2	133298	$17,832,594	$133.78
A1C4D2E3H3	135668	$17,929,594	$132.16
A1C4D2E4H1	122571	$16,914,010	$137.99
A1C4D5E3H0	60688	$7,516,342	$123.85
A1C4D5E3H1	61868	$7,564,842	$122.27
A1C4D5E3H2	63058	$7,613,342	$120.74
A1C4D5E3H3	65428	$7,710,342	$117.84
A1C4D5E4H1	52331	$6,694,758	$127.93
A1C4D6E3H0	65659	$8,929,342	$136.00
A1C4D6E3H1	66839	$8,977,842	$134.32
A1C4D6E3H2	68029	$9,026,342	$132.68
A1C4D6E3H3	70399	$9,123,342	$129.59
A1C6D2E1H0	145397	$22,366,976	$153.83
A1C6D2E1H1	146577	$22,415,476	$152.93
A1C6D2E1H2	147767	$22,463,976	$152.02
A1C6D2E1H3	150137	$22,560,976	$150.27
A1C6D2E2H3	150903	$22,681,476	$150.31
A1C6D2E3H0	154742	$23,188,860	$149.85
A1C6D2E3H1	155922	$23,237,360	$149.03
A1C6D2E3H2	157112	$23,285,860	$148.21
A1C6D2E3H3	159482	$23,382,860	$146.62
A1C6D2E4H0	145205	$22,318,776	$153.71
A1C6D2E4H1	146385	$22,367,276	$152.80
A1C6D2E4H2	147575	$22,415,776	$151.89
A1C6D2E4H3	149945	$22,512,776	$150.14
A1C6D2E5H2	147775	$22,488,076	$152.18
A1C6D2E5H3	150145	$22,585,076	$150.42
A1C6D2E6H3	152320	$23,005,907	$151.04
A1C6D3E1H0	163882	$28,889,602	$176.28
A1C6D3E1H1	165062	$28,938,102	$175.32
A1C6D3E1H2	166252	$28,986,602	$174.35
A1C6D3E1H3	168622	$29,083,602	$172.48
A1C6D3E2H3	169388	$29,204,102	$172.41
A1C6D3E3H0	173227	$29,711,486	$171.52
A1C6D3E3H1	174407	$29,759,986	$170.64
A1C6D3E3H2	175597	$29,808,486	$169.76
A1C6D3E3H3	177967	$29,905,486	$168.04
A1C6D3E4H0	163690	$28,841,402	$176.20
A1C6D3E4H1	164870	$28,889,902	$175.23
A1C6D3E4H2	166060	$28,938,402	$174.26
A1C6D3E4H3	168430	$290,354,020	$1,723.89
A1C6D3E5H2	166260	$29,010,702	$174.49
A1C6D3E5H3	168630	$29,107,702	$172.61
A1C6D3E6H3	170805	$29,528,533	$172.88
A1C6D5E1H0	75157	$12,147,724	$161.63
A1C6D5E1H1	76337	$12,196,224	$159.77
A1C6D5E1H2	77527	$12,244,724	$157.94
A1C6D5E1H3	79897	$12,341,724	$154.47
A1C6D5E2H3	80663	$12,462,224	$154.50
A1C6D5E3H0	84502	$12,969,608	$153.48
A1C6D5E3H1	85682	$13,018,108	$151.94
A1C6D5E3H2	86872	$13,066,608	$150.41
A1C6D5E3H3	89242	$13,163,608	$147.50
A1C6D5E4H0	74965	$12,099,524	$161.40
A1C6D5E4H1	76145	$12,148,024	$159.54

(Continued)

Table 73. (Concluded)

Solution	Output (AAHU)	Cost ($)	Cost per Output
A1C6D5E4H2	77335	$12,196,524	$157.71
A1C6D5E4H3	79705	$12,293,524	$154.24
A1C6D5E5H2	77535	$12,268,824	$158.24
A1C6D5E5H3	79905	$12,365,824	$154.76
A1C6D5E6H3	82080	$12,786,655	$155.78
A1C7D2E1H0	204017	$73,685,710	$361.17
A1C7D2E1H1	205197	$73,734,210	$359.33
A1C7D2E1H2	206387	$73,782,710	$357.50
A1C7D2E1H3	208757	$73,879,710	$353.90
A1C7D2E2H3	209523	$74,000,210	$353.18
A1C7D2E3H0	213362	$74,507,594	$349.21
A1C7D2E3H1	214542	$74,556,094	$347.51
A1C7D2E3H2	215732	$74,604,594	$345.82
A1C7D2E3H3	218102	$74,701,594	$342.51
A1C7D2E4H0	203825	$73,637,510	$361.28
A1C7D2E4H1	205005	$73,686,010	$359.44
A1C7D2E4H2	206195	$73,734,510	$357.60
A1C7D2E4H3	208565	$73,831,510	$354.00
A1C7D2E5H2	206395	$73,806,810	$357.60
A1C7D2E5H3	208765	$73,903,810	$354.00
A1C7D2E6H3	210940	$74,324,641	$352.35
A1C7D3E1H0	222502	$80,208,336	$360.48
A1C7D3E1H1	223682	$80,256,836	$358.80
A1C7D3E1H2	224872	$80,205,336	$356.67
A1C7D3E1H3	227242	$80,402,336	$353.82
A1C7D3E2H3	228008	$80,522,836	$353.16
A1C7D3E3H0	231847	$81,030,220	$349.50
A1C7D3E3H1	233027	$81,078,720	$347.94
A1C7D3E3H2	234217	$81,127,220	$346.38
A1C7D3E3H3	236587	$81,224,220	$343.32
A1C7D3E4H0	222310	$80,160,136	$360.58
A1C7D3E4H1	223490	$80,208,636	$358.89
A1C7D3E4H2	224680	$80,257,136	$357.21
A1C7D3E4H3	227050	$80,354,136	$353.91
A1C7D3E5H2	224880	$80,329,436	$357.21
A1C7D3E5H3	227250	$80,426,436	$353.91
A1C7D3E6H3	229425	$80,847,267	$352.39

Incrementally Effective Plans

From the cost effective solutions, eight were determined to be incrementally effective, or Best Buy Plans, including the No Action plan as shown in Table 74 and Figure 32.

Table 74. Best Buy Plans for Proposed Measures

Plan	Output (AAHU)	Cost ($)	($/AAHU)	Increment $	Increment AAHU	Increment ($/AAHU)
No Action A0C0D0E0	0	0	0	0	0	0
5,000 ac contiguous HWC, 23,000 ac of BLH with seedlings, 300 ft contiguous Riparian Buffer, and 480 ac Moist Soil Treatment A0C2D5E3H3	42,483	4,750,884	111.83	4,750,884	42,483	111.83
10,000 ac contiguous HWC, 23,000 ac of BLH with seedlings, 300 ft contiguous Riparian Buffer, and 480 ac Moist Soil Treatment A0C4D5E3H3	49,352	5,539,384	112.24	788,500	6,869	114.79
WMA, 10,000 ac contiguous HWC, 23,000 ac of BLH with seedlings, 300 ft contiguous Riparian Buffer, and 480 ac Moist Soil Treatment A1C4D5E3H3	65,428	7,710,342	117.84	2,170,958	16,076	135.04
WMA, 10,000 ac contiguous HWC, 85,535 ac of BLH with seedlings, 300 ft contiguous Riparian Buffer, and 480 ac Moist Soil Treatment A1C4D2E3H3	135,668	17,929,594	132.16	10,219,250	70,240	145.49
WMA, 36,000 ac contiguous HWC, 85,535 ac of BLH with seedlings, 300 ft contiguous Riparian Buffer, and 480 ac Moist Soil Treatment A1C6D2E3H3	159,482	23,382,860	146.6176	5,453,266	23,814	228.99
WMA, 36,000 ac contiguous HWC, 85,535 ac of BLH with RPM trees, 300 ft contiguous Riparian Buffer, and 480 ac Moist Soil Treatment A1C6D3E3H3	177,967	29,905,486	168.04	6,522,626	18,485	352.86
WMA, 100,000 ac contiguous HWC, 85,535 ac of BLH with RPM trees, 300 ft contiguous Riparian Buffer, and 480 ac Moist Soil Treatment A1C7D3E3H3	236,587	81,224,220	343.32	51,318,740	58,620	875.45

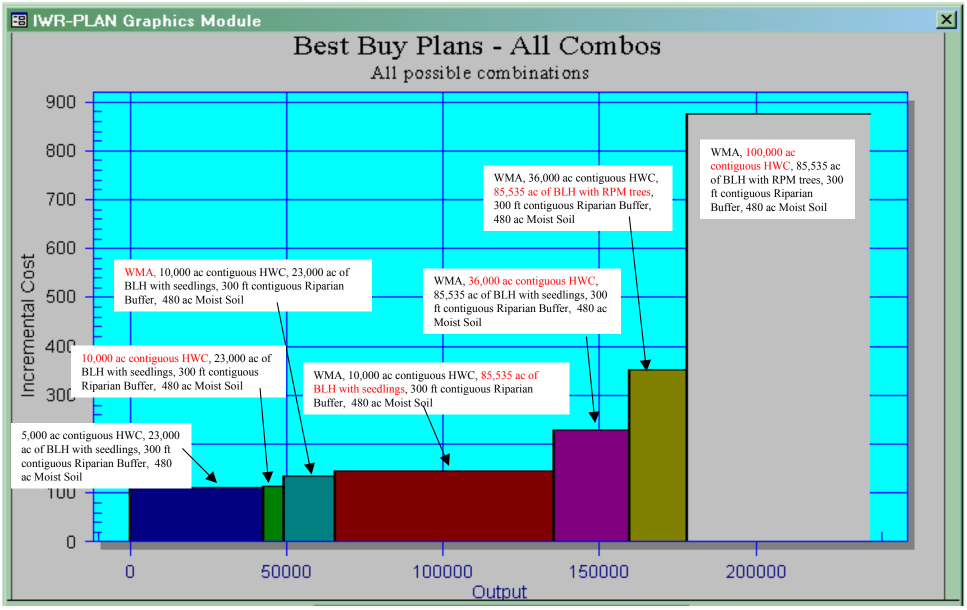

Figure 32. Best Buy Plans for Proposed Measures.

The resulting least cost plan that meets the study goals and objectives is the first plan that yields a combination of WMA, Bottomland Hardwoods planted with seedlings, Riparian Buffer along streambanks, a contiguous tract of Herbaceous Wetland Complex, and a Moist Soil Treatment area (teal narrow bar third from left in Figure 32). However, the next highest plan (burgundy wide bar in the center of Figure 32) provides far more gain in output for the added cost.

DESCRIPTION OF RECOMMENDED PLAN OF IMPROVEMENT FOR WATERFOWL MANAGEMENT

The recommended plan is the combination of measures that best meets the identified needs and opportunities of the project area consistent with the planning objectives and constraints, incorporates the ideas and revisions suggested during higher level reviews, and addresses the concerns expressed by various interest groups during the course of the general reevaluation.

PLAN COMPONENTS

Although not authorized as an ecosystem project, the determination of a National Ecosystem Restoration (NER) plan using costs effectiveness/incremental cost analyses was carried out in a similar manner, resulting in a Waterfowl Management Plan that can contribute national ecosystem benefits in a cost-effective manner.

BEST BUY PLAN

Based on incremental analysis, and as displayed in Figure 32, the recommended plan would be justified WMA features, 10,000 acres of HWC, 85,535 acres of BLH, 300 foot-wide riparian buffers totaling 7,929 acres, and 480 acres of moist soil treatment. However, the local sponsor does not support the plan based on its high costs and probable difficulties in implementation. The local sponsor fully supports recommended WMA features as well as 10,000 acres of HWC, both of which are high state priorities and have secondary cost sharing sponsors. The sponsor does not believe that it would be feasible, both from a cost and local cooperation standpoint, to acquire the acres justified for BLH and riparian buffers. In addition to the high costs, inquiries in the project area do not indicate that landowners would be willing to sell or provide easements on sufficient lands for this number of BLH acres or for the justified acres for continuous buffer. Also, based on the recommendations of the Lower Mississippi Valley Joint Venture that only 240 acres of moist soil treatment are needed in the project area for waterfowl habitat, the sponsor does not support the costs of developing treatments in excess of that recommended by the Joint Venture.

RECOMMENDED PLAN (locally preferred plan)

The recommended plan is the less costly locally preferred plan. This plan includes incrementally justified WMA features, 10,000 acres of HWC, 23,000 acres of BLH planted with seedlings, 100-foot riparian buffers totaling 2,643 acres, and 240 acres of moist soil treatment. This plan is fully supported by the inter-agency planning team composed of the Corps, Natural Resources Conservation Service, USFWS, EPA, AGFC, ANHC, Arkansas Natural Resources Commission, Arkansas Department of Environmental Quality, Ducks Unlimited, and The Nature Conservancy. The costs and outputs per acre of the recommended plan are approximately the same as the winner of the best buy plans except for the riparian buffer portion. However, the smaller buffer still has substantial benefits and is needed to protect aquatic habitat and provide valuable waterfowl outputs. All five of the features provide important waterfowl habitat, and four of them focus on the restoration of native habitats. These features include restoration of vegetation, micro-topography, and hydrology. The plan was formulated in accord with the Environmental Operating Principles and is widely supported not only by natural resource agencies, but also conservations groups and the public-at-large.

WMA Features - Features identified as incrementally justified were those associated with the pump and necessary inlet channel and those in Lower, Upper, and Government Impoundments. Engineering requirements are displayed in Table 75a-b. This waterfowl management feature will significantly improve the largest WMA in the state of Arkansas that at times holds the highest wintering population of mallards in the United States. Table 75a contains descriptions of the measures to be constructed as part of the Waterfowl Management Plan in the Bayou Meto Wildlife Management Area (see Table 75b for feature dimensions).

Pump station and associated channel modifications consist of a 1000 cfs pump station at the outlet of Little Bayou Meto to remove water from behind the Arkansas River Levees. Channel work includes a cleanout and enlargement to a 30-foot bottom width in 10 miles of Little Bayou Meto above the pump station to convey water from the Cannon Brake Structure to the pump station.

Table 75a. Project features to be constructed in the Bayou Meto Wildlife Management Area as part of the Waterfowl Management Plan.

Feature Number	Feature Description	Acres	HSIs	HUs	Weighted HUs
0/1	Remove Bubbling Slough Levee (5,571 ft) (restore hydrology) to Dead Stick Area and Ditching on Bubbling Slough (12,002 ft) (restore hydrology)	417	0.713	297	74
2	Channel cleanout on Five Forks Bayou (25,915 ft) (restore hydrology)	4,293	0.713	3,062	766
3	Channel cleanout on Government Slough (11,676 ft) (restore hydrology)	2,157	0.447	964	241
4	Ditching on Government Impoundment (22,159 ft) and reclaim Dead Stick Area (restore hydrology)	611	0.447	273	68
5/6	Clear noxious woody vegetation on Government Impoundment to reclaim Dead Stick Area and replant desirable vegetation	941	0.447	421	105

Feature Number	Feature Description	Acres	HSIs	HUs	Weighted HUs
7	Channel cleanout on Brushy Slough (16,102 ft) (restore hydrology)	1,746	0.713	1,245	311
9	Channel cleanout on Little Bayou behind Hallowell (14,177 ft) (restore hydrology)	5,071	0.522	2,648	662
10	Channel cleanout on Little Bayou between Salt Ditch and Upper Vallier (2,375 ft) - (improve drainage)	7,829	0.527	4,127	1,032
11	Channel cleanout on Halowell Reservoir perimeter ditch (21,120 ft) (restore hydrology and reduce flooding on adjacent landowners)	615	0.420	258	65
12	Channel cleanout on Tipton Ditch (19,774 ft) (restore hydrology and reduce flooding on adjacent landowners)	764	0.536	410	102
13	Channel cleanout on Hurricane Slough behind Halowell (17,875 ft) (restore hydrology)	3,235	0.536	1,735	434
Feature Number	Feature Description	Acres	HSIs	HUs	Weighted HUs
20	Channel cleanout on Newton Bayou (8,583 ft) (restore hydrology)	128	0.713	91	23
21	Channel cleanout on West Bayou (9,738 ft) (restore hydrology)	982	0.713	700	175
22	Channel cleanout on Little Bayou below Lower Vallier structure (24,626 ft) (restore hydrology)	29,103	0.686	19,963	4,991
25	Channel cleanout on Long Pond Slough (20,935 ft) (restore hydrology)	1,207	0.729	880	220
26	Channel cleanout on Castor Bayou (3,829 ft) (restore hydrology and reduce flooding conflicts with adjacent landowners)	96	0.713	68	17
27	Channel cleanout on Wabbaseka Bayou on west side of Salt Ditch (20,311 ft) (restore hydrology and reduce conflicts with adjacent landowners)	2,337	0.467	1,092	273
28	Channel cleanout on Wabbaseka Bayou east side of Salt Ditch (4,130 ft) (restore hydrology)	137	0.536	73	18
29	Channel cleanout on Cross Bayou in Government Slough (16,014 ft) (restore hydrology reduce flood problems on adjacent landowners)	1,045	0.447	467	117
31/32	Pump station at confluence of Arkansas River and Little Bayou Meto (1,000 cfs); channel cleanout on Little Bayou Meto between Cannon Brake Control Structure and Arkansas River (51,806 ft); flood control by-pass channel from southwest corner of the WMA to connect with Little Bayou Meto (33,301 ft)	36,000	0.699	25,161	6,290
36	Channel cleanout on Salt Ditch from Hwy 79 to Lower Vallier structure (64,808 ft) (restore hydrology)	22,629	0.642	14,536	3,634

TABLE 75b
BAYOU METO WMA ENGINEERING REQUIREMENTS

Work Category
1 - Existing Channel Cleanout and Clearing
2 - New Channel Construction and Clearing
3 - Levee Degradating
4 - Construction of Water Control Structure

Feature Number	Name	Work Item	Work Category	Length (Feet)	Excavation (cu yds)	Clearing = ROW (Acres)	Turfing (Acres)	Assumption factor (sq ft/FT)	Assumptions
zero	Bubbling Slough Levee	Levee Degrading	3	5571	9285	6	6	45.0	3' height, 6' top width, 3H on 1V Slope, 50' clearing ROW width
1	Bubbling Slough	Ditching	2	12002	10668	14	9	24.0	6' BW, 2' depth, 3H on 1V Slope, 50' clearing ROW width
2	Five Forks Bayou	Channel Cleanout and clearing	1	25915	69107	59	40	72.0	15' BW, 3' depth, 3H on 1V Slope, 100' clearing ROW width
3	Government Slough	Channel Cleanout and clearing	1	11676	12108	20	15	28.0	8' BW, 2' depth, 3H on 1V Slope, 75' clearing ROW width
4	Government Slough	Ditching	2	22159	18055	25	16	22.0	6' BW, 2' depth, 3H on 1V Slope, 50' clearing ROW width
5	Government Slough	Clear Noxious Woody Vegetation							
6	Government Slough & Bubbling Slough	Replant desirable trees							
7	Brushy Slough	Channel Cleanout and clearing	1	16102	13120	18	12	22.0	6' BW, 2' depth, 3H on 1V Slope, 50' clearing
9	Little Bayou - behind Halowell	Channel Cleanout and clearing	1	14177	45681	33	20	87.0	20' BW, 3' depth, 3H on 1V Slope, 100' clearing
10	Little Bayou - between Salt Ditch and Upper Vallier	Channel Cleanout and clearing	1	2375	6333	5	4	72.0	15' BW, 3' depth, 3H on 1V Slope, 100' clearing
11	Halowell Reservoir perimeter ditch	Channel Cleanout and clearing	1	21120	18773	24	16	24.0	6' BW, 2' depth, 3H on 1V Slope, 50' clearing
12	Tipton Ditch	Channel Cleanout and clearing	1	19774	20506	34	25	28.0	8' BW, 2' depth, 3H on 1V Slope, 75' clearing
13	Hurricane Slough - behind Halowell	Channel Cleanout and clearing	1	17875	14565	21	13	22.0	6' BW, 2' depth, 3H on 1V Slope, 50' clearing
20	Newton Bayou	Channel Cleanout and clearing	1	8583	6994	10	6	22.0	6' BW, 2' depth, 3H on 1V Slope, 50' clearing
21	West Bayou	Channel Cleanout and clearing	1	9738	7935	11	7	22.0	6' BW, 2' depth, 3H on 1V Slope, 50' clearing
22	Little Bayou - below Lower Vallier	Channel Cleanout and clearing	1	24626	65669	57	38	72.0	15' BW, 3' depth, 3H on 1V Slope, 100' clearing
25	Long Pond Slough	Channel Cleanout and clearing	1	20935	44196	36	23	57.0	10' BW, 3' depth, 3H on 1V Slope, 75' clearing
26	Castor Bayou	Channel Cleanout and clearing	1	3829	3971	7	5	28.0	8' BW, 2' depth, 3H on 1V Slope, 75' clearing
27	Wabbasekka Bayou on West side of Salt Ditch	Channel Cleanout and clearing	1	20311	54163	47	31	72.0	15' BW, 3' depth, 3H on 1V Slope, 100' clearing
28	Wabbasekka Bayou on East side of Salt Ditch	Channel Cleanout and clearing	1	4130	8719	7	4	57.0	10' BW, 3' depth, 3H on 1V Slope, 75' clearing
29	Cross Bayou in Government Impoundment	Channel Cleanout and clearing	1	16014	33807	28	17	57.0	10' BW, 3' depth, 3H on 1V Slope, 75' clearing
31	Little Bayou Meto	Channel Cleanout and clearing	1	51744	1613200	215	N/A	N/A	30-40' BW, 3H on 1V Slope
32	Bypass Channel	Excavation of New Channel	2	26400	586500	197	N/A	N/A	30' BW, 3H on 1V Slope
36	Salt Ditch from Hwy 79 to Lower Vallier	Channel Cleanout and clearing	1	64808	208826	149	92	87.0	20' BW, 3' depth, 3H on 1V Slope, 100' clearing

HWC Development and Management - This measure will closely recreate the most impacted habitat for waterfowl in the region. Unlike other measures, a substantial portion of dryer grassland areas would be integral to the successful establishment of the complex in order to maintain ecosystem integrity. The buffering effects of the dryer habitat would support the wetter areas through water transport, collection, and purification. Also, the buffers surrounding the wetter areas would reduce predation by providing protective cover and dispersing waterfowl and other wetland species throughout the HWC. A large assemblage of ducks and geese would heavily use this habitat type. Also, other waterfowl using these areas are those that would not benefit from forested wetlands, e.g. king rail, American bittern, wood stork, least bittern, pied-billed grebe, purple gallinule, and a host of migrating shorebirds. Also, the plan would provide ancillary benefits to a host of upland species.

BLH Rehabilitation - The 23,000 acres of BLH restoration in the recommended plan, though far less than that determined to be incrementally justified, will go far towards meeting the waterfowl goals for BLH restoration established by the North American Waterfowl Management Plan. Also, the benefits and costs of this plan are proportional to the higher output plan. This waterfowl restoration feature also provides substantial benefits to an array of terrestrial and aquatic resources.

Riparian Buffer Creation - This measure involves establishing 100-foot buffers along channels and streams covering 2,643 acres. Although incremental outputs are less than for the 300-foot buffer plan, its cost are about a third less and its implementation is more feasible. The buffers will not only improve waterfowl habitat but also water quality and habitat for fish and wildlife. It will be necessary to acquire all the land needed for buffer restoration in order to gain sediment-reduction benefits. Reduced sedimentation lessens channel maintenance and improves the aquatic environment. The land would be obtained through restrictive easements; landowners would not be allowed to cut or clear trees within the buffers. The project sponsor would have to periodically remove some trees in order to place sediment and debris blockage from within the channels. Trees would be cleared only to the extent necessary to perform the maintenance, and cleared areas would be allowed to reforest.

Moist Soil Treatments - The recommended plan for 240 acres of moist soil is the plan recommended by the USFWS to meet the deficit for this type of waterfowl habitat within the project area. Even though a higher treatment was determined to be incrementally justified, the local sponsor and interagency team did not believe that the higher treatment, which would require more land to be intensely managed, would be desirable. Also, the costs and outputs for the recommended plan are proportional to the incrementally justified plan.

The greatest loss of incremental benefits is with regard to the riparian buffer plan that is recommended. It can be seen that the costs per AAHU is over two times greater with the LPP. This is because a 300 foot buffer maximizes waterfowl habitat quality and provides an HSI of 1.0 and because 100 foot wide buffers provides an HSI of only 0.30. It was subsequently determined that the value for the 100 foot buffer was undervalued. The 100 foot buffer would provide valuable waterfowl benefits plus provide the other benefits afforded by riparian buffers, i.e., water quality protection, shading, sediment reduction, and valuable habitat to other species. Based on the limited funds available to the local sponsor plus the benefits provided by the reduced size buffer area it was determined that this was an effective expenditure.

Table 75c. Comparison of the Waterfowl Management NER to the Locally Preferred Plan on a cost per Average Annualized Habitat Unit (AAHU) basis.

Feature	NER			Locally Preferred Plan			Assessment
	Cost	Output	Cost/AAHU	Cost	Output	Cost/AAHU	
Herbaceous Wetlands Complex	$1,577,000	10,000 acres 9,159 AAHUs	$172.20	$1,577,000	10,000 acres 9,159 AAHUs	$172.20	NER and LPP are equivalent
Bottomland Hardwood restoration	$13,045,252	85,535 acres 96,074 AAHUs	$135.80	$2,826,000	23,000 acres 25,834 AAHUs	$109.40	LPP is the less costly alternative.
Riparian buffers	$942,384	300' wide, 7,929 acres 9,619 AAHUs	$97.97	$241,000	100' wide, 2,643 acres 1,040 AAHUs	$231.73	Cost/AAHU for LPP is less than shown.
Moist soil treatment	$194,000	480 acres 4,740 AAHUs	$40.93	$97,000	240 acres 2,370 AAHUs	$40.93	NER and LPP have equivalent cost/AAHU; however, the local sponsor prefers to acquire the amount of land recommended by the USFWS.

According to ER 1105-2-100, 4-3 b (2) (a), an LPP can be selected over a NED, NER, or combined NED/NER plan if certain criteria are met. The locally preferred waterfowl plan for Bayou Meto meets these criteria. The LPP is a less costly plan that provides high-priority outputs. The sponsor has worked aggressively to secure funding from state resource agencies and other non-federal organizations. No other non-federal sources for funding are known at this time, and all key state resource agencies and non-governmental organizations participated on the inter-agency planning team. The LPP has greater benefits than any known smaller scale plans that meet resource needs within the project area. The NER plan would provide substantial outputs, but it is not economically viable nor within Corps policy due to the large amount of real estate required. Also, the much larger NER plan is not publicly acceptable because of the large real estate requirement.

FIRST COSTS OF THE RECOMMENDED PLAN

Table 75d is a summary of the cost estimate for the waterfowl management component of the Bayou Meto Basin, Arkansas project, indexed to October 2005 price levels. Project costs for the waterfowl management component ($103,452,000) is based on October 2005 price levels and are assumed to be end of year expenditures.

Table 75d
BAYOU METO BASIN, ARKANSAS PROJECT
Recommended Plan – Waterfowl Management Component
Project First Cost Summary
(October 2005 Price Levels)

ACCOUNT NUMBER	DESCRIPTION	TOTAL PROJECT COST
01	Land and Damages	$42,086,000
02	Relocations	$328,000
03	Reservoirs	$0
06	Fish and Wildlife Facilities	$22,954,000
09	Channels and Canals	$2,545,000
11	Levees and Floodwalls	$182,000
13	Pump Stations	$21,812,000
15	Floodway Control and Diversion Str.	$427,000
19	Building, Grounds, & Utilities	$0
30	Planning, Engineering, and Design	$8,678,000
31	Construction Management	$4,440,000
	TOTAL PROJECT COST	**$103,452,000**

Costs of the recommended plan and a sensitivity analysis assuming varied willing seller participation are shown in Table 76. The total first cost for the recommended plan is $103,452,000 and the annual costs are $6,814,958. Average annual cost per AAHU is $127; cost per DUD is $.32. Cost sharing would be 65% Federal and 35% local. A portion of the pump station cost that benefits the WMA would be allocated to the flood control portion of the project; therefore, the total cost of the waterfowl management plan would be substantially reduced.

Table 76
Final Recommended Plan
October 2005 Price Levels

Feature	First Costs	Annual Costs	AAHU	Cost/AAHU	Net DUD
Bayou Meto WMA	$36,251,000	$2,171,000	16,076	$135	4,197,000
HWC	$19,227,000	$1,577,000	9,159	$172	3,409,000
BLH	$43,366,000	$2,826,000	25,834	$109	11,591,000
Riparian Buffer	$3,638,000	$241,000	1,040	$232	1,201,000
Moist Soil	$970,000	$97,000	2,370	$41	818,000
TOTAL	**$103,452,000**	**$6,912,000**	**54,479**	**$127**	**21,216,000**

0% of HWC, BLH, and Riparian Buffers

Feature	First Costs	Annual Costs	AAHU	Cost/AAHU	Net DUD
Bayou Meto WMA	$36,251,000	$2,171,000	16,076	$135	4,197,000
HWC	$0	$0	0	$0	0
BLH	$0	$0	0	$0	0
Riparian Buffer	$0	$0	0	$0	0
Moist Soil	$970,000	$97,000	2,370	$41	818,000
TOTAL	**$37,221,000**	**$2,268,000**	**18,446**	**$123**	**5,015,000**

25% of HWC, BLH, and Riparian Buffers

Feature	First Costs	Annual Costs	AAHU	Cost/AAHU	Net DUD
Bayou Meto WMA	$36,251,000	$2,171,000	16,076	$135	4,197,000
HWC	$4,807,000	$394,000	2,290	$172	852,000
BLH	$10,842,000	$707,000	6,459	$109	2,898,000
Riparian Buffer	$910,000	$60,000	260	$231	300,000
Moist Soil	$970,000	$97,000	2,370	$41	818,000
TOTAL	**$53,780,000**	**$3,429,000**	**27,454**	**$125**	**9,065,000**

50% of HWC, BLH, and Riparian Buffers

Feature	First Costs	Annual Costs	AAHU	Cost/AAHU	Net DUD
Bayou Meto WMA	$36,251,000	$2,171,000	16,076	$135	4,197,000
HWC	$9,614,000	$789,000	4,580	$172	1,705,000
BLH	$21,683,000	$1,413,000	12,917	$109	5,795,000
Riparian Buffer	$1,819,000	$121,000	520	$233	601,000
Moist Soil	$970,000	$97,000	2,370	$41	818,000
TOTAL	**$70,337,000**	**$4,591,000**	**36,463**	**$126**	**13,116,000**

75% of HWC, BLH, and Riparian Buffers

Bayou Meto WMA	$36,251,000	$2,171,000	16,076	$135	4,197,000
HWC	$14,420,000	$1,183,000	6,869	$172	2,557,000
BLH	$32,525,000	$2,120,000	19,382	$109	8,693,000
Riparian Buffer	$2,729,000	$181,000	780	$232	901,000
Moist Soil	$970,000	$97,000	2,370	$41	818,000
TOTAL	**$86,895,000**	**$5,752,000**	**45,471**	**$126**	**17,166,000**

The Bayou Meto WMA and Moist Soil Complex features cost and outputs are guaranteed based on the opportunity to exercise eminent domain on lands necessary to implement those features if willing sellers are not available. And these features are not sensitive to the HWC, BLH, and riparian buffer efforts. For the HWC, BLH, and riparian buffer work, the costs and habitat outputs are directly proportional to the availability of willing sellers. Therefore, there is no apparent risk of compromising the Federal investment and its outputs by relying on willing sellers.

OPERATION AND MAINTENANCE

An operation and maintenance (OMRR&R) plan for the Little Bayou Meto pump station and other Bayou Meto WMA features will be developed in accordance with the Bayou Meto Wildlife Management Area Wetland Management Plan (Heitmeyer et al. 2004), coordinating with the Bayou Meto interagency planning team. Any future modifications to this plan, if needed, will also be coordinated with the interagency team. The OMRR&R plan for the WMA features will be incorporated into the OMRR&R manual for the entire project. Although the non-Federal sponsor is ultimately responsible for project OMRR&R, it is likely that BLH and moist soil treatments will be turned over to and managed by AGFC along with their current responsibilities for the Bayou Meto WMA. The HWC feature will likely be managed by the Arkansas Natural Heritage Commission. Riparian buffer integrity, in most cases, will be the responsibility of the local sponsor.

In order to protect the Federal investment and otherwise facilitate successful implementation of the wildlife management component (WMC) of the project using easements on a willing seller basis, the Sponsor will dedicate and apply sufficient resources throughout the period of OMRR&R to monitor and enforce all easement terms including land use restrictions.

As part of its OMRR&R responsibility, the Sponsor will manage the project's bottomland hardwood stands for project purposes and outputs. The District, in consultation and coordination with the Sponsor, will develop a written OMRR&R plan during the design of the WMC that will address the general OMRR&R responsibilities of the Sponsor and that will specifically address appropriate timber management practices required to achieve project needs as well as identify the resources the Sponsor will need to dedicate and apply to sufficiently monitor and enforce all easement terms including land use restrictions. Although landowners will not be allowed to reserve rights in the WMC easements to harvest merchantable timber, the written OMRR&R plan also will address general parameters by which the Sponsor could enter into separate written agreements on a landowner-by-landowner basis whereby such landowners could perform on the Sponsor's behalf all or part of the Sponsor's OMRR&R duty to comply with the timber management practices required to support the WMC.

The written OMRR&R plan also will address required monitoring and enforcement by the Sponsor of the easement terms restricting landowners from authorizing public use of the easement areas for hunting or other purposes that are inconsistent with project purposes and outputs. Although landowners will not be allowed to reserve rights in the WMC easements to allow public use of the easement area for hunting, through lease or otherwise, the written OMRR&R plan will address general parameters by which the Sponsor could enter into separate written agreements on a landowner-by-landowner basis where the public access proposed by a landowner is determined to be open and available to all members of the general public on equal terms and otherwise is not inconsistent with project purposes and outputs.

A project cooperation agreement (PCA) will be developed for the Bayou Meto Basin Project. This legally binding document will insure that the project is operated, maintained, and monitored in accordance with the OMRR&R Manual. The project sponsors must sign the PCA prior to initiation of project construction. OMRR&R costs are shown in Table 77.

OPERATIONS AND MAINTENANCE REQUIREMENTS

Table 77
Operations and Maintenance Requirements for the Recommended Plan

Item	Units	Unit Cost	Cost	Frequency	Average Annual Costs
HERBACIOUS WETLAND COMPLEX	acres	$30	$300,000	annual	$300,000
BLH RESTORATION	acres	$30	$690,000	annual	$690,000
MOIST-SOIL HABITAT	acres	$100	$24,000	annual	$24,000
RIPARIAN BUFFERS	acres	$30	$53,500	annual	$53,550
BAYOU METO WMA					
Channel Maintenance:					
Channel Cleanout (Dragline)	19 miles	$2,100	$39,900	every 20 years	$1,122
Herbicide Treatment (aerial app.)	19 miles	$420	$7,980	annual	$7,980
Structure Maintenance:					
Cannon Break					
Maintenance 3 Gated Str.	3 gates	1500/gate	$4,500	annual	$4,500
Operations for 1 year	year	$2,500	$2,500	annual	$2,500
Electricity	year	$600	$600	annual	$600
By Pass channel					
1-Sluice Gate	1 gate	$600/gate	$600	annual	$600
Operations for 1 year	year	$100	$100	annual	$100
Weir Maintenance:					
3 weirs					
Rip-rap or Sheet pile with concrete cap	3	$14,000	$42,000	every 25 years	$672
Levee Maintenance:					
By Pass channel and Cannon Brake					
Extension Guide Levee 9M	52 Acres	$20/acre cut	$1,040	twice yearly	$2,080
(Includes Mowing and Minor fill of washes)					
Pumping Plant (Alt FC3A):					
Pumps (1000 CFS) 2 @ 500 CFS	1000cfs		$57,000	annual	$57,000
Electricity			$321,000	annual	$321,000
TOTAL					**$1,465,704**

RISK AND UNCERTAINTY

There are vast areas of land suitable for waterfowl management features within the project area. Although fee acquisition in most cases, and easements to a lesser extent, would be pursued from willing sellers, the local sponsor would be required to ensure that all lands are provided. There is some risk associated with restoration of native vegetation; success of initial planting efforts might be affected by variables such as weather, insects, disease, fire, and the skill and experience of the planters. Restoration sites would be monitored and replanted if necessary. Hydrogeomorphic classification maps and previous project studies would be utilized by the inter-agency team to prioritize potential restoration sites and to determine appropriate land treatments, identify appropriate species for planting, etc., to help insure successful restoration.

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SECTION IV
COMBINED NED/ WATERFOWL MANAGEMENT PLAN

PLAN FORMULATION

INTRODUCTION

The Waterfowl Management Plan formulated for the Bayou Meto Basin includes substantial waterfowl management features on the state owned Bayou Meto Wildlife Management Area (WMA). The primary component of the Bayou Meto WMA plan is a 1,000-cfs pumping station and necessary channel work that will allow excess water to be drained from the WMA and pumped over the Arkansas River Levee. This levee has hindered natural drainage of the lower Bayou Meto Basin for many years. Without construction of this pumping station, other channel modifications for drainage of the WMA will not be effective. Analysis has demonstrated that construction of this feature is a fully justified waterfowl management feature. However, analysis has also shown that the ability to pump water will also provide substantial flood damage reduction benefits for the project area as a whole. The flood control project could be tied into Little Bayou Meto for drainage via the pump station. It would not be realistic to evacuate floodwaters in any other fashion once this channel work and pump station are in place. Because flood damage reduction benefits are substantial with use of this feature, it became evident that the flood damage reduction component of the Bayou Meto Basin Project bears a portion of the costs. The following is an analysis on the impacts of combining the flood damage reduction and waterfowl components and project cost implications.

PLAN COMPONENTS

NED AGRICULTURAL WATER SUPPLY

Alternative WS4B as described in Section I, Page 95, was identified as the best plan for agricultural water supply. This component allows for preservation of the area's groundwater resources by providing an adequate and dependable supplemental source of irrigation water for agriculture. This enables the project to meet the objective of protecting and preserving the alluvial and Sparta aquifers by minimizing groundwater depletion, thereby allowing the region to maintain its output of agricultural products and its economy. This component provides approximately $32,330,000 in annual irrigation benefits. Conservation efficiencies and management of existing water resources is maximized to the extent practical. A dependable source of water for flooding waterfowl resting and feeding areas during the migration season is available. Fisheries habitat is restored by maintaining year round minimum pools in existing streams. Habitat Unit Values (HUVs) for receiving streams will increase as much as 65 HUVs per month. The plan provides additional habitat with the new canals and reservoirs. Prairie grasses will be established within rights-of-way along new canals located in historically prairie regions of the project area. Buffer strips and drop pipe structures along existing channels significantly increase wildlife habitat and quality of aquatic habitat.

NED FLOOD DAMAGE REDUCTION PLAN

Alternative FC2A is the NED flood damage reduction plan. It includes the cleanout and enlargement of Indian Bayou Ditch through excavation and cutting the left descending bank to a 1 on 3 slope. This alternative also includes limited work on the original Indian Bayou Channel to restore flows through the old meandering stream. The original Indian Bayou channel has been subject to silt deposition and the growth of woody vegetation over the years as flows have been diverted through Indian Bayou Ditch. Structures at the northern confluence of these channels are required to sustain minimum flows for Indian Bayou while diverting flood flows primarily through Indian Bayou Ditch. Indian Bayou and Indian Bayou Ditch combine near Tucker, AR to form Wabbaseka Bayou. Flood control in Wabbaseka Bayou is limited to the amount of work necessary to carry upstream flows without inducing damage to the surrounding landowners. The upper 11 miles and lower 3 miles of this work were limited to cleanout of the existing channel. The remaining 18 miles in-between were targeted for selective clearing. Although this work does not significantly reduce flooding in the surrounding areas, it provides conveyance for the flows received from Indian Bayou.

Flows will be routed within and adjacent to the Bayou Meto Wildlife Management Area for conveyance below Wabbaseka Bayou. This work consists of excavating 1 to 3 feet of material in Little Bayou Meto (including one of the double ditches) and 1 to 2 feet in Boggy Slough. The primary impact is related to clearing on one bank for equipment operation and material disposal.

Crooked Creek converges with Big Bayou Meto above the WMA and meanders for about

16.6 miles before intersecting with Crooked Creek Ditch, another manmade channel built many years ago for local drainage. To provide flood relief in this reach and accommodate flows from the water supply system, channel bottom widths will increase to between 35 and 55 feet and banks will be cut back to 1 on 3 slopes for approximately 9.6 miles of Crooked Creek Ditch. The Crooked Creek channel will be enlarged to a bottom width of 50 to 60 feet for about 8.6 miles below the confluence with Crooked Creek Ditch. Two existing weirs on Crooked Creek also need to be modified to accommodate this work.

The last remaining item in this alternative is a bypass channel on Big Bayou Meto, which will lower flood stages near Interstate 40. Two railroad bridges and a highway bridge cross the channel in this reach and the natural floodway has been reduced by encroachment of fishpond levees and vegetation growth. The bypass channel would be 5 miles in length with a bottom width of 10 feet and a depth of about 12 to 18 feet. This channel will have levees on both sides to prevent flooding of adjacent properties. Existing fishpond levees would serve as the levees for the left descending bank while the right descending levee would have to be constructed. A bridge will be required where the channel crosses Hwy 70 and two low water weirs will be constructed in the channel for maintenance purposes.

Altogether, the NED plan (FC2A) would involve about 118 miles of channel enlargement or new channel at a total cost of $24,239,000. The benefit to cost ratio would be 1.70 to 1.

WATERFOWL MANAGEMENT PLAN

The recommended waterfowl management plan includes: 23,000 acres of bottomland hardwood (BLH) restoration at a total first cost of $43,366,000; 10,000 acres of herbaceous wetland complex at a total first cost of $19,227,000; 2,643 acres of riparian buffer restoration at a total first cost of $3,638,000; a 240-acre moist soil habitat area at a total first cost of $970,000; and a combination of measures to include a pump, channel cleanouts, structural and reforestation measures to benefit over 32,000 acres on the Bayou Meto Wildlife Management Area (WMA) at a total first cost of $36,251,000. The largest cost for the WMA improvements is the cost of constructing a pump station and pump inflow channel features on Little Bayou Meto for $32,014,000. The pump feature is necessary to provide drainage for the WMA and allow recommended drainage improvements on the WMA to properly function. The total first cost for all waterfowl management measures (including a 25% contingency) is $103,452,000.

COMBINED WATERFOWL MANAGEMENT AND FLOOD CONTROL PLAN

Implementation of the Waterfowl Management Plan facilitates accumulation of additional flood control benefits by including the pump station and channel work on Little Bayou Meto in conjunction with the NED Flood Damage Reduction Plan. The pump station and channel work on Little Bayou Meto necessary to obtain the waterfowl benefits are also produce significant benefits for flood control by providing a more efficient means to evacuate flood waters form the project area..

The Waterfowl Plan and Flood Control Plan need to be combined because the pump station and Little Bayou Meto cleanout are required for the Bayou Meto WMA features to properly function. All benefits of the Waterfowl Management Plan would still be realized if combined with flood control for the project area, and impacts associated with the addition of a pump for flood control are mitigated using an HGM analysis. The use of the HGM analysis changes the flood damage reduction mitigation from 2,993 acres to 2,769 acres.

Because of the necessity to operate the pump to obtain waterfowl benefits on the WMA and because the flood damage reduction benefits associated with pumping are substantial, it is reasonable to allocate costs for the pump station and associated channel work on Little Bayou Meto, as well as operation and maintenance between the two project purposes.

PROJECT COSTS

ALLOCATION OF LITTLE BAYOU METO PUMP COSTS

COST ALLOCATION BASED ON SEPARABLE COST- REMAINING BENEFITS METHOD (SCRB METHOD)

The guidance for use of this method is dates back to the mid-20th century when infrastructure within the United States was being constructed, such as locks and dams. Most of these features had multipurpose outputs, e.g. flood control, navigation, recreation, water supply, etc. To attribute cost of features to particular outputs of the project, the SCRB method was used to accomplish the task. For the Bayou Meto project, the separable costs for flood control and waterfowl management are very clear. Flood control component in essence does not impact waterfowl management opportunities. Likewise, the waterfowl management component does not impact flood control opportunities. The two components stand alone except for the utilization of a 1000 cfs pump station and channel work on Little Bayou Meto. Both components will use the Little Bayou Meto pump station and inlet channel at different times to accomplish their design function, with no change in the design of the pump station and channel feature. The separable costs for the flood control component are all of the costs for design considerations contained in the component excluding the pump station and channel work. The separable costs for the waterfowl management component are all of the costs for design considerations contained in the component excluding the pump station and channel work. The 1000 cfs pump station and channel work on Little Bayou Meto would be a joint cost shared by both of the components. The single purpose least cost alternative plan for each of the components would be that component plus the pump station and channel work to obtain the calculated benefits. Table 78 shows how the costs were allocated.

Table 78
Cost Allocation Using SCRB Method

	Annual Costs ($1,000)
Total Waterfowl and Flood Damage Reduction Costs (a+b+c)	**10,306**
a) Flood Control Separable Costs	3,394
b) Waterfowl Management Separable Costs	5,286
c) Joint Costs	1,626

Annual Costs and Benefits ($1,000)

	Flood Control	**Waterfowl Management**	**Total**
d) Average Annual Benefits	5,263	16,076 *AAHU*	
e) Single Purpose Least Cost Alternative Plan	5,020	6,912	
f) Limited Benefits / Costs (lesser of d and e)	5,020	6,912	
g) Separable Costs (a and b)	3,394	5,286	
h) Remaining Benefits (f minus g)	1,626	1,626	
i) Percent of Total	50%	50%	100%
j) Allocated Joint Cost (c times i)	813	813	1,626
k) Total Cost with Allocation (j+a and j+b)	**4,207**	**6,099**	**10,306**

This method verifies that the cost allocation should be 50/50 for the pump station and channel work, since both components need the same size pump station and amount of channel work to achieve calculated benefits. Based on this cost allocation, the flood control component has a first cost of $40,169,000 for all of the flood control features and 50% of the pump station and channel work, and the waterfowl management component has a first cost of $87,522,000 for all of the waterfowl management features and 50% of the pump station and channel work.

DESCRIPTION OF SELECTED PLAN OF IMPROVEMENT FOR FLOOD CONTROL

The selected plan is the combination of measures that best meets the identified needs and opportunities of the project area consistent with the planning objectives and constraints, incorporates the ideas and revisions suggested during higher level reviews, and addresses the concerns expressed by various interest groups during the course of the general reevaluation.

PLAN COMPONENTS

The Bayou Meto Flood control project is designed to reduce agricultural flooding, especially in the lower portion of the watershed, and to ensure compatibility with the Waterfowl Management and Agricultural Water Supply components of the project.

RECONFIGURED COSTS AND BENEFITS OF THE FLOOD CONTROL COMPONENT OF THE COMBINED PLAN

Project costs were then allocated between flood control and waterfowl management with the resulting flood control portion sustaining a first cost of $40.2 million with excess annual benefits of 3.05 million and a benefit/cost ratio of 2.21 to 1 as shown in Table 79 below.

Table 79
PLAN SELECTION/ECONOMIC SUMMARY
FLOOD CONTROL COMPONENT OF COMBINED PLAN
WITHOUT TWO PRAIRIE BAYOU (REACH 6) WORK COSTS/BENEFITS
REVISED MITIGATION
(October 2005 Price Levels, 5-1/8 Percent Discount Rate Analysis)

Item	Plan FC3A
First Costs a_/	40,169,000
Annual Costs a_/ b_/	2,510,000
Annual Benefits b_/	5,559,000
All Categories	
Excess Benefits over Costs c_/	3,049,000
Benefit-Cost Ratio with all Benefit categories	2.21

a_/ October 2005 price levels (revised mitigation costs).
b_/ Annualized with appropriate discount rate factors and 50-year project period of analysis.
c_/ Calculated using all benefits except employment benefits.

CHANGE IN 1950 AUTHORIZED FLOOD CONTROL PROJECT

The flood control project authorized in 1950 had to be modified to accommodate the hydrologic changes within the Bayou Meto basin. Because of these hydrologic changes, a legal opinion was necessary to insure that the Chief had the discretionary authority to approve changes in scope that would be necessary to accomplish the flood control objectives, which were outlined in the 1950 project, and are now part of the current project. Table 80 shows the comparison between the 1950 flood control project (price leveled where applicable) and the current flood control project. Based on ER 1105-2-100, Section III, Paragraph G-13. Approval Authorities, the selected flood control plan is within the Chief's discretionary authority to approve the modifications to the flood control plan.

Table 80
Bayou Meto Comparison Table for Flood Control

Project Items/Outputs	1950 Flood Control Project	Current Flood Control Project	Explanation
Average Annual Acres Flooded	445,000	312,712	Area inundated on an average annual basis.
Average Annual Acres Protected	200,000	181,500	Based on a level of protection around a 2-5 year level.
Miles of Channel	150.9	128.1	Channel work was reduced to have a more environmentally sensitive approach to flood control
Arkansas River Stages (Description)	Pre-Navigation System (Normal river conditions)	Post-Navigation System (Higher river conditions)	Arkansas River stages are higher to maintain navigation pools for barge traffic
Flood Control Cost	$96,000,000	$40,169,000	1950 cost ($6,080,000) was price leveled to 2004
Outlet	1928 Gravity Structure	1928 Gravity Structure and 50% New Pump Station	The levee system was put into place in the late 20's, and the structure, although ineffective, remains in place today. The pump station was fully justified based on waterfowl management; however, cost was allocated to flood control based on benefits for flood control.
Annual Benefits	$7,107,000	$3,049,000	1950 benefits ($1,000,000) were increased to 2004 price levels
Mitigation (acres)	N/A	2,769	Mitigation was not required in 1950
Level of Protection	2-5-year	2-5-year	

ENVIRONMENTAL EFFECTS OF THE SELECTED PLAN

The selected combined plan for waterfowl and flood damage reduction includes features designed to reduce flooding on cleared lands and to minimize impacts to significant habitat as much as possible. Reductions in flooding to bottomland hardwoods in the vicinity of the Bayou Meto WMA will reduce stress on these important resources. Also, restoration of flows to the Indian Bayou Channel will restore aquatic habitat to this degraded system. Adverse impacts to terrestrial habitat, waterfowl habitat, wetland resources, and aquatic resources have been accounted for and minimized as much as possible. A detailed description of project-induced environmental impacts and benefits is presented in the accompanying Environmental Impact Statement (EIS). The U. S. Fish and Wildlife Service has provided a Coordination Act Report included in Volume 10, Appendix D. The inter-agency team determined that additional analyses were needed to identify the actual hydrologic effects of the combined plan.

The inter-agency team believed that the original analysis overstated hydrologic impacts for flood damage reduction and determined that additional analyses were needed to identify the actual hydrologic effects of the combined flood damage reduction and waterfowl plan. The University of Missouri's Gaylord Memorial Laboratory evaluated the hydrologic effects of this plan on BLH (Volume 10, Appendix D, Section XVI). It was concluded that 1,384 acres of BLH would be negatively impacted by the project and recommended that hydrologic impacts and mitigation requirements be determined through a hydrogeomorphic (HGM) evaluation.

The U.S. Army Engineer Research and Development Center, Environmental Laboratory, evaluated the effects of hydrologic changes on project area using an HGM assessment (Volume 10, Appendix D, Section XVIII, Part A). This study concluded that a total of 1,780 acres of BLH restoration would be required to fully mitigate all impacts associated with hydrologic changes induced by the combined plan. This includes 1,340 acres needed to offset adverse hydrologic effects of the combined plan on BLH and an additional 440 acres of needed to mitigate hydrologic impacts to farmed wetlands. The remaining 989 acres are required to offset direct impacts to BLH and farmed wetlands.

CONCLUSION

Although the full costs of pumping is fully justified based on waterfowl management benefits, the reallocation of some of the costs to flood control is a more equitable scenario considering the significant and tangible benefits associated with flood damage reduction. Our analysis indicates that allocation based on pump usage associated with the two project purposes is the most equitable method of distributing costs. The first costs and fully funded costs for the flood control component are presented in Tables 83-85.

Table 83 **BAYOU METO BASIN, ARKANSAS PROJECT** **Selected Plan – Flood Control Component** **Project First Cost Summary** **(October 2005 Price Levels)**		
ACCOUNT NUMBER	**DESCRIPTION**	**TOTAL PROJECT COST**
01	Land and Damages	$5,969,000
02	Relocations	$1,168,000
03	Reservoirs	$0
06	Fish and Wildlife Facilities	$715,000
09	Channels and Canals	$11,400,000
11	Levees and Floodwalls	$714,000
13	Pump Stations	$8,760,000
15	Floodway Control and Diversion Str.	$961,000
19	Building, Grounds, & Utilities	$0
30	Planning, Engineering, and Design	$7,861,000
31	Construction Management	$2,621,000
	TOTAL PROJECT COST	**$40,169,000**

Table 84
BAYOU METO BASIN, ARKANSAS PROJECT
Flood Control Component
Total of All Accounts
Project Cost Schedule*
(October 2005 Price Levels)

CCA	2006	2007	2008	2009	2010	2011	2012	TOTALS
Flood Control								
FC1 Little Bayou Meto Pm St	$747,000	$6,561,000	$2,550,000	$1,058,000	$149,000			$11,066,000
FC2 Little Bayou Meto CC	$1,076,000	$1,419,000	$1,561,000	$808,000				$4,864,000
FC3 Boggy Slough				$673,000				$673,000
FC4 Wabbaseka Bayou Chan		$394,000	$2,084,000	$807,000	$565,000			$3,850,000
FC5 Indian Bayou Ditch			$348,000	$304,000	$1,486,000			$2,138,000
FC6 Indian Bayou Channel			$486,000	$235,000	$1,845,000	$579,000		$3,144,000
FC8 Crooked Creek			$681,000	$327,000	$1,237,000	$2,255,000		$4,501,000
FC9 Big Bayou Meto Div			$677,000	$498,000	$398,000	$4,237,000		$5,811,000
FC10 Mitigation	$277,000	$1,258,000	$773,000	$784,000	$560,000	$470,000		$4,122,000
SUB-TOTAL	$2,100,000	$9,633,000	$9,161,000	$5,494,000	$6,241,000	$7,541,000		$40,169,000

* Schedule assumes new start construction in FY06. No new start construction were received in FY06. Earliest new start construction could occur in FY07.

Table 85
BAYOU METO BASIN, ARKANSAS PROJECT
Flood Control Component
Project Cost Schedule*
Total of All Accounts
(Fully Funded – CWCCIS Index – October 2005)

CCA	2006	2007	2008	2009	2010	2011	2012	TOTALS
Flood Control								
FC1 Little Bayou Meto Pm St	$777,000	$6,895,000	$2,775,000	$1,187,000	$182,000			$11,816,000
FC2 Little Bayou Meto CC	$1,121,000	$1,495,000	$1,676,000	$888,000				$5,180,000
FC3 Boggy Slough				$757,000				$757,000
FC4 Wabbaseka Bayou Chan		$439,000	$2,269,000	$911,000	$635,000			$4,254,000
FC5 Indian Bayou Ditch			$404,000	$367,000	$1,712,000			$2,483,000
FC6 Indian Bayou Channel			$564,000	$283,000	$2,130,000	$663,000		$3,640,000
FC8 Crooked Creek			$790,000	$395,000	$1,448,000	$2,580,000		$5,213,000
FC9 Big Bayou Meto Div			$785,000	$601,000	$481,000	$4,836,000		$6,703,000
FC10 Mitigation	$285,000	$1,334,000	$841,000	$877,000	$656,000	$564,000		$4,557,000
SUB-TOTAL	$2,183,000	$10,163,000	$10,104,000	$6,266,000	$7,244,000	$8,643,000		$44,603,000

* Schedule assumes new start construction in FY06. No new start construction were received in FY06. Earliest new start construction could occur in FY07.

DESCRIPTION OF SELECTED PLAN OF IMPROVEMENT FOR WATERFOWL MANAGEMENT

The selected plan is the combination of measures that best meets the identified needs and opportunities of the project area consistent with the planning objectives and constraints, incorporates the ideas and revisions suggested during higher level reviews, and addresses the concerns expressed by various interest groups during the course of the general reevaluation.

PLAN COMPONENTS

Although not authorized as an ecosystem project, the determination of a National Ecosystem Restoration (NER) plan using costs effectiveness/incremental cost analyses was carried out in a similar manner, resulting in a Waterfowl Management Plan that can contribute national ecosystem benefits in a cost-effective manner.

RECONFIGURED BENEFITS OF THE WATERFOWL MANAGEMENT COMPONENT OF THE COMBINED PLAN

By allocating $15,930,000 first costs of the pumping station and associated costs to the flood control feature, the cost of the Bayou Meto WMA is reduced from $36,251,000 to $20,321,000. Based on revised annual costs of $1,357,958 and DUDs remaining at 4,197,027 the cost per DUD is decreased from about $.38 to about $.19. The cost effectiveness of the total Waterfowl Management Plan (BLH, HBC, etc.) has also increased. Cost per DUD has decreased from about $.20 to $.19 for the total plan.

CONCLUSION

Although the full costs of pumping is fully justified based on waterfowl management benefits, the reallocation of some of the costs to flood control is a more equitable scenario considering the significant and tangible benefits associated with flood damage reduction. The first costs and fully funded costs for the waterfowl management component are presented in Tables 86-88.

Table 86 BAYOU METO BASIN, ARKANSAS PROJECT Selected Plan – Waterfowl Management Component Project First Cost Summary (October 2005 Price Levels)		
ACCOUNT NUMBER	**DESCRIPTION**	**TOTAL PROJECT COST**
01	Land and Damages	$41,866,000
02	Relocations	$0
03	Reservoirs	$0
06	Fish and Wildlife Facilities	$22,954,000
09	Channels and Canals	$0
11	Levees and Floodwalls	$0
13	Pump Stations	$13,052,000
15	Floodway Control and Diversion Str.	$0
19	Building, Grounds, & Utilities	$0
30	Planning, Engineering, and Design	$6,542,000
31	Construction Management	$3,108,000
	TOTAL PROJECT COST	**$87,522,000**

Table 87
BAYOU METO BASIN, ARKANSAS PROJECT
Waterfowl Management Component
Total of All Accounts
Project Cost Schedule*
(October 2005 Price Levels)

CCA	2006	2007	2008	2009	2010	2011	2012	TOTALS
Waterfowl Management								
Herbaceous Wetland Complex		$996,000	$4,478,000	$4,478,000	$4,478,000	$3,829,000	$968,000	$19,227,000
Little Bayou Meto Pm St	$824,000	$7,726,000	$3,815,000	$2,237,000	$1,382,000			$15,984,000
BMTO WMA Features	$847,000	$847,000	$847,000	$947,000	$847,000			$4,337,000
Forest Restoration		$4,577,000	$4,577,000	$8,800,000	$8,800,000	$8,800,000	$7,812,000	$43,366,000
Riparian Buffer Restoration		$549,000	$549,000	$549,000	$847,000	$847,000	$298,000	$3,638,000
Moist Soil Habitat		$931,000	$39,000					$970,000
SUB-TOTAL	$1,671,000	$15,627,000	$14,306,000	$17,012,000	$16,354,000	$13,475,000	$9,077,000	$87,522,000

* Schedule assumes new start construction in FY06. No new start construction were received in FY06. Earliest new start construction could occur in FY07.

Table 88
BAYOU METO BASIN, ARKANSAS PROJECT
Waterfowl Management Component
Project Cost Schedule*
Total of All Accounts
(Fully Funded – CWCCIS Index – October 2005)

CCA	2006	2007	2008	2009	2010	2011	2012	TOTALS
Waterfowl Management								
Herbaceous Wetland Complex		$3,500,000	$4,881,000	$5,020,000	$5,164,000	$4,526,000	$1,126,000	$24,217,000
Little Bayou Meto Pm St	$858,000	$8,122,000	$4,137,000	$2,479,000	$1,550,000			$17,146,000
BMTO WMA Features	$874,000	$899,000	$921,000	$1,057,000	$970,000			$4,721,000
Forest Restoration		$4,864,000	$5,012,000	$9,859,000	$10,138,000	$10,423,000	$9,367,000	$49,663,000
Riparian Buffer Restoration		$586,000	$604,000	$622,000	$971,000	$997,000	$342,000	$4,122,000
Moist Soil Habitat		$982,000	$45,000					$1,027,000
SUB-TOTAL	$1,732,000	$18,953,000	$15,600,000	$19,037,000	$18,793,000	$15,946,000	$10,835,000	$100,896,000

FIRST COSTS OF SELECTED PLAN
(COMBINED NED/WATERFOWL MANAGEMENT PLAN)

Table 89 is a summary of the costs for the Combined NED/Waterfowl Management Plan for the Bayou Meto Basin, Arkansas Project. Cost details for the project are included in the specific component sections of the report and in the corresponding appendices. Detailed estimates and schedules are presented in the MCACES cost estimates (October 2005 price leveled) and the PMP.

Table 89
BAYOU METO BASIN, ARKANSAS PROJECT
Selected Plan – NED/Waterfowl Management Plan
Project First Cost Summary
(October 2005 Price Levels)

ACCOUNT NUMBER	DESCRIPTION	TOTAL PROJECT COST
01	Land and Damages	$66,638,000
02	Relocations	$35,761,000
03	Reservoirs	$1,897,000
06	Fish and Wildlife Facilities	$23,669,000
09	Channels and Canals	$273,681,000
11	Levees and Floodwalls	$714,000
13	Pump Stations	$57,495,000
15	Floodway Control and Diversion Str.	$961,000
19	Building, Grounds, & Utilities	$6,246,000
30	Planning, Engineering, and Design	$41,451,000
31	Construction Management	$21,868,000
	TOTAL PROJECT COST	**$530,381,000**

OPERATIONS AND MAINTENANCE REQUIREMENTS

Operations and maintenance requirements are discussed in the appropriate component section of the report. Annual operation and maintenance costs by project component are presented in Table 90.

Table 90 BAYOU METO BASIN, ARKANSAS PROJECT Selected Plan – NED/Waterfowl Management Plan O&M Costs (October 2005 Price Levels)	
PROEJCT COMPONENT	**ANNUAL COST**
Agricultural Water Supply	$4,235,000
Flood Control	$32,000
Waterfowl Management and Restoration	$1,466,000
TOTAL ANNUAL O&M COST	**$5,733,000**

PROJECT COST/BENEFIT SUMMARY

Table 91 presents a summary of benefits and costs for the selected plan of improvement. The plan (Combined NED/Waterfowl Management Plan) is the plan preferred by the project sponsor. A comparison of the average annual equivalent (AAE) benefits with AAE costs indicates that the plan for the Bayou Meto Basin, Arkansas Project has a benefit-to-cost ratio of 1.19 to 1, with excess benefits of $6,414,000. The plan is based on a combination of the NED benefit-cost analysis, and waterfowl management analysis, including cost effectiveness and incremental cost analysis. Waterfowl Management benefits include, 54,479 average annual habitat units (AAHUs); equivalent to, 21,216,388 duck-use-days (DUDs). The Waterfowl Management Plan is described in detail in Section III of this report.

Table 91
BAYOU METO BASIN, ARKANSAS PROJECT
Selected Plan – NED/Waterfowl Management Plan
Summary of First Costs and Average Annual Equivalent (AAE) Benefits, Costs, Excess Benefits, and Benefit-to-Cost (BCR) Ratio
(October 2005 Price Levels, 5.125% Discount Rate)

BENEFIT/COST CATEGORY	BENEFIT/COST ($)
FIRST COST	
Agricultural Water Supply Component	$402,690,000
Flood Control Component	$40,169,000
Waterfowl Management Component 1/	$87,522,000
TOTAL	**$530,381,000**
ANNUAL BENEFITS	
Agricultural Water Supply Component	$45,909,000
Flood Control Component	$5,559,000
TOTAL	**$51,468,000**
ANNUAL COSTS	
Agricultural Water Supply Component	$30,983,000
Flood Control Component	$2,510,000
TOTAL	**$33,493,000**
EXCESS BENEFITS	
Agricultural Water Supply Component	$14,926,000
Flood Control Component	$3,049,000
TOTAL	**$17,975,000**
BCR	**1.54**

1/ Waterfowl Management Costs Not Used in Cost-Benefit Analysis

PROJECT IMPLEMENTATION

INSTITUTIONAL REQUIREMENTS

Pertinent state of Arkansas statutes to include acts or amendments to statutes concerning surface and groundwater regulation and irrigation districts include:

- Act 1051 of 1985
  - Groundwater Use
- Arkansas Code Annotated of 1987
  - Irrigation, Drainage, and Watershed Improvement District Act
  - Development and Use of Water Resources Generally
  - Determination of Water Use Requirements
  - Arkansas Groundwater Protection and Management Act
- Act 154 of 1991
  - Critical Groundwater Designation
- Act 342 of 1991
- Act 838 of 1995
- Arkansas Code Annotated of 1997
  - 14-116-501: Proposed Improvement Plan for Assessment - Based Water District Projects
  - 14-116-502: Court Approval of Project Improvement Plan - Appointment of Assessor
- Act 1426 of 2001
  - Metering Devices

Arkansas Law applicable to flood control project include:

- Arkansas Code Section 14-91-304: Agreements with Federal Government – Flood Control Improvement District
- Arkansas Code Chapter 24: Flood Control; Sec. 15-24-101 thru 108
- Arkansas Code Section 14-25-303: Power of Districts and Directors
- Arkansas Code Section 14-120-203: Construction of Flood Control and Drainage Works

LEGAL

The legal and institutional requirements at the state and local level are currently in place to allow for project sponsorship and implementation. There are no known barriers to project implementation.

PERMITS AND COMPLIANCE

In order for the project to be built and operated, certain permits must be granted and certified by select Federal and state agencies. The following Federal and state review and/or permit requirements are applicable to the Bayou Meto Basin, Arkansas Project. It is the local sponsor's responsibility to obtain the necessary permits for water withdrawals from the state.

SECTION 404

The authority to regulate discharges of dredged (excavated) or fill material in waters of the United States (including wetlands) was given to the Corps of Engineers with passage of the Federal Water Pollution Act Amendments. This Act was later changed to the Clean Water Act in 1977. The regulation of materials into or from rivers, streams, lakes, and wetlands is intended to "restore and maintain the integrity of the Nation's waters".

SECTION 10

Since 1899, the Corps of Engineers has had authority to regulate any work activity performed over our Nation's navigable waters. Structures, intakes, and any other impacts are included under this jurisdictional mandate.

NON-RIPARIAN PERMIT

The Arkansas Soil and Water Conservation Commission may authorize the transportation of excess surface waters to nonriparians under provisions of Statute 15-22-304. Procedures for application as well as delineation of "excess surface waters" are contained in this statute. For purposes of transfer of excess surface water in the Arkansas River Basin, the transfer amount shall not exceed the amount necessary for fish and wildlife needs, which will in turn insure the minimum pool level required for navigation.

WATER PLAN COMPLIANCE REVIEW

Under Title VI in the ANRC's "Rules For Water Development Project Compliance With The Arkansas Water Plan", all water development "projects", excluding sewage disposal, industrial waste, or other waste treatment systems, shall be subject to review and approval by ANRC. A written application in accordance with Subtitle II must accompany the filing correspondence.

DAM SAFETY PERMIT

If a dam or levee is 25 feet or more in height and impounds 50 acre-feet or more, issuance of a dam permit is required by ANRC. The permit should be obtained before actual construction begins on the dam or levee.

DIVISION OF PLAN RESPONSIBILITIES

PROJECT COOPERATION AGREEMENT

Section 103(j) of the Water Resources Development Act (WRDA) of 1986, Public Law 99-662, mandates that a project shall be initiated only after non-Federal interests have entered into a binding agreement with the Secretary to pay 100 percent of the operation, maintenance, and replacement and rehabilitation costs of the project, to pay the non-Federal share of the costs of construction required by this section, and to hold and save the United States free from damages due to the construction or operation and maintenance of the project, except for damages due to the fault or negligence of the United States or its contractors. That binding agreement is known as a Project Cooperation Agreement (PCA). The Economy Act, 31 U.S.C. 1535, provides the authority for agencies of the Federal Government to reimburse other agencies of the Federal Government for services. ASA(CW), in Memorandums to the Director for Civil Works and Deputy Commander for Civil Works, dated 19 May and 27 September 1999, respectively, determined that the NRCS can be used as the construction agent to implement the on-farm features under the Economy Act due to the NRCS's experience and expertise in these types of features. For the on-farm features implemented by the NRCS, the NRCS's normal procedures to protect the Federal investment through the use of long-term contracts and maintenance agreements will be used. The sponsor will not be required to obtain lands, easements and rights-of-way necessary to operate and maintain the on-farm features and no credit will be given for the lands, easements, and rights-of-way for the on-farm features for which the NRCS acts as the construction agent. The long term contracts and maintenance agreements will be in force as long as the project is authorized. The NRCS has indicated their support for the project and their willingness to act as construction agent, given necessary funding. A memorandum of agreement will be negotiated with the NRCS and included in the PCA package. The model PCA will be modified to enable the use of the NRCS as the construction agent for the on-farm features.

The Arkansas Natural Resources Commission (ANRC), in partnership with the Bayou Meto Water Management District (BMWMD), has indicated their intent to serve as local sponsor for the project and assume the responsibilities of local cooperation.

FINANCIAL DOCUMENTATION

The letter of intent and financing plan along with pertinent cost sharing information and the Commander's Assessment of Financial Capability is included in the Financial Documentation section of this report.

FEDERAL RESPONSIBILITIES

CORPS OF ENGINEERS

The Corps of Engineers is responsible for the implementation of the project. Due to the NRCS's expertise in implementing on-farm features, it was determined that they should be used as the construction agent for these features. This determination was cited in a memo dated 25 April 2005 signed by the ASA(CW). A Memorandum of Agreement will be negotiated with the NRCS to fully describe their involvement in implementing the on-farm features. The Corps of Engineers will be responsible for the planning, engineering, design and construction of the agricultural water supply, flood control, and waterfowl management components of the project. Completion of design memoranda, as needed, and plans and specifications for project construction; review and approval of real estate appraisals; contraction and supervision of construction; inspection of completed work; and performance of all related requirements necessary for project implementation of the agricultural water supply component and associated environmental features will be the responsibility of the Memphis District. Vicksburg District has responsibility for the flood control component and associated environmental features.

NATURAL RESOURCES CONSERVATION SERVICE

The determination was made that NRCS had the authority to act as the construction agent for the on-farm features under the Economy Act. The NRCS indicated that, given the necessary appropriation, they have the necessary authorities and resources available to implement the on-farm features. A Memorandum of Agreement will be developed with the NRCS to enable their use to design and construct the on-farm features. This includes all conservation measures, management strategies, and retrofit of existing irrigation systems to utilize the delivery system. This component also includes provisions for providing waterfowl feeding and resting areas during the fall and winter months. The plans and specifications necessary for construction, along with the operation and maintenance plans and environmental features, will be fully developed in on-farm plans by the NRCS. The on-farm plans will form the basis of the long-term contracts and maintenance agreements used to protect the Federal investment. Typical Corps of Engineers procedures would require that the sponsor acquire the necessary lands, easements, and rights of way for project construction, operation, and maintenance. Operation of the on-farm features to maximize the benefits would require essentially normal farming procedures and flowage easements would be required for the waterfowl flooding. The typical NRCS contracts and binding agreements will be used to ensure construction and OMRR&R for as long as the project is authorized. The sponsor will not be required to obtain an interest in the land for operation and maintenance due to the nature of the on-farm features. The lands, easements, and right-of-way for construction will not be included in the total project costs and credited to the sponsor. The sponsor will be required to ensure OMRR&R for the on-farm features. If a landowner fails to perform OMRR&R, or if a landowner sells the farm and the buyer refuses to accept responsibility to perform OMRR&R, the Sponsor will recover from the landowner the Federal investment in the on-farm features on that farm. The Sponsor would seek to recover the investment on a voluntary basis but would litigate if necessary. The Sponsor would provide the recovered funds to the Corps of Engineers to forward to the Treasury.

COST APPORTIONMENT

A summary of fully funded non-Federal and Federal costs, by fiscal year, is presented in Tables 96 thru 99. However, first costs, not fully funded costs, were used to show that the project is economically justified and those first costs are presented in Tables 91 on page 307 and again in Tables 92-95 on pages 315-316.

AGRICULTURAL WATER SUPPLY COMPONENT

The Non-Federal Sponsor shall contribute 35 percent of water supply component costs. If the Government projects that the value of the Non-Federal Sponsor's LERRD contributions will be less than 35 percent of water supply component costs, the Non-Federal Sponsor shall provide a cash contribution in the amount necessary to make the Non-Federal Sponsor's total contribution equal to 35 percent of water supply component costs.

FLOOD CONTROL COMPONENT

The Non-Federal Sponsor shall provide cash equal to 5 percent of the flood control costs. The Non-Federal Sponsor shall contribute a minimum of 25 percent, but not to exceed 50 percent, of the flood control component costs. The Non-Federal Sponsor shall provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas that the Government determines the Non-Federal Sponsor must provide for the construction, operation, and maintenance of the flood control component, and shall perform or ensure performance of all relocations that the Government determines to be necessary for the construction, operation, and maintenance of the flood control component.

If the Government projects that the value of the Non-Federal Sponsor’s contributions (LERRD + 5 percent cash contribution) will be less than 25 percent of the flood control component, the Non-Federal Sponsor shall provide an additional cash contribution in the amount necessary to make the Non-Federal Sponsor’s total contribution equal to 25 percent of the flood control component costs.

WATERFOWL MANAGEMENT COMPONENT

The Non-Federal Sponsor shall contribute 35 percent of the waterfowl management component in accordance with the provisions of this paragraph. The Non-Federal Sponsor shall provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; and shall perform or ensure performance of all relocations, and shall construct improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material that the Government determines to be required or to be necessary for construction, operation, and maintenance of the waterfowl management component.

If the Government projects at any time that the collective value of the above LERRD contributions will be less than 35 percent, the Non-Federal Sponsor shall provide additional funds in the amount necessary to meet the Non-Federal Sponsor’s required share of 35 percent of waterfowl management component.

If the Government determines that the value of the LERRD provided by the Non-Federal Sponsor for the waterfowl management component has exceeded 35 percent of the total waterfowl management component costs, the Government may afford credit for the excess amount against the total non-Federal share of the project cost associated with the agricultural and flood control components of the overall project. However, credit for such excess value will not be applied against the 5 percent cash requirement for flood control. Further, in no case will any excess LERRD credit from the waterfowl management component be eligible for reimbursement.

Table92
Bayou Meto Basin, Arkansas
Agricultural Water Supply Component
First Cost
(October 2005 Price Level)

Item	Federal Cost	Non-Federal Cost	Total Cost
PED	$ 17,581,000	$ 9,467,000	$ 27,048,000
(Percent)	(65)	(35)	
LERR&D	$ 0	$ 53,397,000	$ 53,397,000
Agricultural Water Supply	244,167,000	78,078,000	322,245,000
Subtotal	$ 244,167,000	$ 131,475,000	$ 375,642,000
(Percent)	(65)	(35)	
Total Component	$ 261,748,000	$ 140,942,000	$ 402,690,000
(Percent)	(65)	(35)	

Table 93
Bayou Meto Basin, Arkansas
Flood Damage Reduction Component
First Cost
(October 2005 Price Level)

Item	Federal Cost	Non-Federal Cost	Total Cost
PED	$ 5,896,000	$ 1,965,000	$ 7,861,000
(Percent)	(75)	(25)	
LERR&D	$ 0	$ 7,137,000	$ 7,137,000
Flood Damage Reduction	24,231,000	940,000	25,171,000
Subtotal	$ 24,231,000	$ 8,077,000	$ 32,308,000
(Percent)	(75)	(25)	
Total Component	$ 30,127,000	$ 10,042,000	$ 40,169,000
(Percent)	(75)	(25)	

Table 94 Bayou Meto Basin, Arkansas Waterfowl Management Component First Cost (October 2005 Price Level)			
Item	Federal Cost	Non-Federal Cost	Total Cost
PED	$ 4,252,000	$ 2,290,000	$ 6,542,000
(Percent)	(65)	(35)	
LERR&D	$ 0	$ 41,866,000	$ 41,866,000
Waterfowl Management	39,114,000	0	39,114,000
Adjust for Excess Contribution	13,523,000	-13,523,000	0
Subtotal	$ 52,637,000	$ 28,343,000	$ 80,980,000
(Percent)	(65)	(35)	
Total Component	$ 56,889,000	$ 30,633,000	$ 87,522,000
(Percent)	(65)	(35)	

Table 95 Bayou Meto Basin, Arkansas All Components First Cost (October 2005 Price Level)			
Item	Federal Cost	Non-Federal Cost	Total Cost
Agricultural Water Supply	$ 261,748,000	$ 140,942,000	$ 402,690,000
	30,127,000	10,042,000	40,169,000
Waterfowl Management	56,889,000	30,633,000	87,522,000
Flood Damage Reduction	$ 348,764,000	$ 181,617,000	$ 530,381,000
Total Project	(66)	(34)	
(Percent)			

Table 96

BAYOU METO BASIN, ARKANSAS PROJECT

AGRICULTURAL WATER SUPPLY COMPONENT

Project Cost Sharing Summary Including On-Farm Features

(October 2005 Price Levels) (All Costs in Thousands of Dollars)

	Total Project Cost			LERRD			Construction				Total Federal Cost
Year	Non-Fed Subtotal	Federal Subtotal	Total	Non-Fed	Federal	Total	Non-Fed Cash	Federal	Total	%	Total Federal
Prior	550	19,665	20,215			0	550	19,665	20,215	5.02	19,665
FY2007	30,921	1,677	32,598	21,058		21,058	9,863	1,677	11,540	2.87	1,677
FY2008	21,203	25,627	46,830	12,250		12,250	8,953	25,627	34,580	8.59	25,627
FY2009	39,430	80,841	120,271	11,188		11,188	28,242	80,841	109,083	27.10	80,841
FY2010	45,042	101,571	146,613	9,559		9,559	35,483	101,571	137,054	34.05	101,571
FY2011	15,543	37,758	53,301	2,353		2,353	13,190	37,758	50,948	12.66	37,758
FY2012	6,612	18,927	25,539	0		0	6,612	18,927	25,539	6.35	18,927
FY2013	3,502	10,024	13,526	0		0	3,502	10,024	13,526	3.36	10,024
Total	162,803	296,090	458,893	56,408	0	56,408	106,395	296,090	402,485	100.0	296,090

Table 97
BAYOU METO BASIN, ARKANSAS PROJECT
FLOOD CONTROL COMPONENT
Project Cost Sharing Summary
(October 2005 Price Levels) (All Costs in Thousands of Dollars)

	Total Project Cost			LERRD			Construction				Total Federal Cost
Year	Non-Fed Subtotal	Federal Subtotal	Total	Non-Fed	Federal	Total	Non-Fed Cash	Federal	Total	%	Total Federal
Prior											
FY2007	804	1,379	2,183	715		715	89	1,379	1,468	4.01	1,379
FY2008	1,676	8,487	10,163	1,126		1,126	550	8,487	9,037	24.67	8,487
FY2009	1,804	8,300	10,104	1,266		1,266	538	8,300	8,838	24.11	8,300
FY2010	981	5,285	6,266	638		638	343	5,285	5,628	15.36	5,285
FY2011	3,014	4,230	7,244	2,740		2,740	274	4,230	4,504	12.29	4,230
FY2012	1,919	6,724	8,643	1,483		1,483	436	6,724	7,160	19.54	6,724
FY2013	0	0	0	0		0	0	0	0	0.00	0
Total	10,198	34,405	44,603	7,968	0	7,968	2,230	34,405	36,635	100.0	34,405

Table 98
BAYOU METO BASIN, ARKANSAS PROJECT
WATERFOWL MANAGEMENT COMPONENT
Project Cost Sharing Summary
(October 2005 Price Levels) (All Costs in Thousands of Dollars)

	Total Project Cost			LERRD			Construction				Total Federal Cost
Year	Non-Fed Subtotal	Federal Subtotal	Total	Non-Fed	Federal	Total	Non-Fed Cash	Federal	Total	%	Total Federal
Prior											
FY2007	214	1,518	1,732	214		214		1,518	1,518	2.99	1,518
FY2008	8,840	10,113	18,953	8,840		8,840		10,113	10,113	19.92	10,113
FY2009	8,706	6,894	15,600	8,706		8,706		6,894	6,894	13.58	6,894
FY2010	9,080	9,957	19,037	9,080		9,080		9,957	9,957	19.61	9,957
FY2011	8,474	10,319	18,793	9,238		9,238	*-764	10,319	9,555	18.82	10,319
FY2012	0	15,946	15,946	8,609		8,609	*-8,609	15,946	7,337	14.45	15,946
FY2013	0	10,835	10,835	5,431		5,431	*-5,431	10,835	5,404	10.64	10,835
Total	35,314	65,582	100,896	50,118	0	50,118	*-14,804	65,582	50,778	100.0	65,582

* Negative non-Federal cash indicates excess contribution by the non-Federal sponsor above the 35% cost-share requirement for the purchase of LERRDs.

Table 99
BAYOU METO BASIN, ARKANSAS PROJECT
TOTAL PROJECT (NED/Waterfowl Management PLAN)
Project Cost Sharing Summary
(October 2005 Price Levels) (All Costs in Thousands of Dollars)

	Total Project Cost			LERRD			Construction				Total Federal Cost
Year	Non-Fed Subtotal	Federal Subtotal	Total	Non-Fed	Federal	Total	Non-Fed Cash	Federal	Total	%	Total Federal
Prior	550	19,665	20,215	0	0	0	550	19,665	20,215	4.14	19,665
FY2007	31,939	4,574	36,513	21,987	0	21,987	9,952	4,574	14,526	2.97	4,574
FY2008	31,719	44,227	75,946	22,216	0	22,216	9,503	44,227	53,730	10.97	44,227
FY2009	49,940	96,035	145,975	21,160	0	21,160	28,780	96,035	124,815	25.48	96,035
FY2010	55,103	116,813	171,916	19,277	0	19,277	35,826	116,813	152,639	31.16	116,813
FY2011	27,031	52,307	79,338	14,331	0	14,331	12,700	52,307	65,007	13.27	52,307
FY2012	8,531	41,597	50,128	10,092	0	10,092	*-1,561	41,597	40,036	8.17	41,597
FY2013	3,502	20,859	24,361	5,431	0	5,431	*-1,929	20,859	18,930	3.86	20,859
Total	208,315	396,077	604,392	114,494	0	114,494	93,821	396,077	489,898	100.0	396,077

* Negative non-Federal cash indicates excess contribution by the non-Federal sponsor above the 35% cost-share requirement for the purchase of LERRDs.

MILESTONES

Table100 shows events leading to report approval by the Assistant Secretary of the Army for Civil Works, signing of the Record of Decision, and signing of a Project Cooperation Agreement with the ASA(CW).

Table 100
Milestones Necessary for Construction Start

Event	Completed
MVM Responds to Public Review comments on Final Report & EIS	January 16, 2007
MVD Transmit Documentation to HQUSACE	January 18, 2007
HQUSACE Transmit Documentation to ASA(CW)	January 22, 2007
ASA(CW) Approves GRR	February 1, 2007
Submission of Record of Decision to MVD Commander	February 1, 2007
Anticipated Signing of Record of Decision by MVD Commander	February 2, 2007
Execute PCA with ASA(CW)	June 3, 2007

VIEWS OF NON-FEDERAL SPONSOR

The Arkansas Natural Resources Commission (ANRC), in partnership with the Bayou Meto Water Management District (BMWMD), will be the non-Federal sponsor for the Bayou Meto Basin, Arkansas Project.

The ANRC has completed all necessary requirements to act as non-Federal sponsor for the Bayou Meto IPA. The Improvement Project Plan for the IPA was approved on 28 August 2000 in the Circuit Court of Lonoke County, Arkansas. The improvement plan was approved and IPA established in accordance with A.C.A. 14-116-501. With the proposed plan of improvement for flood control presented in this report the BMWMD will petition the Arkansas court system to include all areas receiving benefit from the flood control plan of improvement in the IPA.

ANRC has expended substantial resources in preparation to serve as local sponsor and for timely project implementation. They have conducted an intensive information/education program to educate farmers and the general public on the critical need for protecting the groundwater resources and preserving the area's agricultural economy and identify the flooding and environmental resources problems and opportunities within the Bayou Meto basin. While the ANRC has provided a letter of intent to act as the project sponsor, the Bayou Meto Water Management District has formed the legal entity to be a legally and financially capable partner with taxation authority. The BMWMD Board of Directors have established a permanent office; employed a full time executive director, two administrative assistants, state certified assessor, and legal counsel to coordinate local sponsor activities and move the project forward. During the conduct of the general reevaluation BMWMD provided all rights-of-ways requirements, coordinated review meetings with state and local interests, and conducted numerous other activities to assist the Corps of Engineers and NRCS in study execution. Even though directed by Congress at 100 Federal cost until construction, BMWMD provided funds in the amount of $550,000 in FY 2002 to expedite study completion. In accordance with the design agreement amendment no. 1, approved by ASA(CW) and executed 26 March 2003, BMWMD's voluntary contribution of $550,000 will be credited towards the non-Federal share of design costs. Any remainder of the non-Federal share of design costs will be recovered during construction.

The ANRC is the state agency with legal authority and responsibility for protection and management of Arkansas' water resources. The Arkansas Ground Water Protection and Management Act of 1991 provided extensive power to the ANRC in the administration of programs for the protection and management of groundwater resources. The ANRC strongly supports the implementation of projects that develop surface water resources to supplement and protect diminishing groundwater reserves. The Bayou Meto Basin, Arkansas project was developed to be consistent with the Arkansas State Water Plan.

SUMMARY OF COORDINATION

Numerous coordination and public involvement activities were planned and conducted throughout the course of the general reevaluation. These activities included formal public meetings, information workshops, status reports, informal briefings, presentations, site visits, and numerous other correspondence with Federal, state and local resource agencies, agriculture interests, drainage districts, and other interest groups and individuals. Input in the identification of problems, needs, and opportunities; planning and development of the project to include layout and alignment of the water supply distribution system, development of flood control alternatives, fish and wildlife features, conservation measures, and design considerations; and assistance in conducting planning and engineering field activities was provided by numerous interests.

STUDY COORDINATION

OTHER FEDERAL AGENCIES

The NRCS had a major role in the planning and development of the project. The project team included representatives from the NRCS. The NRCS had total responsibility for the planning and design of the on-farm portion of the project. They totally support project implementation.

Recent modeling of the alluvial aquifer to evaluate the regional effects of aquifer and alternative water source development on water level declines by the U. S. Geological Service (USGS) show that conservation measures and use of alternative sources of water could result in considerable recovery of water levels in the aquifer.

Coordination with the U. S. Fish and Wildlife Service (USFWS) has been continuous throughout the study effort. USFWS is a part of the team that developed and formulated alternative plans and measures to be included as an integral part of the plan of improvement for agricultural water supply, flood control, and waterfowl management. The USFWS participated in coordination meetings, in-progress reviews, issue resolution conferences, site visits, data collection and analyses. A Planning Aid Report, Migratory Bird Management Plan, and Fish and Wildlife Coordination Report are included in Volume 10, Appendix D.

STATE AND LOCAL AGENCIES

Coordination with state and local agencies has been ongoing since project inception. The Environmental Planning Team consisted of membership from numerous state and local resource agencies. Coordination with ANRC on water issues and provisions contained in the Arkansas State Water Plan (SWP) and Arkansas law was essential throughout project development. The Arkansas Game and Fish Commission (AGFC) was involved throughout the planning process and provided significant input into project development. The Arkansas Natural Heritage Commission played a major role in the identification of environmental restoration opportunities. A detailed discussion on study participation and coordination is provided in the EIS.

PUBLIC VIEWS AND COMMENTS

Public involvement is discussed in previous sections of this report. No organized opposition to the project has been evident.

CONCLUSIONS

I have reviewed the report and believe it to be responsive to the Congressional direction, which directed the Corps of Engineers to conduct a general reevaluation of the Bayou Meto Basin, Arkansas.

Study results show that there is critical and immediate need to protect and conserve the groundwater resources before they are totally depleted. Water is the lifeblood of eastern Arkansas. The economy of the region and its people are dependent upon it. The state of Arkansas has expended immense resources in identifying and quantifying the magnitude and severity of groundwater depletion. Critical groundwater areas, which include the Bayou Meto IPA, have been designated and legislation has been enacted which provides for regulation. However, the only viable alternative is one that will protect and conserve groundwater resources and sustain the area's economy. The development of an alternative source of water is the only realistic solution.

Flooding problems occur frequently on many streams throughout the Bayou Meto basin. One of areas greatest needs today is relief from flooding and improved drainage and water management capabilities in the lower portion of the basin, which includes the Bayou Meto Wildlife Management Area.

Opportunities for waterfowl management and restoration are significant. The Bayou Meto basin contains nationally significant environmental resources. The basin is a major wintering area for waterfowl. The Bayou Meto Wildlife Management Area contains some 32,000 acres managed for fish and wildlife purposes. Features to provide drainage relief and improved water management capabilities are needed to restore bottomland hardwoods and conserve and manage waterfowl. A waterfowl management and restoration plan has been developed as part of the project.

The implementation of the proposed project will provide:

- Conservation and Management of Existing Water Resources
- Supplemental Supply of Agricultural Irrigation Water
- Waterfowl Conservation and Management Features
- Flood Reduction and Improved Drainage

The recommended plan is the only viable solution to the Bayou Meto Basin's groundwater depletion, agricultural water supply, flooding and drainage, and environmental resources problems. It meets the planning objectives consistent with applicable laws, regulations, and current policy; meets the desires and needs of the project sponsor and the state of Arkansas; and studies demonstrate a Federal interest in project implementation. The conservation and protection of our natural resources is an investment in the future and I believe this project is in the best interest of the state of Arkansas and our Nation.

RECOMMENDATIONS

The tentative recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified during the review and approval process. However, the sponsor, the state of Arkansas, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

I recommend that the Chief of Engineers approve the Flood Control Component of this project for construction in this report under his discretionary authority and the Assistant Secretary of the Army for Civil Works approve the Agricultural Water Supply and Waterfowl Management Components of this project for construction described in this report pursuant to Section 363 of the WRDA of 1996.

I have carefully considered the many significant factors related to the water resources and associated opportunities in the Bayou Meto Basin, Arkansas and the selected plan to address these problems and opportunities. These factors include the economic and social damages caused by the loss of one of Arkansas' most important resources and the probability for devastation of the regional economy; the need for flood protection and improved drainage; the need to restore and preserve the natural environment; the need to restore fish and wildlife habitat; the plan's completeness, effectiveness, efficiency, and acceptability in meeting the planning objectives; the plan's correlation with the state of Arkansas's water resources goals and objectives; the cost and benefits of the plan; and the acceptability of the plan to the potential local sponsor, the state of Arkansas and other Federal, state and local interests. In consideration of all these factors, I have determined that the following recommendations are in the public interest.

I recommend that this report and the improvements described in this report be approved as the basis for proceeding to the development of design memoranda, as needed, preparation of plans and specifications and subsequent project construction, with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable, in accordance with cost-sharing and financing arrangements satisfactory to the President and the Congress. The total first cost of the plan is currently estimated to be $530,381,000. The non-Federal and Federal cost breakdown is presented in Tables 96-99. The annual operation, maintenance, repair, replacement, and rehabilitation costs for the plan are estimated to be $5,733,000. Project features include an import water system from the Arkansas River, a plan of improvement for flood reduction, a waterfowl management plan, and environmental features associated with the flood control and agricultural water supply components to protect, restore, and enhance the area's significant resources. I also recommend that the NRCS be used as construction agent if acceptable to the NRCS and the non-Federal sponsor to accomplish the on-farm portions of the project generally using their normal contracting procedures. The selected plan is in direct accord with the project reauthorization contained in the Water Resources Development Act (WRDA) 1996, Public Law 104-303, for the Bayou Meto portion of the *Grand*

Prairie Region and Bayou Meto Basin, Arkansas project. This recommendation is made with the provision that, prior to project implementation, non-Federal interests must agree to comply with the following requirements:

a. Provide a minimum of 25 percent, but not to exceed 50 percent of total flood control costs as further specified below:

1. Provide 25 percent of design costs allocated by the Government to flood control in accordance with the terms of a design agreement entered into prior to commencement of design work for the flood control features;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to flood control;

3. Provide, during construction, a contribution of funds equal to 5 percent of total flood control costs;

4. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the flood control features;

5. After consideration of any credit that may be afforded pursuant to paragraph b.5. below, provide, during construction, any additional funds necessary to make its total contribution for flood control equal to at least 25 percent of total flood control costs;

b. Provide 35 percent of total waterfowl management costs as further specified below:

1. Provide 25 percent of design costs allocated by the Government to waterfowl management in accordance with the terms of a design agreement entered into prior to commencement of design work for the waterfowl management features;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to waterfowl management;

3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required

or to be necessary for the construction, operation, and maintenance of the waterfowl management features;

4. Provide, during construction, any additional funds necessary to make its total contribution for waterfowl management equal to 35 percent of total waterfowl management costs;

5. In the event that the value of the contributions provided by the non-Federal sponsor under sub-paragraph b.3. of this paragraph exceeds its share of 35 percent of total waterfowl management costs, the excess value amount may be credited toward the non-Federal sponsor's contribution required under paragraph a.5. for flood control and toward the non-Federal sponsor's contribution required under paragraph c.4. for water supply. However, in no event shall the non-Federal sponsor be entitled to a reimbursement for any portion of such excess value amount.

c. Provide 35 percent of total water supply costs as further specified below:

1. Provide 25 percent of design costs allocated by the Government to water supply in accordance with the terms of a design agreement entered into prior to commencement of design work for the water supply features;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to water supply;

3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the water supply features;

4. After consideration of any credit that may be afforded pursuant to paragraph b.5. above, provide, during construction, any additional funds necessary to make its total contribution for water supply equal to 35 percent of total water supply costs;

d. For so long as the project remains authorized, acquire, secure, and maintain the quantity of water that the Government determines is necessary for the construction, operation, and maintenance of the project. The cost of acquiring, securing, and maintaining such water shall be an associated cost of the project and shall be paid 100 percent by the non-Federal sponsor and shall not be shared as part of the total project costs.

e. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefor, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

f. Not less than once each year, inform affected interests of the extent of protection afforded by the flood control features;

g. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

h. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the flood control features;

i. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood control features;

j. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the flood control features afford, reduce the outputs produced by the waterfowl management features, hinder operation and maintenance of the project, or interfere with the project's proper function;

k. Shall not use the waterfowl management features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

l. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

m. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

n. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

o. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

p. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

q. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

r. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

s. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

CERCLA; and

u. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

29 March 2007
Date

Charles O. Smithers
Colonel, Corps of Engineers
District Engineer

CERTIFICATION OF LEGAL REVIEW

The general revaluation report for the Bayou Meto Basin, Arkansas project, including all associated documents required by the National Environmental Policy Act, has been fully reviewed by the Office of Counsel, Memphis District, and is approved as legally sufficient.

District Counsel

11/15/06
Date

BAYOU METO BASIN, ARKANSAS PROJECT

FINANCIAL DOCUMENTATION

Financing Plan

for the

Bayou Meto, Arkansas Project

Arkansas Natural Resources Commission

January 9, 2007

The Arkansas Natural Resources Commission (Commission) and the Bayou Meto Water Management District (District) will act as the non-Federal sponsors of the Bayou Meto, Arkansas Project (Project). Sponsorship entails having a financial responsibility for the non-Federal share of construction costs. The Commission has the financial history necessary to insure the federal government that construction funds will be provided to meet the construction milestones, and the District, which formed the legal entity necessary to be a legally and financially capable partner, has taxation authority in the project area.

The project consists of three separate and distinct components. The separable first is the agricultural water supply component (Irrigation) that is comprised of an on-farm feature (On-Farm) and an irrigation water import system (Import System). The second is the flood control component (Flood Control) that consists of channel improvements, and benefits from construction of a pump station on Little Bayou Meto that also reduces flood damage. The third is a waterfowl management (Waterfowl) component that consists of bottomland hardwood reforestation, wet and upland prairie restoration, and measures to improve water management on the Bayou Meto Wildlife Management Area (WMA), which includes channel and levee work within the WMA, and construction of the pump station and channel work on Little Bayou Meto. The sponsors are actively seeking agreements with partners to share in the non-Federal responsibilities of this project.

With regard to our statement of Financial Capability, the Commission will provide the bonding authority necessary to proceed with the $146.0 million dollars of non-Federal construction funding associated with the Irrigation and Flood Control components of the project. The Commission will do this by seeking an additional $100 million in bonding authority from the Arkansas General Assembly in 2007. This will also require voter approval and be available as early as January, 2009. This will provide $270 million funds for the non-Federal Construction Costs for both the Grand Prairie Demonstration Project and the Irrigation and Flood Control components of the Bayou Meto Project. The sources of the funds will include the sale of bonds issued through the Commission and paid for by the District through the sale of water and, tax assessments on benefited acreage within the Improvement Project Area (IPA) levied by the District. The District is taking financial responsibility for and working with landowners, other state agencies and non-profit corporations to obtain the funds needed for the non-Federal Construction Costs of the Waterfowl component of the Project.

Private landowners will enter in contracts with the construction agent for On-Farm work and portions of the Waterfowl component of the Project. Private land owners will fund the non-Federal portion of On-Farm work. The non-Federal construction cost of the On-Farm features is $26.3 million dollars. Lands valued at $35.3 million dollars will be donated to accomplish the Waterfowl enhancement measures. The construction costs are presented in Table 1 (provided by the Memphis District Corps of Engineers).

Table 1
Summary of Non-Federal Construction Costs
Bayou Meto Basin, AR Irrigation Project
(October 2005, Fully Funded Costs, Includes Estimates for Inflation, $000,000)

Fiscal	Construction Costs			On-Farm	Waterfowl	
Year	Cash	LERRD	Total	Construction	Management	Total
2007	6.9	21.8	28.7	2.5	0.2	31.9
2008	3.8	13.4	17.2	5.8	8.8	31.7
2009	21.8	12.4	34.2	5.9	8.7	49.9
2010	28.0	10.2	38.2	6.0	9.1	55.1
2011	6.3	5.8	12.1	6.1	8.5	27.0
2012	0.0	10.1	10.1	0.0	0	8.5
2013	0.0	5.5	5.5	0.0	0	3.5
Total	66.8	79.2	146.0	26.3	35.3	207.6

The sponsors understand their obligation to operate and maintain this project after its completion. Operation and maintenance of the Project will come from tax revenue generated by the District and water sales in the project area. Operation and maintenance for the On-Farm features and the Waterfowl component will be by the individual owners of the land acquired for these features. Revenues to meet this obligation will come from fees assessed to the project's beneficiaries, including without limitation proceeds from the sale of the approximately 383,320 acre-feet of irrigation water provided annually and levy of assessed benefits within the Project Improvement Area (IPA). An estimate of the project's operation, maintenance, and replacement costs was furnished by the Memphis District Corps of Engineers (Table 2). The above annual revenues will cover the annual operation and maintenance costs and establish a reserve fund to provide for periodic maintenance and replacements.

Table 2 Operation and Maintenance Cost Bayou Meto Basin, AR Irrigation Project		
Item	Frequency	Cost ($)
Agricultural Water Supply		
Building		
Labor	Annual	416,674
Energy	Annual	4,711
Replacement	50 Years	271,432
Canals		
Mowing	Annual	66,600
Maintenance	20 Years	1,105,000
Pump Stations		
Labor	Annual	404,538
Energy	Annual	1,767,985
Maintenance (Mechanicals)	8 Years	33,822
Maintenance (Structures)	50 Years	1,747,425
Canals, Structures, and Pipelines		
Energy	Annual	135,291
Maintenance (Water Control Structures)	8 Years	84,250
Maintenance (Canals & Pipelines)	50 Years	395,037
On-Farm		
Reservoirs	Annual	295,263
Tail Water Recovery	Annual	20,560
Pipelines	Annual	179,825
Pumping Plants	Annual	89,906
Water Control Structures	Annual	106,586
Flood Control		
Channel		
Cleanout	20 Years	165,900
Herbicide Treatment	Annual	33,180
Structures		
Maintenance	Annual	7,700
Electricity	Annual	600
Weirs	25 Years	126,000
Levees	Annual	3,680
Pumping Plant		
Maintenance	Annual	57,900
Electricity	Annual	321,000
Waterfowl Management		
Wet Prairie Restoration	Annual	60,000
Upland Prairie Restoration	Annual	60,000
Bayou Meto WMA Features	Annual	1,880,067
Moist Soil Habitat	Annual	24,000
Waterfowl Flooding	Annual	6,300

Bonds will be issued, as they are needed for project construction and serviced by payments made by the District and participating agencies to the Commission. District revenue sources include an annual property tax, which will be an average of $2.00 per acre on 290,061 irrigated acres, a $0.50 annual tax on 44,436 acres receiving flood reduction benefits, and irrigation water contracts with water users for 383,320 acre-feet. The District is also seeking contributions from other state agencies and non-profit corporations to fund this Project.

Any commitment of funds is subject to approval of a project cooperation agreement between the Commission, District and US Army Corps of Engineers. The Arkansas Constitution limits the expenditure of funds to those funds appropriated for that particular purpose.

Submitted this 9th day of January, 2007.

ARKANSAS NATURAL RESOURCES COMMISSION

By: ______________________________

J. Randy Young, PE Executive Director

Commander's Assessment

of the

Non-Federal Sponsor's Financial Capability

for the

Bayou Meto Basin, Arkansas Project

Memphis District

January 18, 2007

Introduction

This assessment evaluates the Arkansas Natural Resources Commission's (Commission) ability to provide its financial obligations for the Bayou Meto Basin Project as described in the Grand Prairie Region and Bayou Meto Basin, Arkansas Project, Bayou Meto Basin, Arkansas General Reevaluation Report, dated November, 2006. The Commission's financing is dated January 9, 2007 and signed by Mr. J. Randy Young, Executive Director of the Arkansas Natural Resources Commission. Included in the Financing Plan are a schedule of non-Federal construction expenditures and a schedule of expected annual operation, maintenance, and replacement costs. The Financing Plan calls for the Commission to meet its project financial obligations with funds from the following:

(1) Bond sales to cover the construction costs associated with the Import System of the Irrigation component and Flood Control component of the project;
(2) Landowner contracts to cover the On-Farm features of the Irrigation component;
(3) Landowner contracts to cover the Waterfowl component of the project;
(4) Irrigation (excluding On-Farm) and Flood Control Component operation and maintenance provided by the Bayou Meto Water Management District; and
(5) On-Farm and Waterfowl Component maintenance provided by the individual owners of the land acquired for these features.

Construction

Import System and Flood Control Component. The Commission will finance all of the Flood Control Component and all but the On-Farm features of the Irrigation Component through bond sales. The total construction costs that the Commission plans to fund with bonds is currently estimated at $146 million based on fully funded costs and the construction schedule presented in Table 1 of their financing plan. These bonds will be repaid through tax revenues generated within the Bayou Meto Water Management District (District) Improvement Project Area and through sales of irrigation water to the area farmers. All tax revenues and water sales revenues will be managed by the District. The Commission has previously pledged to fund the large Grand Prairie Demonstration Project in Arkansas through bond sales so it has considerable experience with large bond sales. However, the Commission does not currently have sufficient bonding authority to completely fund both projects. It plans to receive an additional $100 million in bonding authority from the State of Arkansas General Assembly in 2007. Increasing its authority will require voter approval and is expected to be available as early as January, 2009. Until then the Commission has more than ample bonding authority to cover both projects until the additional authority is received.

Assessment of the Commission's Plan for Construction of the Import System and Flood Control Component. This project has enjoyed strong support from the Arkansas State Legislature and the Governor. As evidence of this support, the State through the Commission has previously provided funding of $550,000 for feasibility studies and has provided a significant portion of the funding necessary to operate the Bayou Meto Water Management District. The State through the Commission has also demonstrated a strong support of regional water projects to protect its declining aquifers. This is more than amply verified through its support of the Grand Prairie Demonstration Project where the Commission has previously committed to issue up to $111 million in bonds. The State's support of both of these projects exceeds the Commission's current bonding limit. However, the Commission is firmly convinced that it will receive additional bonding authority as early as 2009 to cover all of its $146 million share. The increase will be more than sufficient to fully construct both projects. In the interim the Commission has more than enough authority to cover initial construction requirements for both projects until its authority is increased. Any risk associated with the Commission's bonding authority is expected to be associated with timeliness. Any delays in receiving the approval of the General Assembly or the voters could slow the process. But this is not expected since the Commissions limit is quite large and matching Federal funds at a rate for both projects that will exhaust the Commissions limit is seen as highly unlikely.

On-Farm features of the Irrigation Component. The Commission's plan for the On-Farm features of the Bayou Meto Project is identical to the Grand Prairie Demonstration Project. Private landowners will provide funds and in-kind services including actual construction to sufficiently cover its $26.3 million requirement. These features will be built under the management of the Natural Resources Conservation Service (NRCS). The NRCS has built many on-farm improvements in the two project areas through its current programs and with matching Federal funds associated with the Grand Prairie Project.

Assessment of the Commission's Plan for Construction of the On-Farm Features. There is virtually no financial risk to the Federal government for this portion of the Commission's plan. Federal funds for these features will not be expended until the landowners have provided their matching funds or in-kind services. Since the landowners must provide their contributions prior to the Federal funds, the only possible risk could be with the project's ability to provide its designed level of benefits on a timely basis if the landowners are delayed in providing their funds. However, this has not happened with the Grand Prairie Project. In fact, the landowners have signed up for the on-farm improvements at a rate faster than the Federal government can provide its funds.

Waterfowl Management Component. The Commission's plan calls for private landowners to donate the easements necessary for construction of the Waterfowl component. Several larger landowners in the project area have already expressed interest in doing so and are ready to provide their lands when final project approval is secured and Federal funds are available. The landowners will retain ownership of their lands but will not be able to farm them again due to a perpetual easement. In return for their easement, the landowner's lands will be returned to bottomland hardwood and prairie habitats. These lands will be very valuable to the landowners for hunting leases and future timber harvests. These donations will more than cover the 35 percent non-Federal contribution of the Waterfowl component. In fact, the easement costs are approaching 50 percent of this component’s cost.

Assessment of the Commission's Plan for the Waterfowl Management Component. Like for the On-Farm features, there is virtually no financial risk to the Federal government for this portion of the Commission’s plan. The Federal funds will not be expended until the landowners have provided the necessary easements. Again, since the landowners must provide their part first, the only possible risk could be with the project's ability to provide its designed level of benefits if the landowners do not provide the easements. This is a performance risk, not a financial risk.

Summary. Because of the State's financial strength and commitment provided through the Commission, the financing plan can only be viewed as a sound and viable strategy for funding the non-Federal construction responsibilities.

Operation and Maintenance

Commission's Plan for Operation and Maintenance. The Commission's financing plan calls for the project's operation, maintenance, and replacement to be provided through a contract with the Bayou Meto Water Management District (District). The District will be directly responsible for operation, maintenance, and replacement (OM&R) of both the Import System and the Flood Control Component. The On-Farm features and the Waterfowl Management Component will be maintained by the landowners who provide their lands and in-kind services for these features. The expected OM&R costs for these project features are presented in Table 2 of the Commission’s plan.

Import System. The bulk of the import system's annual cost is for energy (electricity) to operate the pumping stations and structures. These expenditures will be incurred only when there is ample water in the Arkansas River available for diversion into the project area and will be proportional to the volume of water imported. The remaining expenditures are for labor and annual upkeep of the import system which will be incurred regardless of whether there is water available for diversion.

Flood Control Component. Like the Import System, the bulk of the annual cost is for energy (electricity) to operate the pumping stations and structures during times of flooding. These expenditures will be incurred only when there are crops to be protected and flooding is occurring. The remaining expenditures are for labor and annual.

On-Farm Features. The on-farm features require annual expenditures of approximately $700,000 for maintenance of storage reservoirs, tailwater recovery systems, pipelines, pumping plants, and water control systems. The District will enter into sub-agreements with individual landowners to operate and maintain these features.

Waterfowl Management Component. The Waterfowl component requires annual expenditures of approximately $2 million. The District will enter into sub-agreements with the individual landowners to provide for operation and maintain of these features. The District will also

Assessment of Commission's Plan for Operation and Maintenance. The Commission's plan depends largely upon the District's ability to generate the necessary OM&R funds. Currently the District has the authority and capability to sell irrigation water. It also has the authority to tax the project's beneficiaries. The project is expected to provide a mean annual volume of approximately 383,300 acre-feet of irrigation water for sale. This volume will vary from year to year depending on the demand within the project area and the availability of an adequate supply in the Arkansas River. Preliminary estimates show that the bond debt retirement cost plus the annual OM&R cost is less than what an average farmer in the project area is currently paying for energy costs associated with groundwater. Because of this low cost and the lack of alternatives when groundwater is depleted, the District should be able to sell all available water provided by the project.

Their plan also depends on the landowners of the On-Farm features and the Waterfowl Component to maintain these items. Experience with the Grand Prairie Demonstration Project shows that the On-Farm features will be adequately maintained. The Waterfowl component should also be properly maintained because duck hunting in the project area provides a significant portion of the landowner's current income. Since duck hunting is so important and this component must be adequately maintained to provide duck hunting benefits, there should not be significant risk. Also, the District will be able use their projected Import System staff for monitoring of the Waterfowl Component. Import System staff will be directly occupied with providing irrigation water to farms during the irrigation season. But once irrigation season is completed, these staff will be available for any other operation and maintenance activities required by the project including monitoring and enforcement for the Waterfowl Component.

Conclusion

The Commission can confidently meet its construction obligations through the funding sources presented previously. It can also be counted on to properly maintain the project using the Bayou Meto Water Distribution District. I find it reasonable to expect that adequate resources will be available to satisfy all of the non-Federal financial obligations for the project.

Charles O. Smithers
Colonel, Corps of Engineers
Commanding

GRAND PRAIRIE REGION AND BAYUO METO BASIN, ARKANSAS PROJECT

BAYOU METO BASIN, ARKANSAS

GENERAL REEVALUATION REPORT

AND

FINAN ENVIRONMENTAL IMPACT STATEMENT

FINAL ENVIRONMENTAL IMPACT STATEMENT

FINAL ENVIRONMENTAL IMPACT STATEMENT
Bayou Meto Basin, Arkansas General Reevaluation

The responsible lead agencies are the Memphis District and Vicksburg District Corps of Engineers. The Natural Resources Conservation Service is an important partner with planning and construction responsibilities for the on-farm portion of the agricultural water supply and water conservation component of the project.

ABSTRACT:

The Bayou Meto Basin, Arkansas General Reevaluation project area is located in eastern Arkansas and includes portions of Lonoke, Prairie, Jefferson, Arkansas, and Pulaski counties. The Memphis and Vicksburg Districts and the Natural Resources Conservation Service, as a partnering agency, have investigated waterfowl management; agricultural water supply; flood control; water conservation measures; fish and wildlife; and groundwater management strategies that could potentially be implemented within the project area. Alternatives considered consisted of waterfowl habitat improvements and combinations of three flood control plans, and three different water import plans that were investigated in detail and are presented as the final array of alternatives. All plans incorporate water conservation measures and additional water storage with an irrigation water import system, reduce frequency of flooding, and provide additional waterfowl habitat. However, each alternative plan contains a different water import pump size and flood control pump size. Direct and indirect impacts for the water supply component are essentially the same for all plans, while each of the flood control alternatives has somewhat different direct and indirect impacts and benefits to terrestrial and aquatic resources. Also, economic costs and benefits vary with each plan. This environmental impact statement evaluates the effects each plan has on the study area's significant resources. The selected plan is also the National Economic Development (NED) and Waterfowl Management (WM) Plan and includes a 1,750 cubic feet/second (cfs) import system to divert flow from the Arkansas River, a 1,000 cfs pump station to provide water management capabilities to the Bayou Meto Wildlife Management Area and reduce flooding in adjacent areas, 8,832 acres of new on-farm irrigation reservoirs and on-farm tail-water recovery systems. To compensate for impacts associated with construction of the flood control, import system, and on-farm impacts, 4,093 acres of cleared land would be acquired in fee title and planted in bottomland hardwood (BLH) trees. The WM component of the plan contains features to restore 10,000 acres of herbaceous wetland/prairie complex and 25,643 acres of forest and riparian buffer. It also would provide water management capabilities on the Bayou Meto WMA to reduce stress on BLH and create 240 acres of moist-soil habitat for waterfowl and other wetland birds. The WM Plan would provide significant benefits to waterfowl, 21,216,388 duck-use-days, and also provide substantial improvements in terrestrial and aquatic habitats. The estimated fully funded cost (i.e. inflation adjusted cost through project completion) of the selected plan, including mitigation, is $576,299,000; it has a benefit/cost ratio of 1.13.

Send your comments to the District Engineer by 09 JAN 2007

If you would like further information on this statement, please contact:

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NOTE: Information, displays, maps, etc., discussed in the Main Report and appendices are incorporated by reference in the environmental impact statement.

1. SUMMARY

Major Conclusions and Findings

1.1 In response to state and local interests concerns about depletion of the alluvial aquifer in eastern Arkansas caused by extensive agricultural use, the U.S. House of Representatives, Committee on Public Works and Transportation, adopted a resolution in September 1982 authorizing the Corps of Engineers to examine the feasibility of water conservation and water supply improvements in the region. The Eastern Arkansas Region Comprehensive Study area included all or part of 24 counties in eastern Arkansas, and comprised 25% (13,400 square miles) of the state land area. The reconnaissance phase study initiated in October 1983 and the subsequent report completed in March 1985 indicated that several agricultural water supply and conservation plans appeared to be suitable. A feasibility study started in September 1985 and culminated with a draft report that indicated feasible agricultural water supply and conservation plans for five separate agricultural areas: the Grand Prairie, Little Red River, Black River, White River, and Bayou Meto areas. However, the feasibility study was terminated at this stage because Corps policy did not consider agricultural water supply a high-priority output.

1.2 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, 2002, 2003, 2004, and 2006 Appropriations Acts provided funding to continue the reevaluation.

1.3 The purpose of the general reevaluation is to develop plans of improvements that address all of the identified water resources problems and opportunities within the Bayou Meto Basin. The general reevaluation was conducted to fully evaluate and determine the best plan of improvement for flood control, groundwater protection and conservation, agricultural water supply, and waterfowl management. Based on the planning criteria, alternatives were developed and analyzed to the extent required to identify the plan consisting of measures that best meets the area's needs. Once the plan was identified, engineering and design studies were completed to the level of detail required for preparation of a baseline cost estimate and schedule for implementation.

1.4 The Water Resources Development Act (WRDA) of 1996 specifically authorized waterfowl management as a purpose of the Bayou Meto Basin, Arkansas, Project. Also, ecosystem restoration is an important mission of the U.S. Army Corps of Engineers. The purpose of this study effort was to develop a plan that provided substantial waterfowl benefits primarily through restoration of natural habitats. During Civil Works planning, the Corps formulates a National Economic Development (NED) plan, which focuses on contributions to national economic development. This waterfowl management and plan was considered both separately and in combination with the NED plan.

RATIONALE FOR DESIGNATION OF NED PLAN

1.5 The NED plan is defined as the plan that reasonably maximizes beneficial contributions to the national economic development. In order to determine which alternative would yield the greatest net economic benefits, each alternative plan was subjected to economic optimization. Initially it was determined that a combination of water supply (WS) component alternative 4B and flood control (FC) component 2A would provide maximum excess benefits. However, after the costs of the lower pump station were allocated based on expected benefits, a combination of the Waterfowl Management Plan, Flood Control Plan alternative FC2A and water supply component 4B became the NED plan. The estimated fully funded cost of this plan, including mitigation, is $576,299,000; it has a benefit/cost ratio of 1.13.

RATIONALE FOR DESIGNATION OF THE SELECTED PLAN

1.6 A combination of water supply alternative WS4B, flood control alternative FC2A, and the waterfowl management (WM) plan was chosen as the selected plan because these plans maximize net economic (NED Plan) and provide substantial waterfowl management benefits. This plan provides annual net benefits of $ 37,593,000 and it has a benefit/cost ratio of 1.13 (see Section IV, Main Report). Furthermore, it meets the study objectives and satisfies many of the project area's problems and needs. It minimizes groundwater depletion and maximizes water conservation efficiency while providing some flood relief for the more frequently flooded reaches. It also provides additional waterfowl habitat, benefits to tributary stream fisheries and aquatic organisms, and an opportunity to increase substantially the amount of BLH forest and other wildlife habitat within the region.

CONSTRUCTION

1.7 Construction phasing for each project component is presented in Volume 1, Main Report. These sections describe how project construction would be accomplished. A detailed schedule is provided in the Project Management Plan. The Arkansas Natural Resources Commission (ANRC), the non-Federal sponsor, is responsible for all lands, easements, rights-of-way (ROW) including borrow and dredged or excavated material disposal areas, and relocations for construction, operation, and maintenance of the project. Detailed designs and plans and specifications would be prepared for each construction item. Development of plans and specifications would include the preparation of detailed rights-of-way maps along with identification of the relocations necessary for construction of each item of work. The sponsor would coordinate with the owner of the facility to accomplish the relocation. Funds are included in the project costs estimates for these relocations. A summary of the relocations requirements is presented in the Main Report. Volume 5, Appendix B, Section VI, and Volume 9, Appendix C, Section V, provides detailed relocations information. The recommended plan of improvement for flood control would require construction and/or replacement of three bridges, and the relocation or alteration of three power lines, two waterlines, one gas pipeline, three telephone cables and one fiber optic cable. For the water supply component, new bridges at sites where new canals cross existing roads and replacement or modification of bridges across existing ditches would be required at sixty-six crossings to adequately pass the design flows. These sites include 15 state highway bridges (new canals) and 51 (45 on new canals and 6 on existing ditches) county bridges. Bridge designs are based on Arkansas State Highway Department of Transportation standards and current County bridge standards. No railroads would be impacted by the project. Utilities at 159 locations would be impacted by the water supply component. These utilities include overhead electric lines, telephone cables, waterlines, gas service lines, fiber optic cables, ammonia pipelines, and television cables. The extent of utility alterations necessary to accommodate the water supply component is predicated on providing horizontal and vertical clearance for project construction, operation and maintenance.

1.8 A stormwater pollution prevention plan (SWPPP) would be prepared in compliance with U.S. Environmental Protection Agency and State of Arkansas regulations. A notice of intent would be filed with the State of Arkansas to obtain stormwater permits. The SWPPP would outline temporary erosion control measures such as silt fences, retention ponds, and dikes. The construction contract would include permanent erosion control measures such as turfing and placement of riprap and filter material.

1.9 At completion of the right-of-way (ROW) map for each item of construction, the mitigation necessary for that item of work would be included in the ROW request made to the sponsor. The sponsor must provide all necessary ROW for each item before construction can be initiated.

REAL ESTATE ACQUISITION

1.10 The Bayou Meto Basin Project is a cost-shared undertaking between the U.S. Army Corps of Engineers and ANRC, the non-federal sponsor. Under terms of the Project Cooperation Agreement (PCA) to be signed by the both the Corps and the sponsor, the sponsor would be responsible for acquiring all lands, easements, ROWs, relocations, and disposal areas (LERRDs) for the project.

1.11 The sponsor has both the ability and the financial capability to acquire the LERRDs for this project. The sponsor is a political subdivision of the State of Arkansas and would have the power of eminent domain to acquire the ROW for this project through condemnation if purchase of ROW cannot be made through negotiation.

1.12 ROW for this project would be obtained through use of fee purchase or easement estates. The following easement estates would be utilized in this project: restrictive channel improvement, water pipeline, and conservation easements. Publicly owned real estate would be acquired through negotiated purchase or use of permits or licenses, or other instruments as needed.

1.13 The sponsor must comply with the requirements of Public Law 91-646, as amended, since they would acquire all ROW needed for project construction. The sponsor is aware of their obligation under PL 91-646. The Corps would provide the sponsor with any assistance needed concerning acquisition of ROW for this project.

SECTION 404 FINDINGS

1.14 The project features of the selected plan have been evaluated with respect to Section 404(b)(1) Guidelines for Specifications of Disposal Sites for Dredged or Fill Material, published by the U. S. Environmental Protection Agency. These evaluations are included in Volume 10, Appendix D, Section VII. The potential for environmental impact of each disposal activity was estimated on the basis of currently available engineering design data and the pertinent physical, chemical, and biological information that have been compiled as a result of this and other studies. Efforts were made to identify the least environmentally damaging practical alternative for each disposal site, wherever such alternatives were available.

1.15 No particular violations of applicable State of Arkansas water quality standards, other than increased turbidity during construction operations would be expected. Construction methods would be employed to minimize the potential of violating the Toxic Effluent Standards of Section 307 of the Clean Water Act. None of the proposed plans would harm any threatened or endangered species or their critical habitat.

1.16 It is expected that the proposed material discharges would not cause or contribute to significant adverse effects on human health; the life stages of organisms within the aquatic ecosystem; or ecosystem diversity, productivity, and stability. Also, no significant impacts were identified on recreational, aesthetic, or economic values.

FINDINGS ON EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

1.17 Portions of the proposed project would be constructed in floodplains. All non-floodplain alternatives were dropped during screening because they were not economically justified. Section 6 describes the beneficial and adverse impacts of each alternative in the final array and describes any expected losses of natural floodplain benefits. Views of the general public were obtained at public scoping meetings and additional information and concerns will be heard at a public meeting held during review of this EIS. All alternatives were designed to minimize, to the extent practical, adverse impacts to floodplains. The selected plan is responsive to the planning objectives and is consistent with the requirements of Executive Order 11988.

FINDINGS ON EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

1.18 One of the major project planning objectives was to maintain the long-range productivity of wetlands and forests. Although efforts were made to minimize impacts to wetlands, there were no practical alternatives to locating some project features in wetlands. Adverse impacts to wetlands are discussed in Section 6. The selected plan is responsive to the planning objectives established for the study; and it is also consistent with the requirements of Executive Order 11990.

FINDINGS ON EXECUTIVE ORDER 12898, ENVIRONMENTAL JUSTICE IN MINORITY AND LOW-INCOME POPULATIONS

1.19 Project construction is not expected to have adverse environmental or health effects on minority or low-income populations. The economic effects of the project on minorities are all expected to be positive and primarily secondary or indirect. Employment and income levels of minorities would probably be increased slightly during project construction. The project would prevent future increased unemployment of minorities and low-income residents by maintaining irrigated agricultural practices. The project's effects on the general population's health, social, and economic status are addressed in this environmental impact statement as well as the Systems of Accounts table in the Main Report.

FINDINGS ON EXECUTIVE ORDER 13112, INVASIVE SPECIES

1.20 A study by scientists from USACE Engineer Research and Development Center (ERDC) indicated that although it was likely that larval zebra mussels (*Dreissena polymorpha*) would enter the irrigation system from the Arkansas River, factors such as temperature and limited attachment sites would prevent successful colonization. Exotic fish species such as Asian carp that could potentially enter the area as a result of importing water are already present in the project area as a result of accidental releases from local fish farms.

FINDINGS ON ER 1165-2-132, HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

1.21 Engineering Regulation 1165-2-132, Water Resources Policies and Authorities for Hazardous, Toxic, and Radioactive Waste for Civil Works Projects, requires the performance of a hazardous, toxic, and radioactive waste (HTRW) assessment(s) to determine the potential for encountering any HTRW at or near Corps civil works projects.

1.22 A Phase 1 Assessment was conducted to determine the potential for HTRW occurring within the project-affected area. Site inspections, aerial videotape and photography review, document research, and coordination with appropriate agencies were performed in conducting this assessment. Based on these investigations, it was concluded that six sites of concern were located in the direct path, or in the immediate vicinity of proposed project improvements. Additional sampling and analysis would be conducted at these sites during detailed design studies to determine their significance and identify and evaluate alternatives to respond to the potential HTRW problems. Volume I of the HTRW Phase 1 Assessment is included in Volume 10, Appendix D, Section VIII.

Areas of Controversy

1.23 No significant areas of controversy have been identified during the planning phase of this project.

Unresolved Issues

1.24 The U.S. Environmental Protection Agency (EPA) has expressed concern regarding 1,249 acres of wetlands that are projected to be hydrologically impacted by the flood control component of the project and possibly lose jurisdictional status afforded by Section 404 of the Clean Water Act. According to the NRCS, the clearing and conversion of this acreage would be a violation of the Food Security Act even if Section 404 jurisdictional status is lost because of the project. Also, more land has been restored to wetland in the project area in recent years than has been cleared and converted to non-wetland. Appropriate mitigation was calculated for potential impacts on the 1,249 acres.

Relationship of Plans to Environmental Requirements

1.25 Table 1-1 indicates the relationship and compliance status of each plan alternative with federal environmental protection statutes and appropriate executive orders and memoranda. It also describes the necessary action required to comply with the statute, executive order, or executive memorandum in question.

TABLE 1-1
RELATIONSHIP OF PLANS TO ENVIRONMENTAL PROTECTION STATUTES OR OTHER ENVIRONMENTAL REQUIREMENTS, BAYOU METO BASIN, GENERAL REEVALUATION

FEDERAL STATUTES	WS4B/ FC2A	WS4B/ FC3A	WM PLAN	SELECTED PLAN
1. Archaeological and Historic Preservation Act of 1974. Compliance requires Corps to undertake recovery, protection, and preservation of significant cultural resources whenever its activities may cause irreparable loss or destruction of such resources.	FC	FC	FC	FC
2. Clean Air Act, as Amended. Compliance requires coordination with the U.S. Environmental Protection Agency and analysis of potential impacts on air quality. Coordination of DEIS would bring project into full compliance.	FC	FC	FC	FC
3. Clean Water Act of 1977. Compliance requires preparation of 404(b)(1) Evaluation and submission of such to Congress with the DEIS or procurement of state water quality certification. See Volume 10, Appendix D, Section VII, for the 404(b)(1) evaluation.	FC	FC	FC	FC
4. Endangered Species Act of 1973, as Amended. Compliance requires coordination with the U.S. Fish and Wildlife Service (USFWS) to determine if any endangered or threatened species or their critical habitat would be impacted by the project.	FC	FC	FC	FC
5. Federal Water Project Recreation Act. Compliance requires review by the Department of the Interior. Washington level review of the DEIS will bring the project into full compliance.	FC	FC	FC	FC
6. Fish and Wildlife Coordination Act. Compliance requires coordination with the USFWS and the Arkansas Game and Fish Commission. Agency comments and recommendations are	FC	FC	FC	FC

discussed in Volume 10, Appendix D, Section II, Part A, which includes the Fish and Wildlife Coordination Act Report.				

FEDERAL STATUTES	WS4B/ FC2A	WS4B/ FC3A	WM PLAN	SELECTED PLAN
7. Land and Water Conservation Fund Act. Compliance requires Secretary of the Interior approval of replacement property that would be acquired to mitigate converted property purchased with LWCFA funds.	NA	NA	NA	NA
8. National Historic Preservation Act. Compliance requires Corps to take into account the impacts of project on any property included in or eligible for inclusion in the National Register of Historic Places.	FC	FC	FC	FC
9. National Environmental Policy Act. Compliance requires preparation of this EIS, consideration of public comments, and preparation and public review of the final EIS. Signing of the Record of Decision would bring this project into full compliance.	FC	FC	FC	FC
10. River and Harbor Act. No requirements for Corps projects authorized by Congress.	NA	NA	NA	NA
11. Farmland Protection Policy Act. Compliance requires coordination with the Natural Resources Conservation Service to determine if any designated prime or unique farmlands are affected by the project.	FC	FC	FC	FC
12. Watershed Protection and Flood Prevention Act. No requirements for Corps projects.	NA	NA	NA	NA
13. Wild and Scenic River Act. Compliance requires coordination with Department of the Interior to determine if any designated or potential wild, scenic, or recreational rivers are affected by the project. Coordination has been accomplished and there are no such rivers in the project area.	NA	NA	NA	NA
EXECUTIVE ORDER/MEMORANDA	WS4B/ FC2A	WS4B/ FC3A	WM PLAN	SELECTED PLAN

1. Executive Order 11988, Floodplain Management. Compliance requires an assessment and evaluation together with the other general implementation procedures to be incorporated into the GRR and EIS.	FC	FC	FC	FC

2. Executive Order 11990, Protection of Wetlands. Compliance requires results of analysis and findings related to wetlands be incorporated into GRR and EIS.	FC	FC	FC	FC
3. Executive Memorandum, Analysis of Impacts on Prime and Unique Farmlands in EIS. Compliance requires inclusion of effects of proposed action on prime and unique farmlands in EIS.	FC	FC	FC	FC
4. Executive Order 11593, Protection and Enhancement of the Cultural Environment. Compliance requires Corps to administer cultural properties under their control in stewardship for future generations; preserve, restore or maintain such for benefit of the people; and assure that its plans contribute to preservation and enhancement of non-federally owned sites.	FC	FC	FC	FC
5. Executive Order 13112, Invasive Species. Compliance requires assessment of potential for the project to introduce invasive species to the project area.	FC	FC	FC	FC
6. Executive Order 12898, Environmental Justice in Minority and Low-income Populations. Compliance requires assessment of project effects on minority and low-income populations.	FC	FC	FC	FC

FC - In Full Compliance
PC - In Partial Compliance
NA - Not Applicable

2. TABLE OF CONTENTS

3. NEED FOR AND OBJECTIVES OF ACTIONS

3.1 Heavy agricultural use has severely depleted the alluvial aquifer in the Bayou Meto Basin area of eastern Arkansas. Congress, the Corps of Engineers, the Natural Resources Conservation Service (partnering agency), and the Arkansas Natural Resources Commission are responding to the need for water conservation, groundwater management strategies, and irrigation water supply in the Bayou Meto Basin. Relief from flooding problems in the southern portion of the project area is also an important component of this study. Significant flooding occurs on an annual basis on farmland and within the Bayou Meto Wildlife Management Area (WMA), resulting in lost income and stress on the forest habitat. Waterfowl management is also an important objective. Much of the native habitat in the Bayou Meto Basin has been cleared for agriculture, limiting available habitat for waterfowl and isolating flora and fauna in relatively small patches. Therefore, the development of a WM plan that focused on providing substantial waterfowl benefits through habitat restoration was developed.

Project Authority

3.2 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, 2002, 2003, 2004, and 2005 Appropriations Acts provided funding to continue the reevaluation.

Public Concerns

3.3 The continued depletion of the alluvial aquifer and the impact this would have on agriculture and the regional economy has been a major concern prior to and throughout this study. There is also concern related to flooding of agricultural lands and inability to drain excess water from the Bayou Meto WMA. Other economic concerns were related to project costs and potential project impacts to area residences, farm buildings, and other improvements. Environmental concerns primarily involved potential project impacts to aquatic resources, wetlands and other wildlife habitats.

Planning Objectives

NATIONAL OBJECTIVE

3.4 The Water Resources Council's *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies* states that "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements." Contributions to the national economic development (NED) objective are achieved by increasing the net value (expressed monetary units) of the nation's output of goods and services. Water and related land resource management plans must develop long-range goals and priorities for the study area that are consistent with the NED objective. There is a National objective to restore critical ecosystems, and this is addressed in National Ecosystem Restoration (NER) policy. Although development of a NER plan is not authorized, the waterfowl management component of this project provides waterfowl benefits primarily through restoration of native habitats.

PLANNING OBJECTIVES

3.5 After determining the existing and future needs of the project area, a set of planning objectives was established to guide the formulation of alternatives. Planning objectives stem from the national, state, and local water and related land resource management needs. These objectives have been developed through problem analysis and a public involvement program and have provided the basis for formulation of alternatives, impact assessment, and evaluation. The planning objectives are:

1. Protect and preserve the alluvial aquifer.
2. Maximize the use of water conservation.
3. Provide supplemental water supply to meet the irrigation water needs of the Bayou Meto Basin.
4. Restore and enhance waterfowl habitat.
5. Restore native vegetation.
6. Maintain long-range productivity of wetlands and forests.
7. Minimize cost and maximize outputs.

4. ALTERNATIVES

4.1 This section briefly describes the project alternatives retained for further analysis and the various project alternatives examined and eliminated during the screening process, and it also summarizes the potential environmental impacts associated with each alternative in the final array. For a more detailed description of plan formulation, the screening process, and the final array of alternatives, see the plan formulation section of the Main Report.

Without Condition (No Federal Action)

4.2 This alternative is the set of conditions that are expected to occur in the proposed project area in the absence of a project. The supply of irrigation water is decreasing as the groundwater reserves are being depleted. Historical and current trends reaffirmed by well data and field observations in concert with previously discussed groundwater models make obvious the dire seriousness of groundwater depletion. The state of Arkansas recognized the urgency of protecting groundwater resources in 1998 when counties throughout eastern Arkansas including Lonoke, Prairie, Jefferson, and Arkansas in the Bayou Meto Basin were designated as Critical Groundwater Areas. With this designation withdrawals can be limited to the annual recharge rate. Withdrawals from the aquifer would not be allowed when water levels dropped below 50% of the original saturated thickness. These legal and institutional restrictions would then become the governing factor in pumpage instead of physical constraints. The desired land use and demand for irrigation water in the future would remain the same as present conditions; however, only about 34% of the project area can be irrigated during an average year. Flooding and drainage problems in the area would continue, with some areas suffering from severe annual flooding events and flood related losses, and residents would continue to experience adverse social impacts from the constant threat and inconvenience of flooding. In addition, some forested areas would continue to be stressed by frequent and prolonged inundations within and adjacent to the Bayou Meto Wildlife Management Area. The No Federal Action Alternative was carried through detailed hydrologic and economic analyses and used as the base with which to compare the effects of all other alternatives.

Plans Considered in Preliminary Analysis

4.3 Structural and non-structural measures were considered and evaluated in the formulation of alternative plans. Measures that had been determined either not feasible, unacceptable, or did not meet the needs of the area during feasibility studies were not considered in the general reevaluation. These measures included artificial groundwater recharge, intensified mining of deeper aquifers, construction of large reservoirs, and condemnation of homes, and property. Engineering, environmental, economic, sociological, institutional, acceptability, and other factors were key in the formulation of alternatives to insure that resources were not wasted in the development of unimplementable plans.

4.4 The following is a presentation of alternatives developed for the Bayou Meto General Reevaluation. Some of the alternatives were carried forward through complete and detailed engineering, economic, and cost analyses. Others were screened or eliminated from detailed studies at various points throughout the planning process.

4.5 All water supply (WS) alternatives were based on groundwater providing approximately 148,565 acre-feet annually, the long-term sustained yield of the alluvial aquifer from groundwater studies that would allow for aquifer recharge.

4.6 Alternative WS2 consists of additional on-farm storage and conservation measures without any import water. Conservation measures would be implemented to maximize the use of existing water sources to the extent practical. These measures are designed to increase the efficiency or usage of irrigation water. The current 60% efficiency rate would be increased to 70% through the installation of conservation measures. Three levels of on-farm storage were considered for this alternative - 5,954, 8,832, and 14,544 acres. The designation of these levels for this alternative is as follows:

- Alternative WS2A - 5,954 acres of additional storage reservoirs
- Alternative WS2B - 8,832 acres of additional storage reservoirs
- Alternative WS2C - 14,544 acres of additional storage reservoirs

4.7 This alternative, like the No Federal Action Alternative above, uses 2015 groundwater yields of the expected safe yield (yield that would not result in any additional decline of water levels within the aquifer) or recharge rate of 148,565 acre-feet. This level of groundwater, along with existing and new rainfall runoff capture and on-farm storage reservoirs, can support irrigation on only about 46% to 52% of the project area (132,570 acres for WS2A, 141,573 acres for WS2B, and 151,391 acres for WS2C) during an average year. The remainder of the area would convert to dryland agricultural practices consisting mainly of soybeans.

4.8 Alternative WS3 consists of a combination of conservation measures, on-farm storage, and a 1,650 cfs import system. The conservation measures are designed to achieve the optimum level, increasing the irrigation efficiencies from 60% to 70% for the entire project area. These features were analyzed with three levels of on-farm storage reservoirs, 5,954 acres, 8,832 acres, and 14,544 acres of new reservoirs in addition to the existing reservoirs. On-farm storage is used to capture existing runoff and to store import water for use during peak demand periods or when other sources cannot provide the need. Import water is provided by transfer of water from the Arkansas River to the farms through a system of new canals, existing streams, and pipelines. These three components are not independent or stand alone features. They are related and depend on each other to function properly. The above three combinations are designated as:

- 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

4.9 Alternative WS4 is identical to Alternative WS3 with the exception of using a 1,750 cfs import system instead of a 1,650 cfs. It consists of the same combination of conservation measures and on-farm storage reservoirs as Alternative WS3. The conservation measures are set at 70% for the entire project area with on-farm storage reservoirs of 5,954 acres, 8,832 acres, and 14,544 acres of new reservoirs in addition to the existing reservoirs. These combinations are designated as:

- Alternative WS4A – 5,954 acres of additional storage reservoirs
- Alternative WS4B -- 8,832 acres of additional storage reservoirs
- Alternative WS4C -- 14,544 acres of additional storage reservoirs

4.10 Alternative WS5 also consists of the conservation features and on-farm storage levels used in Alternatives WS3 and WS4. Alternative WS5 uses a 1,850 cfs import system in addition to the conservation features and on-farm storage reservoirs. These combinations of Alternative WS5 are designated as:

- Alternative WS5A – 5,954 acres of additional storage reservoirs
- Alternative WS5B -- 8,832 acres of additional storage reservoirs
- Alternative WS5C -- 14,544 acres of additional storage reservoirs

4.11 Alternative WS5, like Alternatives WS2, WS3, and WS4 above, uses 2015 groundwater yields of the expected safe yield or recharge rate of 148,565 acre-feet. Alternative 5 can also support irrigation on about 90% to 96% of the project area (261,278 acres for WS5A, 275,467 acres for WS5B, and 278,860 acres for WS5C) during an average year. The remaining area would convert to dryland agricultural practices consisting mainly of soybeans.

4.12 Seven alternatives were formulated and evaluated for the flood damage reduction portion of the project. Four structural and one non-structural alternative were studied in detail. Two alternatives, FC2A and FC3A were carried into the final array of plans.

4.13 Alternative FC2 consists of a channel cleanout/enlargement to provide some flood relief for the more frequently flooded reaches. The work would be accomplished from one side of the channel and would not require any banklines to be cut back since all material would be excavated from the bottom of the channel.

4.14 Alternative FC2A would be the same as Alternative FC2 with the exception of the Indian Bayou Ditch and Crooked Creek areas. Water supply and flood control channel work would overlap in these areas as discussed in the detailed description of the work in the Main Report.

4.15 Alternative FC3A is the same as Alternative FC2A with the addition of a 1,000 cfs pump on Little Bayou Meto, and related structural and channel features.

4.16 Alternative FC3B is the same as Alternative FC2A with the addition of a 3,000-cfs pump on Little Bayou Meto. This alternative consists of the features of FC2A plus a 3,000-cfs pump and related structural and channel features.

4.17 The nonstructural alternative consists of reforesting some cleared acreages in the flood damage reduction study area. Acres of cleared lands within the study area that are within the 2-year flood plain would be reforested with BLH that would be suitable to the sites. A total of 15,140 acres would be reforested with this plan.

4.18 Waterfowl management features were also studied. They consisted of BLH, herbaceous wetland/prairie complex (HWPC), and riparian buffer strips along Basin streams. The plan also investigated creation of moist soil management areas and making major improvements on the state owned Bayou Meto WMA.

Plans Eliminated From Further Study

4.19 Of all the alternative plans considered in preliminary analyses, only the No Action Alternative (future without-project condition), Alternative WS4B of the water supply portion, Alternatives FC2A and FC3A of the flood control portion of the project and the WM plan were selected for detailed analyses in the final array of alternatives.

4.19 Alternative WS2 (conservation with storage) of the water supply portion was dropped from further analysis because additional conservation and storage cannot supply all of the Bayou Meto Irrigation Project Area's future without-project unmet need. The limiting factor in using conservation measures is that they are effective only when there is available water to recover. A point is quickly reached where the available sources of irrigation water are exhausted, and only a small portion of an average year's unmet need can be satisfied. Conservation practices are recommended for the entire project area in conjunction with the different sources provided by other alternatives, since conservation reduces the total amount of water required and is more cost effective. Because of this, the features in Alternative WS2 were incorporated into the design of Alternatives WS3, WS4, and WS5.

4.20 Analyses indicated that the 1,650 cfs pumping station in alternative WS3 of the water supply portion did not supply the unmet water need of the Bayou Meto Irrigation Project Area. Therefore, Alternative WS3 was not presented in the final array of alternatives.

4.21 Alternative WS5 with the 1,850 cfs pumping station did not deliver the best cost to benefit ratio and was, therefore, not the NED plan.

4.22 Alternative FC2 of the flood control portion of the study was eliminated from further consideration because it did not account for the additional water resulting from the water supply component.

4.23 Alternative FC3B of the flood control portion was eliminated from further consideration because the 3,000 cfs pump station could provide excess water removal capability and had a lower benefit to cost ratio than the NED plan.

Plans Considered in Detail

4.24 The resulting plans are the final array of alternatives. These alternatives, Alternative WS4B of the water supply portion, the Waterfowl Management plan, and Alternatives FC2A and FC3A of the flood control component, are described in the following paragraphs.

WATER SUPPLY ALTERNATIVE WS4B (1,750 CFS IMPORT SYSTEM, CONSERVATION AND 8,832 ACRES OF ADDITIONAL STORAGE RESERVOIRS)/ FLOOD CONTROL ALTERNATIVE FC3A CHANNEL CLEANOUT/ENLARGEMENT WITH 1,000 CFS PUMP STATION AT THE OUTLET OF LITTLE BAYOU METO)

4.25 This plan combines the water supply components of a 1,750 cfs import system, a large reservoir, conservation measures contained in Alternative WS2, and additional water storage consisting of 8,832 acres of additional storage. 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. Volume 3, Appendix B, Section I, provides a detailed description of the pump station and delivery system (including all associated hydraulic structures). Water conservation measures, groundwater management strategies, retrofit of existing farm irrigation systems, and new on-farm irrigation reservoirs are all integral plan components.

4.26 The flood control portion of this alternative consists of the channel excavation and enlargement to selected ditches included in flood control Alternative FC2A, and the addition of channel work on 10 miles of Little Bayou Meto above the pump station to convey water from the Cannon Brake Structure to the pump station. The channel would have a 30-foot bottom width and would essentially be a new channel since the old channel has silted in following the diversion of Little Bayou Meto flows to Big Bayou Meto. The 1,000 cfs pump station would be located at the outlet of Little Bayou Meto and would remove water from behind the Arkansas River Levees. This plan also requires a 5-mile long by 30-foot bottom width by-pass channel to convey water around the southwest corner of the WMA into Little Bayou Meto.

WATER SUPPLY ALTERNATIVE WS4B (1,750 CFS IMPORT SYSTEM, CONSERVATION AND 8,832 ACRES OF ADDITIONAL STORAGE RESERVOIRS)/ FLOOD CONTROL ALTERNATIVE FC2A (CHANNEL CLEANOUT/ENLARGEMENT WITH WATER SUPPLY AJUSTMENTS)

4.27 This plan combines the water supply components of a 1,750 cfs import system, a large reservoir, conservation measures contained in Alternative WS2, and additional water storage consisting of 8,832 acres of additional storage. 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. Volume 3, Appendix B, Section I, provides a detailed description of the pump station and delivery system (including all associated hydraulic structures). Water conservation measures, groundwater management strategies, retrofit of existing farm irrigation systems, and new on-farm irrigation reservoirs are all integral plan components.

4.28 The flood control portion of this alternative consists of channel excavation and/or enlargement to selected ditches within the project boundaries and includes channel work on Indian Bayou Ditch and Crooked Creek to accommodate increased flows resulting from the water supply component. There is no flood control pump station associated with this alternative.

WATERFOWL MANAGEMENT (WM) PLAN

4.29 In addition to the NED plan alternatives, a WM plan was formulated. The Water Resources Development Act (WRDA) of 1996 specifically authorized waterfowl management as a purpose of the Bayou Meto Basin, Arkansas, Project. Also, ecosystem restoration is an important mission of the U.S. Army Corps of Engineers. The purpose of this study effort was to develop a plan that provided substantial waterfowl benefits primarily through restoration of natural habitats.

4.30 Historically, the Bayou Meto Basin contained a diverse array of native plant communities, ranging from low bottomland forests to post oak flats and a herbaceous wetland/prairie complex. Unfortunately, about 85% of these native habitats have been destroyed in the project area. As a result, waterfowl, fish, and terrestrial wildlife populations have declined. Populations of sensitive species, including the king rail, have been drastically reduced. Several species, such as the greater prairie chicken and bison, have been extirpated from the project area. However, a relatively large amount of BLH forest still exists within the southern portion of the basin. These forests provide habitat for a few black bears and winter a large number of waterfowl.

4.31 In response to waterfowl habitat losses within the project area, the WM plan was developed. This plan contains features to restore 10,000 acres of herbaceous wetland/prairie complex and 25,643 acres of forest and riparian buffer. It also would create 240 acres of moist-soil habitat for waterfowl and other wetland birds. The WM Plan also includes 24 features, including a pumping station, to improve waterfowl habitat on the 32,000 acre Bayou Meto WMA. The WM Plan would provide 21,216,388 duck-use-days; significant benefits to forest wildlife, 10,250 Average Annual Habitat Units (AAHUs); substantial benefits (7,328 AAHUs) to grassland species; and 10,289 AAHUs for fisheries. Land for forest and herbaceous wetland/prairie complex restoration would be acquired primarily through conservation easements or fee acquisition with willing landowners. Land for the riparian buffers would be obtained through restrictive easements and land for moist-soil habitat would be acquired in fee simple. See Section III of the Main Report for a detailed description of the WM plan.

Comparative Impacts of Alternatives

4.32 Table 4-1 compares the base and without-project conditions and lists the impacts of the combined water supply and flood control plans on the significant resources of the project-affected area. Plan economic characteristics are also compared. The significant resources are individually described in Section 5 of this environmental impact statement, and the impacts of each alternative plan on each significant resource are detailed in Section 6.

TABLE 4-1
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Rivers and Streams
Base	The study area portion of the Arkansas River extends from the David D. Terry Lock and Dam (River Mile 108) downstream to approximately River Mile (RM) 31. There are numerous smaller tributary streams in the project area; many of these streams are intermittent, particularly during summers, due to their relatively small size and high water withdrawal rates.
Future W/O Project	Additional irrigation water may be taken from the Arkansas River. The smaller project area streams would continue to be adversely impacted by agricultural activities.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Maximum stage reductions of about one foot or less would occur on the Arkansas River during summer/early fall when the river is low and irrigation demands are highest; changes in stage are almost immeasurable during high flows. Supplemental water would be provided to the tributary streams, and weirs would maintain irrigation pools within these streams.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts to the Arkansas River would be very similar to Alternative WS4B/FC3A. Impacts to the tributary streams would be similar, although there would be no cleanout of the lower10 miles of Little Bayou Meto necessary to convey water to the pump station.
WM Plan	Restoration of 2,643 acres of riparian buffer and 92 drop-pipe structures would reduce the amount of sediment entering streams. This would improve water quality and benefit aquatic life.
Selected Plan	The supplemental water, restoration of riparian buffer areas along the streams, and installation of drop-pipes in small ditches and streams should have a significant positive impact on the Basin waterways.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Groundwater
Base	The alluvial aquifer, which is the primary source of agricultural irrigation water for all eastern Arkansas is seriously depleted. Groundwater withdrawals over several decades in excess of recharge (safe yield) have resulted in several large cones of depression in the aquifer. The largest cone is centered over the Grand Prairie Region and Bayou Meto Basin in Arkansas, Prairie, Lonoke, and Jefferson counties.
Future W/O Project	The availability of groundwater to sustain existing and future agriculture needs is expected to significantly decline as the aquifer is depleted. Without any action, under existing state law projections are that all available groundwater reserves would be exhausted and pumpage would be suspended by the year 2013 in the area north and east of Bayou Meto. The area south and west of Bayou Meto would reach this level in 2015.
Water Supply Alternative 4B/ Flood Control Alternative 3A	This plan would sustain the alluvial aquifer by establishing a "safe yield" for the aquifer. By definition "safe yield" is a yield that would not result in any additional decline of water levels within the aquifer. Groundwater modeling studies and analyses completed by the USGS in 2002 determined the safe yield to be 148,565 acre-feet annually (22% of demand) for the Bayou Meto Irrigation Project Area (IPA). In addition to protecting the aquifer from over pumpage and total depletion this plan of improvement provides a supplemental supply of irrigation water that would allow the aquifer to rebound above the minimum saturated thickness which would in turn benefit the other natural resources of this vast ecosystem.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts would be similar to Alternative WS4B/FC3A.
WM Plan	Restoration of large tracts of cropland would reduce agriculture related chemical leaching into the ground water. It would also slightly reduce groundwater withdrawals in the project area.
Selected Plan	The recharge of the aquifer and reduction of leached chemicals from agricultural practices should benefit groundwater and the resources that depend on it.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Water Quality
Base	Salinity in the Arkansas River generally falls in the medium range but increases during dry years. Concentrations for chloride, sulfate, bicarbonate, alkalinity, pH, and heavy metals are generally in the low range. 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.
Future W/O Project	No significant changes are expected.
Water Supply Alternative 4B/ Flood Control Alternative 3A	This plan should not induce any significant sedimentation in tributary streams and the use of Arkansas River water for irrigation purposes should have positive effects on water quality in streams and ditches.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Effects on water quality would be similar to Alternative WS4B/FC3A.
WM Plan	The riparian buffers and drop-pipe structures would reduce sedimentation. Bottomland hardwood forest (23,000 acres), riparian buffer (2,643 acres), and HWPC (10,000 acres) restoration on cleared lands would reduce the amount of agricultural land in the project area, thereby reducing the amount of pesticides entering streams and ditches.
Selected Plan	Additional flows and reduction of non-point source pollutants resulting from riparian buffer strips and other habitat restoration should significantly increase the water quality in the Basin.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Aquatic Resources
Base	The Arkansas River and adjacent oxbow lakes contain valuable commercial and sport fisheries. Fisheries of the smaller tributary streams have been heavily degraded by agricultural activities. Little is known about the mussel population in the Arkansas River in the vicinity of the project. It is likely that the installation of the lock and dam structures in the River have impacted mussel community diversity and population. Mussels are also not present in large numbers or high diversity in the tributary streams; channel modification, agricultural runoff, and irrigation withdrawals have been attributed as limiting factors.
Future W/O Project	The Arkansas River fishery is expected to remain relatively stable. Native mussel populations in the river should remain similar to existing conditions unless the zebra mussel population proliferates. If zebra mussels increase significantly in abundance, native mussels would be adversely impacted. Fish and mussel populations in the smaller tributary streams should remain similar to existing conditions.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Impacts to the Arkansas River fishery as a result of pump entrainment and reductions in surface water elevations are projected to be relatively minor. Benefits to tributary stream fisheries would be 380 Habitat Units (HUs)/month gained, and new irrigation canals would provide 125 HUs/month. The minor changes in river surface water elevations should not impact mussels. There would be negative impacts to freshwater mussels in the tributary streams due to construction; however over time the increased flows and water quality should aid in recolonization and expansion of population throughout the basin.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts would be similar to Alternative WS4B/FC3A.
WM Plan	Water quality improvements resulting from reduced sedimentation and pesticides would benefit aquatic organisms. Also, riparian buffer and bottomland hardwood restoration within the post project two-year floodplain would provide substantial fishery benefits (10,289 AAHUs).
Selected Plan	A significant increase in fishery benefits would be realized by implementation of the selected plan. Other aquatic organisms, initially impacted by construction, would benefit over time from the improved conditions in the streams.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Bottomland Hardwood Forest (BLH)
Base	The project area contains approximately 79,000 acres of BLH forest.
Future W/O Project	The acreage of BLH is expected to increase due to NRCS sponsored conservation projects such as Conservation Reserve Enhancement Program (CREP) and Conservation Reserve Program (CRP). However, the hydrology of BLH in the Bayou Meto Basin could be adversely impacted by groundwater depletion.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Approximately 898 acres (100 acres associated with on-farm construction) would be directly impacted by irrigation related construction, and 797 acres would be impacted by the flood control component. 1,497 acres would be adversely affected by hydrologic changes. A total of 3,514 acres of BLH restoration would be required for mitigation.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts and associated mitigation under this alternative would be significantly less than alternative WS4B/FC3A, primarily because the pump in WS4B/FC3A would have a greater hydrologic effect.
WM Plan	The WM plan could restore 23,000 acres of BLH forest and 2,643 acres of riparian buffer. Also, quality of BLH in the WMA would be greatly improved.
NED/WM–Selected Plan	In addition to the BLH restoration provided by the WM Plan, a total of 4,093 acres of cleared agricultural land would be restored to BLH to offset adverse project impacts to wetlands; 3,514 acres of this restoration would be required to mitigate impacts to BLH.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Wetlands
Base	Approximately 79,000 acres of BLH forest wetlands and 56,667 total acres of cleared wetlands are found within the project area.
Future W/O Project	The amount of BLH forest would likely increase due to CREP and CRP programs. Groundwater wetlands along area streams and ditches could be impacted by a drying effect caused by continued depletion of the alluvial aquifer.
Water Supply Alternative 4B/ Flood Control Alternative 3A	The Habitat Evaluation Procedures (HEP) were utilized to assess terrestrial habitat losses and determine compensatory mitigation for direct construction impacts to 1,595 acres of BLH; 1,974 acres of BLH restoration would be required for mitigation. Hydrogeomorphic assessment (HGM) determined that mitigation of hydrologic impacts to designated farmed wetlands and BLH would require 440 and 1,340 acres, respectively. 139 acres of BLH restoration would be required to offset farmed wetland losses associated with construction of the irrigation delivery system (35 acres impacted) and on-farm features (estimated 100 acres impacted). On-farm construction would also result in the loss of an estimated 100 acres of BLH, resulting in an additional mitigation requirement of 200 acres of BLH restoration. A total of 4,093 acres of BLH restoration is required to fully mitigate project impacts.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Project impacts to wetlands would be much smaller under this alternative. Hydrologic impacts would be significantly reduced without a pump station in Little Bayou Meto.
WM Plan	This plan would restore 23,000 acres of BLH, 2,643 acres of riparian buffer, and 10,000 acres of HWPC; improve hydrology on the ca. 32,000-acre Bayou Meto WMA; and create 240 acres of moist-soil habitat to benefit waterfowl. Creation of buffers, reforestation, and other WM features would substantially improve wetland resources in the project area.
NED/WM–Selected Plan	Impact and mitigation requirements would be the same as for WS4B/FC3A. This combined alternative would also include all of the benefits of the WM plan.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Herbaceous Wetland/Prairie Complex
Base	There currently is virtually no HWPC remaining in the project area.
Future W/O Project	No change in the status of HWPC habitat is expected.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Native prairie vegetation would be established in canal rights-of-way where appropriate. Approximately 200 acres of canal rights-of-way in the historic Long Prairie region would be replanted with native prairie grasses.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts and benefits would be the same as Alternative WS4B/FC3A.
WM Plan	This plan targets a total of 10,000 acres of cleared land for HWPC restoration.
NED/WM–Selected Plan	As many as 10,000 acres are proposed for restoration of HWPC habitat under the selected plan.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Wildlife
Base	A variety of wildlife inhabits the study area, including an abundance of migratory and resident waterfowl.
Future W/O Project	No permanent clearing of woodlands is projected; in fact, probable reforestation of cleared land under the Wetlands Reserve Program (WRP), CREP and CRP could increase the amount of wildlife habitat. However, some wetlands along the basin streams and ditches could become dryer; this would adversely impact wetland dependent wildlife.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Direct construction impacts to BLH associated with this alternative will result in the loss of 3,446.4 AAHU's. To mitigate for these impacts, 1,974 acres of cleared land will be restored to BLH forest. The HGM analysis revealed that 1,780 acres of cleared wetlands would need to be restored to BLH to offset hydrologic effects on wetlands, including impacts to wildlife habitat maintenance. 300 acres of BLH restoration would be required to mitigate on-farm construction losses to BLH (100 acres) and farmed wetlands (100 acres). An additional 39 acres of BLH restoration would be needed to offset farmed wetlands losses associated with construction of the water supply system. Additional shorebird foraging habitat could be provided if the irrigation reservoirs were constructed with gently sloping sides; this would expose additional mudflats during reservoir drawdowns.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Wildlife losses associated with WS4B/FC2A would be less than WS4B/FC3A. Shore bird foraging habitat would be similar to Alternative WS4B/FC3A.
WM Plan	This plan could restore 23,000 acres of forest, 2,643 acres of riparian woodland, and up to 10,000 acres of HWPC. In addition, it would create 240 acres of moist-soil habitat to benefit waterfowl and other wetland birds. This plan would provide significant benefits to forest wildlife (10,250 AAHUs), HWPC wildlife (7,328 AAHUs), fisheries (10,289 AAHUs) and waterfowl (21,216,388 DUDs). Hydrological improvements would also benefit the 32,000-acre Bayou Meto WMA. It would also provide immeasurable benefits to sensitive species, such as king rail, purple gallinule, forest breeding birds, and black bear.
NED/WM–Selected Plan	Wildlife impacts and mitigation requirements would be the same as for WS4B/FC3A. The selected plan would also include all the waterfowl features and benefits of the WM plan.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	State and Federal Holdings
Base	The Bayou Meto WMA is located within the project boundary.
Future W/O Project	Bayou Meto WMA would degrade, with continued stress on BLH forests.
Water Supply Alternative 4B/ Flood Control Alternative 3A	The pump station would allow AGFC to remove excess water from the Bayou Meto WMA. Long periods of inundation have caused large tracts of BLH to become stressed or die.
Water Supply Alternative 4B/ Flood Control Alternative 2A	There would be no relief to the stressed timber in the Bayou Meto WMA under this Alternative.
WM Plan	Improved water management capabilities and forest restoration on private land in the southern portion of the project area would enhance the environmental benefits of the 32,000-acre Bayou Meto WMA. Cleared land for moist-soil habitat would be acquired in close proximity to the WMA.
NED/WM–Selected Plan	The ability to reduce the stress on existing forests within the WMA coupled with the restoration of forests adjacent to the area would significantly increase the environmental benefits of the WMA.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Endangered and Threatened Species
Base	Two threatened or endangered species, the bald eagle and the interior least tern, are known to occur within the study area. Two active bald eagle nests were reported in the southern portion of the project area; however, there is no project related construction proposed within 0.5 miles of these sites. The ivory-billed woodpecker, a recently rediscovered endangered species, is known to inhabit the forests in the Cache River Basin but has not been found in the project area and would not be impacted.
Future W/O Project	The status of these species is expected to remain similar to existing conditions.
All Alternatives	This plan should not adversely impact either of these species.
WM Plan	The WM plan would benefit the bald eagle by providing additional nesting opportunities in the restored forest acres.
NED/WM–Selected Plan	Habitat available for bald eagle would be expected to increase over time.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

	Recreation
Base	The two major recreational activities within the study area are hunting and fishing. The Bayou Meto WMA located in the southern part of the Bayou Meto Basin contains the largest tract (32,000 acres) of BLH in the basin. The Bayou Meto WMA provides both consumptive and non-consumptive recreational opportunities. This area is one of the most significant waterfowl resources along the North American Flyway. The WMA offers some of the best duck hunting in the nation, and averages 350 duck hunters daily throughout the season.
Future W/O Project	Under future without-project conditions, the Bayou Meto WMA would continue to provide opportunities for the public to participate in hunting, fishing, and non-consumptive recreational activities. Recreational opportunities on privately owned lands would probably remain similar to existing conditions over the next 50 years.
Water Supply Alternative 4B/ Flood Control Alternative 3A	The improvements in water quality would increase the fishing opportunities in Basin streams.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Improvements in fishing opportunities would be expected with the implementation of this alternative.
WM Plan	Hunting and fishing opportunities would be expected to significantly improve with implementation of this alternative. Bird watching and hiking opportunities would also be increased. With restoration of unique habitats such as HWPC, many species that are currently rare in the region would be expected to appear, thereby increasing wildlife observation opportunities.
NED/WM–Selected Plan	Hunting, fishing, hiking, bird watching, and other outdoor recreational activities would be expected to increase substantially.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Agricultural Lands
Base	The project area contains approximately 506,246 acres of farmland. Major crops are rice, soybeans, and cotton.
Future W/O Project	Crop production and land use are expected to shift to dryland cropping as the water available for irrigation decreases. It is estimated that under existing state law, all groundwater reserves would be exhausted by 2015.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Approximately 9,782 acres of farmland, including 135 acres (including on-farm impacts) of designated farmed wetlands would be lost as a result of constructing this alternative.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts would be similar to Alternative WS4B/FC3A.
WM Plan	This plan could result in a loss of approximately 36,000 acres of agricultural land. However, a significant portion of this land would still be subjected to frequent flooding after project implementation.
NED/WM–Selected Plan	A large amount of agricultural land could potentially be removed from farming under the selected plan. However, flooding would be reduced on the remaining land and it would be provided with adequate irrigation water to maintain present farming practices.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Navigation
Base	The current operating plan, adopted in 1986, for the McClellan-Kerr Arkansas River Navigation System is not expected to change.
Future W/O Project	The current operating plan, adopted in 1986, for the McClellan-Kerr Arkansas River Navigation System is not expected to change.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Project would not have any impacts to navigation on the Arkansas River.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts would be similar to Alternative WS4B/FC3A.
WM Plan	No effect.
NED/WM–Selected Plan	No effect.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

	Cultural Resources
Base	Project specific cultural resources inventory is not complete. Of 9,700 acres field surveyed to date, over 200 archeological sites and nine historic cemeteries are identified.
Future W/O Project	An unknown number of cultural resources would remain unidentified (that is, sites which would be inventoried should project action alternatives be implemented).
Water Supply Alternative 4B/ Flood Control Alternative 3A	The right-of-ways for any construction or land acquisition would be fully inventoried for cultural resources sites, the sites would be evaluated for significance, and significant sites would be mitigated through avoidance or other treatments such as data recovery.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Cultural resources requirements would be the same as Alternative WS4B/FC3A.
WM Plan	Same as for WS4B/FC3A. Long term stewardship of significant cultural resources sites where present within lands acquired for NED/WM (where lands are in federal ownership, or become transferred to another public agency).
NED/WM–Selected Plan	Same as for WS4B/FC3A. Long term stewardship of significant cultural resources sites where present within lands acquired for NED/WM (where lands are in federal ownership, or become transferred to another public agency).

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

	Noise
Base	The study area is relatively noise free due to it rural setting. Most existing noise is associated with agricultural and recreational activities.
Future W/O Project	Slight increase in outdoor recreational noise due to probable expansions of the Bayou Meto WMA and increase in BLH forests in the Basin. Agricultural noise should remain similar to existing conditions.
Water Supply Alternative 4B/ Flood Control Alternative 3A	There would be an increase in noise during project construction due to equipment operation. Noise would increase at the pump stations during pump operation. However, this noise would be confined to the immediate vicinity of the pump stations.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts during construction would be similar to Alternative WS4B/FC3A. There would be no pump station to cause noise associated with the flood control component.
WM Plan	There would be a slight decrease in noises associated with farming operations. However, recreational noises would increase.
NED/WM–Selected Plan	Impacts would be same as for Alternative WS4B/FC3Aand WM Plan combined.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Air Quality
Base	Air quality is good to above average due to its rural setting and is in attainment for all air quality standards.
Future W/O Project	Air quality is not expected to change.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Machinery emissions and airborne dust would slightly degrade air quality during construction and maintenance. However, project-induced impacts to air quality would be minor and of short duration.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts would be the same as Alternative WS4B/FC3A.
WM Plan	There would be a decrease in the amount of cropland in the project area. Fewer acres of crop stubble would be burned, resulting in a slight improvement to air quality.
NED/WM–Selected Plan	Short-term degradation during construction, with a slight improvement over time.
	Aesthetic Value
Base	Aesthetic value of the study area is closely associated with the beauty and diversity of the flora and fauna in the remaining natural areas.
Future W/O Project	Aesthetic value of the study area would likely increase due to probable cleared land acquisitions and reforestation under federal CREP and CRP.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Vegetative clearing associated with construction would reduce aesthetic value. Also, project features would alter the appearance of the landscape; however, mitigation measures should offset negative impacts to aesthetics.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Impacts would be the same as Alternative WS4B/FC3A.
WM Plan	The restoration of native vegetation in a variety of habitat types will increase the aesthetic value of the region.
NED/WM–Selected Plan	An improvement in the scenic beauty in the Basin would be expected with the selected plan.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Displacement of People
Base	-----
Future W/O Project	Many of the area's residents could be displaced due to loss of jobs associated with a significant reduction of the area's income when the alluvial aquifer can no longer support widespread irrigation practices.
Water Supply Alternative 4B/ Flood Control Alternative 3A	No people would be displaced if this plan implemented. In fact, Alternative WS4B/FC3A could lessen the displacement of the area's residents expected under future without-project conditions. The area's income would be greatly enhanced over the levels expected without the project, which would prevent the expected loss of area employment.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Effects would be similar to Alternative WS4B/FC3A.
WM Plan	No significant displacement of people would be expected with implementation of the selected plan. Employment opportunities would be expected to increase as more tourism occurs in the Basin
NED/WM– Selected Plan	Impacts would be same as for Alternative WS4B/FC3Aand WM Plan combined.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Community Cohesion
Base	The cultural heritage of the project area is linked directly to a rural way of life based on agriculture. The preservation of lifestyle is based on the continued existence of the small farm and activities that support an agricultural based economy.
Future W/O Project	There would be a gradual conversion of some small farms to larger farm complexes, but the base economy would remain dependent of agriculture.
Water Supply Alternative 4B/ Flood Control Alternative 3A	To date there have been no community cohesion issues raised regarding the implementation of the proposed project.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Concerns are the same as Alternative WS4B/FC3A.
WM Plan	Restoration of native vegetation would only occur on property offered by willing sellers; therefore no issues would be expected to arise.
NED/WM–Selected Plan	Significant coordination has to date nullified any community concerns regarding the selected plan.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Local Government Finance, Tax Revenues, and Property Values
Base	The area of local government finance is concerned with items such as tax base, property values, and tax revenues. Each of these, and other items, are important because they impact the financial condition of local government units. Financial soundness is important because it often determines the level and quality of the necessary public services provided by local governments
Future W/O Project	Under future without-project conditions, there would be a significant decrease in property values on cropland and a corresponding drop in tax revenue as the area's lands can no longer support irrigation practices due to the loss in irrigation capacity of the alluvial aquifer.
Water Supply Alternative 4B/ Flood Control Alternative 3A	This plan would halt or significantly reduce the erosion of property values and tax base expected under future without-project conditions thereby maintaining revenues from taxes to the local government entities.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Effects would be the same as Alternative WS4B/FC3A.
WM Plan	Some decrease in assessed property value would be anticipated on lands converted from farming to native vegetation; however, this loss would be more than offset by the increase in revenues derived from the increases in hunting and fishing opportunities.
NED/WM–Selected Plan	Property values would be maintained on farmed land, while the restoration of native vegetation would significantly increase revenues derived from tourism and outdoor activities.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Displacement of Businesses and Farms
Base	----
Future W/O Project	Under future without-project conditions, many of the area's businesses and farms could be displaced when the area's aquifer can no longer support widespread irrigation practices.
Water Supply Alternative 4B/ Flood Control Alternative 3A	The area's agricultural income would be greatly enhanced over the levels expected without the project that would maintain the profitability of the area's businesses and farms. Alternative 4B would stop any displacement of the area's businesses or farms expected under future without-project conditions.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Effects would be the same as Alternative WS4B/FC3A.
WM Plan	Some displacement of farms could occur with implementation of this alternative. However, since land would be acquired only from willing sellers, this displacement would not be unwelcome.
NED/WM–Selected Plan	It is unlikely that any businesses would be displaced by implementation of this alternative. Any farm displacement would be as a result of willing sellers.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Public Services and Facilities
Base	The area of public services and facilities is concerned with the ability of local government to provide the basic public services; e.g., education, police protection, and roads and bridges.
Future W/O Project	Under future without-project conditions, the ability to provide such services would be greatly hindered. The area's tax base is expected to be greatly decreased when the alluvial aquifer is depleted causing a sharp drop in property values. This would cause a corresponding drop in tax revenues needed to provide these services.
Water Supply Alternative 4B/ Flood Control Alternative 3A	This plan would prevent the erosion of property values and corresponding decrease in tax base expected under future without-project conditions. This would maintain the area's ability to provide such basic public services as education, police protection, and roads and bridges.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Effects would be the same as Alternative WS4B/FC3A.
WM Plan	The increase in funds derived from outdoor activities such as duck hunting and fishing would be expected to increase the overall tax base of the Basin, thereby increasing the availability of public services and facilities.
NED/WM–Selected Plan	Property values of farmed lands would be maintained, while increases in revenues resulting from hunting and fishing would further increase the availability of funding for public services.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Community and Regional Growth
Base	Growth in the communities within the project area is directly related to agriculture and agriculture related production.
Future W/O Project	Agricultural production is expected to decrease significantly under future without-project conditions when the alluvial aquifer can no longer support irrigation. The drop in production would mean significant declines in the region's economy with an accompanying decrease in urban and rural population.
Water Supply Alternative 4B/ Flood Control Alternative 3A	This alternative would not contribute appreciably to community and regional growth. However, it would prevent the declines expected in the region's economy under future without-project conditions. It would maintain the area's agricultural and agricultural related production, farms and businesses, income, employment, tax base, public services, and urban and rural population necessary to maintain the area's economy at present levels.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Effects would be the same as Alternative WS4B/FC3A.
WM Plan	The restoration of native vegetation would be expected to draw tourists and hunters. An increase in demand for services by these visitors would be expected to increase the number of businesses and people to operate them.
NED/WM–Selected Plan	An increase in population and businesses would be expected to result from the implementation of the selected plan, due to the increase in tourism and revenue generated from tourists and hunters.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternatives	Significant Resources
	Employment
Base	The area's employment is concentrated in trade, manufacturing, and agriculture.
Future W/O Project	Under future without-project conditions, there would be a significant decrease in agriculture and agriculture related employment as a result of the decline in agriculture's profitability and its accompanying reduction in income as the area's aquifer is depleted and irrigation cannot be sustained. There would also be a significant reduction in employment not directly associated with agriculture due to the secondary effects of the loss in agricultural income to the area's economy.
Water Supply Alternative 4B/ Flood Control Alternative 3A	Alternative 4B would prevent the expected declines in agricultural and agricultural related employment along with any decreases in secondary employment expected under future without-project conditions. There would also be some opportunities for new employment associated with project construction, operation, and maintenance.
Water Supply Alternative 4B/ Flood Control Alternative 2A	Effects would be the same as Alternative WS4B/FC3A.
WM Plan	An increase in employment opportunities would be expected as the opportunities for hunting, fishing, and other outdoor activities increased, with a concurrent demand for services.
NED/WM–Selected Plan	Employment opportunities would be expected to increase in the construction and service industries as a result of implementation of the selected plan.

TABLE 4-1 (cont.)
COMPARATIVE IMPACTS OF ALTERNATIVES

Alternative	Total First Cost	Net Benefits	Benefit/Cost Ratio
Base	–	–	–
Future W/O Project	–	–	–
Water Supply Alternative 4B/ Flood Control Alternative 3A	$420,204,000	$37,593,000	1.13
WM Plan	$87,423,000	21,216,388 DUDs 10,289 Aquatic AAHUs 10,250 Terrestrial AAHUs 7,328 HWPC AAHUs	N/A
Combined NED/WM Plan – Selected Plan	$576,299,000	Economic benefits same as WS4B/FC3A. Environmental benefits same as WM Plan.	

5. AFFECTED ENVIRONMENT

Environmental Conditions

5.1 The following information is largely taken from Heitmeyer et al., 2002 (Volume 10, Appendix D, Section III. The Bayou Meto Basin area of eastern Arkansas includes all or part of the watersheds of Bayou Meto, Bayou Two Prairie, and Wabbaseka Bayou. The project area is bounded on the north by the Grand Prairie Terrace, on the west by the Plum Bayou drainage, and on the east by Bayou Two Prairie. The Arkansas River borders the Basin in the south. The Bayou Meto Basin lies within the Mississippi Alluvial Plain, with most landscapes being formed and shaped by depositional and erosion dynamics of the Arkansas River. Landscapes present within the Bayou Meto Basin range from upland and prairie terrace in the northeast to features associated with the Arkansas River (e.g., natural levees, backswamp deposits, and abandoned courses) in the south. Basin streams typically have low current velocities, meandering channels, and wide floodplains. The largest stream in the Basin is Bayou Meto, which has several tributaries including Bayou Two Prairie, Wabbaseka Bayou, and Mills Bayou. There are a number of perennial streams in the Basin, including Bakers and Salt Bayous, and Caney and Crooked Creeks. There are three distinct geologic regions within the project area. The “Prairie Complex” terrace, also known as the Grand Prairie is located in the northeast part of the Basin and was created in the Pleistocene period (Saucier, 1994). This terrace was formed primarily in the Sangamon interglacial stage, which occurred approximately 120,000 BP. The terrace is a result of fluvial processes of both the historic Mississippi and Arkansas rivers, and was then shaped by backswamp deposits and windblown silts of the late Wisconsin age. The Grand Prairie terrace is mostly over 200 feet above average mean sea level (amsl), with the highest elevations consisting of poorly drained Stuttgart and DeWitt soils with an impervious fragipan 18-24 inches below the surface. The adjacent sloping areas contain relatively poorly drained loamy soils (Calloway-Calhoun-Loring), while the terrace floodplains consist of poorly drained loamy soils (Tichnor). Tertiary soils (Claiborne and Jackson) underlay the Quarternary soils.

5.2 Along the western margin of the Grand Prairie is another terrace region, known as the “Deweyville Complex”. Approximately 25,000 years BP, climatic conditions changed, resulting in higher water tables, increased soil moisture, and large increases in runoff from glaciers. This glacial runoff caused the Arkansas River to have much higher discharges than at present and resulted in wide meanders and the creation of a number of fluvial terraces. This process continued until approximately 14,000 years BP. Although the elevations in the Deweyville Complex are somewhat lower than the neighboring Grand Prairie, they are still several feet higher (>190’ amsl) than the adjacent Arkansas River lowlands. Soils in the highest elevations of the Deweyville Complex are Stuttgart-Dewitt, 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.

5.3 The majority of the Bayou Meto Basin is located in the Arkansas River Lowland, which was formed by historic Arkansas River meanders and subsequent course changes. Five major Arkansas River courses were active in the Bayou Meto Basin during the past 14,000 years, with the oldest (10,000 years BP) of these being the Boggy Bayou and Bayou Meto courses, which were present along the western edge of the Grand Prairie. Over time, the Arkansas River courses moved progressively west, with the Bakers Bayou course forming approximately 6-8,000 years BP, and the Plumb Bayou course being active about 2-5,000 years BP. The present course of the Arkansas River began about 2,000 years ago. The Arkansas River Lowland has elevations ranging from 170-190' 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. For example, the Bakers Bayou course contains sediments about 50 feet deep, and is shallow, wide, and lacks a defined channel (Dunbar 2001, Volume 10, Appendix D, Section V). The abandoned river channels in the Bayou Meto Basin are responsible for the many oxbows and cutoffs found today. These waterbodies are typically not hydrologically connected to any bayous or streams, and receive water only during flood events and from sheetflow drainage from surrounding land. At present, there are over 20 oxbows in the Basin that are each larger than 30 acres. Soils in most abandoned channels are classified as Yorktown clays.

5.4 The backswamp deposits were formed in low floodplain areas behind natural levees of former Arkansas River courses during high water flows. In the Bayou Meto Basin, they consist primarily of layers of silt and silty sands and can be up to 50 feet thick. Backswamp soils are mostly Portland-Perry series. Natural levees result from sediment dropped from water that has overtopped the stream bank during flood events. These levees form adjacent to the channel and are low ridges and decrease in height and thickness away from the levee crest. Natural levees along active channels can be over 5 feet higher than the banks of the stream. Along old Arkansas River channels, these levees can be a considerable distance from the stream or bayou that currently exists, creating occasions where the stream is higher in elevation than the surrounding lands.

5.5 The project area encompasses approximately 765,745 acres within the 1,500 square mile Bayou Meto Basin and includes portions of Lonoke, Jefferson, Prairie, Arkansas, and Pulaski counties (see Plate 1, Main Report). Irrigation is used on 369,874 acres of agricultural land, and 22,942 acres are commercial fishponds. There are approximately 135,586 acres of wetlands within the project area, which comprise approximately 18% of the total area. There are numerous streams and ditches within the project area; Bayou Meto, Bayou Two Prairie, and Wabbaseka Bayou are among the largest of the streams. The Arkansas River occupies only a small portion of the project area in the vicinity of the proposed pumping station north of the David D. Terry Lock and Dam, located southeast of Little Rock, Arkansas (see Plate 2, Main Report).

5.6 The Bayou Meto WMA consists of approximately 32,000 acre BLH wetland owned and operated by the AGFC and is located in the southern portion of the project area. It contains one of the largest areas of BLH in the region and is maintains many of its natural functions. However, over the last 50 years, eight greentree reservoirs were constructed to hold water for waterfowl hunting purposes. Over time, these reservoirs and the system of levees, ditches and water control structures that operate them, have negatively impacted the overall health of the forests (Heitmeyer 2004).

5.7 The alluvial aquifer in the Bayou Meto Basin has been severely depleted. Groundwater from this aquifer has been used extensively for crop irrigation. Groundwater is also the primary source of water in this area for catfish and baitfish farming. Furthermore, the presence of an impermeable clay hardpan severely restricts recharge of the alluvial aquifer.

5.8 Under future without-project conditions, the alluvial aquifer would continue to deplete. It is estimated that the alluvial aquifer would be exhausted and unavailable to farmers for irrigation by the year 2015. Some increase in the amount of BLH forest is likely due to implementation of federal CRP and CREP.

Significant Resources

5.9 Discussions of existing conditions and future without-project conditions of significant resources do not cover the entire 1,500 square mile Bayou Meto Basin; they are restricted to the 765,745-acre project area and the Arkansas River and its floodplain from the David D. Terry Lock and Dam (River Mile 108) downstream to approximately River Mile (RM) 31. Agricultural practices, groundwater depletion, public land acquisitions, and the "swampbuster" provision of the 1985 Food Security Act are major factors influencing existing and future without-project conditions within the study area.

RIVERS AND STREAMS

5.10 As a result of the Rivers and Harbor Act of 1946, the Arkansas River and its tributaries were authorized for development for the purposes of navigation, flood control, water supply, and fish and wildlife. The McClellan-Kerr Arkansas River Navigation System was a result of this act. There are a total of 17 locks and dams on the River, with 12 in Arkansas and 5 in Oklahoma, which provide navigation from the Mississippi River to the Port of Catoosa near Tulsa, Oklahoma. The lock and dam structures have changed the composition of the aquatic community in the River; eliminating some species, while benefiting others. The introduction of the exotic zebra mussel to the River has also impacted aquatic organisms, such as freshwater mussels.

5.11 Numerous tributary streams to the Arkansas River are found within the project area. Bayou Meto, Wabbaseka Bayou, Bayou Two Prairie, Indian Bayou, Bakers Bayou, Crooked Creek, and Salt Bayou are some of the streams in the project area, and there are many unnamed natural and man-made channels located in the project area. Many of the streams contain weirs and/or dams for pooling water for irrigation withdrawals. Several of these streams (e.g. Indian Bayou, Bakers Bayou, and Crooked Creek) are reduced to intermittent status during the summer, consequently diversity and abundance of fishes, mussels, and other aquatic fauna in these streams are considerably less than would normally be expected.

5.12 With the continued depletion of the alluvial aquifer, farmers would rely more on capturing surface runoff and withdrawals from existing streams. Thus, tributary streams would likely degrade further due to agricultural activities.

GROUNDWATER

5.13 The Quaternary alluvium, commonly referred to as the alluvial aquifer, is comprised of two substrata. The upper substratum is a confining layer consisting of clay deposits, and the lower substratum is composed of sands and gravels (Cushing et al. 1964, Boswell et al. 1968). Although the average thickness of the clay confining layer is about 60 feet, it varies from 0 to 100 feet. This confining layer severely restricts recharge of the alluvial aquifer. The water-bearing sand and gravel deposits range from 60 to 140 feet thick but are 80 to 100 feet thick in most portions of the project area.

5.14 Large extractions of water from the Mississippi Alluvial Aquifer began in the early 1900's, primarily for rice production in the Grand Prairie region. Currently there are hundreds of agricultural wells pumping groundwater throughout the Bayou Meto Basin. This pumping has exceeded recharge capabilities in the aquifer since the mid 1900s. Groundwater levels have declined significantly throughout the Basin, and the flow of groundwater has changed from the historically southward direction towards a "cone-of-depression" that exists northeast of the Basin. The historical thickness of the aquifer (70-100 feet) has decreased by up to 50% between Lonoke and Carlisle. Today, approximately 800,000 acre-feet of groundwater is pumped from the Mississippi Alluvial Aquifer in the Bayou Meto Basin each year. This current withdrawal exceeds the safe yield level (280,000 acre-feet per year) by 65% annually on average

5.15 The present annual irrigation demand is 517 million gallons per day (1,587 acre-feet), and approximately 517.4 million gallons per day of water was extracted from the alluvial aquifer in 1995 for agricultural purposes. It is difficult to project exactly when the groundwater reserves would be exhausted; however, studies estimate that they would be depleted by the year 2015 if withdrawals continue at the current rate. However, the State of Arkansas would likely declare this region a critical groundwater shortage area several years prior to the year 2015 and begin limiting withdrawals to the annual recharge rate.

WATER QUALITY

5.16 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). Best management practices will be employed to ensure that any contaminated sediments are avoided or minimally disturbed during construction, thereby significantly reducing the potential for bioaccumulation or biomagnification of contaminants. An in-depth discussion and presentation of data regarding bioaccumulation and other associated issues are included in the Water Quality Section for Flood Control (Appendix D, Section VI, Water Quality, Part B., Flood Control).

5.17 Concentrations of chemical parameters exhibit patterns generally expected within historic agricultural regions. Streams in the more agricultural areas are 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 Total Dissolved Solids (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.

5.18 In the Mississippi Embayment Study (Kliess et. al 2000), 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 had trace amounts of DDT or its derivatives.

5.19 No significant changes in water quality are expected under future without-project conditions.

AQUATIC RESOURCES

5.20 During summer and autumn, low water prevails in the bayous and ditches that traverse a largely agricultural landscape. Irrigation demands are depleting the aquifers, so there is a greater reliance on surface water withdrawal that further reduces water levels in streams and bayous. Stagnant, shallow water results in hypoxia (dissolved oxygen < 3.0 mg/l), cleared stream banks adjacent to agricultural fields increase water temperatures, and excessive sedimentation further degrades the aquatic environment. The fish community reflects anthropogenic disturbances. Approximately 75% of the total numbers of fish collected in the basin is comprised of tolerant, widespread taxa: mosquitofish, bluegill, red shiner, green sunfish, orangespotted sunfish, and golden shiner (Killgore 2002). However, there are stream reaches in the basin that are less disturbed and support a more diverse assemblage of fishes. Overall, 55 species of fish have been documented in the streams and canals of the basin. These include benthic minnows and darters that prefer stable substrates, wetland species that dominate slackwater and vegetated areas, and exploitable fishes in the larger streams.

5.21 Despite low water problems in the basin, flooding does occur in some reaches during the spring. As part of the comprehensive study of Bayou Meto, flood control alternatives were evaluated that include channel work to increase discharge capacity and different pump capacities at Little Bayou Meto. Hydraulic models and GIS land use classifications were used to determine impacts of the flood control project on the 2-year floodplain. Currently, approximately 158,000 acres are flooded at least once every two years. Depending on reach, cultivated agricultural land and BLH forests are the dominant land use category in the 2-year floodplain. Permanent waterbodies are relatively rare.

5.22 Researchers with Engineering Research and Development Center (ERDC) conducted an extensive survey for freshwater mussels in the Bayou Meto Basin, and the proposed intake location on the Arkansas River in the spring of 2001. More than 1,000 individuals representing 18 species of mussels were collected from the streams and ditches within the Basin. Over 85% of the mussels collected were found at 2 sites in Indian Bayou Ditch, while 13% of the total number was collected from 7 sites in Salt Bayou Ditch. Densities and diversity was low at all sites where mussels were collected, and several bayous were completely devoid of mussels. The high water temperatures and low flows resulting from excessive use of stream water for agriculture, creates conditions unfavorable to freshwater mussels. No threatened or endangered mussels were found in the Basin. The fauna was dominated by *Amblema plicata* and *Quadrula quadrula*; two species which are found in a variety of habitat types (Miller and Payne 2002). The results of the survey are located in Volume 10, Appendix D, Section XIV, Part B.

5.23 Since no significant increase in water withdrawals from the Arkansas River is foreseen for future without-project conditions, fish populations in the River are expected to remain relatively stable. The status of native mussels in the Arkansas River may deteriorate due to the abundance of the non-native zebra mussel. The zebra mussel not only competes with freshwater mussels for food, but it is also known to anchor on the shells of native mussels, which can cause mortality due to impaired movement. Fish and mussel populations within the Basin streams would remain degraded due to the continued depletion of the alluvial aquifer and the subsequent heavy reliance on surface water for crop irrigation. Many of the multi-purpose reservoirs would likely be managed solely for agricultural purposes because of the increasing need to utilize available surface water.

BLH FOREST

5.24 BLH forests of the Mississippi Alluvial Valley have been reduced from approximately 24,690,000 acres historically to less than 4,938,000 acres today (Ducks Unlimited 1994). A net annual loss of 300,000 acres of BLH occurred within the conterminous United States between the 1950's and the 1970's; the greatest reductions during this period occurred in Louisiana, Mississippi, and Arkansas (Frayer et al. 1983). From the mid-1970's to the mid-1980's, almost 900,000 acres of BLH forest were lost to agriculture in the Lower Mississippi Alluvial Plain (Hefner et al. 1994). By 1985, only 875,000 acres of Arkansas' original 8,000,000 acres of BLH forest remained (Arkansas Game and Fish Commission 1988).

5.25 BLH forests are productive in terms of wildlife and commercial forest products; and, when flooded, these forests provide aquatic habitat for fish, waterfowl, and other wetland wildlife. White-tailed deer, swamp rabbits, gray and fox squirrels, wood ducks, and mallards are common game species found throughout this habitat type. These forests also support an abundance of songbirds, small mammals, reptiles, and amphibians. Commercial forest products derived from these woodlands include lumber, veneer, and fuel.

5.26 Approximately 79,000 acres of BLH forests are found within the Bayou Meto General Reevaluation study area. A gradation of BLH types occurs throughout the Bayou Meto Basin. BLH areas are typically inundated for at least some period in the average year, and the differences in species composition reflects the variations in flood events. Baldcypress and water tupelo are the predominant species in forests that are flooded on average of at least 3 months during the year. In areas that typically flood for 1-3 months a year, the predominant tree species are green ash, cedar elm, water hickory, overcup oak, water locust, and swamp privet. The predominant vegetation types in sites that flood for a few weeks to 2 months are sugarberry, American elm, Nuttall oak, willow oak, and sweetgum. Higher elevation BLH areas, where flooding occurred up to a few weeks during some years, have as their dominant vegetation types water oak, willow oak, cherrybark oak, shagbark hickory, and sweetgum.

5.27 Impoundments, levees, and water control structures both within the Bayou Meto WMA and in the surrounding region are designed to increase the available habitat for ducks and duck hunting. However, many of these impoundments have not been managed to ensure the health of the BLH, and often the trees show evidence of stress or have already died. A study was conducted on the health of the BLH within the Bayou Meto WMA (Heitmeyer 2004), which documented large areas of stressed and dead or dying timber. The same study also included recommendations on improving hydrology to alleviate water related stress.

5.28 A rich diversity of animals occurs in BLH habitats (Volume 10, Appendix D, Section III). As a response to the dynamic nature of flooding and resource availability, most of the animal species tend to be mobile, omnivorous or seasonally variable in diet. Many are at least partly arboreal.

5.29 Under future without-project conditions, the "swampbuster provision" of the 1985 Food Security Act should deter the clearing of additional BLH acreage for agricultural purposes. Additional cleared land would likely be converted to wetlands under the CREP, CRP, and WRP. Some BLH would continue to be stressed due to the wetter hydrologic regimes created by control structures and impoundments.

WETLANDS

5.30 Wetlands are defined by Title 33, Part 323 CFR, dated 22 January 1977, Regulatory Program of the Corps of Engineers:

> "Wetlands means those areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions."

5.31 There are approximately 89,000 total acres of wetlands within the project boundaries, consisting of 79,000 acres of BLH forest and approximately 10,000 acres of farmed wetlands.

5.32 Under future without-project conditions, the "swampbuster" provision of the 1985 Food Security Act should limit the conversion of wetlands to agricultural lands. Moreover, potential cleared land acquisitions and reforestation under CREP and CRP could increase the amount of BLH forest wetlands within the study area.

HERBACEOUS WETLAND/PRAIRIE COMPLEX

5.33 Heitmeyer et al. 2002 (see Volume 10, Appendix D, section III) is the primary source for the following information. Herbaceous wetland/prairie complex historically occurred on most of the Prairie and Deweyville terraces. The largest patch of HWPC in the Bayou Meto Basin was a relatively narrow area called the "Long Prairie". This type of habitat is wetter than the prairies found in western and northern regions of the United States and included herbaceous wetlands and marsh. Many relatively water tolerant grasses, forbs, and shrubs were found in this complex. The dominant vegetation included switchgrass, gamma grass, prairie cordgrass, mallow, little and big bluestem, Indian grass, splitbeard, coneflower, bitterweed, and scattered shrubs including sassafras and sumac. Wet prairie or herbaceous wetlands were of two general types, one being isolated depressions or "potholes" of perhaps ¼ acre to several acres in size and the other being relict stream channels ranging from less than a hundred feet wide to 150 yards wide and up to tens of miles long. Typical depth was a few feet. This habitat supported a highly diverse animal population.

5.34 Nutrient cycling and food webs in drier areas of the HWPC are dominated by grasses and forbs and processes tend to conserve nutrients. Nutrient cycling is relatively rapid in these areas and causes nutrients to be greater in soils than in biomass. Export of nutrients from HWPC 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, relatively flat high terrace topography, larger interconnected "patches" of grassland, and rapid cycling of grass litter and detritus. Nutrient cycling in HWPC depends on periodic disturbances such as grazing by herbivores and fire.

5.35 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. 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 Pre-settlement period. It is likely that HWPC in the region were gradually shifting from a grasses and forbs to a tree-dominated setting. Consequently, the regular presence of fire was critical to maintain grass and deter invasion by trees. The HWPC was not resilient to changes in land use that occurred after European settlement.

5.36 Under future without-project conditions, there would continue to be little or no HWPC habitat within the project boundaries.

WILDLIFE

5.37 The Southern Mississippi Flyway (i.e., Arkansas, Tennessee, Mississippi, Alabama, Louisiana) winters approximately 26-30% of the North American mallard population (Nichols and Hines 1987). Many portions of the Mississippi Delta north of the Gulf Coast are important wintering areas for mallards and wood ducks (Reinecke 1981); of the almost 1,500,000 mallards that winter in the Mississippi Delta, approximately 1,100,000 congregate in Arkansas (Bellrose 1979). One of Arkansas' most renowned natural resources is the migratory and resident waterfowl that utilize the state's wetlands and agricultural fields for resting, feeding, and brood rearing.

5.38 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 (Arkansas Game and Fish Commission unpublished records). The North American Waterfowl Management Plan established broad goals for nationwide restoration of waterfowl habitat. The Lower Mississippi Valley Joint Venture established habitat goals for the lower valley and by state to achieve the regional share of waterfowl restoration needs. The Joint Venture established a goal of 56,812,750 (duck-use-days) DUDs for naturally flooded habitat in the Mississippi Alluvial Valley of Arkansas. Assuming an average value of 477 DUDs/acre for BLH, 119,104 acres of reforestation would be needed to fully meet this goal.

5.39 As noted by Heitmeyer et al. 2002, many species of fish and wildlife are now extirpated from the Bayou Meto Basin. Populations of bison, mountain lion, prairie chicken, red wolf, and passenger pigeon were recorded by early explorers and naturalists. Although black bears were common in the Basin in the late 1800s, they are now restricted to the southern end of the Basin where large blocks of BLH are present. As these species were eliminated, other opportunistic animals moved in. Among these are the armadillo and nutria.

5.40 Many of the birds that utilized higher elevation BLH and other terrace habitats have declined precipitously. Among these species are the black vulture and Swainson's warbler. Birds that require large blocks of BLH have also seen their numbers decline. The cerulean warbler and Mississippi kites are examples of this type of examples of these.

5.41 Waterbird numbers in the Basin are also significantly reduced from historic levels due to the loss of large areas of wetlands, stream, and riparian habitats. Numbers of waterfowl and some marsh birds (king rail, American bittern, and short-billed marsh wren) tend to increase initially in areas when rice production increases, they then tend to decline over time (Heitmeyer et al. 2002).

5.42 Raptors, wading birds, and shore birds are among the nongame birds inhabiting the study area. Common raptors include the red-tailed hawk, red-shouldered hawk, northern harrier, turkey vulture, black vulture, barred owl, screech owl, and American kestrel. The great blue heron, little blue heron, yellow-crown night heron, green heron, cattle egret, common egret, and snowy egret are wading birds indigenous to the Bayou Meto Basin. Over 20 species of shore birds utilize the study area (Volume 10, Appendix D, Section XI); some of the more common species are the killdeer, long- and short-billed dowitchers, common snipe, pectoral and least sandpipers, and lesser and greater yellowlegs. Shore birds feed on invertebrates found in shallowly flooded crop fields and wetlands and in the mudflats of reservoirs and other impoundments. The belted kingfisher; ruby-throated hummingbird; pileated, red-bellied and downy woodpeckers; Chuck-will's-widow; common nighthawk; and numerous passerine species inhabit the study area as well.

5.43 Eastern cottontail and swamp rabbits, squirrels, and white-tailed deer are important game mammals within the study area. These animals are common throughout much of Arkansas and many other southern states. The swamp rabbit is a close associate of wetlands and riparian habitats; therefore, it is found only along the streams and drainages within the study area. The eastern cottontail rabbit, on the other hand, is widely distributed throughout the study area, wherever protective cover is offered. Fox and gray squirrels are forest species and are, therefore, restricted to the study area woodlands. Deer are closely associated with woodlands, but are not as confined to them. Deer frequently venture into agricultural fields to feed. Other mammals found within the study area include red and gray foxes, mink, muskrat, beaver, spotted and striped skunks, bobcat, and coyotes.

5.44 In the absence of federal action, no permanent clearing of upland habitat is anticipated; and conversion of wetlands to agricultural land should be severely limited due to the "swampbuster" provision of the Food Security Act. Moreover, potential cleared land acquisitions and reforestation under CREP and CRP could increase the amount of available wildlife habitat within the study area.

STATE AND FEDERAL HOLDINGS

5.45 The Bayou Meto WMA located in the southern part of the Bayou Meto Basin contains the largest tract (32,000 acres) of BLH in the basin. The Bayou Meto WMA provides both consumptive and non-consumptive recreational opportunities. This area is one of the most significant waterfowl resources along the North American Flyway. The WMA offers some of the best duck hunting in the state, and averages 350 duck hunters daily throughout the season. Deer, squirrel, turkey, and raccoon hunting also are popular on the WMA. There are six lakes, with a total area of 1,080 acres, present in the WMA. Fishing for crappies is excellent in Cox Cypress Lake, and both Cox Cypress and Wrape Lakes are stocked yearly with catchable-size channel catfish.

5.46 The Arkansas Natural Heritage Commission (ANHC) owns or has conservation easements on ecologically important natural areas that it protects and manages such as the 455-acre Smoke Hole Natural Area in Lonoke County. This Natural Area consists of mature water tupelo swamp that contains trees that are up to sixty inches in diameter. Two Prairie Bayou runs through this holding.

5.47 The University of Arkansas at Pine Bluff (UAPB) and the National Water Management Center developed an 871-acre farm in Lonoke County into a Small Farms Outreach, Wetlands and Water Management Center of Excellence. The farm Offices, laboratories, and about 86 research ponds are located on this property.

5.48 Under future without project conditions, the Bayou Meto WMA, the Smoke Hole Natural Area, and the UAPB Lonoke Research Farm would likely maintain their current boundaries and status.

ENDANGERED AND THREATENED SPECIES

5.49 The bald eagle (Haliaeetus leucocephalus) and interior least tern (*Sterna antillarum*) are federally listed threatened species that utilize the study area. Life history, habitat preference, distribution, and various other information regarding the Interior least tern and bald eagle were obtained, in part, from their respective recovery plans (Bagley et al. 1984 and Murphy 1984). The ivory-billed woodpecker, a species thought to be extinct until recently, is thought to inhabit BLH habitat approximately 30 miles from the eastern-most edge of the project area.

Bald Eagle

5.50 The bald eagle received protection as an endangered species below the 40th parallel in 1973. In 1978, the bald eagle was listed as endangered throughout the conterminous United States except in Oregon, Washington, Minnesota, Wisconsin, and Michigan where it was listed as threatened. The status of the bald eagle was upgraded to threatened throughout the conterminous United States in 1996.

5.51 The bald eagle is a large raptor that occurs primarily near sea coasts, rivers, and large lakes. This bird is an opportunistic feeder; food consumed by the bald eagle ranges from fish to other birds to carrion, with fish comprising the major portion of its diet. Catfish are a favorite food in the Southeast; but other fish, coots, gallinules, waterfowl, and turtles are also among the food items taken by bald eagles.

5.52 Bald eagles begin nesting in the Southeast in early September. Nests are built near (less than two miles) water in living pines or baldcypress. Egg laying begins in late October and peaks in late December. Clutches usually consist of one to two eggs but sometimes contain as many as three. Incubation begins from October to March and is completed in approximately 35 days. Fledging is completed in 10 to 12 weeks; however, parental care may extend for four to six weeks beyond fledging.

5.53 Historically, the bald eagle nested throughout the Coastal Plain of the Southeast and along major rivers and lakes. In Arkansas, bald eagle nests were scattered along the Mississippi and Arkansas river valleys until the early 1950s. The Arkansas Natural Heritage Commission has reported the occurrence of a bald eagle nest in a greentree reservoir located approximately six miles east-northeast of Stuttgart, Arkansas; and two mature eagles were observed in the immediate vicinity of the nest. However, the bald eagle is primarily considered a transient species within the study area, resting and feeding along the Arkansas River during its winter migration (Jason Phillips, U.S. Fish and Wildlife Service, pers. comm.; Craig Uyeda, pers. comm).

5.54 The human population is growing tremendously in the Southeast, resulting in massive land alterations. Rapid and extensive development of eagle habitat is the most significant factor adversely impacting bald eagles in the Southeast. However, manmade reservoirs represent a substantial amount of new eagle habitat. At present, reservoirs are primarily providing wintering and non-nesting habitat; but they are gradually being used more by nesting eagles.

5.55 The shooting deaths of bald eagles has long comprised a large percentage of the annual mortality. However, deaths attributed to shooting have been declining. From 1961-65, 62% of bald eagle deaths were due to shooting. From 1975-81, only 18% of the deaths were attributed to shooting.

5.56 Environmental contaminants caused the most dramatic declines in eagle populations nationwide. The insecticide DDT and its metabolites inhibited calcium deposition, which resulted in the thinning of eggshells and a corresponding decrease in reproductive success. However, eagle productivity has been recovering since a ban was placed on DDT in 1972.

5.57 Under future without-project conditions, no significant changes are anticipated for the Arkansas River or adjacent woodland corridor that would impact the bald eagle. Therefore, the status of the bald eagle in the study area should remain similar to existing conditions.

Interior least tern

5.58 The interior least tern received protection under the endangered species act on June 27, 1985. 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.

5.59 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. 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.

5.60 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 within wide unobstructed river channel. The least tern also utilizes artificial habitats such as sand and gravel pits and dredge spoil islands for nesting (Sidle and Harrison 1990). Large populations of interior least terns have been observed on sand bars along the lower Mississippi River (John P. Rumancik, Jr., Memphis District Corps of Engineers, personal communication).

5.61 Channelization, irrigation, and the construction of reservoirs and pools have contributed to the elimination of much of the tern’s sandbar nesting habitat in the Missouri, Arkansas, and Red River systems. The result of these actions was the replacement of the wide, braided river channels that the terns preferred for nesting with single narrow navigation channels.

5.62 The demands navigation and power are unpredictable and flows can fluctuate greatly. Flow regimes differ greatly from historic regimes. High flow periods may now extend into the normal nesting period, thereby reducing the quality of existing nest sites and forcing the terns to initiate nests in poor quality locations.

5.63 Under future without-project conditions, no significant changes are anticipated for the Arkansas River that would impact the interior least tern. Therefore, the status of the interior least tern in the study area should remain similar to existing conditions.

Ivory-billed woodpecker

5.64 The ivory-billed woodpecker was considered to be an extinct species until March of 2005 when their presence in southeastern Arkansas was confirmed. It is one of the world's largest woodpeckers, averaging 20 inches in length, with a wingspan of 30-32 inches. The ivory-bill is distinguished from the smaller pileated woodpecker by the white patch on its folder wings when perched. The male has a prominent scarlet crest, while the female has a black crest. The bill of both sexes is ivory colored.

5.65 Historically, nesting would begin in early to mid-February in the southern parts of the range and slightly later in the northern portion. It is believed that ivory-billed woodpeckers mate for life, with clutches of eggs usually numbering three. Both parents incubate and raise the young until the young are fledged at the end of the season. It is estimated that a mating pair of ivory-bills need approximately six square miles of mature forest as habitat.

5.66 Nests are excavated in either dead trees or the dead portions of live trees (Tanner 1942 and Bendire 1895), generally under a broken branch or limb which accelerates the decay process, allowing easier excavation (Jackson 2002). Nest openings are generally oval, 4-6 inches in size, and 40 feet or higher above the ground. Tanner (1942) reviewed reports that indicated at least 12 different species of trees were used for nesting, including sweet gum, bald cypress, Nuttall oak, overcup oak, and red maple.

5.67 Ivory-billed woodpeckers were reported to feed on beetle populations found in recently dead trees (Tanner 1942). Often these trees had died as the result of flooding or storms in the Mississippi delta or fire damage in pine forests of Florida (Jackson 1988). Allen (1939) indicated that the species was also observed feeding on ground dwelling insects. Tanner (1942) reported that ivory-bills fed primarily on sweet gum, Nutall's oak, and to a lesser extent on sugarberry in the Singer Tract in Louisiana, while Dennis (1948) observed that the Cuban population fed on insects infesting pine trees. Foraging by birds observed in the U.S. occurred on trees greater than 11.8 inches in diameter over 85% of the time (Tanner 1941) while those in Cuba were usually observed "barking" small pine trees (Dennis 1948).

5.68 Records indicate that the ivory-billed woodpecker existed in at least four states (Tanner 1942), but Jackson (2002) suggested that they were historically present in at least 12 southern states. Breeding pairs of ivory-bills may require at least 6 square miles of uncut forest (Tanner 1942), although this appears to be based on limited observation. Although research to date has not yet been sufficient to determine the existing population size of ivory-billed woodpeckers, further investigations will determine whether breeding pairs exist in the area of the Cache River National Wildlife Refuge of eastern Arkansas, where the 2004 sightings occurred. Fitzpatrick et al. (2005) noted that all the sightings may be of one male bird, which may or may not be part of a breeding pair. No nesting holes have yet been observed, although the size and remoteness of the forest makes discovery problematic.

5.69 Prior to 2004, the last confirmed sighting of the ivory-billed woodpecker was over 50 years ago, although unconfirmed sightings have been reported since then. Due to its size and habits, large areas of mature trees are thought to be required for sustained survival and successful reproduction. Loss of bottomland hardwood habitat, resulting from large scale tree harvesting and draining of swamps over the past 150 years, likely resulted in the severe decline in population size. Jackson (2002) suggested that the ivory-billed woodpecker population was never large, and Allen and Kellogg (1937) suggested that the sedentary nature of the birds may have isolated populations from one another.

5.70 Under future without-project conditions, no significant changes are anticipated for the Bayou Meto Basin that would impact the ivory-billed woodpecker. Therefore, the status of these species in the study area should remain similar to existing.

ARKANSAS SPECIES OF SPECIAL CONCERN

5.71 Arkansas lists 13 species of special concern that are known to inhabit the project area. There are four birds (Swainson's warbler, yellow crowned night heron, common moorhen, and the purple gallinule), six species of plants (corkwood, southern rein orchid, prairie gentian, powdery thalia, prairie evening primrose, and the rare sedge, *Carex bulbostylis*), two reptiles (Graham's crayfish snake, and the western chicken turtle), and one fish (shorthead redhorse). The bird species generally prefer wetlands habitats; two of the plants inhabit prairie type environments, while the remaining species prefer wetlands. Both reptiles prefer habitats around sluggish streams or ponds, while the fish is more tolerant of a variety of flow regimes.

5.72 Another bird, the king rail, is listed by the ANHC as a species of special concern. However, breeding of this species has not been documented in recent decades. The king rail historically occurred in the project area, and breeding of the species was recorded as recently as the 1950's. The ANHC considers protection and restoration of the king rail a high priority.

5.73 Under future without-project conditions, no significant changes are anticipated for the Bayou Meto Basin that would impact these species. Therefore, the status of these species in the study area should remain similar to existing conditions.

RECREATION

5.74 The two major recreational activities within the study area are hunting and fishing. The southern portion of Bayou Meto Basin encompasses the Bayou Meto WMA. This WMA contains the largest tract (32,000 acres) of bottomland hardwoods in the basin. The Bayou Meto WMA provides both consumptive and non-consumptive recreational opportunities. This area is one of the most significant waterfowl resources along the Mississippi Flyway. The WMA offers some of the best duck hunting in the state, and averages 350 duck hunters daily throughout the season.

5.75 Deer, squirrel, turkey, and raccoon hunting also are popular on the WMA. There are six lakes, with a total area of 1,080 acres present in the WMA. Fishing for crappies is excellent in Cox Cypress Lake, and both Cox Cypress and Wrape Lakes are stocked yearly with catchable-size channel catfish.

5.76 The uplands, wetlands, and waters of the study area furnish non-consumptive recreationists with opportunities to participate in bird watching, nature photography, hiking, boating, and other activities.

5.77 Under future without-project conditions, the Bayou Meto WMA would continue to provide opportunities for the public to participate in hunting, fishing, and non-consumptive recreational activities. Recreational opportunities on privately owned lands would probably remain similar to existing conditions over the next 50 years.

AGRICULTURAL LANDS

5.78 Agricultural lands comprise approximately 70% (524,553 acres) of the project area and are of major economic significance. Project area farmland contains approximately 506,247 acres of cropland and 18,306 acres of hay fields and pastureland. Currently approximately 107,319 acres of rice, 308,337 acres of soybeans, 81,418 acres of cotton, and 21 acres of corn and milo are being cultivated in the project area. All of this cropland acreage is presently being irrigated. Also, approximately 22,079 acres are now in aquaculture (i.e., catfish and bait fish ponds).

5.79 In the absence of federal action, the availability of groundwater to sustain existing and future agriculture needs is expected to significantly decline as the aquifer is depleted. By 2019 an estimated 64,267 acres of rice, 109,687 acres of irrigated soybeans, 31,546 acres of irrigated cotton, 15,954 acres of baitfish ponds, 999 acres of irrigated corn, and 803 acres of irrigated grain sorghum will be lost due to groundwater depletion. These 222,256 acres are expected to shift to dryland practices, primarily soybeans. This trend is expected to continue through the year 2049 when an additional 38,483 acres of irrigated crops are shifted to dryland practices.

NAVIGATION

5.80 Reservoirs in the upper Arkansas River Basin support navigation and are operated as part of the navigation system to maintain flow. A series of 17 locks and dams, 12 in Arkansas and 5 in Oklahoma, provide navigation from the Mississippi River to the Port of Catoosa near Tulsa, Oklahoma, a distance of about 450 miles. Each of the seventeen locks measures 110 feet wide and 600 feet long. Individual locks have lifts ranging from 14 feet to 54 feet. The locks in the system provide a total lift of 420 feet. The upstream lakes in eastern Oklahoma play a vital role in the system operation. These multipurpose lakes provide for low flow regulation, sediment control, flood control, domestic and industrial water supply, hydroelectric power, recreation, and fish and wildlife habitat.

5.81 Commodity traffic on the Arkansas River amounts to 11.8 million tons with a value of 2.4 billion dollars. Materials currently transported on the River include iron, steel, chemicals, petroleum products, and agricultural products.

5.82 The current operating plan, adopted in 1986, for the McClellan-Kerr Arkansas River Navigation System is not expected to change. Completion of the Montgomery Point Lock and Dam will provide for more efficient system management and operation.

CULTURAL RESOURCES

5.83 Existing information on cultural resources is relatively limited for this project's regional setting and its specific project area. However, insight for the region's cultural history, in general, may be found in work of Nassaney (1994), Rolingson (1998), McNutt (1996), and the Arkansas Historic Preservation Program (AHPP 1993). The Bayou Meto project area, overall, is estimated at ca. 800,000 acres.

Within that total project area, approximately 62,876 acres are estimated to be the *total* Area of Potential Effects (APE) for cultural resources. The APE is viewed as (1) defining the precise spatial limits for this project's existing conditions for cultural resources, and (2) limited to areas directly impacted, potentially, by project activities. Of the 62,876 acres, it is estimated that 19,876 acres relate to an APE related to water delivery and/or flood control construction right-of-ways, and 43,000 acres correspond to an APE where wildlife mitigation and/or waterfowl management areas would be acquired or otherwise developed. The 43,000 acres does *not* include state lands such as the Bayou Meto Wildlife Management Area where cultural resources APE might extend, but cannot be estimated at present. Returning to the total cultural resources APE of 62,876 acres for this project, cultural resources inventory from field survey specific to this EIS has occurred for 9,721 acres within the water delivery/flood control APE (19,876 acres total). The 9,721 acres of field survey was in an area north of U.S. Highway 79, and it inventoried 216 archeological sites and nine historic cemeteries (Panamerican Consultants, Inc. March 2002 "Management Summary for the Indian Bayou Cultural Resources Survey). Of the 216 archeological sites, 14 sites are interpreted preliminarily to be eligible for listing in the National Register of Historic Places. The ratio of sites and historic cemeteries to the 9,721 acres of field survey to date indicates a substantial number of archeological sites and historic cemeteries yet unidentified may exist in the project's total APE for cultural resources. It is likely that if historic architectural structures of significance remain to be identified, they would be few in number. The NHPA coordination to date for inventory of existing conditions for cultural resources is reflected in the Environmental Effects, Cultural Resources section of this EIS, the summary of Coordination section of this EIS; and Appendix D, Part II, Section C.

Section 122 Items

5.84 Section 122, 1970 River and Harbors Act, Public Law 91-116, necessitate addressing the impacts of each proposed plan upon the following items. The succeeding paragraphs identify these items and briefly explain how they relate to the project-affected area.

NOISE

5.85 The study area is relatively noise free due to its rural setting. Exceptions to this are noises associated with outdoor recreation (e.g., hunting, fishing) and agricultural activities. At times, even in remote parts of the study area, noise levels may be high as a result of these activities. Under future with-and without-project conditions, noise associated with outdoor recreation and agricultural activities should remain similar to existing conditions.

AIR QUALITY

5.86 The air quality in Arkansas for all criteria pollutants for the 1993-95 period was better than the National Ambient Air Quality Standards at all monitoring sites; with the exception of ozone, the measured concentrations were far below that allowed by the standards (John Mitchell, Arkansas Department of Pollution Control and Ecology, pers. comm.).

5.87 Due to its rural setting, air quality within the study area is good to above average. Temporary exceptions to this occur briefly when crop stubble is burned. Air quality is not expected to change under future without-project conditions.

AESTHETIC VALUE

5.88 The Bayou Meto Basin is a diverse and unique area, with landscapes that were formed and shaped by depositional and erosional dynamics of the Arkansas River. Landscape features in the Basin range from upland and herbaceous wetland/prairie terrace in the northeast to a highly interspersed mosaic of currently active drainages, abandoned courses and channels of the Arkansas River in the southeast. There are over 20 oxbow lakes larger than 30 acres in size within the basin. These lakes formed in abandoned channels of the Arkansas River, and support a wide variety of fish, waterfowl, wading and shorebirds, reptiles, and amphibians. The aesthetics of the area are expected to be unchanged under the future without-project conditions.

DISPLACEMENT OF PEOPLE

5.89 Alternative plan impacts as they relate to the displacement of people are concerned with the direct and indirect consequences of plan implementation on areas of existing habitation. An example of a direct plan impact would be those persons forced to move because they inhabit lands required for project construction. An example of an indirect impact would be individuals compelled to move as a result of the decline in agriculture's profitability and its accompanying loss of jobs as the area's aquifer is depleted and irrigation cannot be sustained. Under future without-project conditions, some of the area's residents could be displaced due to loss of jobs associated with a significant reduction of the area's income when the area's aquifer can no longer support widespread irrigation practices.

COMMUNITY COHESION

5.90 The cultural heritage of the project area is linked directly to a rural way of life based on agriculture. The preservation of this lifestyle is based on the continued existence of the small farm and activities that support an agricultural based economy. Under future without project conditions, there would be a gradual conversion of some small farms to larger farm complexes, but the base economy of the area would remain dependent on agriculture.

LOCAL GOVERNMENT FINANCE, TAX REVENUES, AND PROPERTY VALUES

5.91 The area of local government finance is concerned with items such as tax base, property values, and tax revenues. Each of these, and other items, are important because they impact the financial condition of local government units. Financial soundness is important because it often determines the level and quality of the necessary public services provided by local governments. Under future without-project conditions, there would be a significant decrease in property values on cropland and a corresponding drop in tax revenue as the area's lands can no longer support irrigation practices due to the loss in irrigation capacity of the area's alluvial aquifer.

DISPLACEMENT OF BUSINESSES AND FARMS

5.92 Alternative plan impacts as they relate to the displacement of businesses and farms are concerned with the direct and indirect consequences of plan implementation. An example of a direct impact would be those forced to move because they are located on land required for project construction. An example of an indirect impact would be businesses or farms compelled to leave as a result of the loss in area income as the area's aquifer is depleted and irrigation cannot be sustained. Under future without-project conditions, many of the area's businesses and farms could be displaced when the area's aquifer can no longer support widespread irrigation practices.

PUBLIC SERVICES AND FACILITIES

5.93 The area of public services and facilities is concerned with the ability of local government to provide the basic public services; e.g., education, police protection, and roads and bridges. Under future without-project conditions, the ability to provide such services would be greatly hindered. The area's tax base is expected to be greatly decreased when the alluvial aquifer is depleted causing a sharp drop in property values. This would cause a corresponding drop in tax revenues needed to provide these services.

COMMUNITY AND REGIONAL GROWTH

5.94 Growth in the communities within the project area is directly related to agriculture and agriculture related production. Agricultural production is expected to decrease significantly under future without-project conditions when the alluvial aquifer can no longer support irrigation. The drop in the value of this production would mean significant declines in the region's economy with an accompanying decrease in urban and rural population.

EMPLOYMENT

5.95 The area's employment is concentrated in trade, manufacturing, and agriculture. Under future without-project conditions, there would be a significant decrease in agriculture and agriculture related employment as a result of the decline in agriculture's profitability and its accompanying reduction in income as the area's aquifer is depleted and irrigation cannot be sustained. There would also be a significant reduction in employment not directly associated with agriculture due to the secondary effects of the loss in agricultural income to the area's economy.

6. ENVIRONMENTAL CONSEQUENCES

6.1 This section describes the effects of each detailed plan on the previously discussed significant resources and serves as the source of information for Table 4-1, Comparative Impacts of Alternatives, in Section 4. Wetland impacts associated with FC2A and FC3A were initially assessed strictly through the use of hydraulic models and GIS mapping. Pre-project and post-project wetland scenes were generated that approximated jurisdictional wetland boundaries. The acreage differences between the pre-project scene and alternative wetland scenes were used as estimates of the areal extent of wetland impacts for each alternative. FC2A had relatively limited hydrologic impacts in comparison to FC3A because FC3A included a 1,000-cfs pump station on Little Bayou Meto. During the review of impact evaluation results, the inter-agency team discovered that adverse impacts to BLH forests were likely overstated. The inter-agency team determined that additional analyses were needed to identify the actual hydrologic effects of FC3A. FC3A was selected for reevaluation because it included the 1,000-cfs pump station and would have a relatively greater effect on hydrology than FC2A. Also, the 1,000-cfs pump station would be required to provide the necessary water management capabilities identified for the Bayou Meto WMA (see Section III, Waterfowl Management and Restoration Plan, Main Report); therefore, implementation of the waterfowl management (WM) plan could be expected to have hydrologic effects similar to FC3A.

6.2 Heitmeyer and Ederington (2004) found that many BLH tracts originally shown to be adversely affected by FC3A were actually being stressed from excessive flooding and inadequate drainage; this study concluded that these areas of BLH would benefit from FC3A. Also, most of the privately owned BLH areas shown to be impacted by FC3A are greentree reservoirs that are enclosed by levees and hydraulically manipulated for waterfowl hunting. These private greentree reservoirs would not be affected by FC3A. The Heitmeyer et al. (2004) report is included in Volume 10, Appendix D, Section XVI.

6.3 As a follow-up to the Heitmeyer and Ederington (2004) study, Klimas and Blake (2005) performed a hydrogeomorphic (HGM) assessment of the potential hydrologic effects of FC3A on wetlands; this entire report can be found in Volume 10, Appendix D, Section XVIII. The wetland impacts and mitigation requirements, as identified in the HGM analysis, are presented in this EIS for all plan alternatives containing the 1,000-cfs pump station, i.e., FC3A, WM plan, and the selected plan. However, wetland impacts associated with FC2A were not quantified.

6.4 In cases where impacts could not be assessed quantitatively, qualitative assessments were made based on available information and professional judgment. As per Public Law 91-190, decision makers must "*include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on –*

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."

These requirements are considered throughout the Environmental Consequences section of the EIS.

Significant Resources

RIVERS AND STREAMS

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.5 Project-induced impacts to the Arkansas River would be confined within the reach from the David D. Terry Lock and Dam (River Mile 108) downstream to approximately River Mile (RM) 31. Maximum stage reductions would occur during summer/early fall when the river is low and irrigation demands are highest; the maximum stage reduction, compared to existing conditions, would be approximately one foot or less during this period. However, it is important to note that daily variability in river stages is greater than predicted project changes in river stages. Changes in stage are almost immeasurable during high-flow periods.

6.6 This plan has a delivery system that would utilize the existing tributary streams, man-made ditches, and pipelines to distribute irrigation water. Supplemental water would be provided to the streams and ditches, and pools would be maintained within these streams through the installation of numerous weirs. Minimum pool elevations would be maintained even during periods of water shortfall (i.e., irrigation demand exceeds water supply capability) in order to protect aquatic resources and ensure efficient operation of the irrigation system. This plan would benefit fisheries within the tributary streams (Volume 10, Appendix D, Section XIV, Part A).

<u>Water Supply Alternative 4B/ Flood Control Alternative 2A</u>

6.7 Impacts to the Arkansas River are similar to Alternative 4B/3A. The benefits to the tributary streams from additional water would be similar to those in Alternative 4B/3A. The disruptions of aquatic habitat would be smaller in this alternative because there would be no need to alter streams associated with the flood control pump station.

<u>Waterfowl Management Plan</u>

6.8 The effects of this plan on rivers and streams would be positive. The 92 drop-pipe structures that are proposed for the recommended water-supply plan would work in concert with the 2,643 acres of riparian buffer to significantly reduce the amount of sediment entering project area streams. Also, over 36,000 acres of cleared land would be restored to forest, riparian buffer, and herbaceous wetland/prairie complex; and moist-soil habitat would be created on 240 acres of cleared land. Therefore, the WM Plan could take a significant amount of land out of crop production; and this could significantly decrease the amount of pesticides entering project area streams and ditches.

<u>NED/ WM –Selected Plan</u>

6.9 There would be no significant impact to the Arkansas River under this alternative. Predicted project related changes in river stages would be within the daily variability of the River. Additional water, minimum pools, and the reduction of sediment through installation of 92-drop pipe structures and the establishment of riparian buffers along Basin streams, would allow for the establishment of stream characteristics that more closely mimic those found historically.

GROUNDWATER

<u>Water Supply Alternative 4B/ Flood Control Alternative 3A</u>

6.10 Annual withdrawals from the aquifer would be limited to the long-term sustained yield (148,565 acre-feet), which would allow recharge. It is likely that the state of Arkansas would begin limiting annual withdrawals to the sustained yield prior to year 2015. Even without state regulation of groundwater withdrawals, the project would extend the life of the aquifer and allow for recharge during years when sufficient surface water is available to replace groundwater demands.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.11 Impacts would be similar to Alternative WS4B/FC3A.

Waterfowl Management Plan

6.12 Restoration of large tracts of land would reduce agriculture related chemical leaching into the ground water and would aid in recharge of the aquifer.

NED/ WM –Selected Plan

6.13 Under this alternative annual withdrawals would be limited to the long-term sustained yields, allowing the aquifer to recharge, while the restoration of native vegetation on large tracts of farmland would reduce agricultural chemical leaching, thereby improving the quality of the groundwater. This alternative would provide significant protection to the alluvial aquifer.

WATER QUALITY

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.14 Future conditions with the project in place insure that water would be available for irrigation purposes and that there would be no significant changes in farming practices. Because water from the Arkansas River would be used in the delivery system, it was necessary to analyze the water quality of the Arkansas River in order to determine impacts, if any, to farmland and receiving streams. 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. It is predicted that all of the canals would receive some sediment deposition. However, most of the imported sediment would be dropped in the inlet channel. For these reasons, there would be no detectable sediment drop in receiving streams.

6.15 Although the Arkansas River water would contain some suspended sediment, this plan should not induce any significant sedimentation in receiving streams. The incorporation of features such as riparian buffer strips and drop pipe structures would decrease the level of sediment entering Basin streams and ditches.

6.16 Measures to minimize impacts on water quality would be incorporated into project construction, and National Pollution Discharge Elimination System permits would be sought as appropriate. Construction of the pumping station inlet channel and subsequent maintenance dredging would cause short-term increases in stream turbidity within a localized section of the Arkansas River; these activities should not have significant adverse impacts on fish.

6.17 Non-point agricultural run-off would not increase over existing conditions and could be reduced because of buffer strips and recovery efforts. Because many of the streams become stagnant during periods of heavy agricultural usage, the introduction of additional water from the Arkansas River would improve water quality by increasing the level of dissolved oxygen; reducing temperatures; diluting pollutants, and generating flow regimes similar to conditions prior to agricultural withdrawal.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.18 Project effects would be similar to Alternative WS4B/FC3A.

Waterfowl Management Plan

6.19 The water quality in the project area streams and ditches could be significantly improved by the WM Plan. The riparian buffers and drop-pipe structures would reduce sedimentation, and the amount of pesticides entering the streams and ditches would be reduced by forest and HWPC restoration and by the creation of moist-soil habitat.

NED/ WM –Selected Plan

6.20 Because many of the streams become stagnant during periods of heavy agricultural usage, the introduction of additional water from the Arkansas River would improve water quality by increasing the level of dissolved oxygen; reducing temperatures, diluting pollutants, and generating flow regimes similar to conditions prior to agricultural withdrawal. The riparian buffer strips and drop pipe structures would reduce sediment and other non-point source agriculture pollutants to Basin streams.

AQUATIC RESOURCES

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.21 Project impacts on aquatic resources were addressed in ERDC reports, *Bayou Meto Water Supply and Flood Control Project, Fish Evaluation* (Killgore et al. 2005) and

Effects of Channel Modification and Flow Augmentation on Freshwater Mussels in the Bayou Meto Area, Arkansas (Miller and Payne 2002), Volume 10, Appendix D, Section XIV, Parts A and B, respectively. Over 90 miles of bayous and ditches would receive irrigation water diverted from the Arkansas River, and over 100 miles of new canals would be constructed as distributaries. Habitat models developed from field data collected over several years in the basin predict substantial benefits from irrigation water to fish habitat. Species richness (number of species collected at a site) is expected to double or triple in some reaches, which is a similar trend documented by models developed for the Grand Prairie Area Demonstration Project. Additional benefits from weirs, channel work, and storage reservoirs would also be accrued as part of the irrigation project. Over 60 weirs would be constructed to maintain minimum pool elevations, and channel work to increase flow capacity would remove unconsolidated substrates that degrade fish and benthic habitat. Both of these engineering features have been shown to improve species richness and abundance of fishes in delta streams. On-farm storage reservoirs would be constructed throughout the basin, and depending on project alternative, would result in additional lacustrine habitat.

6.22 Diversion of water from the Arkansas River to an irrigation delivery system in the Basin would increase water volume in streams, ditches, and canals. Water would be pumped from the Arkansas River into a 30-40 acre reservoir for regulating flow to a central canal and a system of distributaries. There is a potential of larval fish entrainment during pumping, but ichthyoplankton collections in 2000 and 2001 in the Arkansas River indicate that the risk is low (<3.0%) during the peak irrigation season (summer). Most of the larval fish susceptible to entrainment are widespread, tolerant taxa including gizzard shad and drum that comprised over 90% of the ichthyoplankton collected.

6.23 Based on field collections from 2000 to 2002, floodplain larval fish fauna is diverse (over 20 taxa), consisting of river species that spawn in flooded forests (buffalo, gar), rear in floodplain waterbodies (sunfish, other suckers, minnows), and other wetland specialists that are permanent inhabitants of floodplains and backwaters (pirate perch, silversides, flier, topminnows, certain minnow and darters). Mitigation of impacts would occur through reforestation within the 2-year floodplain to ensure adequate habitat for spawning and rearing. In addition, riparian buffer strips would be established along streams and ditches. Creation of permanent floodplain pools for fishes and amphibians are also restoration techniques that have measurable benefits to the aquatic environment and would be part of the microtopography portion of the mitigation and restoration components of the project.

6.24 Zebra mussels are present in the Arkansas River and are likely to be brought into basin streams and ditches by this project; live specimens were found in Plum Bayou, a stream that is used for irrigation purposes near the project area. However, ERDC investigators deem it unlikely that this species would survive in streams and bayous in the project area for long periods in high numbers because of inappropriate substratum and water temperatures above 29^{o}C during the summer.

6.25 Hydraulic models and GIS land use classifications were used to determine impacts of the flood control project on the 2-year floodplain. Depending on reach, cultivated agricultural land and BLH forests are the dominant land use category in the 2-year floodplain. Permanent waterbodies are relatively rare. Models predict that this alternative would reduce spawning and rearing habitat by 2,275 acres. Based on field collections from 2000 to 2002, floodplain larval fish fauna is diverse (over 20 taxa), consisting of river species that spawn in flooded forests (buffalo, gar), rear in floodplain waterbodies (sunfish, other suckers, minnows), and other wetland specialists that are permanent inhabitants of floodplains and backwaters (pirate perch, silversides, flier, topminnows, certain minnow and darters). Mitigation of impacts would occur through reforestation of 2,133 acres within the 2-year floodplain. Creation of permanent floodplain pools for fishes and amphibians would be a component of mitigation and restoration that would have measurable benefits to the aquatic environment.

6.26 The freshwater mussel community in the Bayou Meto Basin has been negatively impacted by the diversion of water for irrigation purposes and sedimentation. Low flows are common in many of the area streams, and some become dewatered during the summer months. Very few streams were found to have diverse mussel communities when surveyed by ERDC scientists; most had extremely limited populations. The addition of water from the Arkansas River to Basin streams should have a positive impact on the freshwater mussel community; however, it is expected that many mussels in streams scheduled for enlargement or cleanout would be destroyed. This short-term impact should be offset by a long-term improvement in mussel communities once the project is completed.

6.27 In summary, the ERDC studies indicate that potential adverse impacts of this alternative are considered to be minimal, whereas potential aquatic gains from construction of weirs, increased flows in streams, and creation of canals and storage reservoirs are considered to be substantial.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.28 Impacts to floodplain larval fish fauna would be less under this alternative. The reduction in the number of flooded acres used for spawning and rearing would be less without flood control pump station. Benefits to aquatic organisms resulting from the irrigation component of this alternative would be similar to Alternative 4B/3A.

Waterfowl Management Plan

6.29 The improvements to water quality resulting from the WM Plan would benefit aquatic organisms such as fish and invertebrates. Project area fisheries would greatly benefit from reforestation of riparian buffers, and placement of drop pipe structures would reduce sediment and improve aquatic habitat within the post project two-year floodplain. Benefits to fisheries would amount to 10,289 AAHUs for selected evaluation species if measures are fully implemented.

NED/ WM –Selected Plan

6.30 Significant benefits would be realized by the implementation of this plan. The entrainment of larval fish resulting from the pumping of water from the Arkansas River would be offset by the improved quality and quantity of aquatic habitat available in the Basin. As many as 10,289 AAHUs could be generated by the implementation of this plan. Most aquatic organisms would benefit significantly as a result of the minimum pool elevations, riparian buffer strips, and reduction in non-point source pollutants. Although the freshwater mussel community would be significantly impacted in streams proposed for improvements, over time, the improved quality and quantity of available habitat would be expected to benefit and expand the currently limited mussel community.

BLH FOREST

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.31 The project area currently contains approximately 79,000 acres of BLH forest (includes forested swamp). Under future without-project conditions, the amount of BLH forest could increase substantially within the study area due to probable cleared land acquisitions and reforestation by NRCS programs such as CREP and WRP. Under Alternative WS4B/FC3A, a total of 1,595 acres would be lost as a direct result of constructing the water supply delivery system and flood control features. 1,497 acres would be adversely impacted by hydrologic changes. Habitat Evaluation Procedures (HEP) were used to assess impacts and mitigation requirements resulting from direct impacts, and hydrologic effects and associated mitigation were derived using a hydrogeomorphic (HGM) approach. The HEP and HGM evaluations determined that 1,974 acres and 1,340 acres, respectively, would be required to offset impacts to bottomland hardwoods. Also, it is estimated that 100 acres of bottomland hardwoods would be lost to construction of on-farm irrigation features, resulting in the need to restore an additional 200 acres of bottomland hardwoods. A total of 3,514 acres of bottomland hardwood restoration would be required to fully mitigate the bottomland hardwood impacts associated with this alternative. A total of 4,093 acres of bottomland hardwood restoration would be required to fully mitigate all project impacts.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.32 Construction impacts to BLH and associated mitigation requirements would be less than Alternative WS4B/FC3A. The same number of acres would be impacted by the irrigation component; however, the hydrologic impacts would be significantly reduced without a pump station on Little Bayou Meto. The lack of a pump station in Little Bayou Meto would mean that there would be no relief to the stressed BLH forests within the Bayou Meto WMA. This would eventually change the composition of the forest community to tree species better able to handle the long periods of inundation.

Waterfowl Management Plan

6.33 The amount of BLH forest would be increased by 25,643 acres through implementation of the forest and riparian buffer restoration features.

NED/ WM –Selected Plan

6.34 The combined NED/WM plan would offset the potential negative impacts to BLH forest by restoring 4,093 acres of cleared farmland. The restoration effort would include 2,643 acres of riparian buffers and 23,000 acres of BLH restoration. BLH restoration would include connectors between existing tracts of BLH.

WETLANDS

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.35 Heitmeyer and Ederington (2004) evaluated the hydrologic effects of FC3A on BLH; see Volume 10, Appendix D, Section XVI. It was concluded that 4,073 acres of BLH are currently stressed from prolonged flooding during the growing season. These BLH areas are either within or hydrologically connected to greentree reservoirs; therefore, FC3A would have either beneficial effects or no impact on this BLH acreage because water regimes are artificially managed. At present, approximately 1,561 acres of BLH within greentree reservoirs are relatively healthy and are not stressed from prolonged flooding; FC3A would not have a significant effect on these BLH stands because hydrology within these sites is artificially controlled. However, Heitmeyer and Ederington (2004) found that 1,497 acres of BLH would be negatively impacted by the project and recommended that impacts and mitigation requirements be determined through a hydrogeomorphic (HGM) evaluation.

6.36 Klimas and Blake (2005) evaluated the effects of hydrologic changes on project area wetlands using an HGM assessment (see Volume 10, Appendix D, Section XVIII). This study concluded that 1,340 acres of restored BLH would mitigate adverse hydrologic effects of FC3A. An additional 440 acres of frequently flooded cleared land would have to be restored to BLH to offset hydrologic impacts to an estimated 400 acres of farmed wetlands. Another 35 acres of farmed wetlands would be lost as a direct result of project construction (i.e., displaced by project features); 39 acres of BLH restoration would be required to mitigate this loss.

6.37 Construction of Alternative WS4B/FC3A would also result in the direct loss of approximately 1,595 acres of BLH. The Habitat Evaluation Procedures (HEP) were utilized to assess terrestrial habitat losses and determine compensatory mitigation for direct construction impacts (see Volume 10, Appendix D, Section XIII). Direct construction impacts of this alternative would result in the loss of approximately 3,446 average annual habitat units, requiring BLH restoration on 1,974 acres of frequently flooded cleared lands as mitigation.

6.38 The Section 404(b)(1) evaluation is presented in Volume 10, Appendix D, Section VII. This evaluation covers only the water supply and flood control components; it does not cover on-farm project features (i.e., on-farm water distribution system, irrigation reservoirs, tailwater recovery systems). A farmer would have to apply for and obtain a Section 404(b)(1) permit from the Corps of Engineers in order to construct an on-farm feature in a wetland. The NRCS estimates that approximately 200 acres of wetlands would be lost to construction of on-farm features. Assuming 50% of these wetlands would be farmed wetlands and 50% would be BLH, approximately 300 acres of cleared land would have to be acquired and restored to BLH to mitigate this impact. It is important to note that these are only estimates of the on-farm impacts and subsequent compensatory mitigation. The actual impacts and required mitigation would be determined as each on-farm plan is completed. An inter-agency team will be formed to review on-farm activities associated with the agricultural water supply component of the project. This team will include representatives from key federal and state resource agencies. A team charter and standard operating procedures will be developed and adhered to during planning and construction of on-farm features. The on-farm team will be involved in the review of on-farm plans, formulation of measures to avoid/minimize environmental impacts, assessment of impacts to wetlands and other habitats, determination of appropriate compensatory mitigation (if necessary), and other important work. The Corps of Engineers will establish on-farm criteria, such as wetland impact restrictions on reservoirs, to help limit adverse impacts associated with on-farm construction; and a project-specific Section 404 general permit will be developed for on-farm activities. The on-farm team will fulfill a critical advisory role during both of these endeavors as well. The project sponsor would acquire mitigation land for on-farm wetland losses in manageable tracts. Mitigation land acquisition would proceed at the same rate as construction of on-farm features.

6.39 A total of 4,093 acres of BLH restoration would be required to fully mitigate all wetland impacts.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.40 Project impacts to wetlands would be much smaller under this alternative. Hydrologic impacts would be significantly reduced without a pump station in Little Bayou Meto.

Waterfowl Management Plan

6.41 This plan would restore 23,000 acres of BLH, 2,643 acres of riparian buffer, and 10,000 acres of HWPC; improve hydrology on the ca. 32,000-acre Bayou Meto WMA; and create 240 acres of moist-soil habitat to benefit waterfowl. Creation of buffers, reforestation, and other WM features would substantially improve wetland resources in the project area.

NED/ WM –Selected Plan

6.42 Impacts and mitigation requirements would be the same as for WS4B/FC3A. This combined alternative would also include all of the benefits of the WM plan.

HERBACEOUS WETLAND/PRAIRIE COMPLEX

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.43 Because there are essentially no areas of HWPC extant, this alternative would have no negative impacts to this habitat type. Planting of prairie grasses in the canal rights-of-way in the area that was the historic Long Prairie region would restore approximately 200 acres of native prairie vegetation.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.44 Herbaceous wetland/prairie impacts and benefits would be the same as Alternative WS4B/FC3A.

Waterfowl Management Plan

6.45 This plan could result in restoring as much as 10,000 acres of cleared land to HWPC. Substantial waterfowl benefits would be achieved, and sensitive species such as the king rail would be benefited by this restoration.

NED/ WM –Selected Plan

6.46 As much as 10,000 acres of native HWPC vegetation would be established under this alternative. Herbaceous wetlands would be restored in as much as 2,000 acres tracts, with 8,000 additional acres of adjacent prairie buffer. HWPC restoration would benefit waterfowl, including rare species such as the king rail.

WILDLIFE

6.47 Habitat Evaluation Procedures (HEP) were used to determine the direct construction impacts to wildlife (see Volume 10, Appendix D, Section XIII). HEP employs Habitat Suitability Index (HSI) models that describe habitat requirements for species or groups of species. Measurements of appropriate variables are used to rate habitat on a scale of 0 (unsuitable) to 1.0 (optimal). Generally, a number of evaluation species are chosen for each cover type of interest in the study area. Species may be chosen because of their recreational, ecological, or economic value. For this analysis, six species were selected: the gray squirrel (*Sciurus carolinensis*), mink (*Mustela vison*), barred owl (*Strix varia*), wood duck (*Aix sponsa*), Carolina chickadee (*Parus caolinensis*), and the pileated woodpecker (*Dryocopus pileatus*).

6.48 After the cover types in the study area have been mapped and evaluation species selected, habitat variables contained in the HSI models for each species are measured from maps, aerial photographs, and by onsite sampling. HSI values are then calculated, and the initial or baseline number of HUs is determined for each species. On HU is equivalent to 1 acre of optimal habitat; therefore, the number of HUs for a species is calculated as the number of acres of available habitat times its suitability (HU = HSI x acres).

6.49 HSIs appropriate to each species are determined for each of several target years over the period of analysis, which is 50 years. Estimates of the future habitat conditions are made for the without-project alternative and for each with-project alternative. Impacts on each species are then determined by calculating the difference in AAHUs which are the annualized products of habitat quality, acres, and time between with- and without-project alternatives.

6.50 The HGM approach was employed to assess hydrologic effects on wetlands; the HGM report is contained in Volume 10, Appendix D, Section XVIII. Project area wetlands were grouped into regional subclasses based on functional similarities. Wetland functions, including wildlife habitat maintenance, were assessed for pre- and post-project conditions. HGM represents functions in terms of simple logic models made up of variables that can be measured in the field or derived from existing information. Functional Capacity Indices (FCI's) are generated in a process similar to the HSI's used in HEP. The FCI generated by the assessment model is an index between zero and 1.0, were a value of 1.0 represents a fully functional condition.

<u>Water Supply Alternative 4B/ Flood Control Alternative 3A</u>

6.51 Construction impacts to 1,595 acres of BLH forest would result in the loss of 3,446.4 AAHUs. To mitigate for these impacts, 1,974 acres of cleared land would be restored to BLH forest. The HGM analysis revealed that 1,780 acres of cleared wetlands would need to be restored to BLH to offset wetland losses, including impacts to wildlife habitat, associated with hydrologic changes. Construction of on-farm irrigation features would result in the loss of an estimated 100 acres of bottomland hardwoods and 100 acres of farmed wetlands, requiring 300 acres of BLH restoration to mitigate. In addition, 39 acres of BLH restoration would be needed to offset a 35-acre farmed wetland loss associated with construction of the water supply system. Additional shorebird foraging habitat could be provided if the irrigation reservoirs were constructed with gently sloping sides; this would expose additional mudflats during reservoir draw-downs. In fact, the NRCS, in conjunction with the AGFC, has developed a general design for a sloped reservoir. In comparison to a standard reservoir of equal volume, the sloped design would not displace additional land. The NRCS would promote the sloped-sided reservoir design to area farmers.

<u>Water Supply Alternative 4B/ Flood Control Alternative 2A</u>

6.52 Wildlife losses associated with WS4B/FC2A would be less than WS4B/FC3A. Shore bird foraging habitat would be similar to Alternative WS4B/FC3A.

Waterfowl Management Plan

6.53 This plan would restore 23,000 acres of forest, 2,643 acres of riparian woodland, and up to 10,000 acres of HWPC. In addition, it would create 240 acres of moist-soil habitat to benefit waterfowl and other wetland birds. The 32,000 acre WMA would be substantially improved by providing necessary channel improvements, structures, and a pumping plant to allow area managers the means to import and export water to better manage for waterfowl and other WMA species. The combined plan would provide significant benefits to forest wildlife (10,250 AAHUs), HWPC wildlife (7,328 AAHUs), and waterfowl (21,216,388 DUDs). It would also provide significant benefits to sensitive species, such as king rail, purple gallinule, forest breeding birds, and black bear. One of the most important ecological aspects of the plan is that it would allow reintroduction of the greater prairie chicken.

NED/ WM –Selected Plan

6.54 Wildlife impacts and mitigation requirements would be the same as for WS4B/FC3A. The selected plan would also include all the waterfowl features and benefits of the WM plan.

STATE AND FEDERAL HOLDINGS

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.55 This alternative would provide a means of removing excess water from some portions of the Bayou Meto WMA that has caused stress on the forest. Neither the Smoke Hole Natural Area nor the University of Arkansas at Pine Bluff (UAPB) Farm would be impacted.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.56 There would be no reduction in the stress to the BLH forest in the Bayou Meto WMA under this alternative. Neither the Smoke Hole Natural Area nor the University of Arkansas at Pine Bluff (UAPB) Farm would be impacted.

Waterfowl Management (WM) Plan

6.57 The ecological value of the 32,000-acre Bayou Meto WMA would be greatly enhanced by measures planned for the WMA. Twenty-four features are recommended to improve WMA management; the most significant being a pump station to provide a means of evacuating excess water. Many internal drainage improvements to include channel modifications and control structures are also planned. These features would greatly improve the ability to manage the WMA for waterfowl. The moist-soil feature would be constructed in close proximity to the WMA.

NED/ WM –Selected Plan

6.58 The combination of forest restoration, moist-soil acquisition, and removal of excess water from the stressed forest within the WMA would provide significant ecological and economic benefits to the region. The overall size of the WMA could be increased under the selected plan.

ENDANGERED AND THREATENED SPECIES

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.59 This alternative would not adversely impact the interior least tern, the ivory-billed woodpecker, or the bald eagle. No habitat utilized by these species would be negatively impacted due to this alternative. No significant impacts to fisheries occasionally utilized by bald eagles within the Arkansas River and adjacent oxbow lakes are anticipated.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.60 Impacts would be similar to Alternative WS4B/FC3A.

Waterfowl Management (WM) Plan

6.61 The WM plan would likely benefit the bald eagle by increasing available nesting habitat over time.

NED/ WM –Selected Plan

6.62 Over time, an increase in the available nesting habitat for the bald eagle would be anticipated under the selected plan. There would be no negative impacts to the interior least tern.

ARKANSAS SPECIES OF SPECIAL CONCERN

All Alternatives

6.63 None of the project alternatives would have significant adverse impacts on state species of special concern. Moreover, the WM plan would have a beneficial effect on many of the state species of special concern, including the king rail and purple gallinule (see Section III of Main Report).

RECREATION

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.64 The removal of excess water from some portions of the Bayou Meto WMA would allow the forest to become more productive, thereby allowing for larger populations of both game and non-game species. This would improve the quality of outdoor activities such as hunting and bird watching.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.65 There would be some improvement in habitat for game and non-game species along the Basin streams, allowing for a limited increase in hunting and other outdoor activities.

Waterfowl Management (WM) Plan

6.66 Implementation of the WM plan would significantly increases recreational opportunities in the project area by increasing the available acres for hunting, bird watching, hiking, and other outdoor activities. The drop pipe structures, import water, and riparian buffers would improve the fishing in Basin streams.

NED/ WM –Selected Plan

6.67 The selected plan significantly increases the available acres for hunting, bird watching, hiking, and other outdoor activities within the project area. The improved management capabilities for the Bayou Meto WMA would substantially improve the quality of the current forest, which should increase game and non-game species. Water quality would improve with the implementation of riparian buffer strips, drop pipes, and import water; which would improve the fishing.

AGRICULTURAL LANDS

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.68 Approximately 9,782 acres of agricultural land, including approximately 5,366 acres of prime and unique farmland, would be adversely impacted by this alternative, including 4,416 acres that would be required for construction of on-farm reservoirs. The remainder would be lost due primarily to construction of project features such as canals, ditches, and reservoirs. The importation of water would benefit agricultural lands by ensuring a supply of water during the critical growing period.

Water Supply Alternative 4B/ Flood Control Alternative 2A

6.69 Impacts would be similar to Alternative WS4B/FC3A.

Waterfowl Management (WM) Plan

6.70 The WM plan could take as many about 36,000 acres of cropland out of production. However, much of this acreage would be in the post project 2-year flood plain and still be subject to frequent flooding.

NED/ WM –Selected Plan

6.71 The selected plan would result in taking about 36,000 acres out of production. Because most of the land acquired for restoration would continue to be flooded frequently even after project implementation, it would be less valuable lands. The remaining acres of agricultural land would be provided enough water to continue intensive irrigation of crops, plus a means would be provided to reduce flooding impacts on agricultural lands.

NAVIGATION

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.72 No negative impacts to navigation are expected to occur with implementation of this alternative.

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.73 Impacts would be similar to Alternative WS4B/FC3A.

Waterfowl Management (WM) Plan

6.74 Impacts would be similar to Alternative WS4B/FC3A.

NED/ WM –Selected Plan

6.75 Impacts would be similar to Alternative WS4B/FC3A.

CULTURAL RESOURCES

Water Supply Alternative 4B/ Flood Control Alternative 3A

6.76 The Area of Potential Effect (APE) for cultural resources is approximately 63,000 acres, which includes water delivery and/or flood control construction right-of-ways, and acquisition or other development of wildlife mitigation and/or waterfowl management areas. While the National Historic Preservation Act (NHPA) planning process is ongoing, it is incomplete regarding assessment of effect. One exception to this is that project-related construction work already has occurred for existing levee and upgrade of flow structures at Bayou Meto WMA. Effects here were coordinated with the State Historic Preservation Officer (SHPO) in April 2000. That work included a borrow site, but all impact areas were considered to have existing physical disturbance to the point that no field inventory or other actions were needed (see Summary of Coordination section of this EIS, and letters pertinent to cultural resources). Also, in November 2003 some planning coordination was directed to the SHPO and tribes reference Indian Bayou Cleanout and Wabbaseka Bayou Channel Improvement (see Summary of Coordination section of this EIS, and letters in Appendix D, Section II, Part C). This work was covered by the inventory northward of U.S. Highway 79, as described in the Existing Conditions section. However, these engineering projects did not move forward and they are now proposed elements addressed in the present EIS.

6.77 The overall Identification of Historic Properties (36 CFR 800.3 in NHPA regulations Protection of Historic Properties, as amended effective August 5, 2004) process is ongoing for the total project. Full inventory of cultural resources remains to be completed. As a result, potential effects under the project's alternatives cannot be specified *in detail* for *specific* cultural resources at this time. Inventory would be followed by evaluation ("testing") of sites within the full inventory to determine those that are significant. Effects from specific aspects of the project then would be assessed relative to significant sites. After that, mitigation of adverse effects would be performed. The preferred choice for mitigation would be redesign of construction plans to simply avoid significant sites. If that is not possible, other means would be sought to minimize adverse effects, and otherwise compensate for adverse effects. This may include data-recovery excavation, but additional kinds of mitigative treatment would be considered.

6.78 Regarding compliance with the National Historic Preservation Act (NHPA) and other federal and state laws applicable to cultural resources, the NRCS would be responsible for ensuring compliance for NRCS-led construction, or other NRCS services, implemented under provisions of this PCA. The Memphis District would be responsible for NHPA and related compliance for all other aspects of the project.

6.79 The following activities would occur after the completion of the final EIS and ROD:

1. The Memphis District would conduct additional appropriate actions and consultation under the NHPA and other applicable federal laws, regulations, and guidance, and under pertinent state and local laws.
2. A Programmatic Agreement (PA) is being developed, as requested by the SHPO (see Summary of Coordination section of this EIS, and Appendix D, Section II, Part C, letter dated 18 November 2004). As a valid procedural option for large projects like the present one (36 CFR 800.14), a PA will streamline remaining efforts for completing inventory, evaluating sites, assessing effects, and ensuring mitigation. It will also address the project in its entirety, including design, construction, and operation, and the role of other parties involved in these activities. After a period of reasonable time and effort in seeking to develop this PA, if it appears implementation is unachievable, the Memphis District would revert to basic procedures of 36 CFR 800.

<u>Water Supply Alternative 4B/ Flood Control Alternative 2A</u>

6.80 Cultural resources requirements would be the same as Alternative WS4B/FC3A.

Waterfowl Management Plan

6.81 Cultural resources requirements would be the same as Alternative WS4B/FC3A.

NED/WM –Selected Plan

6.82 Cultural resources requirements would be the same as Alternative WS4B/FC3A.

Section 122 Items

NOISE

All Alternatives

6.83 Noise would increase during initial construction due to equipment operation. Following construction, noise levels should return to normal over most of project area. However, noise would increase in the vicinity of the pump station during operation of the pumps. Totally electric pumps would be used instead of diesel pumps or electrical pumps powered by diesel generators; use of totally electric pumps would significantly reduce noises associated with the pump station.

AIR QUALITY

All Alternatives

6.84 Machinery emissions from mobile sources and airborne dust during construction and maintenance activities would not significantly degrade air quality. It is anticipated that any project-related impacts to air quality would be minor and of short duration.

6.85 The Arkansas Department of Pollution Control and Ecology (ADPCE) does not require air quality permits for mobile sources; therefore, an air quality analysis is not required. Also, the project area is in attainment with air quality standards; therefore, a general conformity analysis is not applicable. Project implementation would not impact the attainment status of any standard. The pump station would use totally electric pumps. Diesel generators would be used to provide electricity to the pump station during electrical power outages; however, these generators would not be used to operate the pumps. It is not anticipated that an air quality permit would be required for the generators. Potential air quality issues would be thoroughly coordinated with the ADPCE once the final design for the pumping system is completed. This project does not include any factors that would jeopardize attainment status for any air quality standard.

AESTHETIC VALUE

All Alternatives Excluding the Waterfowl Management Plan

6.86 Vegetative clearing associated with construction of the project would reduce the aesthetic value of the project area. The construction of canal levees and other features would alter the appearance of the landscape; however, establishment of native vegetation within the canal rights-of-ways should offset adverse impacts associated with construction of project features.

Waterfowl Management Plan

6.87 The WM plan would greatly enhance aesthetic values in the area.

DISPLACEMENT OF PEOPLE

All Alternatives Excluding the Waterfowl Management Plan

6.88 None of the alternatives would result in the displacement of people. However, all of the alternatives could halt or significantly lessen the displacement of the area's residents expected under future without-project conditions. Under future with-project conditions, the area's income would be greatly enhanced over the levels expected without the project, which would prevent the expected loss of area employment.

Waterfowl Management Plan

6.89 The WM plan would cause no displacement.

COMMUNITY COHESION

All Alternatives Excluding the Waterfowl Management Plan

6.90 No issues concerning project implementation have surfaced and there is no organized opposition to the project at this time. Promoting the long-term viability of the area for agriculture should help stabilize the economy and promote community cohesion.

Waterfowl Management Plan

6.91 The WM plan would have no effect on community cohesion.

LOCAL GOVERNMENT FINANCE, TAX REVENUES, AND PROPERTY VALUES

All Alternatives Excluding the Waterfowl Management Plan

6.92 All alternatives would halt or significantly reduce the erosion of property values and tax base expected under future without-project conditions thereby maintaining revenues from taxes to the local government entities.

Waterfowl Management Plan

6.93 The WM plan would have no effect on revenues from taxes to the local government entities.

DISPLACEMENT OF BUSINESSES AND FARMS

All Alternatives Excluding the Waterfowl Management Plan

6.94 No businesses or farms are expected to be displaced either directly or indirectly as a result of any of the alternatives. The area's agricultural income would be greatly enhanced over the levels expected without the project which would maintain the profitability of the area's businesses and farms. All alternatives would stop any displacement of the area's businesses or farms expected under future without-project conditions.

Waterfowl Management Plan

6.95 The WM plan would not negatively effect businesses or farms, although some loss of non-productive farmland would be anticipated.

PUBLIC SERVICES AND FACILITIES

All Alternatives Excluding the Waterfowl Management Plan

6.96 All alternatives would prevent the erosion of property values and corresponding decrease in tax base expected under future without-project conditions. This would maintain the area's ability to provide such basic public services as education, police protection, and roads and bridges.

Waterfowl Management Plan

6.97 The WM plan would have no impact on public services or facilities.

COMMUNITY AND REGIONAL GROWTH

All Alternatives Excluding the Waterfowl Management Plan

6.98 The alternatives would not contribute appreciably to community and regional growth. However, they would prevent the declines expected in the region's economy under future without-project conditions. They would maintain the area's agricultural and agricultural related production, farms and businesses, income, employment, tax base, public services, and urban and rural population necessary to maintain the area's economy at present levels.

Waterfowl Management Plan

6.99 The WM plan would have no effect on community or regional growth.

EMPLOYMENT

All Alternatives Excluding the Waterfowl Management Plan

6.100 All alternatives would prevent the expected declines in agricultural and agricultural related employment along with any decreases in secondary employment expected under future without-project conditions. There would also be some opportunities for new employment associated with project construction, operation, and maintenance.

Waterfowl Management Plan

6.101 The WM plan would not have a significant effect on employment in the project area.

Cumulative Impacts

6.102 Cumulative Impacts (also sometimes termed Cumulative Effects) are "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably fore-seeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions. Cumulative Effects can result from individually minor but collectively significant actions taking place over a period of time." (see 40 CFR 1508.7). Simply put, "Cumulative effects result from spatial (geographic) and temporal (time) crowding of environmental perturbations." (CEQ 1997b:7). Consideration of cumulative impacts long has been required under regulations of the National Environmental Policy Act, but it is a difficult and evolving area of study (CEQ 1997a:29) because it requires (1) assessing effects over larger (i.e. regional) areas, (2) assessing effects over longer periods of time including the past and future, and (3) interpreting interactions among multiple, complex, and dynamic human activities. The perspectives of "resource sustainability" (CEQ 1997b:vi) and ecology are often part of cumulative impacts analysis.

Methodology of Cumulative Impacts Analysis

6.103 Methods included a qualitative look at a discrete area and selected activities, past, present, and future, identified for that area. Preliminary analysis did not include assembling matrices or use of formal models. The NEPA Scoping activities from February 2000 did not result in cumulative impacts becoming a key topic of interest.

Activities are described (below) under major time categories of past, present, and future, along with comments on potential incremental and/or collective impacts on selected aspects of the "human environment" (40 CFR 1508.1, 1508.8) and with a focus on environmental consequences. A number of projects identified below were suggested through communications with the project's interagency planning team (focused largely on natural resources issues). For purposes of contrast among project planning alternatives emphasis is placed on the project dimensions of the no action versus the recommended Combined Plan. Other alternatives (mainly from the NED planning process) not addressed are similar enough that it is believed no substantial variations of cumulative impacts are missed. Potential was considered for contrast among additive versus interactive processes (CEQ 1997b:9).

Geographic Area of Potential Effects for Cumulative Impacts

6.104 A physical area was specified for consideration of cumulative impacts. This was interpreted arbitrarily as a corridor 50 miles wide, centered on the Arkansas River, and with its upstream limits being the city of Little Rock, and its downstream limits being the confluence of the Arkansas/White and Mississippi Rivers. Focus was made on the Arkansas River's main channel because of the obvious hydrologic importance of this water feature relative to all aspects of this multi-purpose project. The total "footprint" area for the overall reevaluation project (agricultural water supply, flood control, groundwater protection and conservation, and waterfowl management) is 765,745 acres. This includes all or part of the following counties: Arkansas, Jefferson, Lonoke, Prairie, and Pulaski. The cumulative impacts area of potential effect (CIAPE, i.e. the 50-mile corridor) described above expands the basic project study area to include portions of Saline, Grant, Cleveland, Lincoln, Drew (minimal portion), Desha, and Phillips (minimal portion) Counties. Regarding the hydrologic watershed (i.e. basin) of Bayou Meto, it largely overlaps the *upper* portion of the CIAPE.

Cumulative Impacts in the Past

6.105 The pre-1900s environment in the CIAPE probably was relatively unchanged over the past 2,000 years (Heitmeyer et al. 2002:11). After 1900 and leading to present times the CIAPE has been heavily impacted by human activities. Within the basic project study area, Heitmeyer and others (2002:47) found 85% of native habitats became replaced by agricultural and urban developments. The same is assumed to be accurate for the CIAPE. Ironically, at the same time the CIAPE sustained such impacts, the longstanding waterfowl/migrant bird flyway across the area thrived. This is in part because rice farming developed after the early 1900s, and the irrigation procedures included seasonal ponding of water that benefited waterfowl. Unfortunately this irrigation also depleted aquifer(s) resulting partly in the need for the present project (declining of aquifer(s) was noted as early as 1927).

6.106 The Arkansas River has sustained modifications, including locks and dams along with dredging and snagging maintenance. While river work to facilitate navigation dates back to the late 1800s, today's system of 17 locks and dams along a 445 mile waterway extending into Oklahoma was authorized for construction in 1946 and completed in 1970. It is associated with the Corps' Little Rock District, and the system is officially named the McClellan-Kerr Arkansas River Navigation System (MKARNS). At least five lock and dams and 12 river ports or terminals (majority at Pine Bluff) are within or near the CIAPE. The lower 10 miles of the MKARNS utilize the channel of the White River, and here the newest lock and dam is very near completion. It is referred to as the Montgomery Point Lock and Dam, a $262 million project first studied by the Corps in 1986. It was added to the MKARN because when Mississippi River levels are low, the White River stage drops correspondingly, and unanticipated low stages required extensive dredging to avoid navigation restrictions. With this new lock and dam, dredging in its locality would be reduced by 90%. However, this locality (associated with the Big Island landform, and the most downstream area of the CIAPE) remains a complex hydrologic system, particularly because at higher stages of water the White River may flow into the natural channel of the Arkansas River, or vice versa, as was the case over the long term past. Current study sponsored by the Little Rock District (see Cumulative Impacts in the Present section, below) likely would provide new insight on the historic river flow dynamics for this lower portion of the CIAPE.

6.107 While most of the basic project area (i.e. the 765,745 acres) is largely rural and less populated by humans, looking at the CIAPE brings in urbanized areas including the Little Rock metroplex at the upper end of the CIAPE, and following that the Pine Bluff area on the western side of the Arkansas River. Along with various respective county seats, the manner in which these urbanized areas of Little Rock and Pine Bluff have impacted the CIAPE, including the basic project area, is largely that of the socio-economic links these cities provided as re-distribution points for agricultural products from the rural areas, sources of manufactured/finished goods, and in providing human resources for the related economic and political management of the CIAPE. These urban areas grew dramatically over the past 150 years in a manner directly related to the exploitation of the natural resources in the CIAPE. Linked to both the use of rural natural resources and points where humans gathered to form communities, small or large, transportation was developed. Steamboat activities on the Arkansas River date to as early as the 1820s, and this mode of transportation never would have occurred if not driven by commercial benefits linked to the resources of the CIAPE and the much larger region affiliated with this technology using what were then termed the Western Rivers of the United States (i.e. the Mississippi River network). The considerable amounts of timber required to fuel steamboats likely contributed to deforestation within the CIAPE. By the late 1800s railroads began to overshadow river transportation. That in turn became dominated, largely, by the trucking industry and Federal highways system (see Present section, to follow). All of these transportation modes left their substantial mark on the CIAPE (note the MKARNS, earlier discussed, continues the legacy of the 1800s commercial river transportation).

6.108 Heitmeyer and others (2002:47-48) list 21 specific ways in which natural resources degradation has occurred within the basic project study area. The reader is referred to Heitmeyer and others (2002; also included as Appendix D to the GRR) for more details of that degradation. Those same factors can easily be seen to be associated with the broader area of the CIAPE, and many involve both additive and interactive processes. Particularly, wetland habitat was impacted heavily and negatively by timber removal phases occurring at various times between the 1800s into recent times within the CIAPE (Heitmeyer and others 2002:40). Other aspects of historic conditions, and their interactive components, are discussed in portions of the GRR's presentations on the background for waterfowl management, water resources background (e.g. impacts to the basic study area's aquifers), and NED-related economic analyses. The depletion of aquifers, earlier commented on, probably is the single outstanding water resources problem for the CIAPE, and this decline has been recognized for at least the past 70 years. In fact, a project to supply water to the Grand Prairie region and Bayou Meto Basin was authorized by the Flood Control Act of 1950, but it was not funded.

6.109 Several major public land wildlife refuges have been developed over the past 50 plus years within the CIAPE. The Bayou Meto WMA is directly a part of the current project. Its acquisition by the State of Arkansas began in 1948, and today at 32,000 acres it is one of the largest state wildlife management areas in Arkansas. The MKARNS navigation management affects water levels and duration of flooding within and below the Bayou Meto WMA. In a portion of the lower end of the CIAPE exists the White River National Wildlife Refuge. It was established in 1935 for the protection of migratory birds, and today it is among the largest contiguous BLH conservation habitats in North America. These conservation areas within the CIAPE clearly have evolved into complex relationships with human activities in the CIAPE over the past, and the CIAPE's physical appearance would be substantially different without their presence. Various human-induced chemical activities have taken place within the CIAPE over the past 100 years. The Vertac Chemcial Corporation contaminated a site near the upper end of the CIAPE with activities between 1948 to 1987. What became a Superfund Site was remediated by on-site incineration completed in the 1990s, although dioxin contamination in the area continues to be monitored. Also in the CIAPE is the U.S. Army's Pine Bluff Arsenal, a 431-acre chemical warfare arsenal facility with origins in 1941. It is sufficient to say that cumulative impacts over the past 100 years in the CIAPE reflect very substantial changes brought to the human environment.

<u>Cumulative Impacts in the Present</u>

6.110 This context of time is viewed to include projects or activities with origins or output within what might be termed the very recent past or immediate future. Many aspects of present-time conditions that potentially relate to cumulative impacts are described under the Affected Environment section of this project's EIS. The present study (Bayou Meto Basin Reevaluation) has links viewed as cumulative regarding several Federal projects. First there is the origin of the present study as one of five water supply areas conceptually planned under the Eastern Arkansas Region Comprehensive Study (USACE-MVM 1990): Bayou Meto, Grand Prairie, Black River, Little Red River, and White River. Of these locations, the Grand Prairie Area Demonstration Project (GPADP) has become authorized for construction, with some construction initiated. In fact, the Grand Prairie Region and the Bayou Meto Basin were reauthorized jointly by WRDA of 1996, as explained elsewhere in this GRR. The GPADP is designed to protect aquifers while allowing for continued irrigation of agricultural lands. It also would utilize reservoirs to store water along with tailwater recovery systems and intake from the White River. This project would have similarities to aspects of what is proposed for the Bayou Meto Basin project, and the GPADP is partly within the CIAPE.

6.111 Aquifer system(s) are shared between the Bayou Meto Basin and Grand Prairie project areas. As discussed elsewhere in this GRR, aquifer pumping between the Arkansas and White Rivers (the eastern side of the CIAPE) is in what may described as a precarious "near-balance" condition regarding recharge from rivers and other ground water movements. In the reference to the dynamic interplay between the lowest portions of the Arkansas and White Rivers (the most downstream portion of the CIAPE) the Little Rock District presently has concern regarding scouring, erosion, and cutoff channels, particularly in an area between the Trusten Holder Wildlife Management Area and the Big Island in Desha and Arkansas Counties. If the two rivers are allowed to join, the MKARN's navigation system would be disrupted. This project is termed the Arkansas White River (sic) Cutoff Study (Federal Register 2003). Study results, including formulation of alternatives and NEPA documentation including an EIS, are not yet completed (as of September 2003). Also in the Big Island area, and regarding the Federal highways system, the proposed Interstate Highway 69 (Federal Highway Administration, Highway 65--Mississippi Highway 1, Mississippi) includes a "Great River Bridge" feature that might be placed at the lower end of the CIAPE. The Corp's Arkansas River Navigation Study (for the MKARNS) is underway with emphasis on improving navigation capabilities and reducing flooding of adjacent lands. The first phase of this study is focused on managing water flow, including reduction of impacts from high flows of the river's upper reaches, to improve economic benefits for navigation. A report including an EIS is expected to be released before the end of 2003. While there may be some discernable link to the Combined Plan recommended for Bayou Meto Basin, no negative impacts are anticipated from an additive or interactive perspective.

6.112 More directly within the present study area, should the Bayou Meto Basin project's Combined Plan be implemented, the Bayou Meto WMA's operation and maintenance may change in ways perhaps unanticipated by discussions elsewhere in this GRR. The Bayou Meto Basin project's Combined Plan's adverse effects to natural resources categories are described in the Mitigation section found elsewhere in this EIS. It is proposed that 4,093 acres of BLH restoration would compensate for NED Plan impacts to waterfowl and fishery habitat. One related objective of the Bayou Meto Basin project is to recreate a more natural hydrologic regime in the part of the project area focused on the Bayou Meto Wildlife Management Area. Whatever results here surely would produce some effects linked to the broader area of the CIAPE. In addition to the removal of water from the CIAPE's aquifer(s) for agricultural use, the bait and feeder fish industry has a major presence of aquifer-fed production ponds in the area.

6.113 The U.S. Department of Agriculture and the State of Arkansas recently initiated a Conservation Reserve Enhancement Program (CREP) to improve water quality in the Bayou Meto watershed (i.e. upper end of the CIAPE) and wildlife habitat. Work is planned at approximately 4,700 acres with the goals of reducing sediment loading, and increasing wildlife populations through the creation of 200 miles of riparian buffers. Other USDA conservation programs including CRP, WRP, WHIP, and EQIP are pending or possible at the present. Protection of wetlands is, of course, part of these programs.

6.114 The dioxin contaminants earlier mentioned for the CIAPE remain a consideration in terms of possible disturbance of sediments that might arise from the Bayou Meto Basin project's Combined Plan or other indirect consequences of the project. A state fish consumption advisory along Bayou Meto drainage extends to State Highway 13 (within the CIAPE) and it may be extended further (see discussion elsewhere in EIS's Water Quality Summary).

6.115 In association with the Bayou Meto Basin study, the U.S. Fish and Wildlife Service is working with the Arkansas Game and Fish Commission on a migratory bird management plan. This plan, when finalized, may have cumulative effects presently not understood in great detail.

6.116 One irrigation project in the CIAPE with initial construction complete is the Point Remove Wetlands Reclamation and Irrigation Project. At Galla Creek, a pumping plant would remove water from the Arkansas River, discharging it into a system of canals, streams, and pipelines. This NRCS-authorized project has similarities to the Bayou Meto Basin project, and possible connectivity through cumulative effects.

6.117 A similar irrigation project in the CIAPE is the Plum Bayou Irrigation Project. The Corps' Vicksburg District is studying an area tangent to the lower end of the CIAPE. That project is the Southeast Arkansas Feasibility Study, including the Boeuf-Tensas and Bayou Bartholomew areas of southeastern Arkansas. This study will address ground water supplies for irrigation, a WM Plan, and flood control, and it is currently in the middle of its feasibility study phase.

6.118 Urban and related growth from the Little Rock area in the upper end of the CIAPE appears substantial. The 2000 U.S. Census indicates a steady rate of increase over 10%. Pine Bluff, conversely, appears to be declining in its population growth. Economic benefits along with implications for cumulative impacts pertinent to the Bayou Meto Basin project's Combined Plan are discussed elsewhere in this GRR. There is a marked and dynamic economic relationship among the business of agriculture and waterfowl hunting (along with other recreational forms of hunting and fishing) in the CIAPE, compounded by the fact many hunters originate from urban areas both within and outside the CIAPE.

Cumulative Impacts in the Future

6.119 The typical life span planned for a Corps project, such as portrayed by the Combined Plan for the Bayou Meto Basin project, is 50 years. In terms of cumulative impacts considered into future times, it is appropriate to look forward 100 years. However, with this perspective comes the acknowledgement that forecasting conditions of any type this far into the future is increasingly difficult.

6.120 Our nation's growing water crisis (both drinking water and water for agricultural, industrial, and navigation functions) is a certainty for the long term future. In regard to that, it is possible the other three (of five) water supply areas from the Eastern Arkansas Region Comprehensive Study (USACE-MVM 1990) would become developed in some manner: the Black River, Little Red River, and White River. If one or more of these projects do become viable, there may be additive and interactive cumulative effects regarding a portion of the CIAPE and a broader area of central-eastern Arkansas. The existing GPADP, earlier described, and its relationship with the Bayou Meto Basin project proposed by this GRR - if further developed, constructed, and operated - cannot be underestimated. Certainly 25 to 100 years from now engineers and scientists will look back to see what worked, what didn't work, and what the hydrologic and other relationships are between the GPADP and the Bayou Meto Basin Selected Plan. The "no action" consequences from failure to complete the GPADP and from not implementing the present study's Combined Plan would result in discernable negative effects upon agricultural businesses and the quality of the natural environment.

6.121 Regarding wetlands and effects from the flood control component of the Combined Plan, it is presently difficult to identify what the cumulative effects might be over the long term future. The Bayou Meto Basin project's interagency team plans additional study that may produce a changed interpretation for wetlands should historic hydrology be restored to the state wildlife management area portion of the project. Therefore, we cannot precisely indicate the project's potential effects, long term, to the overall presence of wetlands within the CIAPE. Other wetland protection or restoration programs in the CIAPE, such as the NRCS's Wetlands Reserve Program (WRP) have an established reputation for successful efforts (e.g. Arkansas as a whole is ranked third in the nation in enrolled WRP acres). This makes it likely additive effects from the Bayou Meto Basin project, if implemented, would be positive.

6.122 Phase II of the Arkansas River Navigation Study will focus on channel deepening. It, combined with water flow management changes that might come from Phase I (underway) could result in discernable changes affecting the Bayou Meto Basin Combined Plan and other irrigation/water-withdrawal projects along the Arkansas River and its tributaries in and near the CIAPE (including the Boeuf-Tensas project earlier described). In other words, competition for water is likely to increase, and consideration of multiple in-place and continuing planned water supply and conservation projects is most likely.

6.123 Regarding the Pine Bluff Arsenal (earlier described under Cumulative Impacts in the Past) to safely dispose of approximately 12% of the original U.S. stockpile of chemical weapons, a disposal facility is planned. Like water resources issues, this matter within the CIAPE is a pending national issue that will become of heightened concern over the long-term future. However, it is presumed no activities at the Arsenal will link to cumulative impacts associated with the Bayou Meto Basin project's Combined Plan.

6.124 Transportation development, urban growth, and other socio-economic factors cannot be readily forecast for the long term future in the CIAPE although it is fair to speculate that some growth in all these categories may occur. Likewise, predicting the future of "big agriculture" in the CIAPE, particularly rice production, is most difficult although Arkansas' overall contribution of rice to global consumers is not likely to decrease unless physical limits such as water supply become limiting factors, or other economic issues outside the CIAPE come into play. Elsewhere in the present GRR a forecast for the water production benefits from the Bayou Meto Basin project can be examined, and considered for their long term indications.

6.125 Water quality for the CIAPE into the distant future is an important issue. We know concentrations of certain chemicals, many introduced from agricultural activities, have seasonal patterns of presence and character in the CIAPE's hydrologic system, but anticipating what may be the *specific* content of surface-supplied (or aquifer-supplied for that matter) water for the Bayou Meto Basin project's irrigation and flood control system 50, 75, or 100 years from now is virtually impossible. The natural resources conservation and waterfowl management features associated with the Bayou Meto Basin project's Combined Plan, along with similar efforts through other mechanisms across the CIAPE should bring long term additive and interactive benefits to the natural environment.

6.126 Consequences of not doing the Combined Plan have been addressed elsewhere for the NED Plan components (also see GRR) but the long-term benefits of the WM Plan component must be stressed. The WM Plan, by intent and design, contributes on a national scale of improvement for the ecosystem(s) associated with the CIAPE and well beyond. Section III of the GRR and other portions of this EIS offer details of the WM Plan. It includes many thousands of acres of restoration related to HWPC habitat; bottomland forests benefiting native plants, forest-breeding birds, and bear; direct restoration of a historic water course (Bakers Bayou) with a riparian corridor; other riparian buffers; and moist-soil habitat for waterfowl. The fullest and substantial benefits expected from the WM Plan probably will be most evident 75 to 100 years from now. Surely they will have impressive, positive cumulative impacts. That said, the crucial "operations and maintenance" activities along with unanticipated but necessary refinements for certain conservation and restoration features cannot be assessed for its effectiveness (cumulative or otherwise) until scientists monitor conditions and look back on results over a span of decades into the future. Also, there certainly will be presently unknown shifts in scientific conservation/ecosystem interests, and technical approaches, over the next 100 years. That reflects the dynamic nature of scientific perspective in general, the nature of physical environments, and our nation's values regarding the human environment.

Summary of Cumulative Impacts Analysis

6.127 A qualitative and judgmental review has been offered for cumulative impacts that might be anticipated in a broader geographic area associated with the Bayou Meto Basin's General Reevaluation for flood control, groundwater protection and conservation, agricultural water supply, and waterfowl management. Acknowledging the difficulties inherent in a cumulative impacts perspective, the reader has been provided enough information to gain an understanding of the basic nature and complexity of cumulative impacts associated, or potentially associated, with this project. However, it is evident that the overall cumulative impacts of project implementation will be beneficial to the study area.

MITIGATION

Waterfowl

6.128 Under existing conditions, 13,260 acres of foraging habitat are available to waterfowl in the project area. The U.S. Fish and Wildlife Service conducted an analysis to determine project effects on waterfowl foraging habitat and appropriate mitigation (see Volume 10, Appendix D, Section 10). It was determined that the selected NED/WM plan would result in the loss of 482,948 duck-use-days; 960 acres of BLH (assuming 70% red oak composition) would have to be restored to mitigate this impact.

Aquatics

6.129 An aquatic HEP was conducted to assess fish habitat losses and associated mitigation requirements (Volume 10, Appendix D, Section XIV). The selected plan would result in the loss of 1,640 habitat units. To compensate for these losses, 2,133 acres of bottomland forest would have to be restored in the post project two-year floodplain.

Terrestrial Wildlife

6.130 A terrestrial HEP analysis was performed to determine impacts to terrestrial wildlife habitat (Volume 10, Appendix D, Section XIII). Terrestrial habitat losses associated with the selected plan total 3,446.4 AAHUs; 1,595 acres of BLH would have to be restored to mitigate these losses.

Wetlands

6.131 Heitmeyer and Ederington (2004) evaluated the hydrologic effects of the selected plan on BLH; see Volume 10, Appendix D, Section XVI. It was concluded that 4,073 acres of BLH are currently stressed from prolonged flooding during the growing season. These BLH areas are either within or hydrologically connected to greentree reservoirs; therefore, the selected plan would have either beneficial effects or no impact on this BLH acreage because water regimes are artificially managed. At present, approximately 1,561 acres of BLH within greentree reservoirs are relatively healthy and are not stressed from prolonged flooding; the selected plan would not have a significant effect on these BLH stands because hydrology within these sites is artificially controlled. However, Heitmeyer and Ederington (2004) found that 1,497 acres of BLH would be negatively impacted by the project and recommended that impacts and mitigation requirements be determined through a hydrogeomorphic (HGM) evaluation.

6.132 Klimas and Blake (2005) evaluated the effects of hydrologic changes on project area wetlands using an HGM assessment (see Volume 10, Appendix D, Section XVIII). This study concluded that 1,340 acres of restored BLH would mitigate adverse hydrologic effects of the selected plan. An additional 440 acres of frequently flooded cleared land would have to be restored to BLH to offset hydrologic impacts to an estimated 400 acres of farmed wetlands. Another 35 acres of farmed wetlands would be lost as a direct result of project construction (i.e., displaced by project features); 39 acres of BLH restoration would be required to mitigate this loss.

6.133 Construction of the selected plan would also result in the direct loss of approximately 1,595 acres of BLH. The Habitat Evaluation Procedures (HEP) were utilized to assess terrestrial habitat losses and determine compensatory mitigation for direct construction impacts (see Volume 10, Appendix D, Section XIII). Direct construction impacts of this alternative would result in the loss of approximately 3,446 average annual habitat units, requiring BLH restoration on 2,174 acres of frequently flooded cleared lands as mitigation.

Total Mitigation Requirement

6.134 HEP was used to determine the mitigation required for direct construction impacts to BLH; while HGM was used to assess hydrologic changes to project wetlands. Mitigation requirements for impacts to cleared lands were determined using an HGM-derived multiplier supplied by Dr. Charles Klimas. The total mitigation acreage required to offset impacts that would result from the implementation of the selected plan is 4,093 acres which would be acquired in fee title.

6.135 Following coordination with the inter-agency team, the priority locations for mitigation lands are in the vicinity of the Bayou Meto Wildlife Management Area, located in the southern portion of the project area. Acquisition of mitigation lands within this area would allow for easier management, provide the opportunity for connectivity with larger blocks of land, and potentially remove some frequently flooded lands from agriculture. Prior converted farmlands would be the preferred land for acquisition, however, a watershed approach would be used that stresses acquisition of blocks of land, with preference being given to land adjacent to existing forested lands. Monitoring of mitigation land planting success would be ensured during periodic inspections of project components, and would be the responsibility of the local sponsor. Monitoring protocols, measures of success (e.g. percent planting survival) would be determined through coordination with the inter-agency team.

6.136 Analyses have been conducted for a number of past projects to compare cost effectiveness of various reforesting techniques (i.e., aerial and mechanical seeding of acorns, mechanical and hand planting of seedlings). The mechanical planting of seedlings is the most cost effective method for reforesting mitigation sites. However, this method has never been selected as the preferred alternative. Hand planting seedlings is almost as cost effective as mechanical planting, and is the preferred reforestation technique. Hand planting allows the random distribution of seedlings necessary to achieve a more "natural" community. Mechanical planting is restricted to the placement of seedlings in rows. During the Bayou Meto general reevaluation, comparisons were made among natural succession, hand planting of 1-2 year old seedlings, and hand planting of Root Production Methods (RPM) seedlings. A comparison of costs for these different planting methods is provided in Table 6-1.

Table 6-1. Cost effectiveness/incremental analysis of mitigation plan alternatives. Total acres required based on HGM analysis of most impacted wetland function (Remove Elements and Compounds).

BLH Mitigation Method	Acres Restored	Total Annualized Cost/Acre	Total Land Cost	Cost/ AAHU	AAHUs Gained	Total Cost for AAHUs Gained
Natural Succession	4,093	$76.25	$312,091.25	$479.90	650	$311,935
Planting of 1-2 year old seedlings	4,093	$152.50	$624,182.50	$135.80	4,584	$622,507
Plant RPM* trees	4,093	$228.75	$936,273.75	$170.80	5,320	$908,656

*RPM – Root Production method developed by Forest Keeling Nursery in Elsberry, MO. Method produces large seedlings with dense, fibrous root systems.

7. LIST OF PREPARERS/CONTRIBUTORS

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8. PUBLIC INVOLVEMENT

8.1 This chapter describes the public involvement program to date and discusses how public views guided and were incorporated into the study process. It also describes future public involvement and includes the list of agencies, groups, and individuals to whom the Main Report/EIS will be sent.

Public Involvement Program

8.2 The public has been involved since the inception of this study. A notice of intent to prepare a draft EIS was published in the *Federal Register* on 4 February 2000. Public scoping meetings were held in England, Arkansas, and Lonoke, Arkansas, on 15 and 16 February 2000, respectively. A post-scoping document was prepared and sent to everyone that attended one of the meetings (see Volume 10, Appendix D, Section I). Public comments received at the meetings were considered during the planning process. At least one other public meeting was held during the public review period of the EIS.

8.3 A series of four informational meetings were held during February and April 1999 at various locations throughout the project area to discuss all aspects of the study. Attendance at these meetings ranged from 25 to over 150. The dates, times, and locations of these meetings were announced by radio and newspaper; and written invitations were mailed to all landowners and farmers within the project area. Also, the Bayou Meto Water Management District (BMWMD) has conducted annual meetings since the beginning of the study. Approximately approximately 250 to 300 people (including congressional delegations; state legislators; state, federal, and local agencies; and the general public) have attended each of these meetings. These meetings have included formal project presentations and informational displays.

8.4 Furthermore, numerous coordination meetings were held among the Corps, BMWMD, Natural Resources Conservation Service (NRCS), inter-agency team, and others. Many informal meetings and field investigations were also conducted throughout the course of the study in order to coordinate project activities with interested parties. A number of project briefings were given to various groups and organizations throughout the project area. During February 2001, a series of briefings was held with each BMWMD board member; these meetings were held so that the board members could coordinate all aspects of the project with the people in their districts.

8.5 This intensive public involvement program was initiated, in part, to solicit input from individuals and interested parties so that problems, needs and opportunities within the project area could be properly identified and addressed. It also provided project status updates to concerned organizations and the general public. Public concerns during this study often pertained to potential project impacts to (1) aquatic resources, wetlands, and forests; (2) area residences, farm buildings, and other improvements; (3) water management problems on the Bayou Meto WMA; (4) waterfowl management needs; and

(5) operation of the pump station. Project area farmers and other residents were also concerned about the cost of project-supplied irrigation water and flood control.

Coordination

8.6 An inter-agency environmental planning team was formed to assist in plan formulation, impact and benefit assessments, identification of waterfowl management features, and overall project planning. This team is comprised of representatives from Memphis and Vicksburg Districts, BMWMD, NRCS, U.S. Fish and Wildlife Service, U.S. Army Engineer Research and Development Center, Arkansas Department of Environmental Quality, Arkansas Game and Fish Commission, Arkansas Natural Heritage Commission, Arkansas Natural Resources Commission, University of Arkansas, University of Missouri's Gaylord Memorial Laboratory, The Nature Conservancy, Environmental Protection Agency, and Ducks Unlimited. Numerous environmental planning meetings were held throughout the study. Broad in scope, many of these meetings were held to identify and address environmental issues and concerns relative to the overall project. The objectives of these meetings were to minimize environmental conflicts, miscommunication, and project delays; maximize environmental expertise available for consultation; facilitate development of environmentally sensitive plan alternatives; identify potential ecosystem and waterfowl restoration features; and identify possible survey and impact assessment procedures. In addition, environmental meetings were held to address specific environmental issues. For example, meetings were held to develop waterfowl management features; determine suitable restoration sites; and minimize project construction impacts to sensitive areas. Furthermore, extensive communication was established and maintained with key natural resources agencies such as the USFWS, NRCS, AGFC, and ANHC. Project information was provided to representatives of federally recognized tribes at meetings sponsored by the BMWMD and the USACE Memphis District.

8.7 The environmental impact statement will be provided to the following agencies, groups, and individuals for their review and comment.

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The Honorable Blanche Lincoln U.S. Senate Federal Building, Room 3108 700 West Capitol Little Rock, AR 72201	The Honorable Blanche Lincoln U.S. Senate 359 Dirksen Senate Office Building Washington, D.C. 20510
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Little Rock, AR 72201	
Carlisle Public Library Fifth Street Carlisle, AR 72024	Lonoke County Library 204 East Second Street Lonoke, AR 72086

INDIVIDUAL AND LOCAL INTERESTS	
The Honorable Fred Martin, Jr. Mayor of Altheimer P.O. Drawer F Altheimer, AR 72004	The Honorable James Sanders Mayor of Humphrey P.O. Box 128 Humphrey, AR 72073
The Honorable Tommy James Mayor of Sherrill P.O. Box 203 Sherrill, AR 72152	The Honorable James Murry, Sr. Mayor of Wabbaseka P.O. Box 141 Wabbaseka, AR 72175
The Honorable Kevin Dolphin Mayor of Allport P.O. Box 58 Humnoke, AR 72072	The Honorable Brenda Homer Mayor of Carlisle P.O. Box 49 Carlisle, AR 72024
The Honorable Ruth Baker Mayor of England P.O. Box 249 England, AR 72046	The Honorable Roger Oliver Mayor of Humnoke P.O. Box 116 Humnoke, AR 72072
The Honorable Diane Hall Mayor of Keo P.O. Box 35 Keo, AR 72083	The Honorable Lenville Evans Mayor of Lonoke 107 West Second Street Lonoke, AR 72086
Mr. Thomas Privett Lonoke County Judge 107 West Second Street Lonoke, AR 72086	Mr. Jack Jones Jefferson County Judge Jefferson County Courthouse 101 West Barraque Pine Bluff, AR 71601
Mr. Sonny Cox Arkansas County Judge 312 South College Stuttgart, AR 72160	Mr. Guyman Devore Prairie County Judge Des Arc, AR 72040
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Recommendations of U.S. Fish and Wildlife Service

8.8 This section contains a list of the major mitigation and conservation measures recommended by the USFWS in their Coordination Act Report, dated February 2005, and the Corps of Engineers responses to those recommendations. These USFWS recommendations, as well as the entire Coordination Act Report, are contained in Volume 10, Appendix D, Section II, Part A.

RECOMMENDED MITIGATION AND CONSERVATION MEASURES

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

Response - Authority to establish minimum stream flow was granted to the Arkansas Soil and Water Conservation Commission (currently the Arkansas Natural Resources Commission) by Act 1051 of 1985 and Act 469 of 1989. Minimum stream flow is defined in the legislation as the quantity of water required to meet the largest of the following in-stream needs: (1) interstate compacts, (2) navigation, (3) fish and wildlife, (4) water quality, and (5) aquifer recharge. ANRC determined the minimum in-stream flows based on these needs. The Bayou Meto Basin Project was developed such that there would be no impact to the various stream flow needs.

8.10 Avoid or relocate significant freshwater mussel concentrations.

Response – The significant mussel concentrations found by Miller and Payne (2002) were found at two locations in the Indian Bayou reach. Mussels from these two areas will be relocated to nearby suitable habitat prior to any channel work that may impact them. Once construction within those areas has ceased, and it is determined that suitable stable habitat has returned, those mussels will be relocated to the their original locations.

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

Response – Concur. The inter-agency team was actively involved in determining the methods appropriate for removal of in-stream blockages and determined that when feasible, methods such as SORG would be utilized.

8.12 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.

Response – Concur. Reforestation of farmed wetlands, including improvements to microtopography when needed, will occur on farmed wetlands acquired in fee title.

8.13 Locate irrigation canals and on-farm reservoirs away from wetlands and remnant tallgrass prairie sites.

Response - Alignments of proposed canals and pipelines have been located to minimize impacts to forests and wetlands; these alignments have been coordinated with the inter-agency planning team. There is only one natural heritage site, Smoke Hole Natural Area, in the project area; no project features are located in the vicinity of this site. On-farm features would also avoid and minimize impacts to forests and wetlands to the extent practical. The Natural Resources Conservation Service (NRCS) estimates that no more that 200 acres of wetlands would be impacted by the construction of on-farm features. An inter-agency team would be formed to review on-farm plans and make recommendations to the NRCS design team; this team will strive to avoid and minimize impacts to wetlands and forests. In order for a farmer to construct a feature in a wetland, the farmer would have to apply for and obtain a Section 404 permit.

8.14 Design on-farm reservoirs to benefit migratory birds.

Response - The NRCS and inter-agency team will develop and recommend wildlife features to area farmers. Based on on-farm construction associated with the Grand Prairie Area Demonstration Project, many farmers would elect to incorporate wildlife features in their reservoirs. The inter-agency team developed wildlife enhancement features and management options for an experimental reservoir at the

University of Arkansas at Pine Bluff's Lonoke farm. These features and management options will be included in project reservoir designs.

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

Response – Concur. On-going programs by the NRCS and project conservation features are designed to decrease the amount of sediment and other pollutants entering streams and to increase the amount of riparian forest buffer along these streams.

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

Response – Concur. Over 60 weirs are proposed to be placed within the canals and ditches to maintain minimum pool elevations. Grade control structures are typically used to control headcutting, which has not occurred in the project area.

8.17 Re-vegetate channel rights-of-way.

Response – Concur. The inter-agency team has determined that native vegetation appropriate to the area will planted in the channel rights-of-way. For example, prairie grasses will be planted along channel reaches that pass through the historic Grand Prairie and Long Prairie regions.

8.18 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.

Response – An operation and maintenance (O&M) plan for the Little Bayou Meto pump station and other Bayou Meto WMA features will be developed in accordance with the *Bayou Meto Wildlife Management Area Wetland Management Plan* (Heitmeyer et al. 2004). The O&M plan will be developed in coordination with the Bayou Meto inter-agency planning team. Any future modifications to this plan would also have to be coordinated with the inter-agency team. The O&M plan for the WMA features will be incorporated into the O&M manual for the entire project. A project cooperation agreement (PCA) will be developed for the Bayou Meto Basin Project. This legally binding document will insure that the project is operated and maintained in accordance with the O&M manual. The project sponsors must sign the PCA prior to initiation of project construction.

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

Response – See response to recommendation 8.18 above.

8.20 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.

Response – Concur. All parties participating in the proposed waterfowl management features will be identified. The current schedule has this component of the project being completed concurrently with the irrigation and flood control components.

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

Response – Concur. Future meetings of the inter-agency team will develop a monitoring program to ensure the waterfowl management plan objectives are met.

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10. INDEX

11. ACRONYMS

AAHU	Average Annual Habitat Units
A/E	architect/engineer
AGFC	Arkansas Game and Fish Commission
ANHC	Arkansas Natural Heritage Commission
ANRC	Arkansas Natural Resources Commission
BLH	Bottomland Hardwood
BMP	best management practice
BMWDD	Bayou Meto Water Distribution District
CFS	cubic feet per second
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
DDT	dichloro-diphenyl-trichloro-ethane
DEIS	draft environmental impact statement
DUDs	duck-use-days
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERDC	Engineer Research and Development Center
FC	Flood Control
FEIS	final environmental impact statement
GIS	geographic information system
GPADP	Grand Prairie Area Demonstration Project
GRR	General Reevaluation Report
HES	Habitat Evaluation System
HTRW	hazardous, toxic, and radioactive waste
HUs	habitat units
HUV	habitat unit value
HWPC	herbaceous wetland/prairie complex
LERRDS	Lands, Easements, Rights-Of-Way, Relocations, Disposal Areas
MAV	Mississippi Alluvial Valley
NED	National economic development
NER	National Ecosystem Restoration
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
ROW	Right(s)-of-way
SHPO	State Historic Preservation Officer
STORET	Storage and Retrieval of Environmental Data
TDS	Total Dissolved Solids
UAPB	University of Arkansas, Pine Bluff
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WMA	Wildlife Management Area
W/O	without
WS	Water Supply

RESPONSES
TO
PUBLIC REVIEW COMMENTS

REGARDING

BAYOU METO BASIN, ARKANSAS
GENERAL REEVALUATION REPORT
AND
DRAFT ENVIRONMENTAL IMPACT STATEMENT

RESPONSES
TO
PUBLIC REVIEW COMMENTS

REGARDING

BAYOU METO BASIN, ARKANSAS
GENERAL REEVALUATION REPORT
AND
DRAFT ENVIRONMENTAL IMPACT STATEMENT

BAYOU METO BASIN, ARKANSAS

DRAFT GENERAL REEVALUATION REPORT (GRR)

(Responses To Comments from Public Review -- Only those comments requiring a response are included in this presentation. A copy of all comments received from the public review is attached.)

I. State of Arkansas
Department of Environmental Quality
8001 National Drive, P.O. Box 8913
Little Rock, Arkansas 72219-8913

Comment 1. We have a concern about the possibility of zebra mussels being introduced which is discussed in the reevaluation report.

Response 1. A study by scientists from USACE Engineer Research and Development Center (ERDC) indicated that although it was likely that larval zebra mussels (*Dreissena polymorpha*) would enter the irrigation system from the Arkansas River, factors such as temperature and limited attachment sites would prevent successful colonization.

Comment 2. Another issue is the potential for the existing habitat and/or fishery being adversely affected by changing the flow regime from seasonal to constant as a result of this project.

Response 2. The existing habitat in the basin streams and ditches has been degraded to a significant extent, shifting species compositions to the most tolerant of taxa throughout most of the basin. Increasing water levels will allow the aquatic community the opportunity to return to an assemblage more like that which existed prior to heavy agricultural withdrawal. Benefits to tributary stream fisheries have been estimated to be 380 Habitat Units (HUs)/month gained.

Comment 3. ADEQ cannot issue a 401 water quality certification based on a draft document. We will need to review the final document to properly evaluate any request for a 401 water quality certification.

Response 3. The USACE will request 401 water quality certification when the final document is sent out.

II. Arkansas Department of Health
4815 West Markham Street
Little Rock, Arkansas 72205-3867

Comment 1. Plans for any public water line relocation necessitate by this project shall be submitted to and approved by the Arkansas Department of Health and Human Services-Engineering Section before construction on said water line relocation is commenced.

Response 1. Concur. Any relocation of water lines will be coordinated with your office.

III. Arkansas Natural Resources Commission
101 East Capitol, Suite 350
Little Rock, Arkansas 72201

SPECIFIC COMMENTS ON GRR

Comment 1. The agricultural water supply reliability analysis for the Arkansas River adequately addresses current state minimum streamflow standards.

Response 1. Changes will be made to the GRR to clarify the minimum instream flow used in establishing system reliability of the delivery system (4645 cfs), and the minimum streamflow adopted by the ANRC to represent a shortage condition when all beneficial uses cannot be met (2000 cfs). Based on this information from ANRC, the adoption of the minimum streamflow (2000 cfs) would increase the reliability of the system. However, changes will not be made to the reliability analysis of the delivery system in order to allow some flexibility in the operation of the delivery system and minimizing risk of inoperability during extreme low water periods.

Comment 2. The total annual volume of water needed for diversion to meet all Bayou Meto project objectives should be documented and included in the Main Report.

Response 2. Calculations have been made to compute the maximum annual volume of import water from the Arkansas River based on the 10-day design demand flows depicted on Plate I-B-2. The maximum annual volume withdrawn from the Arkansas River of 173 billion gallons per year will be included in the GRR in the appropriate volumes.

Comment 3. The HGM assessment methodology developed by the state of Arkansas is the appropriate tool for evaluating project wetland impacts and restoration success.

Response 3. Concur. HGM was used to assess hydrologic changes to project wetlands; while mitigation requirements for impacts to cleared lands were determined using an

HGM-derived multiplier supplied by Dr. Charles Klimas.

Comment 4. A short description of an Environmental Team review process to evaluate individual "on-farm" wetland impacts, similar to Grand Prairie project procedures, should be included in the Main Report.

Response 4. Concur. An inter-agency team will be formed to review on-farm activities associated with the agricultural water supply component of the project (see final EIS, p. 73). This team will include representatives from key federal and state resource agencies. A team charter and standard operating procedures will be developed and adhered to during planning and construction of on-farm features. The on-farm team will be involved in the review of on-farm plans, formulation of measures to avoid/minimize environmental impacts, assessment of impacts to wetlands and other habitats, determination of appropriate compensatory mitigation (if necessary), and other important work. The Corps of Engineers will establish on-farm criteria, such as wetland impact restrictions on reservoirs, to help limit adverse impacts associated with on-farm construction; and a project-specific Section 404 general permit will be developed for on-farm activities. The on-farm team will fulfill a critical advisory role during both of these endeavors as well.

IV. United States Environmental Protection Agency

Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

GENERAL COMMENTS

Comment 1. Background section. Description of project, water bodies, and stated purposes. Comments indicate that Two Prairie Bayou is a water body directly involve in the project and that one of the primary purposes of the project is "increased land put into crop production."

Response 1. Two Prairie Bayou is not a water body directly involved in the project. The inter-agency team stated its opposition to using this relatively pristine waterbody for project purposes and it was removed. Increasing land put into crop production is not a project purpose. No additional acres of land are anticipated as being converted into cropland as a result of implementation of this project. In fact, over 35,000 acres of cropland could be restored to native habitats as part of the waterfowl management component.

SECTION 404 ANALYSIS COMMENTS

Comment 1. The Draft EIS Report, Volume 10, Appendix D, Section VII contains a Clean Water Act (CWA) 404 (b)(1) analysis. Upon review of this document, EPA finds that further analysis is needed. This includes incorporating additional information which would fully address the extent of wetland impacts resulting from the project beyond that which occurs only from the direct placement of dredged and or fill material. Specifically, secondary impacts resulting from the project's intended flood control element which will reduce flooding (both depth and duration) on jurisdictional waters needs to be considered and evaluated. Without further analysis, EPA believes that the project as proposed is not consistent or otherwise in compliance with the Section 404 (b)(1) Guidelines.

Response 1. Concur. 404(b)(1) analysis has been updated to include indirect impacts of the project.

Comment 2. As Federal oversight agency for Section 404 of the Clean Water Act, it is EPA's position that those areas identified as being negatively hydrologically impacted either have measures incorporated into the project to minimize impacts to the forested habitats, or provide measures for the loss of jurisdictional resources to be offset by fully mitigating all existing functions.

Response 2. The actual amount of bottomland hardwood forest directly impacted is 1,695 acres. One thousand five hundred ninety-five acres would be directly impacted by construction of the flood control and agricultural water supply components of the project, and 100 acres are projected to be impacted by construction of on-farm features. The draft EIS reported that 1,384 acres would be hydrologically impacted by the flood control component; however, this was an outdated figure that was mistakenly reported in the draft EIS. The actual amount of land that could be indirectly impacted and lose jurisdictional wetland status is 1,497 acres. However, 248 acres are located in the middle of "greentree" areas that are managed for waterfowl. It is the Corps' understanding, based on the February 24, 2006, meeting, that EPA does not believe that the 248 acres will be cleared and converted to another land use due to their location on the landscape. EPA informed the Corps at the February 24 meeting that it should assume that the remaining 1,249 acres would be totally converted to non-wetland uses (e.g., farming, industrial, residential) because this land would lose protection afforded by the Clean Water Act. However, according to the NRCS, the clearing and conversion of this acreage would be a violation of the Food Security Act even if jurisdictional status is lost because of the project. Also, the Corps has determined that more land has been restored to wetland in the project area in recent years than has been cleared and converted to non-wetland. The 1,249 acres in question are located in portions of the project area that are extremely unlikely to be developed. Therefore, assuming a total loss of wetland functions and values for the 1,249 acres would not be appropriate. The project will require a total of 4,093 acres of bottomland hardwood (BLH) restoration to offset adverse impacts. Of this, 1,780 acres of BLH restoration would be needed to mitigate hydrologic impacts to wetlands. Wetland mitigation requirements were determined using HGM.

ON-FARM FEATURES

Comment 1. The NRCS has stated that "A farmer would have to apply for and obtain a Section 404(b)(1) permit for the COE in order to construct an on-farm feature in a wetland." This implies that additional impacts are expected but will be left to the individual permit process and are not addressed in the DEIS. EPA is concerned that without full evaluation of all impacts associated with the complete implementation of the project at the time of funding, the Bayou Meto project would result in failure to comply with the federal guidelines to protect the environment.

Response 1. The estimates of wetland impacts and subsequent mitigation requirements associated with construction of on-farm features are conservative. Total on-farm wetland impacts are not expected to exceed 200 acres. However, additional coordination, analyses, and public disclosure pursuant to the National Environmental Policy Act (NEPA) would be necessary if it were discovered that actual on-farm impacts would exceed the acreage disclosed in the final EIS. An inter-agency team will be formed to review on-farm activities associated with the agricultural water supply component of the project (see final EIS, p. 73). This team will include representatives from EPA and other key federal and state resource agencies. A team charter and standard operating procedures will be developed and adhered to during planning and construction of on-farm features. The on-farm team will be involved in the review of on-farm plans, formulation of measures to avoid/minimize environmental impacts, assessment of impacts to wetlands and other habitats, determination of appropriate compensatory mitigation (if necessary), and other important work. In coordination with the inter-agency team, the Corps of Engineers will establish on-farm criteria, such as wetland impact restrictions on reservoirs, to help limit adverse impacts associated with on-farm construction.

Comment 2. Additionally, EPA would expect that all landowners wishing to receive flood control and irrigation benefits while impacting wetlands as a result of developing on-farm features come under this permit.

Response 2. A project-specific Section 404 general permit will be developed for on-farm activities (see final EIS, p. 73). Wetland impacts covered under this general permit will not exceed 200 acres. The Corps will establish on-farm criteria, including wetland impact limits, which must be met in order for a landowner to receive project funding for the construction of on-farm features. The minimum wetland impact criteria that must be met to secure project funding will likely be less restrictive that the requirements of the general permit. In other words, an on-farm plan would have to meet certain wetland impact limitations in order to receive project funding. If an on-farm plan with wetland impacts were to meet project requirements, it would have to meet even more restrictive criteria to be eligible for the general permit. Farmers with project-eligible on-farm plans that would not meet general permit conditions would have to seek individual Section 404 permits.

The inter-agency team, including EPA, will fulfill a critical advisory role during development of the general permit as well as during the planning and construction of on-farm features.

MITIGATION CONCERNS

Comment 1. EPA recommends that all lands acquired for mitigation of wetlands impacts be Prior Converted (PC) lands as opposed to Farmed Wetlands (FW).

Response 1. Wetland mitigation was determined using HGM. Several assumptions were made regarding potential mitigation land and are described in Volume 10, Appendix D, Section XVIII, Part A, pp.17 and 18. In summary, it was assumed that agricultural land would be converted to native lowland forest, the site would have native soils in place, the site would be in the 1- to 5-year floodplain, micro-topography would be restored, the site would not be subjected to prolonged growing-season flooding, and the site would itself would be large and/or located adjacent to a large, existing block of forest.

The inter-agency will inspect proposed mitigation sites and evaluate potential gains in wetland functional values using HGM. Potential sites with higher existing functional values would obviously provide less functional value gain through restoration or less mitigation credit. The mitigation requirement presented in the draft EIS is a projection based on a theoretical site. The actual amount of mitigation needed could vary based on condition of the site(s) acquired. Opportunities to restore prior-converted farmland would be an important consideration for the inter-agency team. However, the inter-agency team would also have to consider other important factors as well, such as restoration costs and proximity to large, contiguous forest. As a member of the inter-agency team, EPA will have the opportunity to participate in mitigation site evaluations and recommendations.

Comment 2. EPA recognizes that the waterfowl management elements and the proposed development of an interagency management plan for the Bayou Meto Wildlife Management Area offer potentially important environmental gains. However, it is unclear as to when such features will be accomplished or developed. There needs to be a clear statement as to who is responsible for obtaining, developing and managing mitigation and restoration lands and details on how the lands will be managed. Furthermore, the Statement should provide a date by which all such activity must be accomplished. EPA recommends a legally binding agreement be developed to ensure Section 404 (b)(1) compliance.

Response 2. The Project Cooperation Agreement (PCA) between the Project Sponsor and the U.S. Army Corps of Engineers identifies the roles and responsibilities for the project. This document identifies the Project Sponsor responsibility for all project lands, easements, rights of way and relocations. Developing and restoring the project lands will be the U.S. Army Corps of Engineers' responsibility. Managing the project lands will be the Project Sponsor responsibility and the required management activities will be included in the Project Operation and Maintenance Manual. Table 88 of Volume 1, lists the schedule for land acquisition and development by year. This schedule is subject to the availability of Federal Funding. The PCA is the legally binding agreement.

WATER SUPPLY CONCERNS

Comment 1. EPA suggests that the COE address the potential for water quality effects. This includes considering the possible effect of water withdrawal on instream water quality; the potential for water quality degradation and/or improvement in water quality due to irrigation use; and the possible indirect effects on water quality given the encouragement to convert additional acreage to agriculture.

Response 1. The Arkansas Natural Resources Commission has verified that there is adequate flow in the Arkansas River to meet project needs for both the Bayou Meto and South East Arkansas Projects. The water quality analysis for the water supply component has been revised to discuss the impacts of completion of the project features on sediment availability and nutrient load in the Arkansas River and potential changes in contributions to the Mississippi River. Generally, the analyses indicated that the on-farm storage and tailwater recovery features could reduce the amount of runoff into project area streams by 0.6 percent. Based on average concentrations in project area streams, these two features could reduce suspended sediment by approximately 4000 metric tons per year and nitrate by approximately 60 metric tons per year. No conversion of forested land to agricultural production. In fact, an estimated 35,000 acres of farmed land is anticipated to be converted to native vegetation as part of the waterfowl management component.

Comment 2. All of the above should be related to the potential for impacting the load to the Mississippi River, then to the Gulf of Mexico, and potential for contributing to Gulf hypoxia. Since the diversion of river waters onto agriculture lands is proposed for several Basins in Arkansas, analysis of water availability throughout the system, alteration of flow, as well as water constituents, such as nutrients, should be strongly considered to have an effect downstream. The Arkansas and White Rivers converge to flow to the Mississippi River which flows into the Gulf of Mexico where the hypoxia occurrence is a national water quality concern. The impact of the altered river water resources and the potential change in sediment content (important for downstream delta building) should be addressed. EPA suggests the COE address the potential for impacting the flow, the sediment availability and nutrient load to the Mississippi River, to the Gulf of Mexico, and potential for contributing to the Gulf hypoxia.

Response 2. The water quality analysis for the water supply component was revised to discuss the impacts of completion of the project features on sediment availability and nutrient load in the Arkansas River and potential changes in contributions to the Mississippi River. As previously stated, analyses have indicated that no additional land is predicted to be converted to agriculture. The withdrawal of water from the Arkansas River will not significantly impact the flow of water in the Mississippi River system. The Arkansas River is pooled by a series of locks and dams in the intake section of the river, so that no impact is expected on current velocity or water quality issues that could be impacted by flow factors. The project maximum withdrawal is about 5% of the average daily flow of the Arkansas River at the same time of the year, and 0.8% of the Mississippi River at the same time of the year. The water quality analysis shows that bed sediment loading would be largely unaffected by the project due to the system of locks and dams in the McClellan-Kerr Navigation System. Total suspended sediment discharge could be reduced by approximately 0.1 percent of the Mississippi River's total suspended sediment load. Nitrate discharge into the Mississippi River could be reduced by approximately 2.0 percent, while nitrate discharge into the Gulf of Mexico could be reduced by approximately 0.02 percent.

CUMULATIVE IMPACT ANALYSIS

Comment 1. The Draft EIS states that "certain chemicals", many introduced from agricultural activities, will become concentrated within the Cumulative Impacts Area of Potential Effects (CIAPE). The document however does not identify which chemicals these would likely be. The very general and concluding statement within the cumulative impacts section stating, "The natural resources conservation and waterfowl management features associated with the Bayou Meto Basin project's Combined Plan, along with similar efforts through other mechanisms across the CIAPE should bring long term additive and interactive benefits to the natural environment" does not constitute an analysis of cumulative water quality impacts. The DEIS has dismissed any real attempt to address potential cumulative environmental impacts on the basis that to do so would be difficult. EPA believes cumulative impacts could be provided using different "ranges", for example, in acreage potentially requesting river irrigation water and impacts. Please address this concern.

Response 1. A cumulative impact analysis of discharge, sediment load, and nitrate load was added to the water supply component's water quality analysis. The analysis included impacts from completion of the Bayou Meto project, the proposed Boeuf-Tensas Project in South East Arkansas, and the existing McClellan –Kerr Navigation System. The on-farm storage and Arkansas River diversion features for the combined projects would divert approximately 5 percent of the Arkansas River's annual discharge into the Mississippi River. Because of the locks and dams on the Arkansas River, the bed sediment load reaching the Mississippi should be unaffected. The combined projects, however, would reduce the Arkansas River's contribution of suspended sediment into the Mississippi River by 0.27 percent. The combined Arkansas River diversion and on-farm storage for these two projects could remove up to 5.3 percent of the nitrate load into the Mississippi River and 0.06 percent of the nitrate load entering the Gulf of Mexico.

GROUNDWATER

Comment 1. With protection of ground water being important to the ecosystem and its restoration, EPA suggests that a more detailed analysis of ground water protection alternatives be conducted. This would allow for the development of a detailed conservation plan. It should include legally binding commitments by each of the users to follow the conservation plan. We see no evidence that specific groundwater conservation alternatives have been seriously considered for correcting the self-inflicted ground water depletion that has been observed in this area since 1927; only the extensive surface water development approach of the proposed alternative is seriously proposed. It is noteworthy that other areas such as users of the Ogallala Aquifer have been very successful with conservation measures to turn around a ground water depletion situation. The public also should be advised regarding State regulation of groundwater as indicated on page 16 of the Bayou Meto Report.

Response 1. The only way to protect groundwater in this region is to not use it as a major source of irrigation water. Because of the slow recharge rate of the aquifers, artificial recharge was not considered an option. Since a supplemental source of water was necessary to meet the high water demands of the area (runoff, along with conservation measures only accounted for about 35% of the water needed) the supplemental source of water had to come from the Arkansas River. With this project in place, groundwater will slowly begin to recover to some stable level.

V. United States Department of the Interior
Office of the Secretary
Office of Environmental Policy and Compliance
P.O. Box 26567 (MC-9)
Albuquerque, New Mexico 87125-6567

GENERAL COMMENTS

General comments section (FWS recommendations).

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

Response 1. Authority to establish minimum stream flow was granted to the Arkansas

Soil and Water Conservation Commission (currently the Arkansas Natural Resources Commission) by Act 1051 of 1985 and Act 469 of 1989. Minimum stream flow is defined in the legislation as the quantity of water required to meet the largest of the following in-stream needs: (1) interstate compacts, (2) navigation, (3) fish and wildlife, (4) water quality, and (5) aquifer recharge. ANRC determined the minimum in-stream flows based on these needs. The Bayou Meto Basin Project was developed such that there would be no impact to the various stream flow needs.

Comment 2. Avoid or relocate significant freshwater mussel concentrations.

Response 2. The significant mussel concentrations found by Miller and Payne (2002) were found at two locations in the Indian Bayou reach. Mussels from these two areas will be relocated to nearby suitable habitat prior to any channel work that may impact them. Once construction within those areas has ceased, and it is determined that suitable stable habitat has returned, those mussels will be relocated to the their original locations.

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

Response 3. Concur. The inter-agency team was actively involved in determining the methods appropriate for removal of in-stream blockages and determined that when feasible, methods such as SORG would be utilized.

Comment 4. Acquire in fee title and restore/reforest 4,093 (corrected mitigation acres to reflect latest FWS comments) acres of farmed wetlands to compensate for direct and indirect loss of habitat values due to the flood control and water delivery components.

Response 4. Concur. Reforestation of land, preferably prior converted farmlands, including improvements to microtopography when needed, will occur on land acquired in fee title.

Comment 5. Locate irrigation canals and on-farm reservoirs away from wetlands and remnant tallgrass prairie sites.

Response 5. Alignments of proposed canals and pipelines have been located to minimize impacts to forests, prairie remnants, and wetlands; these alignments have been coordinated with the inter-agency planning team. There is only one natural heritage site, Smoke Hole Natural Area, in the project area; no project features are located in the vicinity of this site. On-farm features would also avoid and minimize impacts to forests, prairie remnants, and wetlands to the extent practical. The Natural Resources Conservation Service (NRCS) estimates that no more that 200 acres of wetlands would be impacted by the construction of on-farm features. An inter-agency team would be formed to review on-farm plans and make recommendations to the NRCS design team; this team will strive to avoid and minimize impacts to wetlands and forests. In order for a farmer to construct a feature in a wetland, the farmer would have to apply for and obtain a Section 404 permit.

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

Response 6. The NRCS and inter-agency team will develop and recommend wildlife features to area farmers. Based on on-farm construction associated with the Grand Prairie Area Demonstration Project, many farmers would elect to incorporate wildlife features in their reservoirs. The inter-agency team developed wildlife enhancement features and management options for an experimental reservoir at the University of Arkansas at Pine Bluff's Lonoke farm. These features and management options will be included in project reservoir designs.

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

Response 7. Concur. On-going programs by the NRCS and project conservation features are designed to decrease the amount of sediment and other pollutants entering streams and to increase the amount of riparian forest buffer along these streams.

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

Response 8. Over 60 weirs are proposed to be placed within the canals and ditches to maintain minimum pool elevations. Grade control structures are typically used to control headcutting, which has not occurred in the project area.

Comment 9. Re-vegetate channel rights-of-way.

Response 9. Concur. The inter-agency team has determined that native vegetation appropriate to the area will be planted in the channel rights-of-way. For example, prairie grasses will be planted along channel reaches that pass through the historic Grand Prairie and Long Prairie regions.

Comment 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.

Response 10. An operation and maintenance (O&M) plan for the Little Bayou Meto pump station and other Bayou Meto WMA features will be developed in accordance with the *Bayou Meto Wildlife Management Area Wetland Management Plan* (Heitmeyer et al. 2004). The O&M plan will be developed in coordination with the Bayou Meto inter-agency planning team. Any future modifications to this plan would also have to be coordinated with the inter-agency team. The O&M plan for the WMA features will be incorporated into the O&M manual for the entire project. A project cooperation agreement (PCA) will be developed for the Bayou Meto Basin Project. This legally binding document will insure that the project is operated and maintained in accordance with the O&M manual. The project sponsors must sign the PCA prior to initiation of project construction.

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

Response 11. See response to recommendation 10 above.

Comment 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.

Response 12. Concur. All parties participating in the proposed waterfowl management features will be identified. The current schedule has this component of the project being completed concurrently with the irrigation and flood control components.

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

Response 13. Concur. Future meetings of the inter-agency team will develop a monitoring program to ensure the waterfowl management plan objectives are met.

GRR Specific Comments.

Comment 1. Section I. Agricultural Water Supply Component, Plan Formulation, Environment, Wildlife Habitat, Terrestrial Habitat, page 42, paragraph 2. "Timbered habitat is the second largest cover type in the project area and accounts for 41,350 acres." This contradicts the statement in paragraph one of the Wetlands Section (page 44) that says "The Bayou Meto basin contains a significant amount of wetlands, with over 60,690 acres of forested wetlands alone." The FWS recommends this discrepancy be resolved.

Response 1. The 60,690 acres is a general reference to bottomland hardwoods within the Bayou Meto Basin. The 41,350 acres refers specifically to the number of bottomland hardwood acres within the project area.

Comment 2. Section I. Agricultural Water Supply Component, Plan Formulation, Environment, Fisheries, page 44, paragraph 1. "Human impacts to the fishery include withdrawal of water from the streams and ditches, which reduces water levels and causes stagnant pools with low dissolved oxygen, cleared stream banks that increase water temperature (through lack of shading) and increase sediment load." Another human perturbation that should be included is the channelization and diversion of natural streams.

Response 2. Concur. Channelization and diversion of flows of natural streams was included in the description of perturbations.

Comment 3. Section I. Agricultural Water Supply Component, Plan Formulation, Environment, Wetlands, page 44, paragraph 1. This paragraph describes the tree species that dominate at various hydrologic frequencies and durations. The tree species water oak is written twice in the description of trees found in relatively dry areas. The FWS recommends this redundancy be resolved.

Response 3. Concur.

Comment 4. Section I. Agricultural Water Supply Component, Plan Formulation, Environment, Recreation, page 46. Paragraphs one and two describe the economic impact of resident and non-resident waterfowl hunters and non-consumptive wildlife users. The figures provided are taken from sources ranging from 15 to 21 years old. Because of increases in the local popularity of both waterfowl hunting and non-consumptive uses such as bird watching, the FWS recommends that more recent estimates be cited.

Response 4. Newer data will be utilized to describe the economic impact of waterfowl hunting and non-consumptive wildlife users as available.

Comment 5. Section I. Agricultural Water Supply Component, Plan Formulation, Future Without Project Conditions, Environmental Resources, page 50. Paragraph one describes that continued aquifer decline will "have a drying effect on the wetlands. Recharge from the aquifer to natural streams will decrease as the aquifer declines, thereby changing the ecology of the riverine system." It is the FWS's understanding based on statements and reports from the U.S. Geological Survey that the major rivers in eastern Arkansas are all "losing" streams and receive little if any base flow from aquifers as historically occurred during periods of low rainfall. Most of the current base flow from large rivers comes from upstream dam releases while smaller streams depend largely on irrigation water released from agricultural fields. If most streams are already "losing," how will continued declines in the aquifer affect summer flows? This should be discussed in more detail.

Response 5. One of the purposes of the project is to at a minimum stabilize the aquifers by reducing withdrawal demand. This will allow a stabilization of ecology of the riverine system. It is possible that conditions will improve if the aquifers rebound due to less than expected pumping from wells. This scenario is possible since the price of supplemental water from the irrigation system will be cheaper than pumped well water.

Comment 6. Section I. Agricultural Water Supply Component, Plan Formulation, Future Without Project Conditions, Navigation, page 50. This paragraph describes that the operating plan for the McClellan-Kerr Arkansas River Navigation System is not expected to change and that the Montgomery Point Lock and Dam will provide more efficient system management and operation. The Montgomery Point Lock and Dam is already complete and has been operating for almost a year. The Little Rock and Tulsa Corps Districts are currently planning a project to enlarge the existing navigation system to a dependable depth of 12 feet. This update on the current status of the Montgomery Point Lock and Dam, as well as an update on the planning to enlarge the existing navigation system to a dependable depth of 12 feet should be discussed.

Response 6. Although there is planning for a 12 foot navigation channel, and there has also been some changes at Van Buren Lock and Dam, those changes will have very little effect of pool elevation, and if it does, then it should increase pool depth. The report will be revised to more accurately state the assumptions used in design of the project.

Comment 7. Section I. Agricultural Water Supply Component, Plan Formulation, Concise State of Problems, Needs, and Opportunities, Natural Resources, page 5,1 paragraph 2. "the removal of blockages from some of the Basin streams will allow a more natural flow regime that will benefit aquatic life." The authors should clarify that the "blockages" they refer to consist largely of excess siltation. The removal of this excess siltation will improve the aquatic habitat for many fish and invertebrate species in the long term, but it will not result in a more "natural flow regime." The purpose of the blockage removals is to transport water more quickly through channels in order to: a) reduce overbank flooding; and/or b) allow addition of supplemental irrigation water without inducing overbank flooding. This accomplishes the project purposes but does not result in a more natural flow regime. The FWS recommends this clarifying point be discussed.

Response 7. SORG will be used in areas such as the Indian Bayou obstruction removal effort, but may not be practical in larger cleanouts or enlargements; however, the least destructive method will be used in all cases.

Comment 8. Section I. Agricultural Water Supply Component, Plan Formulation, Concise Statement of Problems, Needs, and Opportunities, Summary, page 52. This paragraph contains the text "The only solution to eastern Arkansas' groundwater problem is the development of alternative water supplies with conservation." This statement is incorrect in that other options may exist that would compliment the proposed project and might lessen the need for surface diversions in the future. The proposed project does not maximize water conservation by mandating adoption of water saving application techniques such as multiple inlet irrigation and has no mention of the development of less water intensive rice varieties or other alternative crops. The diversion of surface water may be the only solution to the groundwater problem that is within the authority of the Corps to address, but it is not the only potential solution. The FWS recommends that this clarifying point be discussed.

Response 8. Water needs will not decrease in the future and eastern Arkansas' groundwater supply can not meet the demand necessary to maintain current agricultural production. Conservation measures or other options have some effect on reducing demand from groundwater, but about 50% of all agricultural water needs to come from an alternate water source. The only guarantee of protecting the aquifers from irreparable damage is to reduce the pumping of groundwater. This 50% demand for agricultural water must come from the only other source available, surface water.

Comment 9. Section I. Agricultural Water Supply Component, Plan Formulation, Project Planning and Development, Analysis and Data Application, Environmental Analysis, page 64, paragraph 2. -"It was assumed that farmers would not construct on-farm systems in wetlands. Any farmers that propose to locate irrigation structures in wetlands will have to apply for an individual Section 404(b)(l) permit." The FWS suggests that any participants that propose to locate features in wetlands should have those plans brought before an interagency team for review to identify any feasible alternatives. If feasible alternatives exist but participants still choose to locate in a wetland, project cost share finding should not be directed towards that particular feature. Additionally, the FWS recommends that any compensatory mitigation required for on-farm impacts to wetlands should be combined to form distinct tracts approved by the interagency team and managed by the Corps or local sponsors.

Response 9. We concur that an inter-agency team will be needed to review any plans to locate reservoirs in wetlands.

Comment 10. Section I. Agricultural Water Supply Component, Plan Formulation, Project Planning and Development, Analysis and Data Application, Environmental Analysis, page 65. The second paragraph indicates that the benefits, such as increasing species richness of fishes, or adding supplemental irrigation water to ditches and streams in the project area, are expected to be similar to those documented for the Grand Prairie Water Supply project. The Grand Prairie project is currently under construction and has not begun to deliver water; therefore, the benefits of that project to fisheries are currently not documented, only predicted. The FWS recommends that this clarifying point be discussed.

Response 10. Concur

Comment 11. Section I. Agricultural Water Supply Component, Plan Formulation, Alternative Plans, Measures, Irrigation Efficiencies, page 74. The first paragraph mentions many conservation measures that can be used to increase application efficiencies. The use of multiple inlet rice irrigation is not among the techniques mentioned. This technique has consistently been shown to result in an average water application savings of 25 percent verses traditional cascade irrigation. The report should document the current adoption rate of this technique and detail how increased use would affect the overall water demand in the project area.

Response 11. The suggested technique for conserving water is an important concept and will certainly be considered by the NRCS during the planning of the on-farm irrigation designs. However, it is at a level of detail that is not normally addressed in a document of this type.

Comment 12. Section I. Agricultural Water Supply Component, Plan Formulation, Alternative Plans, Measures, On-Farm Storage, page 76, top paragraph. "Reservoirs would be placed on cropland, with wooded areas being disturbed as a last resort." It is unclear who determines when all other feasible alternatives have been exhausted and that the feature may be placed in a wooded area and/or wetland. Project funded placement of on-farm features in forested and for wetland areas should occur only with the unanimous approval of the multi-agency review team. The FWS recommends that this clarifying point be discussed.

Response 12. An inter-agency team will be formed to review on-farm activities associated with the agricultural water supply component of the project. This team will include representatives from key federal and state resource agencies. A team charter and standard operating procedures will be developed and adhered to during planning and construction of on-farm features. The inter-agency team will be involved in the review of on-farm plans, formulation of measures to avoid/minimize environmental impacts, assessment of impacts to wetlands and other habitats, determination of appropriate compensatory mitigation (if necessary), and other important work. The Corps of Engineers will establish on-farm criteria, such as wetland impact restrictions on reservoirs, to help limit adverse impacts associated with on-farm construction; and a project-specific Section 404 general permit will be developed for on-farm activities. The on-farm team will fulfill a critical advisory role during both of these endeavors as well. The team will strive to reach a consensus regarding approval of on-farm plans affecting wetlands. However, if a consensus cannot be reached, a majority vote would be needed for approval. The percentage of votes needed for approval will not be determined until the SOPs are developed in coordination with the inter-agency team. It must be noted that the Corps, as the lead federal agency, has the legal responsibility of determining whether individual on-farm plans are acceptable under the Bayou Meto Basin Project. However, the Corps will strongly consider the inter-agency team's recommendations concerning on-farm features. However, the Corps will strongly consider the inter-agency team's recommendations concerning on-farm features.

Comment 13. Section I. Agricultural Water Supply Component, Plan Formulation, Alternative Plans, Measures, Flooding for Waterfowl, page 77. The paragraph describes that the project will "provide a dependable source of water for waterfowl flooding in the Bayou Meto Wildlife Management Area." It should be noted that this feature will only be beneficial if a sustainable water/forest management plan is implemented. Simply providing water in the fall may be detrimental if long term timber health is not addressed in a water management plan. The FWS recommends that this clarifying point be discussed.

Response 13. See response to General Comment 10 above.

Comment 14. Section I. Agricultural Water Supply Component, Plan Formulation, Alternative Plans, Measures, Screening of Alternatives, page 80, first paragraph. "The limiting factor in using conservation measures is that they are effective only when there is available water to recover." This statement is true when referring to techniques such as tailwater recovery. However, some techniques, such as multiple inlet rice irrigation, are effective at reducing the amount of water initially applied to the field. These techniques that improve "application efficiency" should be encouraged in addition to those that "recover" water already used to water crops. The FWS recommends that this clarifying point be discussed.

Response 14. The conservation measures discussed in the report deal primarily with those measures cost shared on this project. Other methods of conservation are encouraged and the report will be revised to state that fact, since all conservation measures are in the best interest of the farmers and the environment.

Comment 15. Section I. Agricultural Water Supply Component, Description of Selected Plan of Improvement for Agricultural Water Supply, Environmental Features, page 106. The first paragraph describes that the project will "provide a dependable source of water for waterfowl flooding within the Bayou Meto Wildlife Management Area." This project component has the potential to allow managers flexibility in water management and could help reduce the impacts associated with traditional rainfall dependent greentree reservoir management. However, a dependable water supply can prove to be a double edged sword and if abused could lead to additional stress to the timber resources on the Wildlife Management Areas. It is essential that a binding water management agreement be a part of any supplemental water provided to the area as part of this project. The FWS recommends that this clarifying point be discussed.

Response 15. See response to EPA General Comment 10 above.

Comment 16. Section I. Agricultural Water Supply Component, Summary of Economic, Environmental, and Other Social Effects, Navigation, page 119. The paragraph describes that "the selected plan of improvement has no impact to navigation on the Arkansas River. Surplus water on the Arkansas River is that water in excess of the needs for navigation." The minimum flows established by the Arkansas Natural Resources Commission for the Arkansas River at Murray Lock and Dam vary depending on the season. Any water withdrawals during the periods of November to March and April to June should not violate the minimum flows established for fish and wildlife use for those seasons (4,361 cfs and 6,778 cfs, respectively). Any withdrawals during the July to October period are constrained by the minimum flows established for navigation as stated in the GRR. The FWS recommends that the report reference seasonal flow restrictions in cfs in addition to river stage when discussing withdrawal limits.

Response 16. Minimum flow requirements remain constant throughout the year, but there was an analysis performed on the river data to show reliability of the river as it relates to the project, which meets the minimum flows requirements, first. This analysis is discussed in Volume 3, Section I - Hydraulics and Hydrology, pages 2-4.

Comment 17. Section II. Flood Control Component, Existing conditions, Wetlands, page 131, second paragraph. "Timber stress is related to the duration of flooding in the spring following the dormant period that coincides with waterfowl migration; and timely evacuation of areas flooded for waterfowl is dependent on an adequate outlet to the Arkansas River." While this statement is accurate, it fails to mention the importance of depth, duration, and fluctuation of water levels in the spring, *fall, and winter.* Early application of water on greentree reservoirs in the fall on a regular basis can also cause timber stress as has been shown on some impoundments within Bayou Meto Wildlife Management Areas. While it is important that the water is removed quickly in the spring before the growing season in most years, it is also important that water is not added in the fall before the dormant season on an annual basis. This highlights the importance of including a water management plan that takes into account wetland/forest functions and attempts to mimic natural hydrology and maintain forest health over the life of the project. The FWS recommends that this clarifying point be discussed.

Response 17. See response to General Comment 10 above. The water management plan will follow the Heitmeyer recommendations to ensure forest health.

Comment 18. Section II. Flood Control Component, Plan Formulation, Environmental Problems, Wetlands and Terrestrial Resources, page 136. The paragraph describes that the reasons for the timber stress and plant community shifts in Bayou Meto Wildlife Management Areas "can be traced to changes in floodwater evacuation capability as a result of the Arkansas River levees in combination with the McClellan-Kerr Navigation Project." Again, this points out the damages caused by late spring flooding but fails to mention the contribution of early fall flooding and past water management practices throughout the winter season. The FWS recommends that this clarifying point be discussed.

Response 18. Concur. The paragraph will be amended to include the impacts of past water management practices and early fall flooding.

Comment 19. Section II. Flood Control Component, Plan Formulation, Environmental Problems, Opportunities, page 138. The paragraph describes that "Waterfowl habitat may be improved in the area through structural measures to reduce flood damage, and having a reliable source of water available from the water supply portion of the project." Again, the reliable water in the fall will be a benefit only if it is applied using the guidance of an interagency team approved water management plan. The FWS recommends that this point be discussed.

Response 19. The water management plan will address the use of available water for use in the BMWMA.

Comment 20. Section III. Waterfowl Management and Restoration Plan. This section does not provide a "Construction Schedule" section as found in Sections I and II. It is important that the waterfowl management features are constructed concurrently with the flood control and irrigation components. The FWS recommends that text be added that addresses a construction schedule.

Response 20. A construction schedule for waterfowl management is shown on pages 292-293 of the Main Report.

Comment 21. Section III. Waterfowl Management and Restoration Plan. The FWS recommends that this section contain a discussion of post-construction monitoring to determine the success of waterfowl management features. The details of such a monitoring plan can be developed by the interagency team in the future, but a cursory discussion and commitment to conduct monitoring should be included.

Response 21. Concur. Although monitoring plans will be detailed in the O&M plan, verbiage addressing the monitoring will be included in the section.

Comment 22. Project Implementation, Non-riparian permit, page 298. The FWS recommends that the Arkansas Natural Resources Commission minimum flows for fish and wildlife (discussed in comment number sixteen) be considered here in addition to navigation requirements.

Response 22. Minimum flows for fish and wildlife concerns were the basis of the design of the system. These minimum flows actually exceed the minimum flow necessary for navigation concerns, and the largest of minimum flows was used for design purposes. This has been clarified on page 329 of the report.

DEIS Specific Comments

Comment 1. Section 5.82, Navigation, page 61. The FWS recommends that this be revised to reflect that a study is currently underway to enlarge the Arkansas River Navigation channel to 12 feet and that the Montgomery Point Lock and Dam is already operating.

Response 1. Concur. This section will be updated.

Comment 2. Section 6.21, Aquatic Resources, page 69. This section states that improvements in aquatic community indicators such as species richness were documented for the Grand Prairie Irrigation Project. In fact, this project has yet to divert any water into project area streams, so improvements in aquatic habitat, thought predicted, have not been *documented* at this point. The FWS recommends that this clarifying point be discussed.

Response 2. Concur.

Comment 3. Section 6.26, Aquatic Resources, page 70. It should be noted that significant mussel populations in Indian Bayou Ditch will be relocated to Indian Bayou following cleanout of that stream. The FWS recommends that this clarifying point be discussed.

Response 3. Concur. The relocation information will be included.

Comment 4. Section 6.38, Wetlands, page 73. The paragraph describes that compensatory mitigation would be acquired by the local sponsor for on-farm wetland losses in manageable tracts. The FWS recommends that the multiagency team be involved in both the approval of on-farm features in sensitive areas such as wetlands and/or forests as well as recommendations for locating and managing compensatory mitigation sites.

Response 4. Concur. An inter-agency team will be formed to review on-farm activities associated with the agricultural water supply component of the project (see final EIS, p. 73). This team will include representatives from key federal and state resource agencies. A team charter and standard operating procedures will be developed and adhered to during planning and construction of on-farm features. The on-farm team will be involved in the review of on-farm plans, formulation of measures to avoid/minimize environmental impacts, assessment of impacts to wetlands and other habitats, determination of appropriate compensatory mitigation (if necessary), and other important work. The Corps of Engineers will establish on-farm criteria, such as wetland impact restrictions on reservoirs, to help limit adverse impacts associated with on-farm construction; and a project-specific Section 404 general permit will be developed for on-farm activities. The on-farm team will fulfill a critical advisory role during both of these endeavors as well.

Comment 5. Section 6.105, Cumulative Impacts in the Past, page 85. The paragraph states that the new lock and dam at Montgomery Point is near completion. The FWS recommends that this text be updated to reflect that this dam is now complete and operational.

Response 5. Concur.

Comment 6. Section 6.126, Cumulative Impacts in the Future, page 91. The paragraph states that restoration of a historic water course (Baker's Bayou) is included in restoration efforts. This proposed feature was removed from consideration due to lack of interest from the affected landowner, The FWS recommends that this clarifying point be discussed.

Response 6. Concur.

Comment 7. Section 6.134, Total Mitigation Requirement, page 93. The paragraph reads that land for compensatory mitigation (4,093 acres) would be acquired in fee title and that preference would be given to lands adjacent to current state holdings such as the Bayou Meto Wildlife Management Areas. The FWS recommends that the multi-agency team have the opportunity to review all potential mitigation sites.

Response 7. Concur. An inter-agency team will be formed to review on-farm activities associated with the agricultural water supply component of the project (see final EIS, p. 73). This team will include representatives from key federal and state resource agencies. A team charter and standard operating procedures will be developed and adhered to during planning and construction of on-farm features. The on-farm team will be involved in the review of on-farm plans, formulation of measures to avoid/minimize environmental impacts, assessment of impacts to wetlands and other habitats, determination of appropriate compensatory mitigation (if necessary), and other important work. The Corps of Engineers will establish on-farm criteria, such as wetland impact restrictions on reservoirs, to help limit adverse impacts associated with on-farm construction; and a project-specific Section 404 general permit will be developed for on-farm activities. The on-farm team will fulfill a critical advisory role during both of these endeavors as well.

VI. Arkansas Natural Heritage Commission
1500 Tower Bldg., 323 Center St.
Little Rock, AR 72201

Comment 1: We are pleased that the scope of the originally-authorized project was broadened to include, among other purposes, waterfowl management as a primary purpose. Placing natural resources management on an equal footing with more traditional purposes such as flood control and agricultural water supply is critical to meeting today's water resource management needs. Planning for the project included studies by Klimas and Heitmeyer and others that provided firm scientific basis for understanding the relationships among hydrology, geomorphology, soils, and wetland distribution and function. These studies also provided the basis for understanding the most effective and efficient approaches to wetland restoration and management within the basin. The U.S. Army Corps of Engineers is to be applauded for basing the project features on such solid scientific foundation.

Response 1: Thank you for your kind praise. The project goal was to comprehensively address the water resources related needs in the basin. The waterfowl management component focuses primarily on the restoration of native habitats, and the referenced studies facilitated development of sound restoration and wetland management plans that benefit waterfowl and a host of other wildlife species.

Comment 2: Features proposed for the Bayou Meto Wildlife Management Area, in conjunction with the pump station on Little Bayou Meto, will greatly improve the capability for wise management of the wetlands and waterfowl resources of this premiere state area. ANHC led a study by the interagency team environmental review team that identified several other priority waterfowl restoration features to be addressed by the project, including wetland restoration in the "Wabbeseka Scatters" area west of Bayou Meto Wildlife Management Area, riparian restoration along several basin watercourses, and restoration of an area between the existing forests of Bayou Meto WMA and the privately-owned and managed Big Ditch area upstream. Completion of these features will result in more functional wetlands as well as larger wetlands within the basin.

Response 2: Concur. The Bayou Meto WMA features will improve the health of this important bottomland hardwood area and tremendously benefit waterfowl. The habitat restoration plans that were developed by the inter-agency team with AHNC leadership will also provide outstanding wildlife benefits. ANHC was a very active member of the inter-agency team, and the Corps of Engineers greatly appreciates the ANHC involvement in this project and many others in Arkansas.

Comment 3: The geomorphic study of Baker's Bayou commissioned as a part of project planning, added valuable knowledge about the geomorphic history of the basin. While not resulting in a project feature, it helped to deemphasize what would have been an inappropriate feature.

Response 3: Concur.

Comment 4: ANHC is most excited about the potential (detailed on pp. 184-190) for restoring large and small blocks of seasonal herbaceous wetlands representative of the Grand Prairie which occupied a substantial part of the project area but has been almost entirely converted to agricultural production. Restoration of substantial areas of native wetlands can help restore populations of King Rails and other waterfowl and wetland species, along with upland species, that were virtually extirpated from the region along with the prairie vegetation. Doing so can also increase recharge of the aquifer and decrease demands on the aquifer, thus contributing to meeting other project purposes. ANHC will do everything possible to assist in accomplishing this project feature. Planting native prairie species on appropriate rights-of-way will enhance this restoration.

Response 4: Restoration of herbaceous wetland-prairie complex is a project priority because of its scarcity and the habitat it provides waterfowl and a number of rare wildlife species. The Corps appreciates ANHC's dedication to making the waterfowl component a success. The Corps has enjoyed a long and valuable relationship with ANHC, working together for many years to promote restoration on the Grand Prairie.

VII. Thomas J. Privett
Mayor, City of Lonoke
107 W. Second Street
Lonoke, AR 72086

Comment 1: The General Reevaluation Plan of the Bayou Meto Basin is the culmination of years of planning by the Federal, state and local planners. It addresses the groundwater, flood control and waterfowl needs of the people of the City of Lonoke, AR (or County of Lonoke, AR). In particular, it provides groundwater protection in the first agricultural area to be designated by the State as a Critical Groundwater Depletion Area.

Response 1: Concur.

Comment 2: This project will allow the agricultural community to remain productive for the nation and locally provide needed jobs. The generated tax revenue supports local government and schools. This project is important to the region and the nation and I request the report be approved and constructed.

Response 2: Concur; the project will provide substantial agricultural and economic benefits. Your request will be given serious consideration.

VIII. Mike Huckabee
Governor, State of Arkansas
State Capitol Bldg., Suite 250
Little Rock, AR 72201

Comment: After voicing strong support for all project components, Governor Huckabee provided the following statement: "This project is extremely important to the people and natural resources of the State of Arkansas and I urge the executive and legislative branches of our federal government to join the State of Arkansas and local landowners in approving and building this project in a timely manner."

Response: Comment noted.

IX. Arkansas Game and Fish Commission (letter of support to Randy Young, ANRC)
2 Natural Resources Drive
Little Rock, AR 72205

Comment: 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.

Response: The Corps appreciates the AGFC's willingness to partner on this project and to provide cost share funding. The AGFC continues to be a very active participant on the inter-agency team and was instrumental in formulating the waterfowl management component.

X. Deputy State Historic Preservation Officer
Arkansas Historic Preservation Program
1500 Tower Bldg., 323 Center St.
Little Rock, AR 72201

Comment: This voluminous document reflects a study of the Bayou Meto Irrigation Project, but we find that it lacks specifics regarding the management of cultural resources. However, we agree that a Programmatic Agreement is needed so that this undertaking can proceed in a manner that takes into account the needs of construction scheduling. While the Memphis District Corps of Engineers is the lead federal agency for this undertaking, the other consulting parties should be signatories to any agreement document.

Response: Specifics related to the management of cultural resources will be addressed in a Programmatic Agreement (PA) that is being developed for the project. The PA is presently being developed through consultation and workshops with federally recognized tribes, Arkansas State Historic Preservation Officer, Arkansas State Archeologist, Advisory Council on Historic Preservation, Natural Resources Conservation Service, and project sponsors. It is understood that the Memphis District is the lead federal agency in this project and that is reflected in the draft PA. Upon completion of the PA all consulting parties will be given the opportunity to be signatories to the PA.

XI. Farelly Lake Levee District
718 Hwy. 343
DeWitt, AR 72042

Comment: It is our conclusion that the Bayou Meto Basin Project has addressed all of the issues that are in the area of responsibility of the Farelly Lake Levee District.

Plan components that make the project compatible include Little Bayou Meto Pump Station, a water control structure a the upper end of the channel, a guide levee to keep Little Bayou Meto and Big Bayou Meto separate, and proper channel excavation. With these, and other components in place, there are many flood control benefits to be gained.

Response: Concur. Many flood control benefits would be achieved through project implementation.

February 2, 2006

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E (Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

My family owns and farms land on both sides of Little Bayou Meto between Reydel, Arkansas and the Arkansas River. I am against the Bayou Meto Project. Too much of our good farmland would be claimed by the project.

The project would affect several of our neighbors' homes that are on the Bayou. The town of Reydel, its Post Office and Baptist Church, which has been there over 60 years, would be affected, as well as the historic Abbey Cemetery that borders the bayou.

Agricultural water supply has not been a problem for us or Reydel. Flooding is a rare occurrence and is not as devastating as the project would be for the area. Waterfowl are attracted to the natural situation of the bayou as is.

I feel that the project is an unnecessary expense and an unnecessary project. I am against the Little Bayou Meto Basin project. It would destroy the area.

Sincerely,

Barbara Kauppila

Barbara Kauppila

Response:

The project as planned will not impact any homes, the Reydell Post Office, or the Reydell Baptist Church. It also will not impact the historic Abbey Cemetery that borders Little Bayou Meto. The public bridge at Reydell and two private bridges above Reydell will be replaced a part of the project. During the project design phase, detailed information will be collected to include surveys, soil borings, cultural resources surveys, and other necessary data which will be used to prepare detailed design drawings and specifications. All structures and significant cultural sites will be shown on these drawings to facilitate avoidance by the project design team.

Although flood control benefits will accrue in the vicinity of Reydell, we understand that you do not feel that you have a significant flooding or agricultural water supply problem on your farm. Because of this, we have worked hard to reduce the total impact of the project in your area. We plan to work from one bank only, to replant areas where trees are removed, and to work with landowners for disposal of material that would be beneficial to the landowner if possible.

The decision to use Little Bayou Meto for removal of floodwater was based on economic and environmental criteria. After examining many options, the plan shown to you during our recent meeting in Reydell was selected as the most appropriate way to address the problems and needs in this study area. We will do our best to limit the impacts to you and your family and in the end leave Little Bayou Meto as resource that you can continue to enjoy and be proud of.

120 Riverview Way
Hot Springs, AR 71901
February 5, 2006

Commander, Memphis District, U.S. Army Corps of Engineers
ATTN: PM-E (Smith)
167 North Main Street, Room B-202
Memphis, TN 38103-1894

Dear Mr. Smith:

I am writing concerning the proposed project on the Bayou Meto Basin in Arkansas, specifically the area of Little Bayou Meto connected to Reydell, Arkansas in Jefferson County. My parents Mr. and Mrs. Sam Luckie own our family farm, part of which is adjacent to Little Bayou Meto.

My first concern is that they nor any other landowner connected to Little Bayou Meto was contacted by your office regarding this project. They would not have known about the meeting in Lonoke on January 25, 2006, had it not been for a family friend.

My second concern is that it has still not been made clear to the landowners what specifically you wish to accomplish with the project. The three components have been listed: 1) agricultural water supply, 2) flood control, and 3) waterfowl management. But nowhere have I seen specifics on how any of it will be accomplished, and who exactly will benefit from the project.

My final concern is that no one seems to have taken into consideration what will be destroyed by the project. Under "Construction Items" in the Plan Components it states "One private bridge and one public bridge will be affected by this work along with some utility lines." Do you realize that numerous homes, businesses, a church, a cemetary and many acres of productive farmland will be destroyed? It appears to me that more harm than good will be done by the proposed Bayou Meto Project.

I hope these and other concerns expressed by all affected parties will be addressed before pursuing the Bayou Meto Basin Project.

Sincerely,

Jane Yahoda

cc: State Representative David Rainey
State Senator Hank Wilkins
U.S. Congressman Mike Ross

Response:
There was no intent to "hide" information from landowners about this project. On the contrary, many landowners throughout the watershed and others involved with state agencies and interest groups were heavily involved in the planning process. The public meeting was held to ensure that landowners such as yourself were given the opportunity to come and express your concerns.
The Bayou Meto General Reevaluation Report was prepared as a mechanism for describing the problems and needs and the process of evaluating these problems and needs resulting in the recommendation of plans to address them. You should have a copy of this report by now which will give detailed information regarding the purpose and accomplishments of the recommended plans. See the response to the Barbara Kauppilla letter for discussion of construction impacts.

February 10, 2006
16801 Nathan Road
Stuttgart, AR 72160

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E M. Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

This letter concerns the Little Bayou Meto Expansion project as it relates to the Grand Prairie Water Distribution Project. I am against this portion of the project.

As a resident of the Reydel area I am aware that we are not a part of the Alluvial Aquifer nor are we a part of the Grand Prairie.

The widening of Little Bayou Meto between the Bayou Meto Wildlife Management Area and the Arkansaa River seems unnecessary. The bayou itself is already quite wide and deep. The farmland adjacent to it and the WMA above seem to rarely flood. There are several places of which they drain naturally. The WMA has several pumps and weirs already in place and several different natural drainage directions.

I fear if Little Bayou Meto is changed it will threaten the homes, farmland, church, post office and cemetery that are so close to it. The Abby Cemetery is on my family's farm and is on the bayou bank.

The only thing I would consider helpful would be a less expensive cleaning out of brush and timber of Little Bayou Meto and the pump station next to the existing flood gate at the end of Little Bayou Meto as is in the plan.

Thank you for your consideration of this matter.

Sincerely,

Mary Ann Luckie DuMond

Response:
The Alluvial Aquifer lies underneath your farm and is used by many landowners for irrigation in the Reydell area. Because you are close the Arkansas River, the Alluvial Aquifer is recharged quickly as landowners in your area use this resource. Your neighbors to the north are not as fortunate as you, however and can only remove water from the aquifer that remains after the farmers in your area have taken what they need. There is only a limited amount of water that this aquifer can transport and the water levels are critical north of you. So although you and the farmers in your area that use groundwater to irrigate their crops probably will not have problems in the future, the water you remove will not be available for those north of you and this is one of the primary reasons for this project in the first place.
The Bayou Meto Wildlife Management area (WMA) has many water control structures designed to hold water for waterfowl during the winter. When spring comes and this water has to be removed, the channels are full from spring rain and the water drains off very slowly. In many cases it is May before all the water is gone. This is having a devastating effect on timber resources in the WMA as well as some of the farmland adjacent to the WMA. In fact, the Arkansas Game and Fish Commission has paid adjacent landowners for flood damages following the waterfowl season in recent years. The pump station at the lower end of Little Bayou Meto was sized to accommodate removal of this water at a rate that would benefit both farmers and the WMA. The pumps cannot function without some channel enlargement on Little Bayou Meto. We sized the channel to provide water to the pump station efficiently and tried to limit the amount of excavation that had to be done from one bank only.
See the response to the Barbara Kauppilla letter for discussion of construction impacts.

February 2, 2006

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E (Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

My family owns and farms land on both sides of Little Bayou Meto between Reydel, Arkansas and the Arkansas River. I am strongly against the Little Bayou Meto Project. Too much of our good farmland would be claimed by the project.

The project would affect several of our neighbors' homes that are on the Bayou. The town of Reydel, its Post Office and Baptist Church, which has been there over 60 years, would be affected, as well as the historic Abbey Cemetery that borders the bayou.

Agricultural water supply has not been a problem for us or Reydel. Flooding is a rare occurrence and is not as devastating as the project would be for the area. Waterfowl are attracted to the natural situation of the bayou as is.

I feel that the project is an unnecessary expense and an unnecessary project. I am against the Little Bayou Meto Basin project. It would destroy the area.

Sincerely,

Julie Kauppila

Response:

The project as planned will not impact any homes, the Reydell Post Office, or the Reydell Baptist Church. It also will not impact the historic Abbey Cemetery that borders Little Bayou Meto. The public bridge at Reydell and two private bridges above Reydell will be replaced a part of the project. During the project design phase, detailed information will be collected to include surveys, soil borings, cultural resources surveys, and other necessary data which will be used to prepare detailed design drawings and specifications. All structures and significant cultural sites will be shown on these drawings to facilitate avoidance by the project design team.

Although flood control benefits will accrue in the vicinity of Reydell, we understand that you do not feel that you have a significant flooding or agricultural water supply problem on your farm. Because of this, we have worked hard to reduce the total impact of the project in your area. We plan to work from one bank only, to replant areas where trees are removed, and to work with landowners for disposal of material that would be beneficial to the landowner if possible.

The decision to use Little Bayou Meto for removal of floodwater was based on economic and environmental criteria. After examining many options, the plan shown to you during our recent meeting in Reydell was selected as the most appropriate way to address the problems and needs in this study area. We will do our best to limit the impacts to you and your family and in the end leave Little Bayou Meto as resource that you can continue to enjoy and be proud of.

February 2, 2006

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E (Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

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Agricultural water supply has not been a problem for us or Reydel. Flooding is a rare occurrence and is not as devastating as the project would be for the area. Waterfowl are attracted to the natural situation of the bayou as is.

After reviewing the scope of the project, I feel that this decision is utterly ridiculous. The flood control in place is more than sufficient if maintained. You are basically destroying a community, wetlands, and perfectly good farm land. I don't know if you are designing for a couple 100-year storms or what, but your design is wasting money at our expense. This farm has been in our family for years and will continue to for years to come. No price per acre you can offer will suffice compared to the constant money flow from a rare necessity for the nation. I am not about to see something happen to my farm, that my ancestors put all their hearts into.

I feel that the project is an unnecessary expense and an unnecessary project. I am against the Little Bayou Meto Basin project. It would destroy the area. Consider a redesign that is cheaper, more environmental friendly, and less destructive of farm land.

Sincerely,

Joel Kauppila, EIT
Reynolds, Smith, and Hills CS, Inc.
Luckie Farms Owner
Cell: 904-477-8690
joel.kauppila@rsandh.com

Response:
The project as planned will not impact any homes, the Reydell Post Office, or the Reydell Baptist Church. It also will not impact the historic Abbey Cemetery that borders Little Bayou Meto. The public bridge at Reydell and two private bridges above Reydell will be replaced a part of the project. During the project design phase, detailed information will be collected to include surveys, soil borings, cultural resources surveys, and other necessary data which will be used to prepare detailed design drawings and specifications. All structures and significant cultural sites will be shown on these drawings to facilitate avoidance by the project design team.
Although flood control benefits will accrue in the vicinity of Reydell, we understand that you do not feel that you have a significant flooding or agricultural water supply problem on your farm. Because of this, we have worked hard to reduce the total impact of the project in your area. We plan to work from one bank only, to replant areas where trees are removed, and to work with landowners for disposal of material that would be beneficial to the landowner if possible.
The decision to use Little Bayou Meto for removal of floodwater was based on economic and environmental criteria. After examining many options, the plan shown during our recent meeting in Reydell was selected as the most appropriate way to address the problems and needs in this study area. We will do our best to limit the impacts to you and your family and in the end leave Little Bayou Meto as resource that you can continue to enjoy and be proud of.

PUBLIC REVIEW COMMENTS

REGARDING

BAYOU METO BASIN, ARKANSAS
GENERAL REEVALUATION REPORT
AND
DRAFT ENVIRONMENTAL IMPACT STATEMENT

ADEQ

ARKANSAS
Department of Environmental Quality

April 14, 2006

Colonel Charles O. Smithers III, District Engineer
Memphis District, U.S. Army Corps of Engineers
ATTN: PM-E (Smith)
16 North Main Street, Room B-202
Memphis, TN 38103-1894

RE: Bayou Meto Basin, Arkansas: General Reevaluation Report
Draft Environmental Impact Statement (DEIS)

Dear Colonel Smithers:

ADEQ has completed the review of the above referenced documents. This letter will serve as our response to your request for comments. The only comments we have at this time are as follows:

- We have a concern about the possibility of zebra mussels being introduced which is discussed in the reevaluation report.
- Another issue is the potential for the existing habitat and/or fishery being adversely affected by changing the flow regime from seasonal to constant as a result of this project.

ADEQ cannot issue a 401 water quality certification based on a draft document. We will need to review the final document to properly evaluate any request for a 401 water quality certification.

Please contact me at (501) 682-0653 or e-mail at brownk@adeq.state.ar.us if you have any questions or require additional information.

Sincerely,

Keith Brown, P.E.
Manager, State Permits Branch

January 13, 2006 District 4

Mr. David Reece
Department of the Army
Memphis District Corps of Engineers
167 North Main Street B-202
Memphis, Tennessee 38103-1894

RE: Bayou Meto Basin General Reevaluation Report
06-56081

Dear Mr. Reece:

The preliminary engineering report for the above captioned project, dated December 22, 2005, and submitted to the Division of Engineering on January 03, 2006, has been reviewed and while we concur in general, we have the following comment:

1. Plans for any public water line relocation necessitated by this project shall be submitted to and approved by the Arkansas Department of Health and Human Services – Engineering Section before construction on said water line relocation is commenced.

The report is being retained for our records.

When submitting correspondence pertaining to this project, please include our plan identification number **06-56081**.

Sincerely,

Glenn A. Greenway, P.E.
Engineer Supervisor
Engineering Section

RH:GAG:CLL:cll

cc: Dave Fenter, P.E., Arkansas Soil & Water Conservation Commission

Arkansas Department of Health and Human Services

Division of Health

Paul K. Halverson, DrPH, Director

Engineering Section – Environmental Health Branch – Center for Local Public Health

Postal Address	**P. O. Box 1437, Slot H-37**	**Little Rock, AR 72203-1437**	**1-501-661-2623**	**TDD: 1-800-234-4399**
Physical Address for UPS or Fedex	**4815 West Markham St., Slot H-37**	**Little Rock, AR 72205**		**Fax: 1-501-661-2032**

January 30, 2006

Mr. David L. Reece
Chief Environmental Branch
Memphis District COE
167 North Main St.B-202
Memphis, TN 38103-1894

RE: USACOE Bayou Meto

Dear Mr. Reece,

A staff review has been made of the information received on the referenced project. The Engineering Section has no comments on the submittal.

If you have any questions or comments, please coordinate them through Gerry Conley, 501-661-2067.

Sincerely,

Bob Makin, P.E.
Assistant Director
Engineering Section

BM:CL:GG:gc

Cc:

Arkansas Natural Resources Commission

J. Randy Young, PE
Executive Director

101 East Capitol, Suite 350
Little Rock, Arkansas 72201
http://www.anrc.arkansas.gov/

Phone: (501) 682-1611
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E-mail: anrc@arkansas.gov

Mike Huckabee
Governor

March 22, 2006

Colonel Charles O. Smithers III, District Commander
Memphis District, U.S. Army Corps of Engineers
ATTN: PM-E (Smith)
167 North Main Street, Room "B-202"
Memphis, Tennessee 38103-1894

Dear Colonel Smithers:

Technical staff of the Arkansas Natural Resources Commission (ANRC) have reviewed the Bayou Meto Basin General Reevaluation Report and we concur with the Draft Environmental Impact Statement conclusions and summations. During the early stages of study planning, it became evident that a single-purpose agricultural water supply project would not address all water resource issues in the Bayou Meto Basin. Appropriately, the study was expanded to include waterfowl management, flood reduction, and environmental restoration components. I commend the District's effort in utilizing the state's most qualified scientists to identify and evaluate basin-specific conditions. This was an essential step for project formulation and subbasin assessment.

Specific comments on the General Reevaluation Report are included below:

1) *The agricultural water supply reliability analysis for the Arkansas River adequately addresses current state minimum streamflow standards.* Page 3 in Volume 3, Appendix B, states that irrigation design flow in the delivery system is based on reliability of the source supply. The report states the Arkansas Soil & Water Conservation Commission (now the Arkansas Natural Resources Commission- ANRC) has authority to establish minimum streamflow, and "*that minimum streamflow is defined in the 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 for 1) interstate compacts, 2) navigation, 3) fish and wildlife, 4) water quality, and 5) aquifer recharge.*" This statement in the report should be clarified. The largest instream flow need in Pool No. 6 as stated in the report is 4645 cfs (fish and wildlife). This instream flow value was used by the Commission in calculating the quantity of water (above that amount needed to satisfy existing and projected future water needs) available for other uses on an average annual basis. The *minimum streamflow* adopted by ANRC in Pool No. 6 is 2000 cfs, based on a 5-day rolling average. The 2000cfs flow does not represent an optimum instream

condition, but rather a shortage condition when all beneficial uses cannot be met. Potential restrictions governing withdrawals above 2000cfs are not being contemplated by the Commission at this time.

2) *The total annual volume of water needed for diversion to meet all Bayou Meto project objectives should be documented and included in the Main Report.* Page 3 in Volume 3, Appendix B, also states that the peak demand flow at the Arkansas River inlet for the entire delivery system is 1750 cfs. This instantaneous peak flow accounts for system operating losses, seepage, and evaporation. Plate I-B -2 of the report depicts reliability of each 10-day design demand flow in relation to the availability of the source supply. However, the report did not identify an annual volume requirement for the delivery system. Given the experience and knowledge gained from the reevaluation studies for the Grand Prairie Project, it is imperative that a maximum annual volume requirement for the project be identified at this point in the study process. That annual volume requirement should represent maximum pumping based on source supply availability and reliability. The Commission must have an annual volume requirement for the project to consider any request for non-riparian intrabasin transfer.

3) *The HGM assessment methodology developed by the state of Arkansas is the appropriate tool for evaluating project wetland impacts and restoration success.* Development of HGM characterization and wetland classification, functional assessment models, and ecoregion guidebooks in Arkansas is a 10-year effort unmatched nationally. HGM functional assessment models are based on reference wetlands in Arkansas, and therefore are the most appropriate procedures to measure wetlands in Arkansas.

4) *A short description of an Environmental Team review process to evaluate individual "on-farm" wetland impacts, similar to Grand Prairie project procedures, should be included in the Main Report.* Inclusion of additional narrative should alleviate concerns that the project will promote indiscriminate loss of wetlands. At a minimum, the report should outline minimum components of an environmental review process for evaluating "on-farm" impacts and adhering to project mitigation standards.

If you have questions concerning staff comments, please contact Ken Brazil of my staff at 501-682-3985. Thank you for the opportunity to comment.

Sincerely,

Earl T. Smith, Jr. P.E.
Division Chief, Water Management

ETS/KWB/ddavis

cc: Mr. J. Randy Young, P.E. Executive Director, Arkansas Natural Resources Commission
Mr. Ken Brazil, Engineer Supervisor, Arkansas Natural Resources Commission

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

MAR 2 8 2006

Colonel Charles O. Smithers III
Memphis District, U.S. Army Corps of Engineers
ATTN: PM-E Smith
167 North Main Street, Room B-202
Memphis, TN 38103-1894

Dear Colonel Smithers:

In accordance with our responsibilities under Section 309 of the Clean Air Act, the National Environmental Policy Act (NEPA), and the Council on Environmental Quality (CEQ) Regulations for Implementing NEPA, the U.S. Environmental Protection Agency (EPA) Region 6 office in Dallas, Texas, has completed its review of the Draft Environmental Impact Statement (DEIS) for the Bayou Meto Basin General Revaluation Report. The purpose of this action is to divert Arkansas River water to address the identified water resource problems and opportunities within the Bayou Meto Basin, Arkansas.

The Corps of Engineers (COE) may wish to apply the Clean Water Act, Section 404(r) to this proposal. Therefore, in accordance with CEQ Guidance it is incumbent upon EPA to provide the following statement: The EPA has determined that this project as proposed is not consistent or otherwise in compliance with the Section 404 (b)(1) Guidelines of the Clean Water Act. EPA has met and will continue close coordination and discussion with the COE in an effort to reach appropriate resolution of this matter.

EPA rates the DEIS as "**EC-2**," i.e., EPA has "**Environmental Concerns and Requests Additional Information in the Final EIS (FEIS)**." EPA has identified environmental concerns and informational needs to be included in the FEIS to complement and to more fully insure compliance with the requirements of NEPA and the CEQ regulations and the Clean Water Act. Areas requiring additional information or clarification include: Section 404 analysis, on-farm features, mitigation, water quality, cumulative impact analysis, and groundwater impact.

Our classification will be published in the Federal Register according to our responsibility under Section 309 of the Clean Air Act to inform the public of our views on proposed Federal actions. Detailed comments are enclosed with this letter, which more clearly identify our concerns and the informational needs requested for incorporation into the FEIS. We understand the EPA Statement related to application of 404 (r) is to be clearly identified in the FEIS, circulated with the statement, and submitted to Congress.

EPA appreciates the opportunity to review the DEIS. If you have any questions, please contact Mike Jansky of my staff at 214-665-7451 or e-mail him at jansky.michael@epa.gov for assistance. Please send our office five copies of the FEIS when it is sent to the Office of Federal Activities, EPA (Mail Code 2252A), Ariel Rios Building, 1200 Pennsylvania Ave, N.W., Washington, D.C. 20460.

Sincerely yours,

Rhonda M. Smith, Chief
Office of Planning and
Coordination (6EN-XP)

Enclosure

DETAILED COMMENTS
FOR THE
DRAFT ENVIRONMENTAL IMPACT STATEMENT
US ARMY CORPS OF ENGINEERS
BAYOU METO BASIN, ARKANSAS

BACKGROUND

Section 204 of the Flood Control Act of 1950 authorized a project for the Grand Prairie Region and the Bayou Meto Basin in eastern Arkansas. Due to a lack of local sponsorship, this project was never funded and was subsequently deauthorized in the late 1980's due to a provision in Section 1001 (B) of the Water Resources Development Act (WRDA) of 1986. However, severe drought in 1980 and a renewed concern of declining groundwater levels prompted interest in developing water conservation and supply project. In 1996, Congress reauthorized the original Grand Prairie Region and Bayou Meto Basin flood control project with a broadened scope of work. The Assistant Secretary of Army for Civil Works will be required to approve these changes in the scope.

The project is located within a five county area covering approximately 863,712 acres. The project as proposed provides for the construction of river water diversion and storage facilities, water control structures, and canals for transport of water; installation of pumping facilities, alterations to bayous and natural streams for transport of water, construction of pipelines, levees and drainage facilities. Water bodies directly involved include Indian Bayou, Indian Bayou Ditch, Wabbaseka Bayou, Boggy Slough, Little Bayou Meto, Salt Bayou, Crooked Ditch, Two Prairie Bayou, Big Bayou Meto, and the Arkansas River.

Among the stated primary purposes for these activities are: increased waterfowl management providing for hunting over greater acreage, increased irrigation, increased land put into crop production, enhancement of crop production, flood damage reduction, and ground water aquifer restoration.

EPA's wetland program has been participating with the Memphis and Vicksburg Districts of the Corps of Engineers (COE) in the review of this project. Interagency meetings have been held. The most recent was held in Little Rock, Arkansas, on February 24, 2006 with a purpose to discuss the project and to identify areas needing further clarification in accordance with the Clean Water Act Section 404(b)(1) Guidelines. EPA expressed its concerns that there is need for the COE to fully acknowledge all impacts resulting from the proposed project to jurisdictional waters of the U.S., including secondary and cumulative impacts. EPA is also concerned that there remains a need for the COE to fully address minimization of impacts and to develop adequate compensatory mitigation to offset these impacts.

COMMENTS

Section 404 Analysis

The Draft EIS Report, Volume 10, Appendix D, Section VII contains a Clean Water Act (CWA) 404 (b)(1) analysis. Upon review of this document, EPA finds that further analysis is needed. This includes incorporating additional information which would fully address the extent of wetland impacts resulting from the project beyond that which occurs only from the direct placement of dredged and or fill material. Specifically, secondary impacts resulting from the project's intended flood control element which will reduce flooding (both depth and duration) on jurisdictional waters needs to be considered and evaluated. Without further analysis, EPA believes that the project as proposed is not consistent or otherwise in compliance with the Section 404 (b)(1) Guidelines.

The COE acknowledges that in addition to the 1,595 acres of forested wetlands which will be lost due to direct impacts by the tentatively selected plan, Alternative WS4B/FC3A, an additional 1,384 acres of forested wetlands may be hydrologically impacted by the project. However, these impacts are not fully addressed in the DEIS. The COE has stated that these areas will fall outside the post project 5% flood duration scene. Loss of wetland hydrology could result in loss of Federal protection since they would no longer meet the Federal parameters for jurisdiction under Section 404. As Federal oversight agency for Section 404 of the Clean Water Act, it is EPA's position that those areas identified as being negatively hydrologically impacted either have measures incorporated into the project to minimize impacts to the forested habitats, or provide measures for the loss of jurisdictional resources to be offset by fully mitigating all existing functions.

In order to comply with CWA, 404 (b)(1) Guidelines, EPA suggests that measures to minimize impacts include placement of conservation easements which include deed restrictions on the properties, requiring such properties remain forested for the life of the project. These commitments should be provided to the decision makers to ensure that the benefits proposed will be carried out. EPA suggests that the COE reevaluate the overall direct and secondary impacts caused by the project and incorporate those areas that would no longer be jurisdictional and take into account all wetland functions that are protected under the CWA.

On-Farm Features

Another area of EPA concern is the development of on-farm features and their impacts to jurisdictional resources. The Natural Resources Conservation Service (NRCS) has indicated that it expects approximately 200 acres of wetlands to be impacted. Approximately 100 acres would be forested and 100 acres would be farmed wetlands, and approximately 300 acres would be acquired, and replanted to mitigate the wetland loss impacts. The NRCS has stated that "A farmer would have to apply for and obtain a Section 404 (b)(1) permit from the COE in order to construct an on-farm feature in a wetland." This implies that additional impacts are expected but will be left to the individual permit process and are not addressed in the DEIS. EPA is concerned that without full evaluation of all impacts associated with the complete implementation of the project at the time of funding, the Bayou Meto project would result in failure to comply with the federal guidelines to protect the environment.

EPA and the COE at the February 24th meeting discussed interest in development of a general permit for certain parts of the project. Should the proposed project go forward, EPA could support such action provided that a cap on wetland impacts authorized by any such permit would not exceed the amount of impacts to wetlands predicted in the environmental evaluation by the NRCS. Such a general permit should be disclosed in the EIS process. Additionally, EPA would expect that all landowners wishing to receive flood control and irrigation benefits while impacting wetlands as a result of developing on-farm features come under this permit.

Mitigation Concerns

EPA recommends that all lands acquired for mitigation of wetlands impacts be Prior Converted (PC) lands as opposed to Farmed Wetlands (FW). The basis for this recommendation is that FW are jurisdictional and currently assessed as Waters of the U.S. and consequently do not add to net gains in the nation's waters and in fact may lead to a net loss of jurisdictional waters. However, PC lands are not waters of the U.S. and restoring such lands adds to the nation's base of wetlands.

EPA recognizes that the waterfowl management elements and the proposed development of an interagency management plan for the Bayou Meto Wildlife Management Area offer potentially important environmental gains. However, it is unclear as to when such features will be accomplished or developed. There needs to be a clear statement as to who is responsible for obtaining, developing and managing mitigation and restoration lands and details on how the lands will be managed. Furthermore, the Statement should provide a date by which all such activity must be accomplished. EPA recommends a legally binding agreement be developed to ensure Section 404 (b)(1) compliance.

Water Supply Concerns

This project involves major streams of national importance and large land acreage. Diversion of Arkansas River water is pivotal to this proposal, although the proposal claims to use "excess" water. We find no analysis of the effect on existing or future withdrawals for water supply uses in the DEIS. The DEIS does contain a statement regarding competition for new uses.

EPA suggests that the COE address the potential for water quality effects. This includes considering the possible effect of water withdrawal on instream water quality; the potential for water quality degradation and/or improvement in water quality due to irrigation use; and the possible indirect effects on water quality given the encouragement to convert additional acreage to agriculture. All of the above should be related to the potential for impacting the load to the Mississippi River, then to the Gulf of Mexico, and potential for contributing to Gulf hypoxia. Since the diversion of river waters onto agriculture lands is proposed for several Basins in Arkansas, analysis of water availability throughout the system, alteration of flow, as well as water constituents, such as nutrients, should be strongly considered to have an effect downstream. The Arkansas and White Rivers converge to flow to the Mississippi River which flows into the Gulf of Mexico where the hypoxia occurrence is a national water quality concern. The impact of the altered river water resources and the potential change in sediment content (important for downstream delta building) should be addressed. EPA suggests the COE address the potential for impacting the flow, the sediment availability and nutrient load to the Mississippi River, to the Gulf of Mexico, and potential for contributing to the Gulf hypoxia.

Cumulative Impact Analysis

The Draft EIS states that "certain chemicals", many introduced from agricultural activities, will become concentrated within the Cumulative Impacts Area of Potential Effects (CIAPE). The document however does not identify which chemicals these would likely be. The very general and concluding statement within the cumulative impacts section stating, "The natural resources conservation and waterfowl management features associated with the Bayou Meto Basin project's Combined Plan, along with similar efforts through other mechanisms across the CIAPE should bring long term additive and interactive benefits to the natural environment" does not constitute an analysis of cumulative water quality impacts. The DEIS has dismissed any real attempt to address potential cumulative environmental impacts on the basis that to do so would be difficult. EPA believes cumulative impacts could be provided using different "ranges", for example, in acreage potentially requesting river irrigation water and impacts. Please address this concern.

Groundwater

With protection of ground water being important to the ecosystem and its restoration, EPA suggests that a more detailed analysis of ground water protection alternatives be conducted. This would allow for the development of a detailed conservation plan. It should include legally binding commitments by each of the users to follow the conservation plan. We see no evidence that specific groundwater conservation alternatives have been seriously considered for correcting the self-inflicted ground water depletion that has been observed in this area since 1927; only the extensive surface water development approach of the proposed alternative is seriously proposed. It is noteworthy that other areas such as users of the Ogallala Aquifer have been very successful with conservation measures to turn around a ground water depletion situation. The public also should be advised regarding State regulation of groundwater as indicated on page 16 of the Bayou Meto Report.

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
P.O. Box 26567 (MC-9)
Albuquerque, New Mexico 87125-6567

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

March 1, 2006

File 9043.1
ER 06/018

Commander
Memphis District, U.S. Army Corps of Engineers
ATTN: PM-E (Smith)
167 North Main Street, Room B-202
Memphis, TN 38103-1894

Dear Mr. Smith:

The U.S. Department of the Interior (Department) has reviewed the December 2005 Draft General Reevaluation Report (GRR) and Draft Environmental Impact Statement (DEIS) for the Grand Prairie Region and Bayou Meto Basin, Arkansas Project. The following comments are submitted in accordance with the provisions of the Fish and Wildlife Coordination Act, as amended (16 U.S.C.§§ 661-667e); section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. §§1531-1543); the National Environmental Policy Act (42 U.S.C.§ 4321 et seq.); and the Clean Water Act (33 U.S.C. §1251 et seq.).

The U.S. Army Corps of Engineers (Corps) has developed a plan for improvement that addresses the identified water resource problems and opportunities within the Bayou Meto Basin, Arkansas. The GRR was conducted to fully evaluate and determine the best plan of improvement for flood control, groundwater protection and conservation, agricultural water supply, and waterfowl management.

The following are the Department's comments on the draft GRR and DEIS, as well as additional general comments regarding the Bayou Meto General Reevaluation (also referred to as the Bayou Meto Irrigation, Flood Control, and Waterfowl Management Project).

General Comments

In February 2005, the U.S. Fish and Wildlife Service (FWS) developed a Draft Coordination Act Report (DCAR) for this proposed project. This report is located in Volume 10, Appendix D, Section II, Part A. The Memphis District of the Corps provided detailed responses to the FWS's recommendations within the DEIS (Sections 8.8-8.21, pages114-116). The FWS was satisfied with all of the responses but we are including the following summary of recommendations so that it may be noted in the record of agency comments.

To protect and conserve the fish and wildlife resource values of the project area, reduce and minimize project impacts, and ensure realization of project benefits, the FWS 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 Arkansas Soil and Water Conservation Commission.
2. Avoid or relocate significant freshwater mussel concentrations.
3. Removal of stream blockages should be done conservatively and with established methods acceptable to the FWS (Stream Obstruction Removal Guidelines, AFS/TWS 1983).
4. Acquire in fee title and restore/reforest 7,756 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 canals and on-farm reservoirs away from wetlands and remnant tallgrass prairie sites.
6. Design on-farm reservoirs to benefit migratory birds.
7. Use Best Management Practices 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 right-of-ways.
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 Wildlife Management Area features: (a) in accordance with the Bayou Meto Wildlife Management Area Wetland Management Plan (Heitmeyer 2004); and (b) with recommendations and approvals by 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.

GRR Specific Comments

Section I – Agricultural Water Supply Component, Plan Formulation, Environment, Wildlife Habitat, Terrestrial Habitat, page 42, paragraph 2 - "Timbered habitat is the second largest cover type in the project area and accounts for 41,350 acres." This contradicts the statement in paragraph one of the Wetlands Section (page 44) that says "The Bayou Meto basin contains a significant amount of wetlands, with over 60,690 acres of forested wetlands alone." The FWS recommends this discrepancy be resolved.

Section I – Agricultural Water Supply Component, Plan Formulation, Environment, Fisheries, page 44, paragraph 1 - "Human impacts to the fishery include withdrawal of water from the streams and ditches, which reduces water levels and causes stagnant pools with low dissolved oxygen, cleared stream banks that increase water temperature (through lack of shading) and increase sediment load." Another human perturbation that should be included is the channelization and diversion of natural streams.

Section I – Agricultural Water Supply Component, Plan Formulation, Environment, Wetlands, page 44, paragraph 1 – This paragraph describes the tree species that dominate at various hydrologic frequencies and durations. The tree species water oak is written twice in the description of trees found in relatively dry areas. The FWS recommends this redundancy be resolved.

Section I – Agricultural Water Supply Component, Plan Formulation, Environment, Recreation, page 46 - Paragraphs one and two describe the economic impact of resident and non-resident waterfowl hunters and non-consumptive wildlife users. The figures provided are taken from sources ranging from 15 to 21 years old. Because of increases in the local popularity of both waterfowl hunting and non-consumptive uses such as bird watching, the FWS recommends that more recent estimates be cited.

Section I – Agricultural Water Supply Component, Plan Formulation, Future Without Project Conditions, Environmental Resources, page 50 - Paragraph one describes that continued aquifer decline will "have a drying effect on the wetlands. Recharge from the aquifer to natural streams will decrease as the aquifer declines, thereby changing the ecology of the riverine system." It is the FWS's understanding based on statements and reports from the U.S. Geological Survey that the major rivers in eastern Arkansas are all "losing" streams and receive little if any base flow from aquifers as historically occurred during periods of low rainfall. Most of the current base flow from large rivers comes from upstream dam releases while smaller streams depend largely on irrigation water released from agricultural fields. If most streams are already "losing," how will continued declines in the aquifer affect summer flows? This should be discussed in more detail.

<u>Section I – Agricultural Water Supply Component, Plan Formulation, Future Without Project Conditions, Navigation, page 50</u> - This paragraph describes that the operating plan for the McClellan-Kerr Arkansas River Navigation System is not expected to change and that the Montgomery Point Lock and Dam will provide more efficient system management and operation. The Montgomery Point Lock and Dam is already complete and has been operating for almost a year. The Little Rock and Tulsa Corps districts are currently planning a project to enlarge the existing navigation system to a dependable depth of 12 feet. This update on the current status of the Montgomery Point Lock and Dam, as well as an update on the planning to enlarge the existing navigation system to a dependable depth of 12 feet should be discussed.

<u>Section I – Agricultural Water Supply Component, Plan Formulation, Concise Statement of Problems, Needs, and Opportunities, Natural Resources, page 51, paragraph 2</u> - "the removal of blockages from some of the Basin streams will allow a more natural flow regime that will benefit aquatic life." The authors should clarify that the "blockages" they refer to consist largely of excess siltation. The removal of this excess siltation will improve the aquatic habitat for many fish and invertebrate species in the long term, but it will not result in a more "natural flow regime." The purpose of the blockage removals is to transport water more quickly through channels in order to: a) reduce overbank flooding; and/or b) allow addition of supplemental irrigation water without inducing overbank flooding. This accomplishes the project purposes but does not result in a more natural flow regime. The FWS recommends this clarifying point be discussed.

<u>Section I – Agricultural Water Supply Component, Plan Formulation, Concise Statement of Problems, Needs, and Opportunities, Summary, page 52</u> - This paragraph contains the text "The only solution to eastern Arkansas' groundwater problem is the development of alternative water supplies with conservation." This statement is incorrect in that other options may exist that would compliment the proposed project and might lessen the need for surface diversions in the future. The proposed project does not maximize water conservation by mandating adoption of water saving application techniques such as multiple inlet irrigation and has no mention of the development of less water intensive rice varieties or other alternative crops. The diversion of surface water may be the only solution to the groundwater problem that is within the authority of the Corps to address, but it is not the only potential solution. The FWS recommends that this clarifying point be discussed.

<u>Section I – Agricultural Water Supply Component, Plan Formulation, Project Planning and Development, Analysis and Data Application, Environmental Analysis, page 64, paragraph 2</u> - "It was assumed that farmers would not construct on-farm systems in wetlands. Any farmers that propose to locate irrigation structures in wetlands will have to apply for an individual Section 404(b)(1) permit." The FWS suggests that any participants that propose to locate features in wetlands should have those plans brought before an interagency team for review to identify any feasible alternatives. If feasible alternatives exist but participants still choose to locate in a wetland, project cost share funding should not be directed towards that particular feature. Additionally, the FWS recommends that any compensatory mitigation required for

on-farm impacts to wetlands should be combined to form distinct tracts approved by the interagency team and managed by the Corps or local sponsors.

Section I – Agricultural Water Supply Component, Plan Formulation, Project Planning and Development, Analysis and Data Application, Environmental Analysis, page 65 - The second paragraph indicates that the benefits, such as increasing species richness of fishes, or adding supplemental irrigation water to ditches and streams in the project area, are expected to be similar to those *documented* for the Grand Prairie Water Supply project. The Grand Prairie project is currently under construction and has not begun to deliver water; therefore, the benefits of that project to fisheries are currently not documented, only *predicted.* The FWS recommends that this clarifying point be discussed.

Section I – Agricultural Water Supply Component, Plan Formulation, Alternative Plans, Measures, Irrigation Efficiencies, page 74 - The first paragraph mentions many conservation measures that can be used to increase application efficiencies. The use of multiple inlet rice irrigation is not among the techniques mentioned. This technique has consistently been shown to result in an average water application savings of 25 percent verses traditional cascade irrigation. The report should document the current adoption rate of this technique and detail how increased use would affect the overall water demand in the project area.

Section I – Agricultural Water Supply Component, Plan Formulation, Alternative Plans, Measures, On-Farm Storage, page 76, top paragraph - "Reservoirs would be placed on cropland, with wooded areas being disturbed as a last resort." It is unclear who determines when all other feasible alternatives have been exhausted and that the feature may be placed in a wooded area and/or wetland. Project funded placement of on-farm features in forested and/or wetland areas should occur only with the unanimous approval of the multiagency review team. The FWS recommends that this clarifying point be discussed.

Section I – Agricultural Water Supply Component, Plan Formulation, Alternative Plans, Measures, Flooding for Waterfowl, page 77 - The paragraph describes that the project will "provide a dependable source of water for waterfowl flooding in the Bayou Meto Wildlife Management Area." It should be noted that this feature will only be beneficial if a sustainable water/forest management plan is implemented. Simply providing water in the fall may be detrimental if long term timber health is not addressed in a water management plan. The FWS recommends that this clarifying point be discussed.

Section I – Agricultural Water Supply Component, Plan Formulation, Alternative Plans, Screening of Alternatives, page 80, first paragraph - "The limiting factor in using conservation measures is that they are effective only when there is available water to recover." This statement is true when referring to techniques such as tailwater recovery. However, some techniques, such as multiple inlet rice irrigation, are effective at reducing the amount of water initially applied to the field. These techniques that improve "application efficiency" should be encouraged in addition to those that "recover" water already used to water crops. The FWS recommends that this clarifying point be discussed.

Section I – Agricultural Water Supply Component, Description of Selected Plan of Improvement for Agricultural Water Supply, Environmental Features, page 106 - The first paragraph describes that the project will "provide a dependable source of water for waterfowl flooding within the Bayou Meto Wildlife Management Area." This project component has the potential to allow managers flexibility in water management and could help reduce the impacts associated with traditional rainfall dependent greentree reservoir management. However, a dependable water supply can prove to be a double edged sword and if abused could lead to additional stress to the timber resources on the Wildlife Management Areas. It is essential that a binding water management agreement be a part of any supplemental water provided to the area as part of this project. The FWS recommends that this clarifying point be discussed.

Section I - Agricultural Water Supply Component, Summary of Economic, Environmental, and Other Social Effects, Navigation, page 119 - The paragraph describes that "the selected plan of improvement has no impact to navigation on the Arkansas River. Surplus water on the Arkansas River is that water in excess of the needs for navigation." The minimum flows established by the Arkansas Natural Resources Commission for the Arkansas River at Murray Lock and Dam vary depending on the season. Any water withdrawals during the periods of November to March and April to June should not violate the minimum flows established for fish and wildlife use for those seasons (4,361 cfs and 6,778 cfs, respectively). Any withdrawals during the July to October period are constrained by the minimum flows established for navigation as stated in the GRR. The FWS recommends that the report reference seasonal flow restrictions in cfs in addition to river stage when discussing withdrawal limits.

Section II – Flood Control Component, Existing Conditions, Wetlands, page 131, second paragraph - "Timber stress is related to the duration of flooding in the spring following the dormant period that coincides with waterfowl migration; and timely evacuation of areas flooded for waterfowl is dependent on an adequate outlet to the Arkansas River." While this statement is accurate, it fails to mention the importance of depth, duration, and fluctuation of water levels in the spring, *fall, and winter*. Early application of water on greentree reservoirs in the fall on a regular basis can also cause timber stress as has been shown on some impoundments within Bayou Meto Wildlife Management Areas. While it is important that the water is removed quickly in the spring before the growing season in most years, it is also important that water is not added in the fall before the dormant season on an annual basis. This highlights the importance of including a water management plan that takes into account wetland/forest functions and attempts to mimic natural hydrology and maintain forest health over the life of the project. The FWS recommends that this clarifying point be discussed.

Section II – Flood Control Component, Plan Formulation, Environmental Problems, Wetlands and Terrestrial Resources, page 136 - The paragraph describes that the reasons for the timber stress and plant community shifts in Bayou Meto Wildlife Management Areas "can be traced to changes in floodwater evacuation capability as a result of the Arkansas River levees in combination with the McClellan-Kerr Navigation Project." Again, this points out the damages caused by late spring flooding but fails to mention the contribution of early fall flooding and past water management practices throughout the winter season. The FWS recommends that this clarifying point be discussed.

Section II – Flood Control Component, Plan Formulation, Environmental Problems, Opportunities, page 138 - The paragraph describes that "Waterfowl habitat may be improved in the area through structural measures to reduce flood damage, and having a reliable source of water available from the water supply portion of the project." Again, the reliable water in the fall will be a benefit only if it is applied using the guidance of an interagency team approved water management plan. The FWS recommends that this point be discussed.

Section III – Waterfowl Management and Restoration Plan - This section does not provide a "Construction Schedule" section as found in Sections I and II. It is important that the waterfowl management features are constructed concurrently with the flood control and irrigation components. The FWS recommends that text be added that addresses a construction schedule.

Section III – Waterfowl Management and Restoration Plan - The FWS recommends that this section contain a discussion of post-construction monitoring to determine the success of waterfowl management features. The details of such a monitoring plan can be developed by the interagency team in the future, but a cursory discussion and commitment to conduct monitoring should be included.

Project Implementation, Non-riparian permit, page 298 - The FWS recommends that the Arkansas Natural Resources Commission minimum flows for fish and wildlife (discussed in comment number sixteen) be considered here in addition to navigation requirements.

DEIS Specific Comments

Section 5.82, Navigation, page 61 - The FWS recommends that this be revised to reflect that a study is currently underway to enlarge the Arkansas River Navigation channel to 12 feet and that the Montgomery Point Lock and Dam is already operating.

Section 6.21, Aquatic Resources, page 69 - This section states that improvements in aquatic community indicators such as species richness were documented for the Grand Prairie Irrigation Project. In fact, this project has yet to divert any water into project area streams, so improvements in aquatic habitat, thought predicted, have not been *documented* at this point. The FWS recommends that this clarifying point be discussed.

Section 6.26, Aquatic Resources, page 70 - It should be noted that significant mussel populations in Indian Bayou Ditch will be relocated to Indian Bayou following cleanout of that stream. The FWS recommends that this clarifying point be discussed.

Section 6.38, Wetlands, page 73 - The paragraph describes that compensatory mitigation would be acquired by the local sponsor for on-farm wetland losses in manageable tracts. The FWS recommends that the multiagency team be involved in both the approval of on-farm features in sensitive areas such as wetlands and/or forests as well as recommendations for locating and managing compensatory mitigation sites.

Section 6.106, Cumulative Impacts in the Past, page 85 - The paragraph states that the new lock and dam at Montgomery Point is near completion. The FWS recommends that this text be updated to reflect that this dam is now complete and operational.

Section 6.126, Cumulative Impacts in the Future, page 91 - The paragraph states that restoration of a historic water course (Baker's Bayou) is included in restoration efforts. This proposed feature was removed from consideration due to lack of interest from the affected landowner. The FWS recommends that this clarifying point be discussed.

Section 6.134, Total Mitigation Requirement, page 93 - The paragraph reads that land for compensatory mitigation (4,093 acres) would be acquired in fee title and that preference would be given to lands adjacent to current state holdings such as the Bayou Meto Wildlife Management Areas. The FWS recommends that the multiagency team have the opportunity to review all potential mitigation sites.

If you have questions concerning these comments, please contact Jason Phillips at (870) 347-1617, or the Acting Field Supervisor, Melvin Tobin, Conway, Arkansas, Ecological Services Field Office, at (501) 513-4473. Thank you for the opportunity to provide these comments. We trust they will be of use as you prepare the final documents.

Sincerely,

Stephen R. Spencer
Regional Environmental Officer

The Department of
Arkansas Heritage

Mike Huckabee, Governor
Cathie Matthews, Director

Arkansas Arts Council

▪

Arkansas Historic Preservation Program

▪

Delta Cultural Center

▪

Historic Arkansas Museum

▪

Mosaic Templars Cultural Center

▪

Old State House Museum

Arkansas Natural Heritage Commission

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323 Center Street
Little Rock, AR 72201
(501) 324-9619
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tdd: (501) 324-9811
e-mail: info@arkansasheritage.org
website:
http://naturalheritage.com

An Equal Opportunity Employer

Date: March 14, 2006
Subject: Bayou Meto Basin, Arkansas
General Reevaluation Report
Main Report and DEIS
ANHC No.: F-COEM-05-033

Commander
Memphis District, U.S. Army Corps of Engineers
ATTN: PM-E (Smith)
167 North Main Street, Room B-202
Memphis, TN 38103-1894

Dear Sir:

Staff members of the Arkansas Natural Heritage Commission (ANHC) have reviewed the Bayou Meto Basin General Reevaluation Report, Volume 1, Main Report and Draft Environmental Impact Statement (DEIS). The project is designed to provide a comprehensive water management plan for the Bayou Meto basin and includes three major components: (1) agricultural water supply and conservation and groundwater preservation, (2) flood control, and (3) waterfowl management.

We are pleased that the scope of the originally-authorized project was broadened to include, among other purposes, waterfowl management as a primary purpose. Placing natural resources management on an equal footing with more traditional purposes such as flood control and agricultural water supply is critical to meeting today's water resource management needs. Planning for the project included studies by Klimas and Heitmeyer and others that provided firm scientific basis for understanding the relationships among hydrology, geomorphology, soils, and wetland distribution and function. These studies also provided the basis for understanding the most effective and efficient approaches to wetland restoration and management within the basin. The U.S. Army Corps of Engineers is to be applauded for basing project features on such a solid scientific foundation.

Features proposed for the Bayou Meto Wildlife Management Area, in conjunction with the pump station on Little Bayou Meto, will greatly improve the capability for wise management of the wetlands and waterfowl resources of this premiere state area. ANHC led a study by the interagency environmental review team that identified several other priority waterfowl restoration features to be addressed by the project, including wetland restoration in the "Wabbaseka Scatters" area west of Bayou Meto Wildlife Management Area, riparian restoration along several basin watercourses, and restoration of an area between the existing forests of Bayou Meto WMA and the privately-owned and managed Big Ditch area upstream. Completion of these features will result in more functional wetlands as well as larger wetlands within the Basin.

The geomorphic study of Baker's Bayou commissioned as a part of project planning, added valuable knowledge about the geomorphic history of the basin. While not resulting in a project feature, it helped to deemphasize what would have been an inappropriate feature.

ANHC is most excited about the potential (detailed on pp. 184-190) for restoring large and small blocks of seasonal herbaceous wetlands representative of the Grand Prairie which occupied a substantial part of the project area but has been almost entirely converted to agricultural production. Restoration of substantial areas of native wetlands can help to restore populations of King Rails and other waterfowl and wetland species, along with upland species, that were virtually extirpated from the region along with the prairie vegetation. Doing so can also increase recharge of the aquifer and decrease demands on the aquifer, thus contributing to meeting other project purposes. ANHC will do everything possible to assist in accomplishing this project feature. Planting native prairie species on appropriate project rights-of-way will enhance this restoration effort.

Attached is an updated list of the species of special concern. This list includes those species recorded within both the Irrigation Water Distribution District Boundaries and the Flood Control Boundaries. Five state concern species have been added to the list: beach-dune tiger beetle (*Cicindela hirticollis*), black sandshell mussel (*Ligumia recta*), taillight shiner (*Notropis maculatus*), ornate box turtle (*Terrapene ornata ornata*) and Oklahoma grass-pink (*Calopogon oklahomensis*). Three state concern species have been downgraded, and do not appear on the new version of the list: yellow-crowned night heron (*Nyctanassa violacea*, now considered a "watchlist" species), southern rein-orchid (*Platanthera flava*), and the sedge (*Carex bulbostylis*). A legend is provided to help interpret the codes used on the list.

The opportunity to comment is appreciated.

Sincerely,

Cindy Osborne for

Tom Foti
Chief of Research

LEGEND

STATUS CODES

FEDERAL STATUS CODES

C = Candidate species. The U.S. Fish and Wildlife Service has enough scientific information to warrant proposing this species for listing as endangered or threatened under the Endangered Species Act.

LE = Listed Endangered; the U.S. Fish and Wildlife Service has listed this species as endangered under the Endangered Species Act.

LT = Listed Threatened; the U.S. Fish and Wildlife Service has listed this species as threatened under the Endangered Species Act.

-PD = Proposed for Delisting; the U.S. Fish and Wildlife Service has proposed that this species be removed from the list of Endangered or Threatened Species.

PE = Proposed Endangered; the U.S. Fish and Wildlife Service has proposed this species for listing as endangered.

PT = Proposed Threatened; the U.S. Fish and Wildlife Service has proposed this species for listing as threatened.

T/SA
E/SA = Threatened (or Endangered) because of similarity of appearance.

STATE STATUS CODES

INV = Inventory Element; The Arkansas Natural Heritage Commission is currently conducting active inventory work on these elements. Available data suggests these elements are of conservation concern. These elements may include outstanding examples of Natural Communities, colonial bird nesting sites, outstanding scenic and geologic features as well as plants and animals, which, according to current information, may be rare, peripheral, or of an undetermined status in the state. The ANHC is gathering detailed location information on these elements.

WAT = Watch List Species; The Arkansas Natural Heritage Commission is not conducting active inventory work on these species, however, available information suggests they may be of conservation concern. The ANHC is gathering general information on status and trends of these elements. An "*" indicates the status of the species will be changed to "INV" if the species is verified as occurring in the state (this typically means the agency has received a verified breeding record for the species).

MON = Monitored Species; The Arkansas Natural Heritage Commission is currently monitoring information on these species. These species do not have conservation concerns at present. They may be new species to the state, or species on which additional information is needed. The ANHC is gathering detailed location information on these elememts

SE = State Endangered; the Arkansas Natural Heritage Commission applies this term to native plant taxa which are in danger of being extirpated from the state.

ST = State Threatened; The Arkansas Natural Heritage Commission applies this term to native plant taxa which are believed likely to become endangered in Arkansas in the foreseeable future, based on current inventory information.

DEFINITION OF RANKS

Global Ranks

G1 = Critically imperiled globally. At a very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

G2 = Imperiled globally. At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

G3 = Vulnerable globally. At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

G4 = Apparently secure globally. Uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5 = Secure globally. Common, widespread and abundant.

GH = Of historical occurrence, possibly extinct globally. Missing; known from only historical occurrences, but still some hope of rediscovery.

GU = Unrankable. Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

GX = Presumed extinct globally. Not located despite intensive searches and virtually no likelihood of rediscovery.

GNR = Unranked. The global rank not yet assessed.

GNA = Not Applicable. A conservation status rank is not applicable.

T-RANKS= T subranks are given to global ranks when a subspecies, variety, or race is considered at the state level. The subrank is made up of a "T" plus a number or letter (1, 2, 3, 4, 5, H, U, X) with the same ranking rules as a full species.

State Ranks

S1 = Critically imperiled in the state due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors making it vulnerable to extirpation.

S2 = Imperiled in the state due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it vulnerable to extirpation.

S3 = Vulnerable in the state due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

S4 = Apparently secure in the state. Uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5 = Secure in the state. Common, widespread and abundant.

SH = Of historical occurrence, with some possibility of rediscovery. Its presence may not have been verified in the past 20-40 years. A species may be assigned this rank without the 20-40 year delay if the only known occurrences were destroyed or if it had been extensively and unsuccessfully sought.

SU = Unrankable. Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

SX = Presumed extirpated from the state. Not located despite intensive searches and virtually no likelihood of rediscovery.

SNR = Unranked. The state rank not yet assessed.

SNA = Not Applicable. A conservation status rank is not applicable.

General Ranking Notes

Q = A "Q" in the global rank indicates the element's taxonomic classification as a species is a matter of conjecture among scientists.

RANGES= Ranges are used to indicate a range of uncertainty about the status of the element.

? = A question mark is used to denote an inexact numeric rank.

B = Refers to the breeding population of a species in the state.

N = Refers to the non-breeding population of a species in the state.

3/14/2006

Arkansas Natural Heritage Commission
Department of Arkansas Heritage
Species of Special Concern
Bayou Meto Basin Study Area
(Bayou Meto Regional Irrigation Water Distribution District and Flood Control Area)

Scientific Name	Common Name	Federal Status	State Status	Global Rank	State Rank
Animals-Invertebrates					
Cicindela hirticollis	beach-dune tiger beetle	-	INV	G5	S2S3
Ligumia recta	black sandshell	-	INV	G5	S2
Animals-Vertebrates					
Fish					
Moxostoma macrolepidotum	shorthead redhorse	-	INV	G5	S2?
Notropis maculatus	taillight shiner	-	INV	G5	S3
Reptiles					
Deirochelys reticularia miaria	western chicken turtle	-	INV	G5T5	S3
Regina grahamii	graham's crayfish snake	-	INV	G5	S2
Terrapene ornata ornata	ornate box turtle	-	INV	G5T5	S2
Birds					
Gallinula chloropus	Common Moorhen	-	INV	G5	S1B,S2N
Haliaeetus leucocephalus	Bald Eagle	LT-PD	INV	G4	S2B,S4N
Limnothlypis swainsonii	Swainson's Warbler	-	INV	G4	S3B
Porphyrio martinica	Purple Gallinule	-	INV	G5	S1B
Sterna antillarum athalassos	Interior Least Tern	LE	INV	G4T2Q	S2B
Plants-Vascular					
Calopogon oklahomensis	Oklahoma grass-pink	-	INV	G4?	S2
Eustoma exaltatum	catchfly prairie gentian	-	INV	G4G5	S2
Leitneria floridana	corkwood	-	INV	G3	S3
Oenothera pilosella ssp. sessilis	prairie evening primrose	-	ST	G5T2Q	S2
Thalia dealbata	powdery thalia	-	INV	G4	S3

CITY OF LONOKE
Thomas J. Privett
Mayor

Office 501-676-6123 ◆ Fax 501-676-2500

March 21, 2006

Jim Lloyd
US Army Corps of Engineers
167 North Main Street, B202
Memphis, TN 38103-1894

Dear Mr. Lloyd,

The General Reevaluation Plan for the Bayou Meto Basin is the culmination of years of planning by the Federal, state and local planners. It addresses the groundwater, flood control and waterfowl needs of the people of the City of Lonoke, AR (or County of Lonoke, AR). In particular, it provides groundwater protection in the first agricultural area to be designated by the State as a Critical Groundwater Depletion Area.

This project will allow the agricultural community to remain productive for the nation and locally provide needed jobs. The generated tax revenue supports local government and schools. This project is important to the region and the nation and I request the report be approved and constructed.

Sincerely,

Thomas J. Privett
Mayor

TJP/gkp

CC: Sullivan & Associates

107 W. Second Street ◆ Lonoke, Arkansas 72086

STATE OF ARKANSAS
OFFICE OF THE GOVERNOR

Mike Huckabee
Governor

January 23, 2006

Colonel Charles Smithers, III
US Army Corps of Engineers – Memphis District
167 North Main Street, B 202
Memphis, Tennessee 38103-1894

Dear Colonel Smithers:

The General Reevaluation Plan for the Bayou Meto Basin is the culmination of nine years of comprehensive planning by a team of federal, state and local water resource planners. It adequately addresses the needs of the people in the Bayou Meto Basin while protecting and conserving our natural resources. The plan has three components addressing vital water resource concerns.

The Groundwater Protection/Irrigation Water Supply component provides for groundwater protection in the first agricultural area to be designated by the State as a "Critical Groundwater Depletion Area." It also allows landowners to maintain their current level of irrigated agriculture in the basin and provides over $32,000,000 in average annual benefits.

The Waterfowl Management component provides benefits that extend far beyond the borders of our state. It provides for the structural work needed to allow the Arkansas Game and Fish Commission to properly manage the 38,000-acre Bayou Meto Wildlife Management Area, one of the most important wintering areas for mallards in the North American Flyway. This component also provides for the restoration of 23,000 acres of bottomland hardwood and 10,000 acres of native prairie grasses.

The Flood Control component provides average annual benefits of over $5,000,000. It also provides the protection necessary to restore the hardwoods and properly manage the Bayou Meto Wildlife Management Area.

The local landowners have voluntarily organized an entity with the necessary legal authority to carry out the non-federal responsibilities for project implementation, are

State Capitol Building, Suite 250 * Little Rock, AR 72201 * mike.huckabee@state.ar.us
501-682-2345 * Fax 501-682-1382 * TDD 501-682-7515

currently taxing their land, and were anxious to move ahead with the project. This project is extremely important to the people and natural resources of the State of Arkansas and I urge the executive and legislative branches of our federal government to join the State of Arkansas and local landowners in approving and building this project in a timely manner.

Sincerely yours,

Mike Huckabee

Mike Huckabee

MH:jry:th

cc: J. Randy Young, Executive Director, ANRC

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
Director

Cc: Bayou Meto Regional Irrigation Water District

Bcc: Commissioners
Colonel Charles O. Smithers, USACE Memphis District
Colonel Anthony C. Vesay, USACE Vicksburg District
Edward Lambert, USACE Memphis District
U. S. Fish & Wildlife Service

The Department of
Arkansas Heritage

Mike Huckabee, Governor
Cathie Matthews, Director

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www.arkansaspreservation.org

January 27, 2006

Commander
ATTN: PM-E (Smith)
Memphis District Corps of Engineers
167 North Main Street, Room B-202
Memphis, Tennessee 38103-1894

RE: Multi County - General
Section 106 Review - COE
Bayou Meto Irrigation and Flood Control Project
AHPP Tracking No: 55116

To Whom It May Concern:

My staff has reviewed the document entitled "Bayou Meto Basin, Arkansas General Reevaluation Report" together with its draft Environmental Impact Statement (DEIS). This voluminous document reflects a study of the Bayou Meto Irrigation Project, but we find that it lacks specifics regarding the management of cultural resources. However, we agree that a Programmatic Agreement is needed so that this undertaking can proceed in a manner that takes into account the needs of construction scheduling. While the Memphis District Corps of Engineers is the lead federal agency for this undertaking, the other consulting parties should be signatories to any agreement document.

Thank you for the opportunity to comment on this undertaking. 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. Christopher G. Davies, Little Rock District Corps of Engineers
Dr. Steven G. Del Sordo, Advisory Council on Historic Preservation
Dr. Ann M. Early, Arkansas Archeological Survey
Mr. Don L. Klima, Advisory Council on Historic Preservation
Mr. Jimmy D. McNeil, Memphis District Corps of Engineers
Mr. Kalven Trice, Natural Resources Conservation Service
Mr. Anthony Whitehorn, Osage Nation
Ms. Carrie V. Wilson, Quapaw Tribe of Oklahoma
Mr. Jim Wojtala, Vicksburg District Corps of Engineers

Farelly Lake Levee District

718 Hwy 343
DeWitt, Arkansas 72042

Phone 870-946-3383
Fax 870-946-2384

March 20, 2006

Mr. James W. Lloyd, P.E.
167 N. Main Rm B202
Memphis, Tennessee 38103-1894

Dear Mr. Lloyd,

At a meeting of the Farelly Lake Levee District Board of Commissioners on March 15, 2006, the following action was taken. The Farelly Lake Levee District of Arkansas and Jefferson Counties, Arkansas, supports the Bayou Meto Basin Project.

The Farelly Lake Levee District is a flood control district. The district is located, in part, on the lower end of Little Bayou Meto, where a floodgate is in place to help control flooding. After a presentation by representatives of both the Vicksburg and Memphis Corps of Engineers, and the Executive Director of the Bayou Meto Water Management District, all of the project information was reviewed. It is our conclusion that the Bayou Meto Basin Project has addressed all of the issues that are in the area of responsibility of the Farelly Lake Levee District.

Plan components that make the project compatible include the Little Bayou Meto Pump Station, a water control structure at the upper end of the channel, a guide levee to keep Little Bayou Meto and Big Bayou Meto separate, and proper channel excavation. With these, and other components in place, there are many flood control benefits to be gained.

Thank you for involving and including the Farelly Lake Levee District in the recommended plan.

Sincerely,

Eddie Lumsden, Chairman
Farelly Lake Levee District

cc: Mr. Steve Orlicek, Farelly Lake Levee District
Mr. Tommy Sollars, Farelly Lake Levee District
Mr. Leland Fuhrman, Farelly Lake Levee District
Mr. Jesse Briggs, Farelly Lake Levee District
Mr. Sam Luckie, Farelly Lake Levee District
Mr. Robert Standley, Southeast Arkansas Project Office
Mr. Jeffery Maxey, Southeast Arkansas Project Office
Mr. Jim Spencer, Project Resources Management Branch
Mr. Gene Sullivan, Bayou Meto Water Management District

February 2, 2006

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E (Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

My family owns and farms land on both sides of Little Bayou Meto between Reydel, Arkansas and the Arkansas River. I am against the Bayou Meto Project. Too much of our good farmland would be claimed by the project.

The project would affect several of our neighbors' homes that are on the Bayou. The town of Reydel, its Post Office and Baptist Church, which has been there over 60 years, would be affected, as well as the historic Abbey Cemetery that borders the bayou.

Agricultural water supply has not been a problem for us or Reydel. Flooding is a rare occurrence and is not as devastating as the project would be for the area. Waterfowl are attracted to the natural situation of the bayou as is.

I feel that the project is an unnecessary expense and an unnecessary project. I am against the Little Bayou Meto Basin project. It would destroy the area.

Sincerely,

Barbara Kauppila

Barbara Kauppila

February 2, 2006

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E (Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

My family owns and farms land on both sides of Little Bayou Meto between Reydel, Arkansas and the Arkansas River. I am strongly against the Little Bayou Meto Project. Too much of our good farmland would be claimed by the project.

The project would affect several of our neighbors' homes that are on the Bayou. The town of Reydel, its Post Office and Baptist Church, which has been there over 60 years, would be affected, as well as the historic Abbey Cemetery that borders the bayou.

Agricultural water supply has not been a problem for us or Reydel. Flooding is a rare occurrence and is not as devastating as the project would be for the area. Waterfowl are attracted to the natural situation of the bayou as is.

I feel that the project is an unnecessary expense and an unnecessary project. I am against the Little Bayou Meto Basin project. It would destroy the area.

Sincerely,

Rodney Kauppila

Rodney Kauppila

120 Riverview Way
Hot Springs, AR 71901
February 5, 2006

Commander, Memphis District, U.S. Army Corps of Engineers
ATTN: PM-E (Smith)
167 North Main Street, Room B-202
Memphis, TN 38103-1894

Dear Mr. Smith:

I am writing concerning the proposed project on the Bayou Meto Basin in Arkansas, specifically the area of Little Bayou Meto connected to Reydell, Arkansas in Jefferson County. My parents Mr. and Mrs. Sam Luckie own our family farm, part of which is adjacent to Little Bayou Meto.

My first concern is that they nor any other landowner connected to Little Bayou Meto was contacted by your office regarding this project. They would not have known about the meeting in Lonoke on January 25, 2006, had it not been for a family friend.

My second concern is that it has still not been made clear to the landowners what specifically you wish to accomplish with the project. The three components have been listed: 1) agricultural water supply, 2) flood control, and 3) waterfowl management. But nowhere have I seen specifics on how any of it will be accomplished, and who exactly will benefit from the project.

My final concern is that no one seems to have taken into consideration what will be destroyed by the project. Under "Construction Items" in the Plan Components it states "One private bridge and one public bridge will be affected by this work along with some utility lines." Do you realize that numerous homes, businesses, a church, a cemetary and many acres of productive farmland will be destroyed? It appears to me that more harm than good will be done by the proposed Bayou Meto Project.

I hope these and other concerns expressed by all affected parties will be addressed before pursuing the Bayou Meto Basin Project.

Sincerely,

Jane Yahoda

Jane Yahoda

cc: State Representative David Rainey
State Senator Hank Wilkins
U.S. Congressman Mike Ross

February 10, 2006
16801 Nathan Road
Stuttgart, AR 72160

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E M. Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

This letter concerns the Little Bayou Meto Expansion project as it relates to the Grand Prairie Water Distribution Project. I am against this portion of the project.

As a resident of the Reydel area I am aware that we are not a part of the Alluvial Aquifer nor are we a part of the Grand Prairie.

The widening of Little Bayou Meto between the Bayou Meto Wildlife Management Area and the Arkansaa River seems unnecessary. The bayou itself is already quite wide and deep. The farmland adjacent to it and the WMA above seem to rarely flood. There are several places of which they drain naturally. The WMA has several pumps and weirs already in place and several different natural drainage directions.

I fear if Little Bayou Meto is changed it will threaten the homes, farmland, church, post office and cemetery that are so close to it. The Abby Cemetery is on my family's farm and is on the bayou bank.

The only thing I would consider helpful would be a less expensive cleaning out of brush and timber of Little Bayou Meto and the pump station next to the existing flood gate at the end of Little Bayou Meto as is in the plan.

Thank you for your consideration of this matter.

Sincerely,

Mary Ann DuMond

Mary Ann Luckie DuMond

February 2, 2006

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E (Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

My family owns and farms land on both sides of Little Bayou Meto between Reydel, Arkansas and the Arkansas River. I am strongly against the Little Bayou Meto Project. Too much of our good farmland would be claimed by the project.

The project would affect several of our neighbors' homes that are on the Bayou. The town of Reydel, its Post Office and Baptist Church, which has been there over 60 years, would be affected, as well as the historic Abbey Cemetery that borders the bayou.

Agricultural water supply has not been a problem for us or Reydel. Flooding is a rare occurrence and is not as devastating as the project would be for the area. Waterfowl are attracted to the natural situation of the bayou as is.

I feel that the project is an unnecessary expense and an unnecessary project. I am against the Little Bayou Meto Basin project. It would destroy the area.

Sincerely,

Julie Kauppila

Julie Kauppila

February 2, 2006

Commander
Memphis District
U.S. Army Corps of Engineers
Attn: PM-E (Smith
167 North Main Street
Memphis, TN 38103-1894

Dear Sirs:

My family owns and farms land on both sides of Little Bayou Meto between Reydel, Arkansas and the Arkansas River. I am strongly against the Little Bayou Meto Project. Too much of our good farmland would be claimed by the project.

The project would affect several of our neighbors' homes that are on the Bayou. The town of Reydel, its Post Office and Baptist Church, which has been there over 60 years, would be affected, as well as the historic Abbey Cemetery that borders the bayou.

Agricultural water supply has not been a problem for us or Reydel. Flooding is a rare occurrence and is not as devastating as the project would be for the area. Waterfowl are attracted to the natural situation of the bayou as is.

After reviewing the scope of the project, I feel that this decision is utterly ridiculous. The flood control in place is more than sufficient if maintained. You are basically destroying a community, wetlands, and perfectly good farm land. I don't know if you are designing for a couple 100-year storms or what, but your design is wasting money at our expense. This farm has been in our family for years and will continue to for years to come. No price per acre you can offer will suffice compared to the constant money flow from a rare necessity for the nation. I am not about to see something happen to my farm, that my ancestors put all their hearts into.

I feel that the project is an unnecessary expense and an unnecessary project. I am against the Little Bayou Meto Basin project. It would destroy the area. Consider a redesign that is cheaper, more environmental friendly, and less destructive of farm land.

Sincerely,

Joel Kauppila, EIT
Reynolds, Smith, and Hills CS, Inc.
Luckie Farms Owner
Cell: 904-477-8690
joel.kauppila@rsandh.com

Arkansas GEOLOGICAL COMMISSION

VARDELLE PARHAM GEOLOGY CENTER•3815 WEST ROOSEVELT ROAD• LITTLE ROCK, ARKANSAS 72204

Mike Huckabee
Governor
Bekki White
Director and State Geologist

January 9, 2006

Commander
Memphis District, U.S. Army Corps of Engineers
ATTN: PM-E (Smith)
167 North Main Street, Room B-202
Memphis, TN 38103-1894

Dear Sir:

This letter is a response to a request by the U.S. Army Corps of Engineers for comments on the Bayou Meto Basin, Arkansas, General Reevaluation Report, Volume 1, Main Report and Draft Environmental Impact Statement (DEIS) dated December 2005. Since the sections in the report that describe the geology and hydrogeology are more than adequate I find no need to add further comment.

Sincerely,

William Lee Prior
Geologist Supervisor

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