Appendix C
Biological Resources

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APPENDIX C:

BIOLOGICAL RESOURCES

C.1 Introduction

This appendix includes additional information concerning biological resources located in the MKARNS system and associated properties. Biological resources as discussed previously in this document, includes threatened and endangered species, other protected species, wetlands, aquatic resources, and terrestrial resources. The documents included in this section and their authors are as follows:

- USFWS Planning Aid and CAR, USFWS;
- Biological Assessment, Tulsa District USACE;
- USFWS Draft Biological Opinion, USFWS;
- Terrestrial Habitat Evaluation Procedures, Parsons in coordination with ERDC-EL;
- Aquatic Habitat Evaluation Procedures, ERDC-EL;
- Aquatic Mitigation Summary, USACE
- Aquatic Monitoring and Adaptive Management, USACE
- Aquatic Mitigation Cost Effective and Incremental Cost Analysis, USACE
- Mussel Survey, Ecological Specialists Inc.;
- Geomorphic Assessment, ERDC-EL; and
- Prime Farmland Coordination, Parsons and NRCS.

C.2

USFWS Planning Aid and CAR

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
222 S. Houston, Suite A
Tulsa, Oklahoma 74127

April 2, 2001

Thomas A. Holden, Jr.
U.S. Army Corps of Engineers
P. O. Box 867
Little Rock, Arkansas 72203 – 0867

#2-14-01-I-0385

Dear Colonel Holden:

This transmits planning information for the Arkansas River Navigation Study, Arkansas and Oklahoma. The purpose of the study is to develop and evaluate various solutions for the economic problems resulting from the sustained high flows on the McClellan-Kerr Arkansas River Navigation System (MKARNS). The MKARNS experiences sustained high flows from the upper reaches of the Arkansas River watershed that result in decreased navigation traffic, losses to recreational use, flooding, and other adverse effects. The area for this feasibility study consists of the entire MKARNS in Arkansas and Oklahoma, and the study will be conducted in two phases.

The first phase is expected to take three years to complete, and will investigate various alternatives to reduce impacts of high flows, such as operational changes to existing reservoirs on the MKARNS, additional storage in the existing reservoirs, and construction of additional lakes and levees. If funding is continued, the second phase will overlap with the third year of the first phase, and take an additional two years to complete. This phase will investigate the feasibility of deepening the entire length of the MKARNS and adding passing lanes on the Verdigris River in Oklahoma. The enclosed Planning Aid Report provides preliminary information on existing fish and wildlife resources present.

This planning assistance report is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. et seq.), but is not intended to fulfill the reporting requirements of Section 2 (b) of the Act.

We appreciate the opportunity to participate in this study during the preliminary planning phase, and look forward to further coordination should additional planning be initiated. If you have any questions, please contact Richard Stark at 918-581-7458, extension 240.

Sincerely,

Jerry J. Brabander
Field Supervisor

Enclosure

This page reproduces the text from the April 2, 2001 letter from the USFWS on the preceding page as the scanned document is difficult to read.

April 2, 2001

Thomas A. Holden, Jr. #2-14-01-I-0385
U.S. Army Corps of Engineers
P. O. Box 867
Little Rock, Arkansas 72203 – 0867

Dear Colonel Holden:

This transmits initial planning information for the Arkansas River Navigation Study, Arkansas and Oklahoma. The purpose of the study is to develop and evaluate various solutions for the economic problems resulting from the sustained high flows on the McClellan-Kerr Arkansas River Navigation System (MKARNS). The MKARNS experiences sustained high flows from the upper reaches of the Arkansas River watershed that result in decreased navigation traffic, losses to recreational use, flooding, and other adverse effects. The area for this feasibility study consists of the entire MKARNS in Arkansas and Oklahoma, and the study will be conducted in two phases.

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Sincerely,

Jerry J. Brabander
Field Supervisor

cc: Director, Oklahoma Department of Wildlife Conservation, Oklahoma City, OK
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Manager, White River National Wildlife Refuge, DeWitt, AR
Manager, Holla Bend National Wildlife Refuge, Dardanelle, AR

RCS:ag:FA/ARNS-PAL.COE

PLANNING AID REPORT

ARKANSAS RIVER NAVIGATION STUDY, ARKANSAS AND OKLAHOMA

Little Rock District

U.S. Army Corps of Engineers

Prepared by Richard C. Stark

Oklahoma Ecological Services

U.S. Fish and Wildlife Service

Tulsa, Oklahoma

March 2001

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INTRODUCTION

This report provides information on fish and wildlife resources associated with the McClellan-Kerr Arkansas River Navigation System (MKARNS) for use during the preliminary planning phase of the Arkansas River Navigation Study, Arkansas and Oklahoma (ARNS). Specifically, this report is intended to provide an overview of the existing fish and wildlife resources associated with the MKARNS, address possible impacts to fish and wildlife resources, discuss unmet mitigation needs associated with the initial development of the MKARNS, and provide preliminary recommendations for fish and wildlife habitat restoration projects. This report is based largely on past Fish and Wildlife Service (Service) reports concerning resources in the project area (Arkansas River/MKARNS) in Oklahoma and Arkansas. Concerns and recommendations listed here are preliminary and subject to change upon receipt of more detailed project descriptions.

The purpose of the Study is to develop and evaluate various operational changes to the MKARNS that will serve as solutions to the problems resulting from sustained high flows on the MKARNS that originate from the upper reaches of the Arkansas River watershed. These problems include decreased navigation traffic, flooding, and losses to recreational use. Alternatives currently are being developed to address these problems.

This report has been coordinated with the Oklahoma Department of Wildlife Conservation (ODWC) and the Arkansas Game and Fish Commission (AGFC) and is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended, 16 U.S.C. 661 et seq.), but is not intended to fulfill the reporting requirements of Section 2 (b) of the Act. A formal Fish and Wildlife Coordination Act report from the Service will be prepared after the Corps develops formal project alternatives.

PROJECT AREA

The following description of the project area is based largely on the ecoregions (i.e., large geographic divisions based on natural communities, geology, and land use) as mapped by Omernik (1995), and on the recent conservation assessments of the terrestrial and freshwater ecoregions of North America undertaken by the World Wildlife Fund (Abell et al., 2000; Ricketts et al., 1999). These assessments divide the continent into coarse terrestrial and freshwater ecoregions similar to other classification schemes such as Kuchler (1975), Bailey (1994) and Omernik (1995), and describe the biodiversity of each area.as well as the threats that each ecoregion currently faces.

The area for this study consists of the entire 445–mile–long MKARNS in Arkansas and Oklahoma (Figure 1) (except for the ten mile White River entrance channel), and the 11 upstream multi-purpose reservoirs in Oklahoma that act as the MKARNS's primary flow modifiers: Copan, Hulah, Oologah, Kaw, Keystone, Pensacola (Grand), Hudson (Markham Ferry), Fort Gibson, Tenkiller Ferry, Eufaula, and Wister (Table 1). The MKARNS has a minimum depth of nine feet, a minimum width of 250 feet, and a normal current velocity range between two and four miles per hour. The upstream reservoirs can store about 7.6 million acre-feet of water for flood control, and each project has a specific purpose as authorized by Congress (Table 1). Although the Corps has broad authority to modify the operations of the reservoirs to benefit navigation, navigation is an authorized purpose for only 3 reservoirs (Oologah, Keystone, and Eufaula), and operational plans of the reservoirs cannot be changed in a way that is detrimental to their authorized purpose.

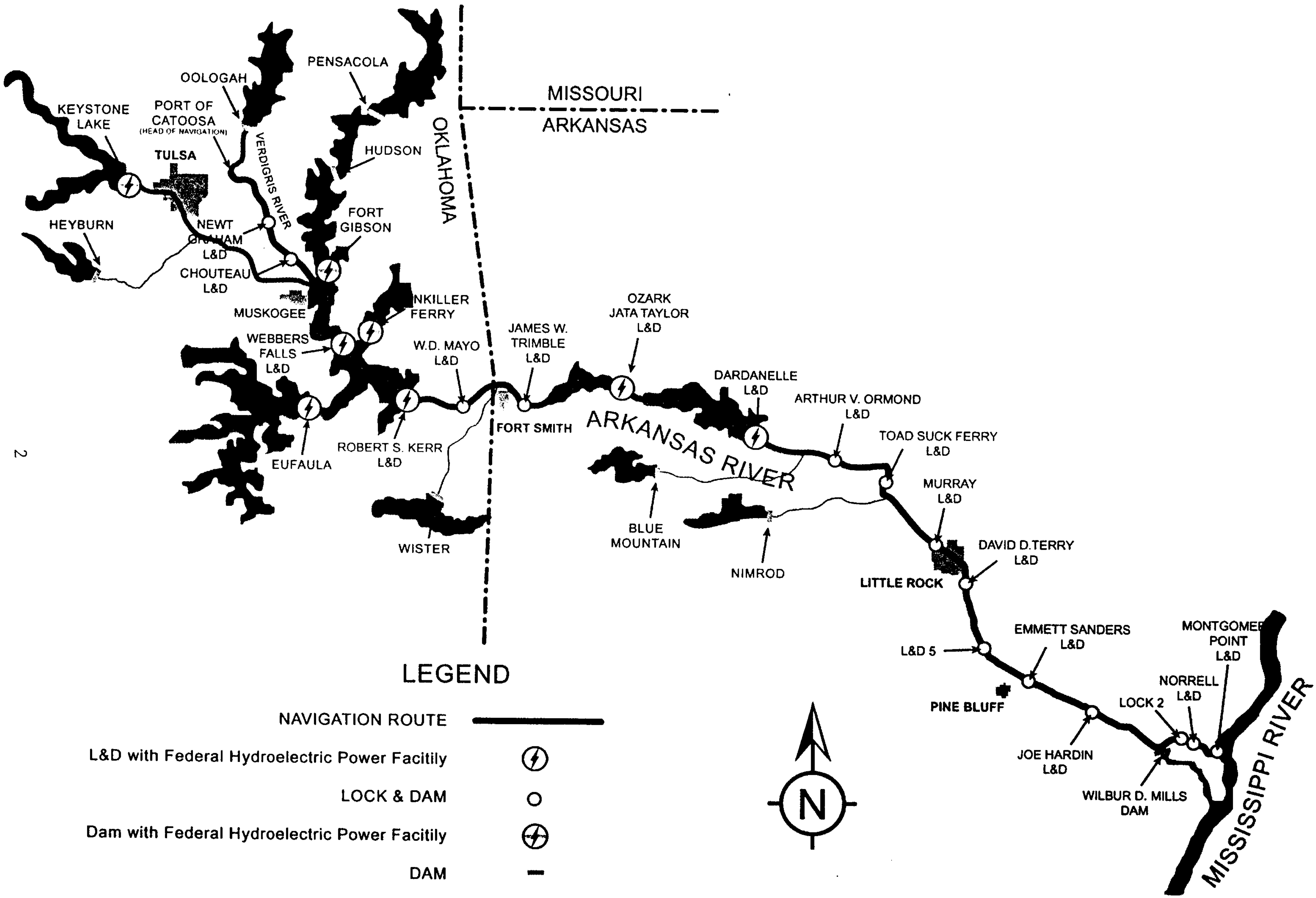

Figure 1. Location of the McClellan-Kerr Arkansas River Navigation System.

Table 1. Information on the Eleven upstream reservoirs in Oklahoma (US Fish and Wildlife Service, 1985; Oklahoma Water Resources Board, 1990).

Reservoir	Agency	Counties	River/Stream and Purpose of reservoir	Ecoregion (Ricketts et al., 1999)	Normal pool(acres)/ elevation (NGVD)	Flood pool(acres)/ elevation (NGVD)	Drainage area (sq. miles)	Shoreline length (miles)
Copan	Corps	Washington	Little Caney River; flood control, water supply, water quality control, recreation, fish and wildlife	Central Forest/ Grassland Transition Zone	4, 850/710.0	13, 380/732.0	505	30
Hulah	Corps	Osage	Caney River; flood control, water supply, low-flow regulation, conservation	Flint Hills Tall Grasslands/ Central Forest Grassland Transition Zone	3, 570/733.0	13, 000/765.0	732	62
Oologah	Corps	Nowata, Rogers	Verdigris River; flood control, water supply, and navigation	Central Forest/Grassland Transition Zone	29, 460/638.0	56, 800/661.0	4, 339	180
Kaw	Corps	Kay, Osage	Arkansas River; flood control, water supply, water quality, recreation, fish and wildlife	Central and Souther Mixed Grasslands/Flint Hills Tall Grasslands	17, 040/1, 010.0	38, 020/1, 044.5	46, 530	168
Keystone	Corps	Osage, Creek, Pawnee, Tulsa	Arkansas and Cimarron River; flood control, water supply, hydroelectric power, navigation, fish and wildlife	Central Forest/ Grassland Transition Zone	23, 610/723.0	54, 320/754.0	74, 506	330
Grand	GRDA[1]	Ottawa, Delaware, Mayes	Neosho and Spring River; flood control, hydroelectric power	Central U.S. Hardwood Forests and Central Forest /Grassland Transition Zone	46, 500/745.0	59, 200/755.0	10, 298	1, 300

Table 1
continued

Reservoir	Agency	Counties	River/Stream and Purpose of reservoir	Ecoregion (Ricketts et al., 1999)	Normal pool(acres)/ elevation (NGVD)	Flood pool(acres)/ elevation (NGVD)	Drainage area (sq. miles)	Shoreline length (miles)
Hudson (Markham Ferry)	GRDA[1]	Mayes	Neosho River; flood control, hydroelectric power	Ozark Mountain Forests	250/756	NA	NA	8
Fort Gibson	Corps	Mayes, Wagoner, Cherokee	Neosho River; flood control, hydroelectric power	Ozark Mountain Forests	19, 900/554.0	51, 000/582.0	12, 492	225
Tenkiller	Corps	Cherokee, Sequoyah	Illinois River; flood control, hydroelectric power	Ozark Mountain Forests	12, 900/632.0	20, 800/667.0	1, 610	130
Eufaula	Corps	McIntosh, Pittsburg	North Canadian, South Canadian, and Deep Fork; flood control, water supply, hydroelectric power, navigation	Central Forest/ Grassland Transition Zone	105, 000/585.0	143, 000/597.0	47, 522	600
Wister	Corps	LeFlore	Poteau River and Fourche Maline Creek; flood control, water supply, low flow augmentation, water conservation and sedimentation	Ozark Mountain Forests	7, 333/478.0	23, 070/502.5	993	115

1 Grand River Dam Authority

Although the Arkansas River constitutes a large portion of the MKARNS, the Arkansas River and the reservoirs on or associated with the river are not one in the same with the MKARNS. The MKARNS consists of four distinct segments: fifty miles of the Verdigris River in Oklahoma (RM 445 - 394), 375 miles of the Arkansas River proper in Oklahoma and Arkansas (RM 394 - 19), the manmade Arkansas Post Canal (RM 19 -10), and the White River entrance channel in Arkansas (RM 10 -0). The MKARNS was constructed to enable large vessels to overcome the steep slope of the Arkansas River Valley due to the 420-foot difference in elevation from the Mississippi River to the head of the MKARNS near Catoosa, Oklahoma.

There are 17 existing locks and dams on the MKARNS (all 110 feet wide by 600 feet long) with 5 in Oklahoma and 12 in Arkansas; and one currently is under construction on the White River entrance channel. Although the series of locks, dams, and reservoirs associated with the MKARNS can be considered beneficial because they allow inland navigation and provide flood control, hydroelectric power, water supply, and recreational activities such as boating, camping, fishing, hunting, and hiking, they have also resulted in negative ecological impacts. These include inundation of vast areas of numerous natural habitat types including forests, grasslands, palustrine and riverine wetlands, tributary streams, and oxbow lakes; additional ecological impacts have occurred as a result of secondary development such as dredging and vegetation removal.

The head of the MKARNS is at the Port of Catoosa in Rogers County in northeast Oklahoma near Tulsa (navigation mile 444.8). From this port, the MKARNS follows the Verdigris River for 50 miles southeasterly through the Newt Graham Lock and Dam (# 18 at NM 421.4) and the Chouteau Lock and Dam (# 17 at NM 401.4) in Wagoner County. This area of Oklahoma is in the Central Forest/Grassland Transition Zone terrestrial ecoregion (CTZ) (Ricketts et al. 1999) and the Central Prairie freshwater ecoregion (Abell et al. 2000). The area is a combination of Omernik's (1995) Central Irregular Plains and Central Oklahoma/Texas Plains. The Arkansas, Grand, Verdigris, Cimarron, and Canadian Rivers each drain portions of this area of Oklahoma.

Oologah, Keystone, Copan, Fort Gibson, Hudson, and Eufaula Reservoirs are located in this portion of the study area, which consists primarily of a mixture of prairie, savannah, and woodlands on low rolling hills, and broad floodplain forests of elm, oak, hackberry, cottonwood, and sycamore created by slow-moving and muddy tributaries. The grasslands occur on relatively deep and fertile soils as opposed to the thin layer of soil over limestone that occurs in the Flint Hills Tall Grasslands (Ricketts et al., 1999) to the northwest (location of Hulah Reservoir). The CTZ is distinguished from the Central and Southern Mixed Grasslands (Ricketts et al., 1999) of central and western Oklahoma (location of Kaw Reservoir) by its increased average annual precipitation resulting in a higher density of trees and shrubs.

Typical grasses of the CZT include big bluestem (Andropogon gerardi), little bluestem (Schizachyrium scoparium), Indian grass (Sorghastrum nutans), switchgrass (Panicum virgatum), and grama grasses (Bouteloua spp.) Upland forests dominated by oak (Quercus spp.) and hickory (Carya spp.) occur in the more mesic draws and ravines. The "crosstimbers" (wide belt of timber on the prairie encountered by explorers as they crossed the plains) also occur in this area on light colored sandy soils with reddish clay subsoils, and consist of hickory trees scattered among short post oak (Q. stellata) and blackjack oaks (Q. marilandica). Considered one of the richest places for biodiversity in North America because of its large size and proximity to both the great plains and eastern deciduous forests, this area is within the top 10 ecoregions for bird, reptile, and tree species (Ricketts et al. 1999). Much of the fauna is shared with the adjacent grassland ecoregions (prairie species can be found in the woodland understory layer).

The major aquatic habitat types are temperate headwaters and lakes. Endemism for aquatic species is relatively low (Abell et al. 2000). The biological distinctiveness of the area (i.e., the

biological importance of an ecoregion based on species richness and endemism, and rarity of ecological phenomena and habitat types within the ecoregion) is considered regionally outstanding (high regional biodiversity). Only 1 percent of the area is thought to be intact as a result of intensive farming for crops such as corn and soybeans, and the degree of fragmentation is ranked as extremely high (Ricketts et al., 1999).

The MKARNS joins the Arkansas River northeast of Muskogee in Muskogee County, Oklahoma (NM 395.0), and then extends southeasterly through Oklahoma toward Arkansas through Webbers Falls Lock and Dam (# 16 at NM 366.6) creating the 34.5 mile-long Webbers Falls Reservoir in portions of Muskogee, Wagoner, and Cherokee counties. Webbers Falls impounds 28 miles of the Arkansas River to the mouth of the Verdigris River and then 6.5 miles up the Verdigris to Chouteau Lock and Dam (U. S. Fish and Wildlife Service, 1983).

From Webbers Falls Lock and Dam, the channel forms a portion of the county line between Sequoyah and Muskogee and Sequoyah and Haskell counties near the Sequoyah National Wildlife Refuge (NWR) (described below), and then extends through Robert S. Kerr Lock and Dam (# 15 at NM 336.2) creating Robert S. Kerr Reservoir. Kerr Reservoir forms many irregular arms and peninsulas and extends about 32.7 navigation miles upstream to Webbers Falls Lock and Dam. From Kerr Reservoir, it continues along the Sequoyah/LeFlore County line through W. D. Mayo Lock and Dam (# 14 at NM 319.6), as it leaves Oklahoma and enters Arkansas, where it flows through the James W. Trimble Lock and Dam (#13 at NM 292.8) along the Crawford/Sebastian County line, and through the Ozark – Jeta Taylor Lock and Dam (# 12 at NM 256.8) in Franklin County creating Ozark Lake. Continuing southeasterly along the Johnson/Logan County line, the MKARNS forms Lake Dardanelle at Dardanelle Lock and Dam (#10 at NM 205.5), and then flows along the Yell/Pope County lines, forming the northern border of Holla Bend NWR (described below) in Pope County. From there, it flows through Arthur V. Ormond Lock and Dam (#9 at NM 176.9) in Conway County and along the Conway/Perry and Faulkner/Perry County lines where it extends through Toad Suck Ferry Lock and Dam (# 8 at NM 155.9). The MKARNS continues along the Faulkner/Pulaski County lines, and through the Murray Lock and Dam (# 7 at NM 125.4) in Paluski County near Little Rock.

This area of Oklahoma and Arkansas is within the Ozark Mountain Forests terrestrial ecoregion as defined by Ricketts et al. (1999) and the Central Prairie freshwater ecoregion from around Muskogee, Oklahoma, to the Oklahoma/Arkansas state line where the project area enters the Ozark Highlands freshwater ecoregion as defined by Abell et al. (2000). These ecoregions combine Omernik's (1995) Ouachita Mountains (location of Wister Reservoir), Ozark Mountains (location of Grand and Tenkiller Reservoirs), and Arkansas Valley ecoregions, with the Arkansas Valley occurring between the others. The Arkansas River floodplain is confined to the Arkansas Valley ecoregion.

Other major rivers in this broad area include the Grand, Illinois, and Poteau Rivers in Oklahoma and the Petit Jean, Fourche Lafave, and Ouachita Rivers in Arkansas.

The natural communities of the area include bottomland hardwood forests along rivers and streams, oak – hickory forests in upland sites, shortleaf pine savannas and mixed pine – hardwood forests on ridge tops, and scattered tallgrass prairie communities in the valley between the dry upland forests and bottomland hardwood forests. The limestone formation (karst geology) in the northern portion of the area (Ozarks) has dissolved in many places, forming caves. Many of the natural communities of the project area have been greatly altered by timber harvesting, cultivated agriculture, and development of the MKARNS. Riparian habitat along the

Arkansas River is considered severely degraded, and only about 3 percent of the pre-settlement habitat is intact as a result of agriculture, logging, fire suppression, and grazing (Ricketts et al., 1999). Several near-endemic herpetofauna species are found in this area including Strecker's chorus frog (Pseudacris streckeri), the ringed salamander (Ambystoma annulatum) (Abell et al., 2000) and the many-ribbed salamander (Eurycea multiplicata) (Conant and Collins, 1991).

From Little Rock, the Arkansas River/MKARNS continues southeasterly through the David D. Terry Lock and Dam (# 6 at NM 108.1) in Paluski County and through Lock and Dam # 5 (at NM 86.3) in Jefferson County. It then flows through Emmet Sanders Lock and Dam (#4 at NM 66.0) northeast of Pine Bluff. From there, it continues through Joe Hardin Lock and Dam (# 3 at NM 50.2) along the Jefferson/Lincoln County Line, and along the Arkansas/Lincoln and Arkansas/Desha county lines. It extends then through Lock # 2 (at NM 13.3) and Norrell Lock and Dam # 1 (at NM 10.3) as it follows the nine mile manmade Arkansas Post Canal in Arkansas County that connects the White and Arkansas Rivers. Finally, ten miles of the White River in eastern Arkansas (mile 599 on the Mississippi River) make up the MKARNS's entrance channel.

This portion of the MKARNS is within the Mississippi Embayment freshwater ecoregion (Abell et al., 2000) and the Mississippi Lowland Forest terrestrial ecoregion (Ricketts et al., 1999). In Arkansas, this is identical to Omernik's (1995) Mississippi Alluvial Plain. Other major rivers in the area are the White and Mississippi rivers. Wetland areas, oak-hickory-pine forests, and bottomland hardwoods once dominated the landscape; however, these habitats have been extensively altered resulting in the loss of most (91–95%) of the original riparian and bottomland forest systems. Much of the remaining floodplain forests include river swamp forests, forests of backwater and flats, and upland transitional forests. Much of the remaining habitat is restricted to wet areas that are difficult or not feasible to exploit economically through cultivation or other means (Ricketts et al., 1999). The biological distinctiveness of the Mississippi Embayment is considered globally outstanding (i.e., the biological diversity of the area is equaled or surpassed in few other places worldwide) (Abell et al., 2000).

The geology of the entire project area varies from recent alluvium and terrace deposits of the Mississippi Alluvial Plain in eastern Arkansas and the Mississippian and Pennsylvanian Ozark and Ouachita Highlands in central/western Arkansas and eastern Oklahoma, to the more recent Quaternarian sand dunes and silts of major drainages in the west. The area contains a variety of siltstones, sandstones, clays, sedimentary limestones, and shales formed during the Pennsylvanian and Permian periods (U. S. Fish and Wildlife Service, 1990).

The climate is primarily influenced by movement of moist air from the Gulf of Mexico, hot and dry air from the desert southwest, and cold air from the Arctic. The region undergoes seasonal variations in temperature and precipitation and typically experiences long, humid summers and short, mild winters. Mean annual precipitation increases from west to east and ranges from 36 inches near Keystone Reservoir west of Tulsa, Oklahoma, to 54 inches in eastern Arkansas at the Arkansas River's confluence with the Mississippi River. Average annual temperatures range from about 60–62° Fahrenheit, and the growing season varies from 209 days in the grasslands and crosstimbers of Oklahoma to about 220 days in the Mississippi Alluvial plain of eastern Arkansas.

PROJECT DESCRIPTION

The Study will be conducted in two phases. The first phase is expected to take three years, and will investigate possible operational changes that might improve the MKARNS's ability to evacuate high water from the eleven upstream reservoirs in Oklahoma and reduce impacts of sustained high flows. The potential alternatives include altering the reservoir regulation plan through operational changes to the MKARNS in Oklahoma which might include changes in flow rates and durations, reallocating storage from one reservoir to another, or adding storage in the reservoirs. Other possible changes include constructing additional reservoirs, additional high flow relief structures (i.e., spillways), and additional levees along the MKARNS, as well as adjustments/increases in flowage easements, removal of channel restrictions, in-stream modification of existing navigation structures, and restoration/enhancement of aquatic and riparian habitat along the MKARNS. If funding is continued, the second phase will overlap with the third year of the first phase, and take an additional two years to complete. This phase would investigate the feasibility of deepening the entire length of the MKARNS from 9 to 12 feet to allow for deeper tow drafts, and adding passing lanes on the Verdigris River in Oklahoma for increased tow safety. Formal project alternatives have not been developed to date.

FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

The Corps has not supplied formal project alternatives that will serve as potential solutions for the problems resulting from the sustained high flows on the MKARNS. Accordingly, this section will provide general information on the fish and wildlife resources in the vicinity of the project area. Specifically, this section includes general information on the terrestrial and aquatic fish and wildlife resources associated with the MKARNS, the eleven Oklahoma reservoirs and their associated rivers/streams, wildlife management areas, and national wildlife refuges. This section also covers information on the federally-listed proposed, threatened, endangered and species of concern, as well as state-listed and rare species that occur within the vicinity of the project area. Detailed descriptions of the aquatic and terrestrial resources of the individual reservoirs and associated streams/rivers have been described in previous reports on various individual projects (lock and dams, hydropower, etc.) and will not be repeated here. More detailed and quantitative information can be provided when specific project alternatives are available.

Arkansas River and Eleven Oklahoma Reservoirs: Aquatic Resources

A variety of fish species occur in the eleven reservoirs in Oklahoma that act as the MKARNS's primary flow modifier, in the Arkansas River/MKARNS in Oklahoma and Arkansas, and in other streams/rivers associated with the upstream reservoirs. Prior to construction of the locks, dams, and reservoirs on the MKARNS, the fish fauna in the various rivers/streams were diverse and unique. However, construction of the MKARNS has resulted in increased occurrence of minimum flows, stabilized channel conditions, and the creation of reservoirs that provide habitat for lake fishes, but limit habitat for native riverine species. The result of the changes is an overall more homogenous aquatic environment within the MKARNS that benefits particular fish fauna at the expense of others. Thus, the fishery resources are generally similar except in areas where trout are stocked below cold water discharges, such as in the lower Illinois below Tenkiller Ferry. A list of fish species common to the eleven upstream reservoirs in Oklahoma is provided in Table 2. Table 3 lists fish species found in the MKARNS in Oklahoma and Arkansas.

Management of the fishery resources in the project area is a cooperative effort between the Corps and the respective state wildlife agencies, and involves monitoring studies and stocking programs. Management programs recognize all species, but concentrate on those most popular with fishermen, such as largemouth bass, crappie, walleye, blue catfish, flathead catfish, white bass, and striped bass. More detailed information on fish species and required habitats can be provided when specific project details are available.

Other fishery resources of significance include oxbow lakes adjacent the MKARNS, tributaries

Table 2. Common fish species found in the eleven Oklahoma reservoirs.

	Copan	Hulah	Oologah	Kaw	Keystone	Grand	Hudson	Fort Gibson	Tenkiller	Eufaula	Wister
Species											
largemouth bass	x	x	x	x	x	x	x	x	x	x	
spotted bass						x	x	x	x		
smallmouth bass			x			x	x		x	x	
white crappie	x	x	x	x	x	x	x	x	x	x	
black crappie			x		x		x		x		
white bass		x	x		x	x	x	x	x	x	x
striped bass	x/hybid		x/hybrid	x	x	x/hybrid	x		x		
channel catfish	x	x	x	x	x	x		x	x	x	
bluegill	x	x	x	x	x	x	x	x	x	x	x
longear sunfish	x	x	x		x	x	x	x	x	x	
carp		x	x		x	x	x	x	x	x	x
freshwater drum		x	x		x	x	x	x	x	x	
smallmouth buffalo		x			x	x	x	x	x	x	
bigmouth buffalo		x	x				x	x	x	x	x
river carpsucker		x	x		x	x		x	x	x	
black bullhead								x	x		
spotted sucker									x		
golden redhorse									x	x	
river redhorse									x	x	
shorthead redhorse									x	x	
flathead catfish	x	x	x	x	x	x	x	x	x	x	x
xlongnose gar		x							x	x	
spotted gar		x							x	x	
gizzard shad		x	x	x	x	x	x	x	x	x	
walleye			x				x	x	x	x	
paddlefish			x	x		x	x	x			
black bullhead		x			x						
green sunfish		x	x		x	x	x	x	x	x	
warmouth			x		x	x	x	x	x	x	x
orange spotted		x	x		x		x	x			x
redear sunfish		x	x	x	x	x	x	x	x	x	x

Table 3. Fish species known to occur (not inclusive) in the MKARNS and tributaries in Oklahoma and Arkansas (Buchanan, 1976; Jimmie Pigg, unpublished data).

Common Name	Scientific Name
chestnut lamprey	*Ichthyomyzon castaneus*
bowfin	*Amia calva*
American eel	*Anguilla rostrata*
blue catfish	*Ictalurus furcatus*
channel catfish	*Ictalurus punctatus*
flathead catfish	*Pylodictus olivaris*
yellow bullhead	*Ictalurus natalis*
black bullhead	*Ictalurus melas*
tadpole madtom	*Notorus gyrinus*
brindled madtom	*Notorus miurus*
white bass	*Morone chrysoos*
striped bass	*Morone saxitalis*
largemouth bass	*Micropterus salmoides*
spotted bass	*Micropterus punctulatus*
black crappie	*Pomoxis nigromaculatus*
white crappie	*Pomoxis annularis*
walleye	*Stizostedion vitreum*
sauger	*Stizostedion canadense*
warmouth	*Lepomis gulosus*
green sunfish	*Lepomis cyanellus*
longear sunfish	*Lepomis megalotis*
bluegill	*Lepomis macrochirus*
orangespotted sunfish	*Lepomis humilis*
longnose gar	*Lepisosteus osseus*
spotted gar	*Lepisosteus oculatus*
shortnose gar	*Lepisosteus platostomus*

Table 3 continued

Common Name	Scientific Name
skipjack herring	*Alosa chrysochloris*
shovelnose sturgeon	*Scphirhynchus platorynchus*
paddlefish	*Polyodon spathula*
blue sucker	*Cycleptus elongatus*
largemouth buffalo	*Ictiobus cyrpinellus*
smallmouth buffalo	*Ictiobus bubalus*
river carpsucker	*Carpiodes carpio*
golden redhorse	*Moxostoma erythrurum*
carp	*Cyprinus carpio*
drum	*Aplodinotus grunniens*
gizzard shad	*Dorosoma pentenense*
threadfin shad	*Dorosoma pentenense*
golden shiner	*Notemigonus crysoleucas*
pallid shiner	*Hybopsis amnis*
redfin shiner	*Lythrurus umbratilis*
emerald shiner	*Notropis atherinoides*
ghost shiner	*Notropis buchanani*
mimic shiner	*Notropis volucellus*
central stoneroller	*Campostoma anomalum*
blackstripe topminnow	*Fundulus notatus*
blackspotted topminnow	*Fundulus olivaceous*
bullhead minnow	*Pimephales vigilax*
suckermouth minnow	*Phenacobius mirabilis*
silver chub	*Macrhybopsis storeriana*
Mosquito fish	*Gambusia affinis*
brook silversides	*Labidesthes sicculus*

Table 3 continued

Common Name	Scientific Name
logperch	*Percina caprodes*
greenside darter	*Etheostoma blennioides*
bluntnose dater	*Etheostoma chlorosomum*
fantail darter	*Etheostoma flabellare*
slough darter	*Etheostoma gracile*
cypress darter	*Etheostoma proeliare*
banded darter	*Etheostoma zonale*
dusky darter	*Percina sciera*
redfin darter	*Etheostoma whipplei*

Table 4. Major Tributaries of the Arkansas River in Arkansas (U. S. Fish and Wildlife Service, 1988).

Mountain Steams	Delta Streams
Little Maumelle River	Big Bayou Meto
Maumelle River	Little Bayou Meto
Palarm River	Plum Bayou
East Fork Cadron River	Pennington Bayou
Point Remove Creek	
Illinois Bayou	
Big Piney Creek	
Lee Creek	
Petit Jean River	
Fourche Lafave River	
Big Mulberry Creek	

of the MKARNS in Arkansas such as mountain streams west of Little Rock and delta streams east of Little Rock (Table 4), and four Corps lakes in Arkansas that total 51, 360 surface acres: Blue Mountain Lake on the upper reach of the Petit Jean River, Lake Dardanelle and Ozark Lake on the MKARNS, and Nimrod Lake on the upper reach of the Fourche Lafave River. Prominent game species inhabiting the oxbow lakes include largemouth bass, catfish spp., bluegill, carp, and crappie spp. The fisheries of the mountain streams in Arkansas are considered excellent including smallmouth bass, largemouth bass, spotted bass, bluegill, walleye, sauger, and numerous minnow and sucker species. The principal fish species in the delta streams include crappie spp., catfish spp., bluegill, largemouth bass, carp, and buffalo. Common game and commercial fish species occurring in the four Corps lakes in Arkansas include largemouth bass, bluegill, crappie spp., and striped bass (U. S. Fish and Wildlife Service, 1988).

<u>Arkansas River Basin (AR and OK), and Eleven Oklahoma Reservoirs: Terrestrial Resources</u>

Numerous important habitats that support a wide variety of wildlife occur within the project area in Oklahoma and Arkansas. A tentative list of habitat types include: post oak – blackjack oak forest, oak – hickory forest, oak – hickory – pine forests, tallgrass prairie, midgrass prairie, caves, cropland, introduced grassland, riparian forest, bottomland forest, river swamp forests, lower hardwood swamp forests, lacustrine and palustrine wetlands, lentic aquatic habitat, and lotic aquatic habitat (U. S. Fish and Wildlife Service, 1985; U. S. Fish and Wildlife Service, 1988). These habitat types support numerous game and nongame wildlife within the project area; a list of indicator flora and fauna for the habitat types is presented in Table 5. The list is not inclusive of all species typically found in a particular type, since the exact species that occur in each habitat type can vary from location to location.

The habitat types are subjectively ranked according to their overall value to fish and wildlife. The ratings can vary within habitat types, and site specific evaluations would be appropriate when project alternatives are developed and studied in more detail. The following description of the habitat types that may occur within the project area is drawn largely from the Service's reports for a similar study by the Corps on the Arkansas River Basin where proposals were reviewed for storage, conservation, treatment, and conveyance of water in the Arkansas River and tributaries in Arkansas and Oklahoma for industrial and municipal uses (U. S. Fish and Wildlife Service, 1985; U. S. Fish and Wildlife Service, 1988).

The post oak – blackjack oak forest (crosstimbers) occurs on thin soils prone to erosion if disturbed. Plant species diversity is relatively low; however, the juxtaposition of this forest type with native grasslands greatly increase its value to wildlife.

The oak – hickory forest covers a large portion of the Ozark Plateau in Eastern Oklahoma and Western Arkansas. This forest type tends to have higher species diversity than the crosstimbers resulting in a potentially greater number of ecological niches for fauna. Tracts adjacent to bottomland hardwood forests and/or riparian forests are especially valuable and provide high quality habitat for many wildlife species.

Tallgrass prairie occurs in deep, fertile soil on the eastern and western borders of the crosstimbers and in the flint hills. Bison were abundant in the prairies during pre-settlement times, and contributed to the major disturbance regimes which were grazing, drought, and fire (Ricketts et al., 1999). Because of highly fertile soils, much of tallgrass prairie has been converted to cultivated agriculture and introduced grassland pasture (except in the flint hills due to limestone beneath the soil). The remaining tracts of tall grass prairie provide valuable wildlife habitat (Table 5).

Table 5. Cover types, indicator species, and cover type value – index. Indices range from 1 (low habitat potential) to 5 (high habitat potential) (U. S. Fish and Wildlife, 1985).

Habitat Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Post oak – blackjack oak forest	post oak, blackjack oak, dogwood, red cedar, sumacs, buckbrush	white-tailed deer, fox squirrel, bobwhite, carolina chickadee, black and white warbler, armadillo, garter snake, ground skink	3
Oak-hickory forest	post oak, black hickory, mockernut hickory, bitternut hickory, white oak, sugar maple, winged elm	white-tailed deer, fox squirrel, gray squirrel, eastern woodrat, cottontail rabbit, eastern chipmunk, downy woodpecker, white-breasted nuthatch, fence lizard, black rat snake, American toad	4
Oak-hickory-pine forest	post oak, white oak, northern red oak, mockernut hickory, bitternut hickory, black hickory, shagbark hickory, shortleaf pine, loblolly pine, sweetgum	white-tailed deer, fox squirrel, pileated and hairy woodpeckers, gray fox, three-toed box turtle	4
Tallgrass prairie	big and little bluestem, switch grass, Indian grass, goldenrods, side oats grama	coyote, red-tailed hawk, bobwhite, eastern meadowlark, grasshopper sparrow, dickcissel, ornate box turtle, ribbon snake, great plains rat snake	3
Midgrass prairie	little and big bluestem, purple cone flower, gramas, buffalo grass	thirteen-lined ground squirrel, eastern cottontail, jackrabbit, bobwhite, ornate box turtle, Texas horned lizard, prairie kingsnake, prairie skink, Woodhouse's toad	3

Table 5 continued

Habitat Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Caves	–	Bats (Myotis and Pipistrellus spp.), Ozark cavefish, grotto salamander, cave salamander	5
Cropland	wheat, alfalfa, soybeans, sorghums, etc	white-footed mouse, eastern cottontail, mourning dove, eastern meadowlark	2
Introduced grassland	Bermuda grass, fescue, rye, buffalo bur, nightshade, ragweeds	cotton rat, eastern meadowlark	1
Riparian forest	cottonwood, willow, green ash, hackberry, elm, sycamore, dogwood, river birch	white-tailed deer, raccoon, river otter, beaver, red-bellied woodpecker, belted kingfisher, eastern phoebe, fox squirrel, wood duck, herons, cricket frog, green frog	5
Bottomland forest	oaks, sycamore, elms, pecan, boxelder, greenbriar	white-tailed deer, gray squirrel, pileated woodpecker, wood duck, red-shouldered hawks, spring peeper	5
River swamp forests	bald cypress, black willow, water tupelo, water elm, button bush	white-tailed deer, beaver, ducks, warblers, herons, egrets, squirrel, barred owl, swamp rabbit, chorus frogs, aquatic snakes	5

Table 5 continued

Habitat Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Mud flats	devoid of vegetation when inundated; barnyard grass, rushes spp., sedges spp.	raccoon, lesser yellowlegs, common snipe, great blue heron	2 – 5
Lower hardwood swamp forests	red maple, water hickory, green ash, river birch, hackberry, American holly, sweetgum, willow oak, laurel oak	white-tailed deer, beaver, ducks, warblers, herons, egrets, prothonotary warbler, squirrel, swamp rabbit, spotted salamander, chorus frogs, aquatic snakes	5
Lacustrine wetland	cattails, rushes, smartweeds, muskgrass, sedges	bullfrog, cricket frog, carp, water snakes, belted kingfisher, great blue heron, ducks	4
Palustrine wetland	willows, cottonwood, cattails, rushes, pondweed, sedges, buttonbush	beaver, great blue heron, egrets, American bittern, waterfowl, snipe, marsh hawk, marsh wren, red-winged blackbird, grebes, leopard frog, eastern newt, water snakes	5
Lentic aquatic habitat	algae, coontail, bladderwort	largemouth bass, bluegill, catfish, crappie, carp	4
Lotic aquatic habitat	algae, other periphyton	minnows, striped bass, channel catfish	3 – 5*

* mountain streams = 5; Arkansas River/System and associated tributaries and delta streams = 3.

Midgrass prairie occurs in scattered tracts in central and western Oklahoma. Much of the midgrass prairie has been altered by grazing and agricultural practices; however, the prairie that remains supports numerous wildlife species (Table 5).

Caves generally occur in areas with karst topography (areas of carbonate rock, especially limestone, where sinkholes, springs, and caves have formed as a result of the dissolution of the rock by chemical action). They provide a stable environment and habitat for many animals such as frogs, salamanders, reptiles, bats, snails, isopods, amphipods, crayfish, fish, spiders, and crickets. Although caves are underground habitats, they face many potential threats from activities above ground because they typically are connected to the surface through many openings.

Cropland and introduced grassland have increased greatly since settlement and continue to increase at the expense of natural terrestrial habitats with high value for fish and wildlife. Cropland adjacent or in close proximity to other habitats, such as forests, wetlands, or grasslands, provides beneficial habitat to some wildlife species. However, monotypic introduced grasses tend to provide few requisites for wildlife.

Bottomland hardwood forests occur in floodplains throughout the study area. Few undisturbed tracts remain. In Oklahoma, over 85 percent of the bottomland hardwood forests have been lost, and only a portion of the remaining forest is undisturbed (Oklahoma Water Resources Board, 1990). At one time, about 8 million acres of bottomland hardwood forests occurred in Arkansas. Today, only about 850, 000 acres remain, with almost 160, 000 of these acres in a contiguous block in the White River NWR. Due to the presence of productive soils, favorable water regimes, and juxtaposition with other habitats, the bottomland forests are one of the most productive habitats in the U. S. (Clark et al., 1981), and may be the most important wildlife habitat in the project area.

Riparian forests occur in frequently flooded areas adjacent to streams that have saturated soils and high water tables. They generally occur along tributary streams that lack a well-defined flood plain. The juxtaposition of riparian forest with other habitat types enhances the value of the forest for many species.

Numerous palustrine and lacustrine wetlands (Cowardin et al., 1979) occur in association with the MKARNS, its tributaries, and the 15 aforementioned reservoirs in Oklahoma and Arkansas. Wetlands are one of the most important areas in the U. S. due to their numerous valuable functions which include providing crucial habitat for numerous fish and wildlife species, as well as functions that benefit people such as water quality improvement, flood control and prevention, groundwater recharge and discharge, erosion control, and education, recreation, and aesthetics. About 221 million acres of wetlands are estimated to have occurred in the U. S. at the time of settlement; however, less than half of this amount (105.5 million acres) is thought to exist today. Between 1950 and 1970, it is estimated that the annual loss of wetlands was about 458, 000 acres. Data gathered between 1986 and 1997 indicate the annual loss during this period was 58, 500 acres, which represents an 80 percent reduction in the average annual wetland loss. Factors involved in this decline include implementation and enforcement of wetland protection measures and wetland restoration and creation actions (Dahl, 2000).

Lacustrine wetlands (Cowardin et al., 1979) include permanently flooded lakes and reservoirs, impounded lakes, and intermittent lakes such as playa lakes (depressions on the plains that seasonally pond during events of high rainfall and vary from a few hundred feet to several miles in diameter). Lacustrine wetlands tend to be areas of deep water with extensive wave action that are bounded by upland or wetland vegetation such as trees, shrubs, emergents, mosses, or lichens. Lacustrine wetlands exceed 20 acres, occur in topographic depressions or on a dammed river, lack extensive areal vegetative cover (<30%), and provide valuable habitat for numerous species that require standing water environments (Table 5).

Palustrine wetlands (Cowardin et al., 1979) include swamps, marshes, bogs, mudflats, fens, and ponds. They can be isolated or occur shoreward of lakes and river channels, on river floodplains, on slopes, or within a lacustrine or riverine system (wetlands within a channel except those dominated by vegetation) as islands. They typically are smaller than 20 acres, less than 2 meters deep, and lack significant wave action. Palustrine wetlands provide habitat for many game, non-game, and fur-bearing species.

Lentic aquatic habitats include the aquatic areas in oxbow lakes (old river and stream channels that have been cut off from the main channel), reservoirs, and ponds. Although not as valuable as the pre-impoundment conditions for many species, impoundments have increased the availability of niches for species that require large bodies of standing water, such as warm water lake fish species.

Lotic aquatic habitat is represented by the streams in the project area. Many of these streams have diminished value to fish and wildlife due to impoundment, and as a result of water quality degradation from municipal, industrial, and agricultural effluents. However, because many of the mountain streams in Arkansas are relatively unaltered, many of the fisheries there are still considered to be of excellent condition.

Wildlife Management Areas and National Wildlife Refuges

McClellan – Kerr Wildlife Management Areas (WMAs) managed specifically for wildlife by the ODWC and Corps occur along the MKARNS near Chouteau Lock and Dam in Wagoner County, Webbers Falls Reservoir in Muskogee County, and Robert S. Kerr Reservoir in Haskell and Sequoyah Counties. Nine of the eleven Oklahoma Reservoirs that serve as the MKARNS's primary flow modifier also have WMAs (Table 6). Wildlife management areas in the project area in Arkansas (managed by the Arkansas Game and Fish Commission) include Dardanelle, Bayou Meto, Trusten Holder, and Galla Creek (Table 6). The WMAs in both states provide habitat for species such as white-tailed deer, rabbit, squirrel, migratory birds, quail, turkey, songbirds, and many species of reptiles and amphibians. The areas provide a total of 276, 058 acres of public lands available to sportsmen.

Three national wildlife refuges (NWR) occur along or near the MKARNS. The refuges are the Sequoyah NWR in eastern Oklahoma, and the Holla Bend NWR and White River NWR in Arkansas.

The Sequoyah NWR occurs in Haskell, Muskogee, and Sequoyah Counties near the confluence of the Arkansas and Canadian Rivers in Oklahoma. The refuge was established by cooperative agreement between the Service and the Corps in 1970 to provide habitat for waterfowl and other migratory birds. The refuge covers about 29, 000 acres and annually hosts the largest concentration of wintering snow geese in Oklahoma. Bottomland hardwood habitat found at the refuge provides habitat for numerous wildlife species such as songbirds, raptors, quail, rabbit, muskrat, deer, bobcat, and squirrels, as well as many species of reptiles and amphibians including green tree frogs, cottonmouths, red-eared sliders, diamond back water snakes, and bullfrogs.

The refuge also appears to be one of the last strongholds in Oklahoma for the alligator snapping turtle, a state species of special concern in Oklahoma. Sequoyah NWR offers the public

Table 6. Wildlife Management Areas near the MKARNS in Oklahoma and Arkansas.

Wildlife Management Areas		Acres
Copan (OK)		7,500
Hulah (OK)		16,141
Oologah (OK)		14,155
Kaw (OK)		16,254
Keystone (OK)		16,537
Fort Gibson (OK)		21,798
Tenkiller (OK)		1,950
Eufaula (OK)		48,469
Wister (OK)		35,550
McClellan Kerr (OK)		7,875
	Subtotal (OK)	186,229
Dardanelle (AR)		42,500
Bayou Meto (AR)		34,000
Trusten Holder (AR)		10,000
Galla Creek (AR)		3,329
	Subtotal (AR)	89, 829
	Total	276,058

opportunities for hiking, wildlife photography, bird watching, and freshwater fishing. Public hunting is allowed for waterfowl, deer, and small game (rabbit, grey squirrel, fox squirrel, coot, snipe, mourning dove, woodcock, and bobwhite quail).

The Holla Bend NWR in west-central Arkansas was established in 1957 and covers 7, 057 acres of bottomland hardwoods and wetlands. The refuge lies along the Arkansas River in Pope County, and is bounded by an oxbow lake created when the Corps cut a channel through the bend in the river to improve the MKARNS for navigation and flood control. Wildlife at the refuge includes wintering waterfowl, the golden eagle, the federally-listed threatened bald eagle, migratory songbirds, as well as many species of mammals, reptiles, and amphibians. The refuge receives about 40,000 visitors annually and offers the public opportunities for hiking, wildlife photography, hunting, bird watching, and freshwater fishing.

The White River NWR in Desha, Monroe, and Phillips Counties in eastern Arkansas is located near the confluence of the Arkansas and White Rivers. The refuge occupies 90 of the lower 100 miles of the White River in Arkansas as well as three miles of the MKARNS's Arkansas Post Canal. Established in 1935, the refuge consists of about 160, 000 acres including about 154, 000 acres of forest, 1, 000 acres of grassland, 900 acres of cropland, and 4, 000 acres of natural and manmade lakes. The area provides habitat for wading birds, shorebirds, waterfowl, raptors, a variety of reptiles, amphibians, and mammals, including a healthy population of black bears. The refuge also has four active nests of the federally-listed threatened bald eagle, and hosts the largest concentration of wintering mallard ducks in the Mississippi Flyway. White River NWR is visited by about 150,000 people annually and offers opportunities for hunting, boating, fishing, wildlife observation and photography, and hiking.

Threatened and Endangered Species

The Endangered Species Act (87 Stat. 884 as amended; 16 U. S. C. 1531 et seq.) requires consultation with the Service regarding endangered and threatened species. Thirteen federally-listed endangered and threatened species, one species proposed for federal listing, and one candidate for federal listing occur within the vicinity of the project area. A species by county list for Oklahoma and Arkansas is enclosed as Appendix A and B, respectfully. Endangered species include the interior least tern (Sterna antillarum athalassos), gray bat (Myotis grisescens), Indiana bat (M. sodalis), Ozark big-eared bat (Corynorhinus tonsendii), pink mucket pearlymussel (Lampsilis abrupta), Harperella (Ptilimium nodosum), and the American burying beetle (Nicrophorus americanus). Threatened species include the bald eagle (Haliaeetus leucocephalus), piping plover (Charadrius melodus), Arkansas River shiner (Notropis girardi), Geocarpon minimum (no common name), and the western prairie fringed orchid (Platanthera praeclara). The scaleshell mussel (Leptodea leptodon) is proposed for federal listing as endangered and occurs within the vicinity of the study area, as does the Arkansas darter (Etheostoma cragini), which is a federal candidate species.

The endangered interior least tern is a piscivorous bird (McDaniel and McDaniel, 1963) that nests on sandbars and sandy islands of major rivers and sandy shorelines of reservoirs in the interior United States. Reasons for the decline include anthropomorphic causes (U. S. Fish and Wildlife Service, 1990) such as impoundments and irrigation, overgrowth of vegetation, the recreational use of sandbars by humans, and flooding of nesting areas caused by unpredictable water discharge patterns below reservoir dams (U.S. Fish and Wildlife Service, 1993). Within the project area, interior least terns forage and nest along the Arkansas River in Oklahoma and Arkansas from April through late August and early September. Interior least terns nest in small colonies and prepare nests by making small scrapes in the sand where two or three eggs are usually laid. Both parents feed the young, which are fairly mobile upon hatching. Terns tend to forage in shallow water habitats on small surface schooling fish (2.0 to 9.0 cm long for adults and 1.5 to 4.0 cm long for chicks) (Atwood and Minsky, 1983; Schweitzer and Leslie, Jr., 1996; Wilson et al., 1993). They are considered "surface plungers" (Erickson, 1985) because they hunt for prey while hovering five to ten meters over water bodies, and plunge into the water to capture the fish. Distance to water bodies with available food highly influences reproductive success. Density of surface schooling fish and aquatic vegetation, and water transparency affect the suitability of an area for this species (Schweitzer and Leslie, Jr., 1996). The Nature Conservancy manages about 1, 175 acres along the Arkansas River in Tulsa, Oklahoma, as the Arkansas River Least Tern Preserve.

Three endangered bat species occur within the project area. Gray bats are medium sized grayish-brown bats with a wing span of ten to eleven inches. They occur in Oklahoma and Arkansas, and migrate each year from summer caves that are typically located near lakes and rivers to winter caves, where mating occurs (U.S. Fish and Wildlife Service, 1993). Gray bats feed on insects almost exclusively over water along reservoir edges and rivers, and use associated forest canopy as a travel corridor and escape route between caves and feeding sites (U.S. Fish and Wildlife Service, 1982). Indiana bats occur in the Midwest and the eastern United States where the western edge of the Ozark region in Oklahoma marks the western limit of their range. They mate in caves during fall and begin hibernation in October in limestone caves. During summer, females and juveniles roost in small colonies under tree bark usually near streams, and forage in riparian woodlands and floodplains. Males tend to forage over floodplain ridges and hillside forests (U.S. Fish and Wildlife Service, 1993). Hence, rivers may provide important summer habitat (U.S Fish and Wildlife, 1985). Ozark big-eared bats are medium sized bats with distinctively long ears and facial glands on either side of the face. They primarily dwell in caves. In Arkansas, the bats are known to occur only in Marion and Washington Counties, outside of the project area. Caves in Adair County, Oklahoma, support some of the largest maternity colonies and hibernacula for both Ozark big-eared bats and gray bats. However, except for a small portion of Spavinaw Creek, these caves do not include any major water areas in the project area.

The pink mucket pearlymussel is an endangered mussel that occurs in Arkansas in the Lower Mississippi River and its larger tributaries. The largest populations occur in the Spring and White Rivers. Smaller populations occur in the Ouachita and Little River systems. The pink mucket pearlymussel prefers sand and gravel. The shell is thick, round to elliptical and smooth with a tan, yellow, or yellowish green color and either faint green rays or no rays. Misidentification by commercial harvesters may be a leading factor in its decline.

Populations of the endangered American burying beetle are known to occur within Arkansas and Oklahoma. Current information suggests that this species is a habitat generalist that occurs in both grasslands and forests. American burying beetles feed on carrion about the size of chipmunks, and carrion availability and the availability of enough humus and top soil for carrion burial may be one of most important factors determining where this species can survive (U. S. Department of the Interior, 1989). The beetle is active only on warm nights (> about 60^0F). The most effective method known for surveying for American burying beetles is the use of small baited pitfall traps (24 oz. plastic cups) (Creighton et al., 1993, unpublished data); however, baiting pitfall trips may bring beetles into an otherwise unoccupied area.

Harperella is an endangered annual herb that is known to occur in only 12 extant populations, including populations in Yell and Scott Counties, Arkansas. Habitat includes palustrine and riverine wetlands. It typically occurs in rocky/gravel shoals of swift, clear streams, and edges of intermittent pine land ponds. This species requires moderately intensive spring floods. Causes for decline include alterations of water regime from impoundments, water withdrawal, draining or deepening of ponds, and shoreline development.

The threatened bald eagle breeds and winters in Oklahoma and Arkansas where it is known to occur along the Arkansas River/MKARNS and near large reservoirs where it utilizes large trees for perching and roosting. Trees used for diurnal perches and feeding are typically different than those used for roosting at night. Trees used for diurnal perching are usually tall, with large diameters and stout branches. Trees used for communal night roosts are usually more secluded but are usually located near their feeding areas. The eagles along the MKARNS and reservoirs probably feed mainly on fish, but may also eat waterfowl and carrion. Several of the eleven upstream Oklahoma reservoirs support sizeable concentrations of wintering bald eagles: Keystone, Eufaula, Wister, Grand, Fort Gibson, and Kaw. Additionally, bald eagles are known to nest at numerous locations within the project area, especially along the mainstem of the Arkansas River.

The Arkansas River shiner is a threatened species that is native to wide, sandy streams in the Arkansas River drainage in Arkansas, Kansas, New Mexico, Texas, and Oklahoma. However, the shiner is currently limited to the Canadian River in Oklahoma, Texas, and New Mexico, and to the Cimarron River in Kansas and Oklahoma. Threats to the shiner include habitat destruction and modification resulting from the construction of impoundments, stream water depletion due to groundwater pumping and diversion of surface water, and water quality degradation (U. S. Fish and Wildlife Service, 1998). Proposed critical habitat for the shiner includes the Canadian River in Oklahoma. Eufaula reservoir is located on the Canadian River at river mile 27.0.

The threatened western prairie fringed orchid once occurred in the vicinity of the project area. This species was found in moist areas in tallgrass prairie or sedge meadows throughout the tallgrass regions of North America. The orchid has, however, experienced a drastic decline, and currently, extant populations are found only in Iowa, Kansas, Minnesota, Missouri, Nebraska, and North Dakota (U.S. Fish and Wildlife Service, 1993).

The threatened piping plover is a migratory bird that breeds from southern Canada to the northeastern and central United States. It winters along the southern Atlantic and Gulf Coasts. Piping plovers use sand-bottom rivers, reservoir beaches and mudflats in their migration corridor. They migrate through Oklahoma every year, and are known to use the Winganon Flats at Oologah reservoir (U.S. Fish and Wildlife Service, 1993).

Geocarpin minimum (no common name) is a small succulent annual plant that is federally-listed as threatened. It is known to only occur in 14 sites in Missouri and 4 sites in Arkansas, including a small population in Franklin County. This species typically occurs on sandy-clay prairies which may represent Pleistocene lake beds. Threats include habitat modification, trampling and grazing by livestock, and off-road vehicle use.

The only species proposed for federal listing that may occur within the vicinity of the project area is the scaleshell. The scaleshell is a relatively small mussel that possesses a thin shell with faint green rays. It occurs in medium to large rivers with stable channels and sand and gravel bottoms, where it partially buries itself and siphons the water for food, improving water quality. Over the last fifty years this species has declined due to pollution, increased sedimentation (suffocates the mussels and makes feeding difficult), and dams (act as barriers to host fish, isolate populations, and destroy habitat), and it is currently proposed for federal listing as endangered. There are only 13 known scattered populations in the Mississippi River basin in Missouri, Oklahoma, and Arkansas.

The Arkansas darter is a federal candidate species that occurs in the Arkansas River drainage in

Missouri, Colorado, Kansas, Arkansas, and Oklahoma. It is a small, strongly bicolored fish (upper half dark brown, lower half white to orange). Within the vicinity of the study area, it occurs in northeastern Oklahoma and northwestern Arkansas in spring fed vegetated creeks and headwaters typically over mud. Although not afforded protection under the Endangered Species Act (only listed and proposed species are protected pursuant to the Act), the Service provides this information to encourage efforts to avoid adverse impacts to this species.

More specific project information is required to determine impacts on federally-listed threatened and endangered species. As solutions for problems resulting from the sustained high flows on the MKARNS are determined, it will be incumbent upon the Corps to determine if the selected solutions will adversely affect federally-listed or proposed species, or their designated critical habitat. If a project is determined to adversely affect these resources, then formal consultation under Section 7 of the Endangered Species Act will be required.

Other species that also should be considered during project planning include state-listed and rare species, species with restricted ranges, and species of concern such as paddlefish (Polydon spatula) that may occur within the project area (Tables 7 and 8; It is important to note that rare/declining, state-listed threatened or endangered species, and species of concern are not afforded protection under the Act, unless proposed for federal listing, but protection of these species now will help prevent the need to list them in the future.). Paddlefish are smooth-skinned fish with an elongated snout that occupy the calmer, open waters of large rivers. They prefer slow moving water behind islands and sandbars because of the abundance of zooplankton, their primary food source. They were once common in big rivers in the Mississippi basin such as the Arkansas River. However, excessive commercial harvest for roe (mass of eggs in the female fish) that is processed and sold as caviar, and water development projects that greatly altered their natural habitat have drastically reduced this species in the Arkansas River. For example, rising water levels in spring trigger upstream spawning migrations. However, in many cases, migrations are blocked by dams. Restoration attempts through a joint effort of the Tishomingo National Fish Hatchery, Oklahoma Fisheries Resource Office, Oklahoma Ecological Services, and the ODWC have resulted in a self-sustaining population above Kaw Reservoir in Oklahoma, and the stocking of about 80, 000 paddlefish in the Arkansas and Verdigris Rivers in northern Oklahoma. Currently, Service fisheries biologists are conducting surveys on the brood stock.

IMPACT EVALUATION AND PRELIMINARY CONCERNS

The Service's overall goal is to protect and/or enhance important fish and wildlife resources. A brief discussion of the general impacts that may be associated with the potential measures that might serve as solutions to the problems resulting from sustained high flows of the MKARNS are discussed below followed by some preliminary concerns. Because formal project alternatives have not been developed to date, a detailed evaluation of all potential impacts is not possible. As more in-depth project alternative descriptions become available, site-specific determinations of impacts can be provided. In general, a diverse water project that may include the construction of new reservoirs and flood control levees, changes to flow rates on the MKARNS, reallocating or adding storage in the eleven upstream Oklahoma reservoirs, raising of levees, removal of channel impediments, deepening the entire MKARNS, and adding passing lanes on the Verdigris River portion of the MKARNS will cause various physical changes leading to numerous impacts, both positive and negative, on fish and wildlife resources.

Due to the nature of the various solutions being investigated, it is likely that wetlands will be impacted by the project. The Service's Mitigation Policy (Federal Register 46(15):7644-7663) provides guidance for formulating measures to eliminate, reduce and offset environmental

Table 7. State-listed rare and endangered/threatened species that occur or may occur within the project area in Oklahoma.

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Animals		
Gray bat (Myotis grisescens)	E	northeastern OK; limestone caves, forests near rivers/lakes
Indiana bat (Myotis sodalis)	E	eastern OK; caves, forests
Ozark big-eared bat (Plecotus townsendii ingens)	E	northeastern OK; caves (karst areas) in oak-hickory forests
Marsh rice rat (Oryzomys palustris)	SS2	eastern OK; near wetlands, grasslands
Golden mouse (Ochrotomys nuttali)	SS2	east-central OK; greenbriar thickets, swamps
Long-tailed weasel (Mustela frenata)	SS2	variety of habitats statewide
Mountain lion (Felis concolor)	SS2	rare in eastern OK
Rafinesque's big-eared bat (Plecotus rafinesqui)	SS2	east-central Oklahoma; forests with dense foliage
River otter (Lutra canadensis)	SS2	eastern OK, Wister WMA; aquatic
Woodchuck (Marmota monax)	SS2	east-central & northeastern OK; open woodlands
Piping plover (Charadrius melodus)	T	migrates through central and eastern OK; known to use Winganon Flats at Oologah Reservoir
Bald eagle (Haliaeetus leucocephalus)	E	major rivers and reservoirs
Interior least tern (Sterna antillarum)	E	Arkansas and Canadian Rivers
Prairie falcon (Falco mexicanus)	SS1	dry plains and prairies
Swainson's hawk (Buteo swainsoni)	SS2	grasslands

Table 7 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Loggerhead shrike (Lanius ludovicianus migrans)	SS2	open areas with high perches
Barn owl (Tyto alba)	SS2	woodlands, savannas, farmlands, suburbs
Bell's Vireo (Vireo bellii)	SS2	deciduous thickets along streams, ravines, forest edges
Arkansas darter (Etheostoma cragini)	SS2	northeastern Oklahoma; spring feed vegetated creeks and headwaters typically over mud
Arkansas River shiner (Notropis girardi)	T	Canadian River above Eufaula Reservoir
Ozark cavefish (Amblyopsis rosae)	T	streams in nutrient rich caves in northeastern OK/Ozark highlands
Blackside darter (Percina maculata)	T	eastern OK in pools of creeks of small-medium rivers
Longnose darter (Percina nasuta)	E	east-central OK in gravel runs of small-medium rivers
Alabama shad (Alosa alabame)	SS2	east-central and northeast OK in open water of medium - large rivers
Alligator gar (Lepisosteus spatula)	SS2	eastern OK except northeast in pools and backwaters of rivers, lakes, swamps
Arkansas River speckled chub (Macrhybopsis aestivalis tetranemus)	SS2	gravel runs of major rivers and tributaries
Blue sucker (Cycleptus elongatus)	SS2	Grand lake and tailwaters
Black buffalo (Ictiobus niger)	SS2	eastern and central OK in rivers and lakes
Bluntface shiner (Notropis camurus)	SS2	northeastern OK in small clear streams

Table 7 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Harlequin darter (Etheostoma histrio)	SS2	mostly Saline, Spavinaw, and Spring Creeks
Kiamichi shiner (Notropis ortenburgeri)	SS2	Poteau River and streams in Ouachita Mountains
Pallid shiner (Notropis amnis)	SS2	Poteau River
Plains topminnow (Fundulus sciadicus)	SS2	Grand River drainage
Ribbon shiner (Lythrurus fumeus)	SS2	Illinois and Poteau Rivers
River Darter (Percina shumardi)	SS2	Grand and Illinois Rivers
Shorthead redhorse (Moxostoma macrolepidotum)	SS2	northeastern OK in clear gravel-bottom streams/rivers
Shovelnose sturgeon (Scaphirhyncus platorynchus)	SS2	Arkansas River and tributaries
Southern brook lamprey (Ichthyomyzon gagei)	SS2	clear streams of Ouachitas and Ozarks
Spotfin shiner (Notropis spilopterus)	SS2	Illinois River
Spotted bass (Micropterus punctulatus)	SS2	eastern OK in clear, spring- fed streams
Stonecat (Notorus flavus)	SS2	northeatern OK in clear bottom, gravel streams
Northern scarlet snake (Cemophora coccinea)	SS2	eastern OK in sandy/loamy areas
Alligator snapping turtle (Macroclemys temminckii)	SS2	Eastern OK in lakes, rivers, oxbows, and sloughs; known to occur at Seqouyah NWR and near Eufaula Reservoir
Map turtle (Graptemys geographica)	SS2	Delaware County; large bodies of water

Table 7 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Texas horned lizard (Phrynosoma cornutum)	SS2	grasslands with areas of sparse vegetation
Rich Mountain salamander (Plethodon ouachitae)	SS2	north facing talus slopes of Ouachtia Mountains
Grotto salamander (Typhlotriton spelaeus)	SS2	northeastern OK in limestone caves with springs
Oklahoma salamander (Eurycea tynerensis)	SS2	northeast OK in spring-fed creeks with gravel bottoms
Ouachita dusky salamander (Desmognathus brimleyorum)	SS2	southeastern OK in springs, streams
Ringed salamander (Ambystoma annulatum)	SS2	eastern OK in moist wooded areas
Scaleshell (Leptodea leptodon)	SS2	scattered populations in Arkansas River Basin
Neosho mucket (Arkansia wheeleri)	E	Illinois River above Lake Tenkiller
Western fanshell (Cyprogenia aberti)	SS2	historically occurred in Verdigris and Caney Rivers ; may be extirpated from Oklahoma
Spectacle-case shell (Quadrula cylindrica)	SS2	Illinois River in Cherokee County
Rich Mountain Slitmouth (Stenotrema pilsbryi)	SS1	talus slope in Ouachita Mountains
American Burying Beetle (Nicrophorus americanus)	E	habitat generalist; grasslands, forests
Prairie mole cricket (Gryllotalpa major)	SS2	prairies
Plants		
Ozark chinquapin oak (Castenea pumela var. ozarkensis	R	eastern OK in oak-pine and oak-hickory forests

Table 7 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Waterfall's sedge (Carex latebracteata)	R	mesic slopes in southeastern OK
Hammock sedge (Carex fissa)	R	northeastern OK along edges of ponds/lakes
Ozark wake-robin (Trillium pusillum var. ozarkanum)	R	Oak-hickory and Oak-pine woodlands in LeFlore County
Ozark spiderwort (Tradescantia ozarkana)	R	eastern OK in deciduous forests in ravines and steep rocky hillsides
Skinner's false foxglove (Agalinis skinneriana)	R	Delaware County in prairies and open areas of oak-hickory forests but may be extirpated from OK
Earleaf false-foxglove (Agalinis auriculata)	R	currently only known from prairie hay meadows bordered by upland woods in Choctaw County
Dwarf pipewort (Eriocaulon kornickianum)	R	sandy hillsides in Atoka, Muskogee, and Pushmataha Counties
Southern Lady's slipper (Cypripedium kentuckiense)	R	southeastern OK in floodplain forests and mesic ravines
Ouachita indigo bush (Amorpha ouachitensis)	R	Leflore, McCurtain, and Pushmataha Counties along rocky creeks, streambanks, and floodplains
Western prairie fringed orchid (Platanthera praeclara)	T	northeastern Oklahoma in moist grasslands; may be extirpated from Oklahoma

1 E = Endangered

T = Threatened

SS1 = Species of Special Concern where current evidence indicates species is vulnerable because of limited range, low population, or other factors

SS2 = Species of Special Concern that is possibly threatened or vulnerable but with little evidence to document current population levels and range.

R = Rare

Table 8. Arkansas state-listed rare species that occur or may occur within the project area. All state listed threatened/endangered can be found in the federal list in Appendix B (list of species and their state rank provided by the Arkansas Natural Heritage Commission).

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Animals		
Rafinesque's big-eared bat (Corynorhinus rafinesquii)	S2	statewide except Ozark Mountains; occupies buildings, barns, caves, forests
Brazilian free-tailed bat (Tadarida brasiliensis)	S3	central and southern Arkansas; occupies buildings, forests
Gray myotis (Myotis grisescens)	S2	forests and caves near rivers, lakes
Florida panther (Puma concolor coryi)	SH	–
Swainson's warbler (Limnothlypis swainsonii)	S3B	possibly statewide; swamp forests, bottomland hardwood forests, riparian forests
Interior least tern (Sterna antillarum athalassos)	S2B	sand bars on Arkansas and White Rivers
Bald eagle (Haliaeetus leucocephalus)	S2B, S4N	statewide; rivers, reservoirs/lakes
Strecker's chorus frog (Pseudacris streckeri streckeri)	S2	eastern and central Arkansas; moist woods, rocky ravines, riparian forests, lagoons, swamp forests, croplands
Plains spadefoot (Scaphiopus bombifrons)	S1	isolated population in north-central/northwest Arkansas; grasslands
Arkansas River shiner (Notropis girardi)	SX	–
Shorthead redhorse (Moxostoma macrolepidotum)	S2	northern half of Arkansas; rocky pools and riffles of small and large rivers, lakes
Slenderhead darter (Percina phoxocephala)	S2	western Arkansas; gravel runs and riffles of small creeks to medium rivers

Table 8 continued

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Suckermouth minnow (Phenacobius mirabilis)	S1	west-central Arkansas; gravel/rubble riffles and runs of creeks, and in small to large rivers
Flathead chub (Platygobio gracilis)	S1?	eastern Arkansas; sandy runs of rivers
Paddlefish (Polydon spathula)	S2?	statewide; slow flowing, deep water of large rivers
Swamp darter (Etheostoma fusiforme)	S2?	south and eastern Arkansas; standing of slow-moving water over sand or mud
Goldeye (Hiodon alosoides)	S2B, S4N	statewide; occurs in deep open pools, channels, lowland rivers, lakes.
Plains minnow (Hybognathus placitus)	SX	west-central Arkansas; shallow sandy runs, pools of creeks, and small to large rivers
Lake sturgeon (Acipenser fulvescens)	S1	eastern Arkansas; bottom of lakes and large rivers
Lake chubsucker (Erimyzon sucetta)	S2?	southern, east-central, and eastern Arkansas; lakes, ponds, and swamps over silt, sand, or debris
Plants		
San Antonio false-foxglove (Agalinis homalantha)	S1	statewide; oak woodlands
Texas bergia (Bergia texana)	S2	Johnson , Perry, ansd Desha Coutnies; swamps, mud flats, muddy pond shores
Tissue sedge (Carex hyalina)	S3	statewide inventory needed; margins of forested wetlands and swamps
Scratch-daisy (Croptilon hookerianum var. validum)	S2	limited to the Arkansas Valley and Mississippi Alluvial Plain

Table 8 continued

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Lax hornpod (Cynoctonum mitreola)	S3	wetlands
Six-angle spurge (Euphorbia hexagona)	S2	known to occur in Franklin and Pope Counties; sandy shores and bottoms
Showy prairie-gentian (Eustoma russellienum)	S2	Clark County and Arkansas River Valley
Soapwart gentian (Gentiana saponaria)	S3	western and central Arkansas; swamps, bogs
Hairy water-fern (Marsilea vestita)	S3	Arkansas River Valley and in Bradley, Chicot, Washington and Polk Counties; wetlands
California bullrush (Scirpus californicus)	S1S2	known to occur in Hempstead, Johnson, and Conway Counties; wetlands
Riddell's spike moss (Selaginella arenicola)	S3	known from the Ozark Plateau; dry rocks and packed sand
Twistflower (Streptanthus obtusfolius)	S3	restricted to Ouachita Mountains

1 S1 = Extremely rare. Typically 5 or fewer estimated occurrences in the state, or only a few remaining individuals, may be especially vulnerable to extirpation.

S2 = Very rare. Typically between 5 and 20 estimated occurrences or with many individuals in fewer occurrences, often susceptible to becoming extirpated.

S3 = Rare to uncommon. Typically between 20 and 100 estimated occurrences, may have fewer occurrences but with many large number of individuals in some populations, may be susceptible to immediate threats.

S4 = Common, apparently secure under present conditions. Typically 100 or more estimated occurrences but with large number of individuals in some populations, may be restricted to only a portion of the state.

? = Indecision regarding rank assignment

B = Breeding status

N = Non-breeding status

impacts. These guidelines follow the sequenced approach to mitigation presented in the Council on Environmental Quality's National Environmental Policy Act (NEPA) regulations (40 CFR 1508.20). The mitigation definition found in the NEPA regulations consists of five sequential steps: 1) avoiding the impact altogether by not taking a certain action or parts of an action; 2) minimizing impacts by limiting the degree or magnitude of the action; 3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; 4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and 5) compensating for the unavoidable impacts by replacing or providing substitute resources or environments. The primary focus of the Mitigation Policy is mitigation of losses of habitat value, with the degree of mitigation corresponding to the value and scarcity of habitat for selected evaluation species to be impacted by a proposed project. The Service's mitigation policy for wetlands is No Net Loss.

Construction of new reservoirs

The effects of constructing a new dam are various and so complex that all possible impacts will not be discussed here. Actual impacts will ultimately depend on the project location, design and operation.

Creation of a new reservoir through the impoundment of a river will have the obvious effect of dramatically changing a running river and associated terrestrial ecosystem that once provided habitat to a wide variety of fish and wildlife species into a large standing aquatic ecosystem providing habitat for a manmade warm water fishery and wildlife associated with large standing bodies of water. If not cleared, the terrestrial habitats in the area to be flooded will experience continuous inundation and decomposition of inundated vegetation may result in high rates of deoxygenation leading to a reduction in the original fish population. New habitat types along the edge of the reservoir may be created. The species that occurred in the area prior to inundation will experience increased stress due to the necessity of migrating to new suitable habitat or dying (non-mobile species will experience local die-offs), and from the increase in competition from other animals already occupying niches in the new habitat area. Factors involved in determining the significance of the change include the amount of area that will be flooded, the habitat types in the area, and the wildlife inhabiting these habitats.

By storing water and releasing it at a later date, the physical and biological characteristics of the area downstream become controlled and unnatural. Flow patterns will change depending on the purpose of the reservoir, and the type of flow modification that occurs will determine the extent of the impacts.

A wide variety of physical and biological changes can occur as a result of a new impoundment. Other impacts associated with dam construction include downstream changes in water quality and temperature (Churchill, 1965), increased erosion (Hagan and Roberts, 1972), changes in river morphology (Kupier, 1965), and changes in the habitat types that occur along the river (Hagan and Roberts, 1972).

Reallocating or adding storage in the eleven upstream Oklahoma reservoirs

Increasing storage in an existing reservoir may result in flooding terrestrial habitat types resulting in habitat loss for many species. For example, the federally-listed threatened piping plover is known to use the Winganon Flats area at Oologah Reservoir. An increase in water storage that caused continuous inundation of this area would represent habitat loss for this species. As mentioned above, continuous inundation of areas with terrestrial vegetation can increase the rates of deoxygenation through the decomposition of vegetation which can be detrimental to aquatic organisms. Increasing storage in the reservoirs also may result in changes in the physical characteristics of the river downstream of the dam such as depth, velocity, temperature, and turbidity which, in turn, affect the biology of the area. For example, holding water in a reservoir upstream of a breeding colony of endangered interior least terns could cause sandy islands used by the terns for nesting to become connected to the shore, thereby increasing predation on this species. Releasing large amounts of water during the breeding season, by contrast, may result in the loss of nests and chicks to flooding (Leslie et al., 2000).

Drawdowns in reservoirs can result in a loss of habitat for various fish species that inhabit littoral zones and impact fish spawning. Aquatic vegetation in littoral zones provides cover for many spawning fish and their eggs. A loss of this habitat type could force the fish into open water habitat where spawning is less successful, and predation rates may increase.

Adjustments/increases to flowage easements and changes in flow rates and duration

The upstream reservoirs in Oklahoma have multiple purposes; however, only three reservoirs are authorized for navigation (Table 1). Although the Corp has broad authority to modify the operations of the reservoirs to benefit navigation, the operational plans cannot be changed in a way that is detrimental to any authorized purpose of a reservoir. For example, slowing the flow rate from reservoirs after flood events that are authorized for flood control so that navigation can resume earlier may be detrimental to the flood control function of the reservoirs (U. S. GAO, 1988). Likewise, the Corps does not have the authority to make adjustments in flow rates from reservoirs with the authorized purpose of fish and wildlife, if the changes will have negative impacts to fish and wildlife. For example, Keystone Reservoir is authorized for flood control, navigation, and fish and wildlife. It is reasonable to assume that the Corps cannot legally change the operational plan of the MKARNS if the change will directly or indirectly cause flooding of endangered interior least tern nests below Keystone or result in land bridging of islands and, thereby, increasing predation pressure on the terns, because such operational changes would be detrimental to the fish and wildlife function of habitat directly influenced by the reservoir, as well as a negative impact to a federally-listed species. It is our understanding that, by law, the Corps must make adjustments on the MKARNS that are compatible with all reservoir functions unless the Corps can obtain legislative approval to remove an approved function of a reservoir.

Constructing new flood control levees

New levees usually contain potential overbank flooding, that could produce negative impacts on adjacent wetlands. New levees may also allow the adjacent lands to be converted to agricultural or industrial use that could likely increase the amount of nutrients, pesticides, and other pollutants entering the MKARNS that are harmful to aquatic organisms. Additionally, borrow areas used for the levees could result in the loss of valuable habitat, and levees placed adjacent to the channel could cause a loss of riparian vegetation that serves as wildlife habitat and as a buffer zone between the waterway and potential pollution sources.

Removal of channel restrictions

Removal of flow obstructions may result in a loss in habitat diversity in areas along the MKARNS. Large logs and islands in rivers provide valuable wildlife habitat. For example, pools created by turbulence from water flowing around or over obstructions such as logs increase habitat diversity in uniform systems such as navigation channels. The pools would be lost when the obstruction is removed. Removal of channel restrictions also may negatively affect adjacent wetlands by decreasing the amount of water for over bank flooding due to improved water conveyance efficiency in the MKARNS, and water quality likely would be affected by a short term increase in suspended solids, nutrients, and pesticides as bottom sediments are disturbed.

Constructing additional spillways

The area of the floodplain subject to periodic inundation downstream of the spillway is likely to be reduced. Wetlands associated with these flood events may be negatively impacted. Depending on the capacity of the structure, a spillway can cause reduced flows and pooling that decreases the ability of the waterway to dilute or assimilate pollutants, which then may concentrate in an area and negatively affect the aquatic organisms.

Deepening the entire MKARNS from 9 to 12 feet

Deepening the entire MKARNS will allow it to carry more water during flood periods which also may result in several negative ecological impacts. More water in the MKARNS results in less water for floodplain overflow, thereby negatively affecting the ecology of the floodplain. Adjacent wetlands may be drained by the deeper channel, especially during dry periods. The flood waters may move quickly through the enlarged waterway, but the water will likely concentrate somewhere downstream of the MKARNS. Increasing the depth of the entire channel from 9 to 12 feet will require dredge material disposal sites. Disposal of the material adjacent to the MKARNS will reduce floodplain area subject to periodic flooding, and riparian vegetation is often lost because it is either removed or suffocates beneath the deposits. Construction activities also may decrease water quality by releasing substances such as metals, nutrients, and pesticides otherwise bound to bottom sediments.

Adding passing lanes on the Verdigris River portion of the MKARNS in Oklahoma

Adding passing lanes will eliminate existing riparian and wetland habitat along the Verdigris River valuable to many species of mammals, amphibians, reptiles, and birds, and may increase water temperatures due to the loss of shade provided by the vegetation. Clearing the riverside vegetation also may reduce the stability of the stream banks resulting in increased erosion and suspended solids in the water columns. Due to construction activities, there may be an additional increase in suspended solids resulting in greater sediment deposition in the floodplain or downstream sites. However, widening also could result in a decrease in bed load and cause deposition near the project area because the larger cross-sectional area of the waterway may decrease its ability to transport sediments. Widening also will allow the MKARNS to carry more water during flood events, thereby negatively impacting adjacent wetlands by reducing the amount of water for floodplain overflow. The addition of passing lanes also would require spoil deposition areas that may result in the reduction of the floodplain area subject to periodic flooding and the loss of fish and wildlife habitat.

Restoration/enhancement of aquatic and riparian habitat

The Service recommends making every possible effort to operate the MKARNS in a manner that promotes the health and diversity of the various ecosystems associated and impacted by the MKARNS. Today, there are innovative river structures and concepts that can be used to improve navigation while still providing positive benefits to the environmental resources of a highly altered area such as the MKARNS. These innovative concepts have been used successfully by other Corps districts such as the St. Louis District on the Mississippi River and include: 1) notched dikes that allow the river to move in and out between notches resulting in sediment build up that can create valuable habitat in the form of small islands between the dikes, 2) stepped up dikes that tend to counteract sediment deposition, 3) off bank line revetments that do not require the loss of terrestrial habitat, and create habitat diversity and fishing opportunities between the revetment and the shore, 4) placement of dredge material behind chevron dikes to form valuable habitat in the form of small islands, and 5) notches in closure structures so that flow is allowed to re-enter side channels, thereby increasing habitat diversity. The Service also recommends restoring and enhancing habitat by acquiring land through fee title interests, conservation easements, or management agreements in habitat types that are known to have high habitat values, including lands adjacent to the MKARNS that are susceptible to flooding but currently being farmed. The property could be deeded to the state fish and wildlife agencies as additions to their wildlife management areas, to the Service as additions to the Nation's refuge system, or other appropriate environmental agencies or organizations to conserve the environmental resources of the area and be used by the general public. Trips along the MKARNS in Arkansas and Oklahoma will allow Corps engineers and biologists, state and federal agency biologists, and local hunters and anglers to identify potential enhancement and restoration sites.

Preliminary concerns

1) *Loss of fish and wildlife habitat* – Habitat loss would result from construction, excavation, inundation, and drainage and dredging activities.

2) *Loss or deterioration of highly productive, valuable, or scarce habitats* – Construction of a new reservoir(s), changes in the operating pools of existing reservoirs, excavation of borrow areas for new levees, and disposal of dredge material could result in the loss of already scarce habitat types such as bottomland hardwood forests, palustrine wetlands, and unaltered stream habitats.

3) *Deleterious impacts to rare, threatened and endangered species and their habitats* – The Endangered Species Act (87 Stat. 884 as amended; 16 U. S. C. 1531 et seq.) requires consultation with the Service regarding endangered and threatened species and designated critcal habitat. Identification of habitat for federally-listed species, as well as any potential impacts to these species, should be an integral part of the study.

4) *Changes in water level fluctuations of existing reservoirs* – Alteration of water levels would impact the littoral zone that provides spawning and nursery habitat for many fish species, and may alter valuable aquatic and terrestrial habitat.

5) *Impairment of operating efficiency of existing public parks and/or fish and wildlife installations* – National wildlife refuges, wildlife management areas, public hunting areas, state parks, and natural heritage areas could be negatively impacted. The Service is concerned about potential loss of land and valuable habitat at these areas due to construction and/or inundation.

6) *Possible degradation of water quality* – Increased turbidity, sedimentation, and resuspension of contaminants in the MKARNS, streams and existing reservoirs during construction of new levees, spillways, dams, etc., and from dredging and subsequent development can cause degradation of the water quality.

7) *Impacts on in-stream flows* – Fish and wildlife resources dependent on flowing waters in streams should be protected by establishing recommended in-stream flow regimes to meet seasonal needs.

8) *Loss of free flowing mountain stream* – Numerous miles of free flowing mountain streams have been lost to the construction of reservoirs in the past such as at Nimrod and Blue Mountain Lakes in Arkansas. Preserving these stream types should be a high priority considering the excellent quality and increasing rarity of these fisheries and associated aquatic ecosystems.

9) *Mitigation of important habitat values that may be unavoidably lost due to project construction or operation* – The Service has preliminarily categorized fish and wildlife resources in the study area in accordance with the Service's mitigation policy. These categorizations are in the following section (Preliminary Categorization of Habitat Types). Our objective is to avoid or minimize habitat value losses, and where appropriate to mitigate/compensate for lost resources.

10) *Loss of backwater areas adjacent to the MKARNS* – The shallow water areas adjacent to the MKARNS, such as sloughs and side channels, serve as important spawning and nursery areas for many fish species. These shallow water areas are being negatively impacted or lost due to dikes and other structures blocking side channels and sloughs, and from deposition of dredged material adjacent to the channel resulting in increased siltation.

11) *Declining productivity of the oxbow lakes* – Productivity in oxbow lakes declines when flood waters deposit sediment that fills in aquatic habitat, increases turbidity levels, and smother fish eggs and benthic organisms. Flood waters also cause channel cutting in the lower end of the lake that lowers the lake's average water depth.

12) *Increased barge traffic may impact fish and wildlife populations* – Through increased noise levels, increased potential for the accidental release of pollutants, and changes in water quality due to various factors, fish and wildlife populations may be adversely impacted.

13) *Unmet mitigation needs* – As discussed in greater detail below in the Discussion and Preliminary Recommendations section, the full extent of impacts caused by the original development of the MKARNS were not known during the initial project planning process, or were not adequately mitigated at the time of implementation. Thus, it was not possible to consider all actual impacts during the development of the project mitigation plan, and appropriate mitigation measures could not have been incorporated into the initial project development. The area impacted by the operation of the MKARNS greatly exceeds the MKARNS's flowage easements. This study provides an opportunity for the Corps to address these unmet mitigation needs. The Service will place emphasis on this issue in the course of these invetsigations.

PRELIMINARY CATEGORIZATION OF HABITAT TYPES

Because it is the objective of the Service to minimize or avoid the loss of habitat values in planning water development projects, we have categorized fish and wildlife resources in accordance with the Service's Mitigation Policy (U. S. Fish and Wildlife Service, 1981) to facilitate ongoing project investigations.

Category 2 resources, as defined in the policy, includes high quality habitats that are scarce or becoming scarce in the ecoregion or nationwide. The mitigation goal for this category is no net loss of in-kind habitat value. Included in category 2 for the project area are high quality native prairie, caves, streams (mountain), oxbow lakes, bottomland hardwood forests, riparian forests, and other high quality palustrine and lacustrine wetlands such as river swamp forests. Areas of somewhat lesser quality bottomland forests, riparian forests, upland forests, prairies, the Arkansas River proper and its associated tributaries and delta streams, man-made wetlands and reservoirs are assigned to category 3. Category 3 includes high to medium value habitat that is abundant on a national basis. The preferred mitigation goal for category 3 habitat is no net loss of habitat value while minimizing loss of in-kind habitat value. Mitigation in-kind for category 3 resources is preferred, but out-of-kind mitigation with no net loss is acceptable.

EVALUATION DATA NEEDS AND FUTURE FISH AND WILDLIFE COORDINATION ACTIVITIES

The Corps has not supplied formal project alternatives that will serve as potential solutions for the problems resulting from the sustained high flows on the MKARNS. To determine impacts to existing fish and wildlife resources associated with the MKARNS, upstream reservoirs and intervening aquatic, wetland, and terrestrial habitats, the Service requests the following information be provided by the Corps:

1) Specific solutions with alternatives to the problem of sustained high flows on the MKARNS. The alternatives should contain detailed quantitative descriptions of all the possible operational changes to the MKARNS, including but not limited to, information regarding: a) reallocating storage from one project purpose to another, b) changes in flow rates and durations, and, c) adjustments/ increases in flowage easements. Adequate assessment of impacts to fish and wildlife resources also will require detailed and quantitative information, including specific locations, on any possible changes such as: a) new levees, b) additional reservoir (s), c) all possible in-stream modification of existing navigation structures, d) all channel restrictions that might be removed, and, e) any new high flow relief structures (spillways) that may be constructed.

2) Possible changes in quantity of habitat types (quantitative gain or loss) associated with the MKARNS in Oklahoma and Arkansas and the eleven upstream reservoirs in Oklahoma, including habitat types in the wildlife management areas and national wildlife refuges, and all other areas with ecological/fish and wildlife value such as, but not limited to, the habitat types listed in this report.

3) Locations and sizes of all potential dredge material disposal sites, and quantitative information regarding the existing habitat types at these sites.

4) Locations and sizes of all potential borrow areas that may be excavated for construction of new levees, and quantitative information regarding the existing habitat types at these sites.

5) Detailed and quantitative information regarding the addition of passing lanes on the Verdigris River portion of the MKARNS in Oklahoma.

6) Amount, location, and type of wetlands along either side of the Verdigris River portion of the MKARNS in Oklahoma that might be impacted by adding passing lanes to this portion of the MKARNS, as well as potential wetland, bottomland forest and riparian forest restoration sites.

7) As discussed below in the Recommendations section of this report, the full extent of impacts caused by the original development of the MKARNS were not known during the initial project planning process. Thus, it was not possible to consider all actual impacts during the development of the project mitigation plan, and appropriate mitigation measures could not have been incorporated into the initial project development. This study provides an opportunity for the Corps to address these unmet mitigation needs. The Service requests that the Tulsa and Little Rock Districts quantify project impacts attributable to construction and operation of the MKARNS on fish and wildlife resources for the entire navigation system (including upstream reservoirs and intervening aquatic, wetland, and terrestrial habitats) and initiate planning to address these impacts. The Service requests the mitigation plan be developed through interagency coordination.

8) Local anglers, hunters, Corps engineers, and wildlife and fisheries biologists participated on trips on the MKARNS from the Arkansas/Oklahoma state line to Lock # 2 in eastern Arkansas during Fall 2000 to locate areas with the potential for fish and wildlife enhancement projects. As a result of the trips, 256 possible fish and wildlife enhancement projects were identified for further evaluation. The Service commends the Corp's effort, and looks forward to additional opportunities for enhancement/restoration projects for fish and wildlife resources. The projects identified on the Arkansas trip have been included below as part of our recommendations. The Service is aware that a similar trip along the Oklahoma portion of the MKARNS is being planned for Spring 2001 that will involve local anglers and hunters, Corps engineers, Service biologists, and state fish and wildlife biologists. Again, we appreciate this effort and look forward to the possibilities.

Future fish and wildlife coordination activities include: 1) attending meetings pertaining to this study; 2) investigating potential sites for fish and wildlife enhancement/restoration projects; 3) gathering data as necessary to investigate potential project impacts to fish and wildlife resources as more details on the alternatives are developed; and 4) providing the Corps with evaluation data needs not mentioned in this report if required by new developments/details on project alternatives that have not been provided to the Service as of the date of this report. The Service also will provide the Corps with a draft FWCA report about 60 days after receiving formal project alternatives and the requested information needed to adequately assess impacts to fish and wildlife resources (evaluation data needs).

DISCUSSION AND PRELIMINARY RECOMMENDATIONS

The project study area contains a variety of high quality fish and wildlife resources on public and private lands. These include several rivers, numerous lakes and wildlife management areas, three national wildlife refuges, numerous state parks, and many natural heritage areas. The Service's overall goal is the protection and enhancement of important fish and wildlife resources, with special emphasis on those discussed above. We recommend that the Corps make fish and wildlife conservation an integral part of the project and seek full Congressional funding for these efforts.

The Corps should avoid negative impacts to all federally-listed species. Examples of potential concerns include alterations to interior least tern habitat on the Arkansas River due to changes in the operational plans of Keystone Reservoir. The Corps currently often changes the flow rates from Keystone Reservoir at the request of Southwestern Power Administration, an agency of the Department of Energy located in Tulsa, Oklahoma, that markets the hydroelectric power produced at numerous Corps dams in Oklahoma, Texas, Arkansas, and Missouri. Operational plans that flood nesting habitat or cause land-bridging of islands used during the breeding season may result in increased predation and human access pressure on the terns and should be avoided. If the Corps and Southwestern Power Administration determine that negative impacts to terns cannot be avoided, formal consultation with the Service should be initiated.

Similarly, the Corps should avoid impacts to bald eagles and their nests along the MKARNS and lakes and streams in the project area. Surveys for bald eagle nests and winter roosts should be conducted prior to removal of any large trees. Changes in operational plans that may reduce potential piping plover habitat at Oologah Reservoir also should be avoided. If the Corps (and Southwestern Power Administration) determines that negative impacts to any federally – listed species within the project area as discussed above cannot be avoided, formal consultation with the Service should be initiated.

Three of the eleven upstream Oklahoma Reservoirs have fish and wildlife conservation as a project purpose. The Services requests that any new operational plans developed by the Corps not be detrimental to the fish and wildlife conservation function of these reservoirs or downstream and upstream habitat associated with these reservoirs. Further, the Service recommends ensuring that shallow water habitat that provides spawning and nursery habitat is available by making every reasonable effort at holding reservoir pool levels relatively stable during the fish spawning season.

Adverse impacts to the three national wildlife refuges should be avoided. The National Wildlife Refuge System Improvement Act of 1997 that amends the National Wildlife Refuge System Administration Act of 1966 clearly states that the primary mission of the nation's refuges is wildlife conservation; however, the legislation does not preclude the Service from allowing other uses if they area determined to be compatible with the Refuge System mission and the purposes of individual refuges (65 FR 62457). If refuge lands are impacted by navigation or required for project right-of-way, mitigation for adverse impacts will be required since navigation is not consistent with the purpose for each refuge (Table 9).

As discussed above, the White River NWR consists of about 160, 000 acres including about 154, 000 acres of bottomland hardwood forests. Although historically about 8 million acres of bottomland hardwood forests occurred in Arkansas, today only about 850, 000 acres remain. Almost 160, 000 of these acres occur in a contiguous block of forest in the White River NWR, representing nearly 20 percent of the state's remaining bottomland hardwood forest acreage. As the host of the largest concentration of wintering mallard ducks in the Mississippi Flyway the refuge helps bring about 2.5 million dollars per day to the area during the sixty day duck hunting season, and thus is already a major economic asset to the area. The refuge also brings additional economic activity to the area through eco-tourism. People visit the refuge not only for the chance to witness the largest concentration of wintering mallard ducks in the Mississippi Flyway, but also because the refuge provides habitat for thousands of neo-tropical migratory songbirds, about 325 black bears, and contains cypress trees nearly 1, 000 years old; the refuge also has 350 lakes suitable for fishing and contains one of the best warm water fisheries in the Mississippi Basin. The number of people visiting the area annually is likely to increase in the future. A thorough investigation of the refuge will be necessary to ensure its health and preservation.

The White River NWR occupies about three miles of the MKARNS's Arkansas Post Canal and also houses the dredge disposal sites needed when this portion of the Arkansas Post Canal (mile marker 8 – 10) is dredged for maintenance purposes. These spoil areas are not consistent with the Refuge System mission or the purposes of White River NWR, although attempts are being made to pass legislation that will allow the continued use of the spoil areas. Mitigation for the spoil areas is required since navigation is not consistent with the purpose of the refuge. Appropriate mitigation measures currently are being investigated.

Opportunities for fish and wildlife habitat/restoration enhancement projects also exist at Sequoyah and Holla Bend NWRs. Coordination with the individual refuges during project planning to explore these possibilities is essential. Also, each refuge is currently developing a Comprehensive Conservation Plan (CCP) that will guide management activities for the next 15 years. The Service requests that the Corps incorporate the CCPs of the refuges, as they become available, as part of the operational plan of the MKARNS to help ensure adverse impacts to the fish and wildlife resources associated with the refuges do not occur as a result of navigation operations.

During Fall 2000, local anglers, hunters, Corps engineers, and wildlife and fisheries biologists participated on trips on the MKARNS from the Arkansas/Oklahoma state line to Lock # 2 in

Table 9. Purpose of White River, Holla Bend, and Sequoyah National Wildlife Refuges (http://refuges.fws.gov/databases/purposes.taf?function=form).

National Wildlife Refuge	Purpose
White River	Breeding ground and inviolate sanctuary for migratory birds and other wildlife; conservation, maintenance, and management of wildlife resources/habitat; fish and wildlife oriented recreational development; conservation of endangered and threatened species.
Holla Bend	Inviolate sanctuary for migratory birds; management of migratory birds; development, advancement, management, conservation, and protection of fish and wildlife resources; fish and wildlife oriented recreational development; conservation of threatened and endangered species.
Sequoyah	Conservation, maintenance, and management of wildlife resources/habitat.

eastern Arkansas to locate areas with the potential for fish and wildlife enhancement projects. As a result of the trips, about 255 possible fish and wildlife enhancement projects were identified for further evaluation. The projects include: 1) notching dikes to create backwater areas for spawning fish, 2) notching revetments for fish, angler, and hunter access, 3) development of moist soil management areas for waterfowl, 4) island construction for interior least tern and other shorebird habitat, 5) construction of nursery ponds for fish production, and 6) establishment of water level management plans for fish spawning season.

The Service recommends incorporating these fish and wildlife enhancement opportunities into the project, as well as potential restoration/enhancement projects that might be identified during a similar trip along the Oklahoma portion of the MKARNS scheduled for Spring 2001. These projects should include enhancement/restoration of habitat used by popular sport fish and game species, non-game species, and rare/declining species. Because several federally-listed species occur in the project area, the projects also offer the Corps an opportunity to carry out Section 7 (a) 1 responsibilities, as mandated by the Endangered Species Act. Section 7 (a) 1 of the Act requires that all federal agencies use their authorities to carry out programs for the specific purpose of conserving threatened and endangered species. Island construction for interior least terns could represent one such opportunity.

In previous Service reports and letters to the Corps regarding the MKARNS, dated May 5, 1989, October 20, 1989, October 6, 1992, and January 4, 1994, the Service noted that the areas impacted by occasional or permanent flooding were underestimated during the original project planning process. The initial real estate interests purchased prior to construction and development of the MKARNS were based on a flat pool elevation at normal navigation pool levels. However, the water levels of the pools are sloping rather than flat. The effects of the MKARNS greatly exceed the original flowage easements. The impacted areas include important fish and wildlife habitat.

For example, the inundation of the Arkansas River channel and tributary streams has resulted in the loss of stream fishery habitat. Additionally, vast tracts of valuable wildlife habitat, such as bottomland hardwood forests, have been negatively impacted by continuous inundation. Because the full extent of impacts caused by the development of the MKARNS were not known during the initial project planning process, all impacts could not have possibly been considered during the development of the project mitigation plan, and appropriate mitigation measures could not have been incorporated into the initial project development. Section 906 (b) of the Water Resources Development Act of 1986 authorizes the Secretary of the Army to mitigate damages to fish and wildlife resources resulting from any water resource project under his jurisdiction, whether completed, under construction, or to be constructed. This study provides an opportunity for the Corps to address the unmet mitigation needs of the original project, and the Service applauds the Corps for listing fish and wildlife habitat restoration and enhancement projects as a part of this study. In light of this exciting opportunity, the Service requests the following:

1) The Tulsa and Little Rock Districts quantify project impacts attributable to construction and operation of the MKARNS to fish and wildlife resources for the entire navigation system (including upstream reservoirs and intervening aquatic, wetland, and terrestrial habitats) and initiate planning to address these impacts.

2) The Corps should acquire fee title interests or conservation easements in lands that are impacted by the project and known to have high habitat values, including lands adjacent to the MKARNS that are susceptible to flooding but currently being farmed, and deed the property to the state fish and wildlife agencies as additions to their wildlife management areas, to the Service as additions to the National Wildlife Refuge System, or other appropriate environmental agencies

for fish and wildlife management purposes.

Due to the nature of the various solutions being investigated, such as adding passing lanes along the Verdigris River portion of the MKARNS in Oklahoma and reallocating or adding storage to existing reservoirs, it is likely that wetlands will be adversely impacted by the project. The Service is aware that the mitigation plan for the resource losses likely will be extensive after the Corps quantifies both the potential impacts from the possible changes to the MKARNS now being considered and the unanticipated impacts on fish and wildlife resources for the entire navigation system as a result of the original project. Again, the Service applauds the Corps for listing potential fish and wildlife habitat restoration and enhancement projects as a part of the study. We believe this will provide a significant opportunity for habitat restoration, and request that a mitigation plan for future potential impacts and unmet mitigation needs be developed through interagency coordination. The plan should include: 1) actions discussed in this report such as habitat restoration, enhancement, and creation projects within the project area for habitats used by federally-listed species, rare/declining species, and species popular with local anglers and hunters; 2) mitigation for impacts to refuges; and 3) acquisition of ecologically valuable habitats that are scarce in the ecoregion and/or provide quality hunting and fishing opportunities for addition to the Nation's refuge system, as potential additions to the states' wildlife management areas, or to be deeded to other appropriate environmental agencies so the areas could be conserved and used by the general public. The Service recommends that the Corps seek full Congressional funding for these efforts.

The Service appreciates the opportunity to provide preliminary comments and recommendations. We emphasize that this report is based on a very general and large-scale project description. Comments, concerns, and recommendations included in this report are subject to revision as more information is developed on project alternatives and impacts. We look forward to working with the Corps as the study progresses and more details are provided.

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APPENDIX A

OKLAHOMA COUNTY DISTRIBUTIONS
OF
FEDERALLY LISTED SPECIES

FEDERALLY LISTED THREATENED OR ENDANGERED SPECIES,
PROPOSED SPECIES, AND CANDIDATE SPECIES
OKLAHOMA COUNTY DISTRIBUTIONS
MARCH 2001

COUNTY	SPECIES	CLASSIFICATION
Cherokee	American burying beetle	Endangered
	gray bat	Endangered
	Ozark big-eared bat	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Creek	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Delaware	gray bat	Endangered
	Indiana bat	Endangered
	Ozark big-eared bat	Endangered
	bald eagle	Threatened
	Ozark cavefish	Threatened
	piping plover	Threatened
	Arkansas darter	Candidate
Haskell	American burying beetle	Endangered
	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Kay	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	black-tailed prairie dog	Candidate
LeFlore	American burying beetle	Endangered
	Indiana bat	Endangered
	interior least tern	Endangered
	Ouachita rock-pocketbook	Endangered
	bald eagle	Threatened
	leopard darter	Threatened
	leopard darter critical habitat	
	piping plover	Threatened
	scaleshell	Proposed Endangered
Mayes	bald eagle	Threatened
	Ozark cavefish	Threatened
	piping plover	Threatened
	Arkansas darter	Candidate

COUNTY	SPECIES	CLASSIFICATION
McIntosh	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	Arkansas River shiner	Threatened
	Arkansas River shiner critical habitat	Proposed
Muskogee	American burying beetle	Endangered
	interior least tern	Endangered
	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Nowata	bald eagle	Threatened
	piping plover	Threatened
Osage	interior least tern	Endangered
	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	mountain plover	Proposed Threatened
Ottawa	gray bat	Endangered
	Ozark big-eared bat	Endangered
	winged mapleleaf	Endangered
	bald eagle	Threatened
	Neosho madtom	Threatened
	piping plover	Threatened
	Arkansas darter	Candidate
Pawnee	interior least tern	Endangered
	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Pittsburg	American burying beetle	Endangered
	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	Arkansas River shiner	Threatened
	Arkansas River shiner critical habitat	Proposed
Rogers	interior least tern	Endangered
	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	western prairie fringed orchid	Threatened
	Arkansas darter	Candidate

COUNTY	SPECIES	CLASSIFICATION
Sequoyah	American burying beetle	Endangered
	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Tulsa	American burying beetle	Endangered
	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Wagoner	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Washington	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	mountain plover	Proposed Threatened

APPENDIX B

ARKANSAS COUNTY DISTRIBUTIONS
OF
FEDERALLY LISTED SPECIES

FEDERALLY LISTED THREATENED OR ENDANGERED SPECIES, PROPOSED SPECIES, AND CANDIDATE SPECIES
ARKANSAS COUNTY DISTRIBUTIONS
MARCH 2001

COUNTY	SPECIES	CLASSIFICATION
Arkansas	bald eagle	Threatened
	pink mucket	Endangered
Conway	Florida panther	Endangered
	interior least tern	Endangered
Crawford	scaleshell	Proposed Endangered
	interior least tern	Endangered
Desha	bald eagle	Threatened
	interior least tern	Endangered
Faulkner	interior least tern	Endangered
Franklin	<u>Geocarpin</u> <u>minimum</u>	Threatened
Jefferson	Florida panther	Endangered
	bald eagle	Threatened
Johnson	Florida panther	Endangered
	interior least tern	Endangered
Lincoln	bald eagle	Threatened
Logan	bald eagle	Threatened
	Magazine Mountain shagrine	Threatened
	American burying beetle	Endangered
	Arkansas River shiner	Threatened
	interior least tern	Endangered
Perry	scaleshell	Proposed Endangered
	red-cockaded woodpecker	Endangered
	interior least tern	Endangered
Pope	gray bat	Endangered
	interior least tern	Endangered
Sebastian	bald eagle	Threatened
	American burying beetle	Endangered
	interior least tern	Endangered

COUNTY	SPECIES	CLASSIFICATION
Yell	Florida panther	Endangered
	harperella	Endangered
	interior least tern	Endangered

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
222 South Houston, Suite A
Tulsa, Oklahoma 74127
918/581-7458 / (FAX) 918/581-7467

In Reply Refer To:
FWS/R2/OKES/
ARNS

June 23, 2005

Colonel Wally Walters
U.S. Army Corps of Engineers
Little Rock District
P. O. Box 867
Little Rock, Arkansas 72203 – 0867

Dear Colonel Walters:

Enclosed is the U. S. Fish and Wildlife Service's (Service) final report on the fish and wildlife resources likely to be impacted by proposed actions related to the Arkansas River Navigation Study, Arkansas and Oklahoma. This report fulfills the reporting requirements set forth in Section 2 (b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*) (FWCA) and is intended to accompany the U. S. Army Corps of Engineers' (Corps) feasibility report on this project.

The Corps, Service, Oklahoma Department of Wildlife Conservation, and Arkansas Game and Fish Commission have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening feature would have on fish and wildlife resources. As of the date of this report, a full assessment of adverse impacts and a complete mitigation plan have been developed for impacts due to disposal of dredged material at terrestrial sites within the floodplain of the navigation system in Oklahoma. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report. The Service understands that the Corps intends to fully mitigate for aquatic resource impacts. This report provides additional compensatory mitigation recommendations for aquatic resource impacts for Corps consideration during development of the final mitigation plan for aquatic resource impacts in Appendix G. We believe that incorporating these additional mitigation features into the mitigation plan should serve to adequately offset aquatic resource impacts. The final mitigation plan for aquatic resource impacts would be acceptable provided that it was demonstrated through a Habitat Evaluation Procedures or similar analysis to completely offset losses in habitat value over the project life. A final aquatic mitigation plan could be provided in a supplemental FWCA report.

The Service appreciates the cooperation of your staff in development of this report. If you have any questions, please contact Richard Stark of this office at 918-581-7458, extension 240.

Sincerely,

Jerry J. Brabander
Field Supervisor

Enclosure

cc: Chief, Planning and Environmental, U.S. Army Corps of Engineers, Tulsa, OK
Regional Director (ARD-ES), FWS, Albuquerque, NM
(Attn:: Dean Watkins)
Regional Director (ARD-ES), FWS, Atlanta, GA,
(Attn:: Jeff Weller)
Director, Arkansas Game and Fish Commission, Little Rock, AR
(Attn:: Craig Uyeda)
Director, Oklahoma Department of Wildlife Conservation, Oklahoma City, OK
(Attn:: Fisheries and Natural Resources Section)
Oklahoma Department of Wildlife Conservation, Northeast Regional Office,
Porter, OK (Attn:: Mike Plunkett, Randy Hyler, and Gary Peterson)
Director, Oklahoma Department of Environmental Quality, Oklahoma City, OK
(Attn:: Water Quality Programs Division 0207)
Regional Administrator, Environmental Protection Agency, Dallas, TX
(Attn: 6WQ-EM)
Director, Department of Arkansas Heritage, Little Rock, AR
Field Supervisor, U. S. Fish and Wildlife Service, Conway, AR
(Attn: Marge Harney)
Manager, Sequoyah National Wildlife Refuge, Vian, OK
Manager, White River National Wildlife Refuge, DeWitt, AR
Manager, Holla Bend National Wildlife Refuge, Dardanelle, AR
Natural Resources Library, U.S. Department of the Interior, Washington, DC

RCS:plh:ARNS CAR Transmittal letter

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

FINAL COORDINATION ACT REPORT
ARKANSAS RIVER NAVIGATION STUDY, ARKANSAS AND OKLAHOMA

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EXECUTIVE SUMMARY

This summarizes the U. S. Fish and Wildlife Service's (Service) final report on the fish and wildlife resources likely to be impacted by proposed actions related to the Arkansas River Navigation Study, Arkansas and Oklahoma. This report will accompany the U. S. Army Corps of Engineers' (Corps) feasibility report on this project.

The Little Rock and Tulsa Districts of the Corps are charged with the operation and maintenance of the McClellan-Kerr Arkansas River Navigation System (MKARNS) for commercial navigation. The proposed action is to improve and maintain the MKARNS through three features: 1) River Flow Management, 2) Navigation Channel Deepening, and 3) Navigation Channel Depth Maintenance.

This final report 1) identifies the effects of actions proposed to maintain and improve navigation on the MKARNS on fish and wildlife resources within the project area, 2) discusses measures to appropriately identify, avoid, and minimize environmental impacts, and 3) provides recommendations to appropriately compensate for unavoidable impacts to fish and wildlife resources and to maintain the value of the fish and wildlife resources associated with the navigation system.

The project area consists of the entire 445–mile–long MKARNS in Arkansas and Oklahoma, and 11 upstream multi-purpose reservoirs in Oklahoma that act as the MKARNS's primary flow modifiers. The extensive project area contains a diversity of high quality fish and wildlife resources.

Important fish and wildlife resources are associated with the 11 upstream reservoirs used to regulate flow on the system. These include state wildlife management areas (WMAs) located on the project lands surrounding the reservoirs and managed by the Oklahoma Department of Wildlife Conservation (ODWC), WMAs managed by the Arkansas Game and Fish Commission (AGFC), river oxbows, dike fields, floodplain habitat, bottomland hardwood forest, wetlands, national wildlife refuges, the Arkansas and Verdigris rivers and their tributaries, and numerous federally-listed species.

RIVER FLOW MANAGEMENT

The purpose of the River Flow Management feature of the study is to improve the safety and efficiency of commercial navigation operations, and to reduce flood damages by managing the MKARNS to limit periods of sustained high flows that originate from the upper reaches of the Arkansas River watershed. The effects of modifying the current operating plan were evaluated using the Corps "Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System," also known as the SUPER Model. For this evaluation, reservoir elevations and river stages were modeled using a 61 year (January 1940 – December 2000) period of record.

The River Flow Management feature would consist of maintaining the existing operating plan (*i.e.*, operating Van Buren at 150,000 cubic feet per second (cfs)), but replacing the current 75,000 cfs bench with a 60,000 cfs bench beginning at 3 percent lower system storage, except from June 15 – October 1. Fluctuations of reservoir water levels under the selected plan are expected to change only slightly from current operations. Based on average annual lake levels and stream flows, impacts to fish and wildlife resources at the reservoirs would appear not to differ significantly from current conditions. The Service believes, however, that it is important to also consider all conditions that would occur in extreme high and low years in order to adequately evaluate potential effects to fish and wildlife resources. Anticipated impacts could include altering the littoral zone, eliminating vegetated areas adjacent to the reservoirs, adversely impacting fish spawning and recruitment, and reducing available habitat for migratory birds.

Implementation of the selected plan also would reduce the duration of flooding in the floodplain downstream of the 11 reservoirs. Because the hydrology of wetlands in the floodplain would be altered, important wetland habitats may be adversely impacted. In order to adequately assess impacts to these wetlands and compensate for unavoidable losses, we recommend that the Corps identify the specific lands that would receive flood protection benefits, determine the quantity (acres) and quality (habitat type and value) of wetlands that the selected operating plan would alter, and determine the quantity (acres) and quality (habitat type and value) of wetlands that would be acquired and/or managed to compensate for wetland losses.

NAVIGATION CHANNEL DEEPENING

The purpose of the proposed Navigation Channel Deepening feature is to remove the disparity between the navigation channel depths of the MKARNS (9 feet) and the Lower Mississippi (12 feet), and thereby increase the volume and efficiency of commercial navigation operations. The proposed action is anticipated to have substantial direct and indirect effects to important fish and wildlife resources. Impacts would include the loss of terrestrial habitat due to the disposal of dredged material in upland sites; the loss of aquatic habitat due to disposal of dredged material in aquatic sites and the construction and raising of river training structures; the removal and alteration of gravel bars, which support a variety of aquatic species, due to dredging activity; and adverse effects on freshwater mussel patches and beds (*i.e.,* mussel concentrations) due to dredging activity and the disposal of dredged material.

Early in the evaluation process, a Multi-agency Ecosystem Evaluation Team was established to evaluate impacts of the proposed Navigation Channel Deepening feature on terrestrial and aquatic habitats and ecological benefits resulting from proposed mitigation measures. The multidisciplinary team included biologists with technical expertise from the Corps, Little Rock and Tulsa Districts, the Service, the Corp's Engineer Research and Design Center, ODWC, AGFC, and Parsons, a private consulting firm. The team evaluated the environmental impacts of proposed dredging and disposal of dredged material using Habitat Evaluation Procedures (HEP).

The HEP were used to conduct assessments at the terrestrial dredged material disposal sites and at selected mitigation sites. The disposal of dredged material at terrestrial sites would result in the loss of about 750 acres of important habitat in Oklahoma, for which compensatory mitigation is being recommended. Terrestrial dredge disposal sites in Arkansas would occur in cropland sites along the Post Canal, which were selected to avoid impacts to important fish and wildlife habitat. Habitat conditions were projected over the 50-year life of the project. A mitigation plan to offset anticipated impacts was developed through interagency cooperation of biologists with the Corps, Service, and the ODWC. The compensatory mitigation plan currently endorsed by the Service and ODWC consists of bottomland hardwood restoration and marsh creation at two sites along the Verdigris River that are currently agricultural fields.

The entire aquatic impacts analysis has not been completed as of the date of this report due largely to the expedited study schedule and missing information. Certain variables used in the analysis are currently being fine-tuned. Aquatic mitigation features considered to date would result in a net gain of habitat units in Oklahoma, but a deficit in Arkansas. The Corps, Service, and the AGFC have recently developed additional and modified mitigation features for the Arkansas portion of the project. This report provides these additional compensatory mitigation recommendations for aquatic resource impacts for consideration by the Corps during development of a complete mitigation plan. We believe incorporation of these recommendations into the final mitigation plan would serve to completely offset losses in habitat value (see Appendix G).

NAVIGATION CHANNEL MAINTENANCE

The purpose of the proposed Maintenance Dredging and Disposal feature is maintenance of the navigation channel through the continued use of a series of river training structures, as well as maintenance dredging at locations where the channel is less than desired depth due to sediment accumulation. This feature would consist of disposal of dredged material at new sites not included in the original Operation and Maintenance Plan, once existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. This component also includes new river training structures. Impacts anticipated as a result of the Navigation Channel Maintenance feature are being assessed using the same HEP methodology as described above for the Navigation Channel Deepening element.

FEDERALLY-LISTED SPECIES

Several federally-listed species occur in the project area. Formal consultation under section 7 of the Endangered Species Act (ESA) currently is in progress for the following four species: the interior least tern, American burying beetle, bald eagle, and pallid sturgeon.

The study offers the Corps an opportunity to carry out both section 7 (a) 1 and 7 (a) 2 responsibilities, as mandated by the ESA. Section 7 (a) 1 of the ESA requires that all federal agencies use their authorities to carry out programs for the specific purpose of conserving threatened and endangered species. Island construction for interior least terns using dredged material could represent one such opportunity. Section 7 (a) 2 responsibilities are addressed in the Service's biological opinion.

MITIGATION AND SERVICE POSITION

Environmental Management Program

The effects of the development, operation, improvement, and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, the downstream segments of the rivers, wetlands, backwater areas, and in the main stem of the navigation channel) will have long-term consequences that cannot be adequately identified or appropriately assessed without long-term studies and extensive monitoring efforts. The Service believes the Corps should seek Congressional authorization and funding for an Environmental Management Program in order to perform long-term monitoring and resource studies to assess the true magnitude of the development, operation, and maintenance of the MKARNS. The Service also recommends that a mitigation fund be established that would be utilized to address mitigation needs identified through the long-term monitoring program. The cost of the long-term monitoring program and the mitigation fund should be considered in the Corp's benefit:cost analysis for the Arkansas River Navigation Study. Benefits to local economies attributable to expenditures by outdoor recreation enthusiasts, such as wildlife observers, hunters, and anglers, are likely to increase as the quality of habitat supporting fish and wildlife species increases. These benefits to local/regional economies also should be considered.

Unmet Mitigation Needs

The MKARNS is a large and complex system that impacts rivers, tributaries, oxbows, reservoirs, wetlands, and other important natural resources. The original construction of the navigation project destroyed a considerable amount of highly valuable fish and wildlife habitat along the Verdigris and Arkansas rivers. Losses of fish and wildlife habitat as a result of original construction, operation and maintenance of the MKARNS were not evaluated using habitat value as a basis for determining compensation needs. About 28,200 acres of project lands, including the Sequoyah National Wildlife Refuge and McClellan-Kerr WMA units, were allocated for wildlife management after construction of the MKARNS. The Service believes it is reasonably certain that the total combined habitat value lost within the impacted areas far exceeds the habitat value gained from project lands and water licensed and designated for fish and wildlife resource management.

Furthermore, since the initial navigation project was completed, many acres of impacts have been identified that were not accounted for originally. Impacts to these areas were never fully assessed or mitigated during initial navigation project planning or implementation. In addition, the proposed project likely will increase the impacts to these areas. The full extent of unmitigated impacts associated with the original project, and the current proposed project impacts, should be considered within this project assessment and mitigated appropriately.

The Service recommends that the Corps seek Congressional authorization and funding to initiate a study to address any unmet mitigation needs of the original project and implement conservation measures previously recommended by the Service. This study could constitute an initiation of the Environmental Management Program.

Service Position

Fish and wildlife resources and wildlife-associated recreational activities are an important aspect of American culture. In 2001, U. S. residents spent more than $108 billion dollars while pursuing fish and wildlife related activities. In Oklahoma alone, wildlife observers, hunters, and anglers spent $193,248,000, $248,071,000, and $476,019,000, respectively during 2001 (USDOI and USDOC, 2001). In 2002, over 35 million people visited national wildlife refuges. Their expenditures (*e.g.*, lodging, food, equipment) generated over $809 million in regional economies (USFWS, 2003).

The Service's overall mitigation goal is to conserve important fish and wildlife resources for the benefit of the American people, while facilitating balanced development. This goal is supported by language in the Fish and Wildlife Coordination Act (FWCA) and other authorities. The FWCA establishes fish and wildlife conservation as a coequal purpose of water resource development projects and states that fish and wildlife resources shall receive equal consideration with other features of water resources development programs.

The action alternatives for deepening and maintaining the navigation channel would have significant adverse impacts on both terrestrial and aquatic fish and wildlife resources. As of the date of this report, a full assessment of adverse impacts and a complete mitigation plan have been developed for impacts due to disposal of dredged material at terrestrial sites within the floodplain of the navigation system in Oklahoma.

The Corps, Service, ODWC, and AGFC have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening would have on aquatic fish and wildlife resources. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report. The Service understands that the Corps intends to fully mitigate for aquatic resource impacts. This report provides additional compensatory mitigation recommendations for Corps consideration during development of the final mitigation plan for aquatic resource impacts in Appendix G. We believe that incorporating the additional mitigation features into the mitigation plan should serve to adequately offset aquatic resource impacts. The final mitigation plan for aquatic resource impacts would be acceptable to the Service, ODWC, and AGFC provided that it was demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

The Service believes that in order to ensure that fish and wildlife resources receive equal consideration, as mandated by the FWCA, the Corps should:

- Develop a final mitigation plan through interagency coordination that would minimize, avoid, and compensate for all project impacts;

- Utilize the authorities provided under section 906(b) Water Resources Development Act (WRDA) 1986 and section 306 WRDA 1990 to seek full Congressional authorization and funding for an Environmental Management Program in order to perform the long-term studies and monitoring of the fish and wildlife resources associated with the navigation system; and

- Establish a mitigation fund that would be utilized to address mitigation needs identified through the long-term monitoring program.

INTRODUCTION

This Fish and Wildlife Coordination Act Report (CAR) provides information on fish and wildlife resources associated with the McClellan-Kerr Arkansas River Navigation System (MKARNS) for use during the Arkansas River Navigation Study, Arkansas and Oklahoma (ARNS). This study is being conducted by the U. S. Army Corps of Engineers (Corps) to investigate maintenance and improvement of commercial navigation on the MKARNS.

The development of the Arkansas River and its tributaries for the purposes of navigation, flood control, hydropower, water supply, recreation, and fish and wildlife habitat was initially authorized by the Rivers and Harbors Act of July 24, 1946. Public Law 91-649 stated the project would be known as the McClellan – Kerr Arkansas River Navigation System. Development of and construction on the MKARNS began in 1957 and was completed in 1971.

The current study results from an March 11, 1982, Resolution by the Committee on Public Works and Transportation of the U. S. House of Representatives dated March 11, 1982, known as the Arkansas River Basin Study Authority. This resolution authorized the Corps to examine proposals for storage, conservation, treatment, and conveyance of water in the Arkansas River and Tributaries in Arkansas and Oklahoma for municipal and industrial uses. The resultant reconnaissance study that began in 1984 recommended that more detailed feasibility level studies be conducted to solve navigation, flood control, recreation, water supply, and fish and wildlife resource problems in the Arkansas River Basin in Arkansas and Oklahoma. Funds were provided in the Energy and Water Development Appropriations Act of 1999 to perform a reconnaissance study of the flooding problems in the vicinity of Fort Smith, Arkansas. As a result of the reconnaissance study, a section 905(b) analysis in accordance with the Water Resources and Development Act (WRDA) of 1986 was prepared by the Southwest Division Corps. The report recommended the current feasibility study with two phases, and was approved by the Corps Headquarters on January 4, 2000.

The Corps completed a draft Feasibility Report and Environmental Impact Statement for Phase 1 in August 2003. The purpose of Phase 1 was to investigate possible operational changes that might improve the MKARNS's ability to evacuate high water through the system and reduce impacts of sustained high flows. The purpose of Phase 2 was to investigate the feasibility of deepening the entire length of the MKARNS from 9 to 12 feet where necessary to allow for deeper tow drafts. Phase 2 also would have been used to investigate adding passing lanes on the Verdigris River in Oklahoma for increased tow safety. However, the Corps decided to combine the two phases into a single comprehensive study based on comments received during the National Environmental Policy Act scoping process for Phase 1 and Phase 2 (Notice of Intent published in the July 16, 2004, issue of the 136 FR 42549).

The purpose of the comprehensive ARNS was to identify and evaluate environmental and socioeconomic aspects of viable alternatives to improve the productivity of commercial navigation on the MKARNS while maintaining the other project purposes of flood control, recreation, hydropower, water supply, and fish and wildlife. The alternatives evaluated in detail are associated with three major elements related to the maintenance and improvement of the MKARNS, and, therefore, influence navigation on the system. The three elements considered in this study are: 1) River Flow Management, 2) Navigation Channel Deepening and 3) Navigation Channel Maintenance.

The purpose of the River Flow Management element is to develop and evaluate various modifications to the MKARNS that would resolve specific socioeconomic problems resulting from sustained high flows that originate from the middle reaches of the Arkansas River watershed. These problems include flood damages along the river, decreased navigation traffic, and losses to recreational use.

The study team initially examined eight structural alternatives and 23 non-structural alternatives, including altering the current reservoir regulation plan, to facilitate operational changes to the MKARNS in Oklahoma. These alternatives examined measures such as modification of reservoir releases to enable changes in flow rates and durations, reallocating storage from one reservoir to another, or adding storage in the reservoirs. Other alternatives included constructing additional reservoirs, additional high flow relief structures (i.e., spillways), and additional levees along the MKARNS, as well as adjustments/increases in flowage easements, removal of channel restrictions, in-stream modification of existing navigation structures, and restoration/ enhancement of aquatic and riparian habitat along the MKARNS. The study team determined that structural alternatives would be too expensive relative to the associated benefits and would not adequately meet the study objective. From the 23 non-structural alternatives evaluated, four operational alternatives were examined in detail. The detailed analysis for each of the four operational alternatives included a hydraulics study, hydrologic modeling of the river system, and an economics study for each proposed alternative.

The purpose of the Navigation Channel Deepening feature was to determine the feasibility of deepening the MKARNS to improve efficiency and productivity of commercial navigation. The existing 9-foot draft channel limits towboat loads when compared with loads supported by the 12-foot draft channel of the Lower Mississippi River. The disparity between the channel depths of the two systems is believed to result in less efficient operations than could be achieved with a consistent 12-foot navigation channel depth throughout the two systems. Channel deepening has been proposed to occur in six river segments: 1) mouth to Pine Bluff, 2) Pine Bluff to Little Rock, 3) Little Rock to Dardanelle, 4) Dardanelle to Ft. Smith, 5) Fort Smith to Muskogee, and 6) Muskogee to Catoosa. Alternatives considered include a 10-, 11-, and 12-foot channel depth. However, only the 12-foot channel depth would address the channel disparity between the Mississippi River and the MKARNS.

The purpose of the Navigation Channel Maintenance feature is to maintain the desired navigation channel depth (currently 9-feet) through the continued use of a series of river training structures and maintenance dredging. Dredging would be required to continue ongoing operation of the existing 9-foot navigation channel. Ongoing channel maintenance activities since completion of the MKARNS in 1971 have resulted in previously authorized dredged material disposal sites reaching capacity. Six new disposal sites will be required to accommodate continued channel maintenance activities.

This report provides the U. S. Fish and Wildlife Service's (Service), in cooperation with the Oklahoma Department of Wildlife Conservation (ODWC) and Arkansas Game and Fish Commission (AGFC), evaluation of likely impacts to fish and wildlife resources as a result of possible structural and operational changes to the MKARNS in Oklahoma and Arkansas. Specifically, this report is intended to 1) identify the effects of river flow management, channel deepening, and navigation channel depth maintenance alternatives on fish and wildlife resources within the project area; 2) discuss measures to avoid and minimize environmental impacts; and 3) provide recommendations to appropriately compensate for unavoidable impacts to fish and wildlife resources.

This CAR has been prepared under the authority of and in accordance with the Fish and Wildlife Coordination Act (FWCA; 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and fulfills the reporting requirement set forth in section 2(b) of the FWCA. The CAR is intended to accompany the Corps report on the feasibility of adopting one of four river flow and channel deepening alternatives for the MKARNS that are intended to improve commercial navigation. This report has been coordinated with the ODWC and the AGFC, and has their support as indicated in Appendix A.

The Service (Oklahoma and Arkansas field offices) previously provided an evaluation of resources likely to be affected by proposed improvements to the MKARNS in planning aid reports (PAR) dated September 24, 1985, May 13, 1986, June 23, 1988, February 23, 1989, and a CAR dated December 21, 1989. We provided an overview of the existing fish and wildlife resources associated with the MKARNS, addressed possible impacts to fish and wildlife resources, discussed unmet mitigation needs associated with the initial development of the MKARNS, and provided preliminary recommendations for fish and wildlife habitat restoration projects for the present feasibility study in a planning aid report dated April 2, 2001. Planning assistance letters dated September 29, 2003 (pertaining to anticipated project impacts and assessments); March 1, 2004 (pertaining to our concerns regarding the expedited schedule for impact analysis, EIS completion, and implementation); May 5, 2004 (pertaining to aquatic habitat assessment methodology); June 15, 2004 (pertaining to dredging, dredge disposal sites, and mitigation for dredge disposal impacts); and April 29, 2005 and May 11, 2005 (both pertaining to freshwater mussel impacts and mitigation) also have been provided. A preliminary draft CAR dated February 25, 2005, also was provided.

PROJECT AREA

The following description of the project area is derived largely from the ecoregions (*i.e.*, large geographic divisions based on natural communities, geology, and land use) as mapped by Omernik (1995), and on the recent conservation assessments of the terrestrial and freshwater ecoregions of North America undertaken by the World Wildlife Fund (Abell *et al.*, 2000; Ricketts *et al.,* 1999). These assessments divide the continent into coarse terrestrial and freshwater ecoregions similar to other classification schemes such as Kuchler (1975), and Bailey (1994), and describe the biodiversity of each area as well as the threats that each ecoregion currently faces.

The project area for this study encompasses the entire 445–mile–long MKARNS in Arkansas and Oklahoma (Figure 1), and the 11 upstream multi-purpose reservoirs in Oklahoma that act as the MKARNS's primary flow modifiers (Table 1). The series of locks, dams, and reservoirs associated with the MKARNS facilitate inland navigation and provides flood control, hydroelectric power, water supply, and recreational activities such as boating, camping, fishing, hunting, and hiking. The 11 upstream reservoirs can store about 7.7 million acre-feet of water for flood control. Each reservoir has specific purposes as authorized by Congress (Table 1). Although the Corps has broad authority to modify the operations of the reservoirs to benefit navigation, operational plans of the reservoirs cannot be changed in a way that is detrimental to their authorized purpose. Navigation is an authorized purpose for only three reservoirs (Oologah, Keystone, and Eufaula). Runoff from a 7,500 square mile drainage area below the 11 reservoirs and above Van Buren, Arkansas, is uncontrolled.

FOUR SEGMENTS OF THE MKARNS

The MKARNS consists of four distinct segments: 1) 50 miles of the Verdigris River in Oklahoma (RM 445 - 394), 2) 375 miles of the Arkansas River proper in Oklahoma and Arkansas (RM 394 - 19), 3) the manmade Arkansas Post Canal (RM 19 -10), and 4) the White River entrance channel (RM 10 - 0) at the confluence of the White and Mississippi Rivers in Desha County, Arkansas.

The head of the MKARNS is the Port of Catoosa in Rogers County, Oklahoma near Tulsa (navigation mile (NM) 444.8). From this port, the MKARNS follows the Verdigris River for 50 miles southeasterly through the Newt Graham Lock and Dam (# 18 at NM 421.4) and the Chouteau Lock and Dam (# 17 at NM 401.4) in Wagoner County. This area of Oklahoma is in the Central Forest/Grassland Transition Zone terrestrial ecoregion (CTZ) (Ricketts *et al.* 1999) and the Central Prairie freshwater ecoregion (Abell *et al.* 2000). The area is includes portions of Omernik's (1995) Central Irregular Plains and Central Oklahoma/Texas Plains. The Arkansas, Grand, Verdigris, Cimarron, and Canadian Rivers each drain portions of this area of Oklahoma.

Oologah, Keystone, Copan, Fort Gibson, Hudson, and Eufaula Reservoirs are all located in this portion of the project area, which consists primarily of a mixture of prairie, savannah, and woodlands on low rolling hills, and broad floodplain forests of elm *Ulmus* spp., oak *Quercus* spp., hackberry *Celtis occidentalis*, cottonwood *Populus deltoides*, and sycamore *Platanus occidentalis* created by slow-moving and muddy tributaries. The CTZ grasslands predominantly occur on relatively deep and fertile soils with the exception of those occurring on the thin layer of soil over limestone that occurs in the Flint Hills Tall Grasslands (Ricketts *et al.*, 1999) to the northwest (location of Hulah Reservoir). A greater average annual precipitation in the CTZ results in higher densities

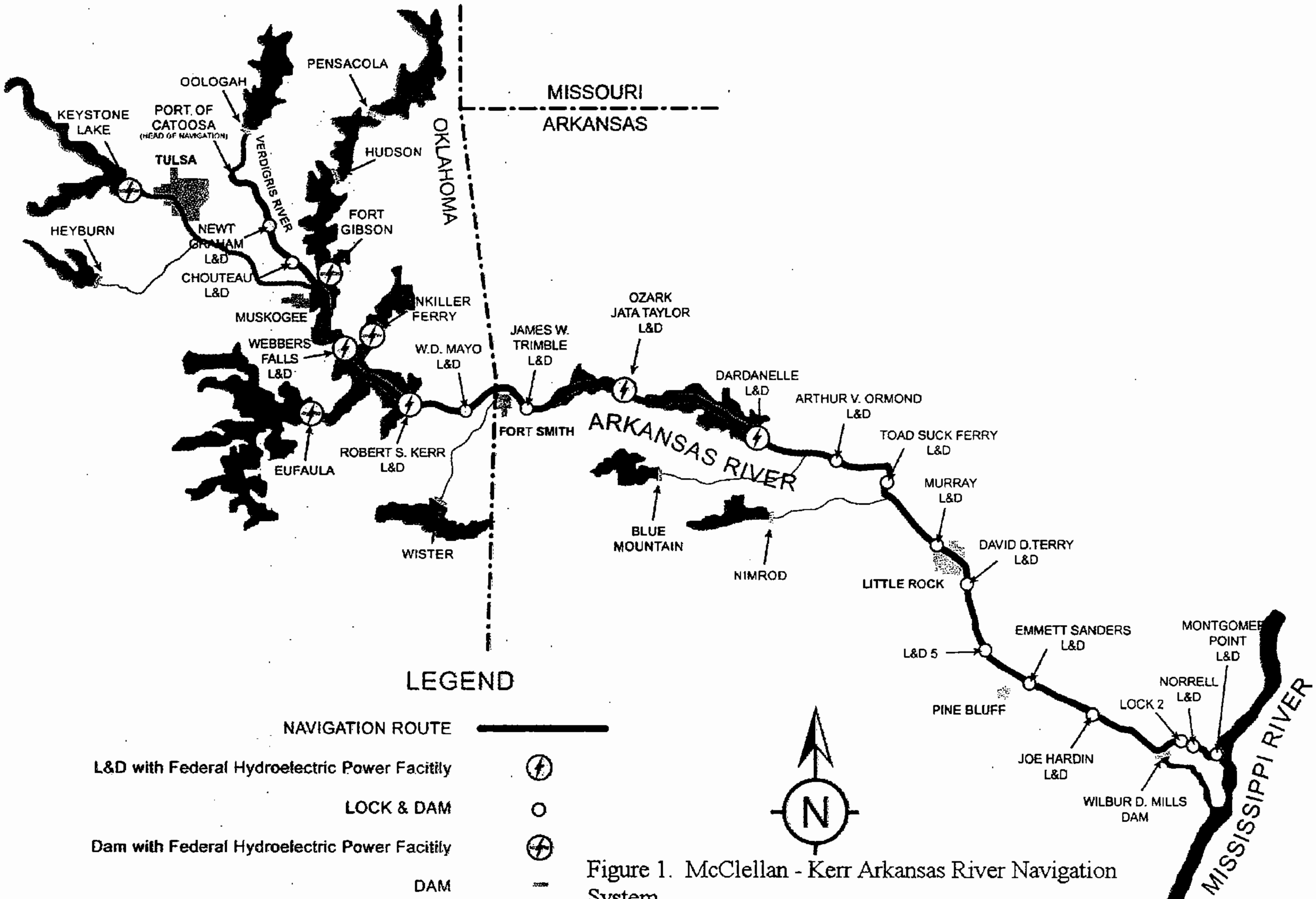

Figure 1. McClellan - Kerr Arkansas River Navigation System

Table 1. Information on the 11 upstream reservoirs in Oklahoma (U.S. Fish and Wildlife Service, 1985; Oklahoma Water Resources Board; 1990).

Reservoir	Agency	Counties	River/Stream and Purpose of Reservoir	Flood Storage (acre-feet)	Conservation pool(acres)/ elevation (NGVD)	Flood pool(acres)/ Elevation (NGVD)	Drainage area (sq. miles)	Shoreline length (miles)
Copan	Corps	Washington	Little Caney River; flood control, water supply, water quality control, recreation, fish and wildlife	184,300	4,850/710.0	13,380/732.0	505	30
Hulah	Corps	Osage	Caney River; flood control, water supply, low-flow regulation, conservation	257,900	3,570/733.0	13,000/765.0	732	62
Oologah	Corps	Nowata, Rogers	Verdigris River; flood control, water supply, navigation, fish and wildlife	965,600	29,460/638.0	56,800/661.0	4,339	180
Kaw	Corps	Kay, Osage	Arkansas River; flood control, water supply, water quality, recreation, fish and wildlife	919,400	17,040/1, 010.0	38,020/1, 044.5	46,530	168
Keystone	Corps	Osage, Creek, Pawnee, Tulsa	Arkansas and Cimarron River; flood control, water supply, hydroelectric power, navigation, fish and wildlife	1,180,000	23,610/723.0	54,320/754.0	74,506	330
Grand	Corps/ GRDA	Ottawa, Delaware, Mayes	Neosho and Spring River; flood control, hydroelectric power	525,000	46,500/745.0	59,200/755.0	10,298	1,300
Hudson (Markham Ferry)	Corps/ GRDA	Mayes	Neosho River; flood control, hydroelectric power	244,210	10,900/619	18,800/636	11,533	200

Table 1 Continued

Reservoir	Agency	Counties	River/Stream and Purpose of reservoir	Flood Storage (acre-feet)	Conservation pool(acres)/ elevation (NGVD)	Flood pool(acres)/ Elevation (NGVD)	Drainage area (sq. miles)	Shoreline length (miles)
Fort Gibson	Corps	Mayes, Wagoner, Cherokee	Neosho River; flood control, hydroelectric power	919,200	19,900/554.0	51,000/582.0	12,492	225
Tenkiller	Corps	Cherokee, Sequoyah	Illinois River; flood control, hydroelectric power	576,700	12,900/632.0	20,800/667.0	1,610	130
Eufaula	Corps	McIntosh, Pittsburg	North Canadian, South Canadian, and Deep Fork; flood control, water supply, hydroelectric power, navigation, fish and wildlife	1,510,800	105,000/585.0	143,000/597.0	47,522	600
Wister	Corps	LeFlore	Poteau River and Fourche Maline Creek; flood control, water supply, low flow augmentation, water conservation, sedimentation	386,800	7,333/478.0	23,070/502.5	993	115

of trees and shrubs relative to the Central and Southern Mixed Grasslands (Ricketts *et al.*, 1999) of central and western Oklahoma (location of Kaw Reservoir).

Typical grasses of the CZT include big bluestem *Andropogon gerardii*, little bluestem *Schizachyrium scoparium*, Indian grass *Sorghastrum nutans*, switchgrass *Panicum virgatum*, and grama grasses *Bouteloua spp*. Upland forests dominated by oak *Quercus spp*. and hickory *Carya spp*. occur in the more mesic draws and ravines. The "crosstimbers" (wide belt of timber on the prairie encountered by explorers as they crossed the plains) also occur in this area on light colored sandy soils with reddish clay subsoils, and consist of hickory trees scattered among short post oak *Q. stellata* and blackjack oaks *Q. marilandica*. Considered one of the most biologically diverse areas in North America because of its large size and proximity to both the great plains and eastern deciduous forests, this region is within the top 10 ecoregions nationally for bird, reptile, and tree species diversity (Ricketts *et al.*, 1999). Much of the fauna is shared with the adjacent grassland ecoregions (prairie species can be found in the woodland understory layer).

The major aquatic habitat types are temperate headwaters and lakes. Endemism for aquatic species is relatively low (Abell *et al.*, 2000).

Only 1 percent of the area is thought to be intact as a result of intensive farming for crops such as corn and soybeans. The degree of terrestrial habitat fragmentation is ranked as extremely high (Ricketts *et al.*, 1999).

The MKARNS joins the Arkansas River northeast of Muskogee in Muskogee County, Oklahoma (NM 395.0). The MKARNS then extends southeasterly through Oklahoma toward Arkansas through Webbers Falls Lock and Dam (# 16 at NM 366.6) creating the 34.5 mile-long Webbers Falls Reservoir in portions of Muskogee, Wagoner, and Cherokee Counties. Webbers Falls impounds 28 miles of the Arkansas River to the mouth of the Verdigris River and then 6.5 miles up the Verdigris to Chouteau Lock and Dam (USFWS, 1983).

From Webbers Falls Lock and Dam, the river channel forms a portion of the county line between Sequoyah/Muskogee and Sequoyah/Haskell Counties near the Sequoyah NWR (described below), and then extends through Robert S. Kerr Lock and Dam (# 15 at NM 336.2) creating Robert S. Kerr Reservoir. Kerr Reservoir forms many irregular arms and peninsulas and extends about 32.7 navigation miles upstream to Webbers Falls Lock and Dam. From Kerr Reservoir, the river continues along the Sequoyah/LeFlore County line through W. D. Mayo Lock and Dam (# 14 at NM 319.6), where it leaves Oklahoma and enters Arkansas. The MKARNS then flows through the James W. Trimble Lock and Dam (# 13 at NM 292.8) along the Crawford/Sebastian County line, and through the Ozark – Jeta Taylor Lock and Dam (# 12 at NM 256.8) in Franklin County, creating Ozark Lake. Continuing southeasterly along the Johnson/Logan County line, the MKARNS forms Lake Dardanelle at Dardanelle Lock and Dam (# 10 at NM 205.5), and then flows along the Yell/Pope County lines, abutting the northern border of Holla Bend NWR (described below). From there, the river flows through Arthur V. Ormond Lock and Dam (# 9 at NM 176.9) in Conway County and along the Conway/Perry and Faulkner/Perry County lines where it extends through Toad Suck Ferry Lock and Dam (# 8 at NM 155.9). The MKARNS continues along the Faulkner/Pulaski County lines, and through the Murray Lock and Dam (# 7 at NM 125.4) in Pulaski County near Little Rock.

This area of Oklahoma and Arkansas lies within the Ozark Mountain Forests terrestrial ecoregion as defined by Ricketts *et al.* (1999) and the Central Prairie freshwater ecoregion near Muskogee, Oklahoma, to the Oklahoma/Arkansas state line, where the project area enters the Ozark Highlands freshwater ecoregion as defined by Abell *et al.* (2000). These ecoregions are a combination of Omernik's (1995) Ouachita Mountains (location of Wister Reservoir), Ozark Mountains (location of Grand and Tenkiller Reservoirs), and Arkansas Valley ecoregions (with the Arkansas Valley occurring between the others). The Arkansas River floodplain is confined to the Arkansas Valley ecoregion. Other major rivers in this broad area include the Grand (Neosho), Illinois and Poteau Rivers in Oklahoma and the Petit Jean, Fourche Lafave, Mulberry, and Ouachita Rivers in Arkansas.

The natural communities of the area include bottomland hardwood forests along rivers and streams, oak – hickory forests in upland sites, shortleaf pine savannas and mixed pine – hardwood forests on ridge tops, and scattered tallgrass prairie communities in the valley between the dry upland forests and more mesic bottomland hardwood forests. The limestone formation (karst geology) in the northern portion of the area (Ozarks) has dissolved in many places, forming caves.

Many of the natural communities of the project area have been greatly altered by timber harvesting, cultivated agriculture, and development of the MKARNS. Riparian habitat along the Arkansas River is considered severely degraded, and only about 3 percent of the pre-settlement habitat is intact as a result of agriculture, logging, fire suppression, and grazing (Ricketts *et al.*, 1999). Several near-endemic herpetofauna species are found in this area including Strecker's chorus frog *Pseudacris streckeri*, the ringed salamander *Ambystoma annulatum* (Abell *et al.*, 2000) and the many-ribbed salamander *Eurycea multiplicata* (Conant and Collins, 1991).

From Little Rock, the MKARNS continues southeasterly through the David D. Terry Lock and Dam (# 6 at NM 108.1) in Pulaski County and through Lock and Dam (# 5 at NM 86.3) in Jefferson County. The MKARNS then flows through Emmet Sanders Lock and Dam (#4 at NM 66.0) northeast of Pine Bluff. From there, the MKARNS continues through Joe Hardin Lock and Dam (# 3 at NM 50.2) along the Jefferson/Lincoln County Line, and along the Arkansas/Lincoln and Arkansas/Desha County lines. The channel then extends through Lock (# 2 at NM 13.3) and Norrell Lock and Dam (# 1 at NM 10.3) as it follows the nine mile manmade Arkansas Post Canal in Arkansas County that connects the White and Arkansas Rivers. Finally, ten miles of the White River in eastern Arkansas (mile 599 on the Mississippi River) make up the MKARNS's entrance channel from the Mississippi.

This lower reach of the MKARNS is within the Mississippi Embayment freshwater ecoregion (Abell *et al.*, 2000) and the Mississippi Lowland Forest terrestrial ecoregion (Ricketts *et al.*, 1999). In Arkansas, this is identical to Omernik's (1995) Mississippi Alluvial Plain. Other major rivers in the area are the White and Mississippi Rivers. Wetland areas, oak-hickory-pine forests, and bottomland hardwoods once dominated the landscape; however, these habitats have been extensively altered resulting in the loss of most (91–95 percent) of the original riparian and bottomland forest systems. Much of the remaining floodplain forests include river swamp forests, forests of backwater areas and flats, and upland transitional forests. Most of the remaining habitat is restricted to wet areas that are difficult or not feasible to exploit economically through cultivation or other means (Ricketts *et al.*, 1999). The biological distinctiveness of the Mississippi Embayment is considered globally outstanding (*i.e.*, the biological diversity of the area is equaled or surpassed in only a few other places worldwide) (Abell *et al.*, 2000).

ELEVEN OKLAHOMA RESERVOIRS

Water flow and storage on the MKARNS is influenced primarily by the following 11 Oklahoma reservoirs: Copan, Hulah, Oologah, Kaw, Keystone, Pensacola (Grand), Hudson (Markham Ferry), Fort Gibson, Tenkiller Ferry, Eufaula, and Wister (Table 1). Collectively, storage by these reservoirs represents more than 70 percent of total flood control storage in the basin. The reservoirs modify flow within the system through controlled water releases through spillways and power generating units (for those reservoirs with hydropower capabilities). Water releases depend on numerous complex factors such as weather conditions, water storage capacity, inflow rates, river flow rates downstream, power requirements, and navigation water requirements. Brief information specific to each reservoir is provided below. A summary of reservoir characteristics (*e.g.*, reservoir purpose, drainage area, storage capacity, etc.) was previously provided in Table 1.

Copan Lake: This reservoir is located in Washington County on the Little Caney River, a tributary of the Caney River, at river mile 7.4 in the Verdigris River watershed. Copan Lake was authorized by the Flood Control Act approved October 23, 1962. Construction began in 1972 and the project was in full operation in 1983. The reservoir is located in the CTZ among gently rolling hills forested with oak, hickory, and other small hardwood trees, tall grass prairie habitat, and bottomland hardwoods. Copan Lake was constructed by the Corps for flood control, water supply, water quality control, recreation, and fish and wildlife. The normal pool area is 4,850 acres. The drainage area is about 505 square miles (Oklahoma Water Resources Board, 1990).

Hulah Lake: Located in the Verdigris watershed at river mile 96.2 on the Caney River in Osage County, this lake was constructed by the Corps under the authority of the Flood Control Act approved June 22, 1936, for flood control, water supply, low-flow regulation, and conservation. Construction began in 1946 and the project was completed in 1951. The normal pool is 3,570 acres. The total drainage area is 732 square miles (Oklahoma Resources Board, 1990). The reservoir is located in the Flint Hills Tall Grasslands ecoregion (Ricketts *et al.*, 1999). The area surrounding the reservoir is characterized by rolling hills with a habitat mixture of oak woodlands, prairie, and bottomland hardwoods.

Oologah Lake: Oologah Lake is located on the Verdigris River within the CTZ. The lake was authorized by the Flood Control Act approved June 28, 1938. Construction began in 1950. The project was in full operation in 1974. The Corps constructed the project for flood control, water supply, and navigation. Oologah Lake is considered a key unit in the flood control plan for the Arkansas River Basin. The normal pool area is 56,800 acres. The drainage area consists of 4,339 square miles (Oklahoma Water Resources Board, 1990).

Kaw Lake: Kaw Lake was authorized by the Flood Control Act approved October 23, 1962. Construction began in 1966. The project was in full operation in 1976. The reservoir is located in the Flint Hills Tall Grasslands ecoregion (Ricketts *et al.*, 1999). The lake was constructed by the Corps for flood control, water supply, water quality, recreation, and fish and wildlife. The normal pool is about 17,000 acres. The drainage area is 46,530 square miles (Oklahoma Water Resources Board, 1990).

Keystone Lake: Keystone Lake was constructed by the Corps on the Arkansas River in Osage, Pawnee, Creek, and Tulsa Counties, near the confluence with the Cimarron River, for flood control, water supply, hydroelectric power, navigation, and fish and wildlife. Keystone Lake was authorized by the Flood Control Act approved May 17, 1950. Construction began in 1957. The project was completed in 1964. The drainage area is 74,506 square miles and the normal pool is 23,610 acres (Oklahoma Water Resources Board, 1990).

Grand Lake: Grand Lake was authorized by the Grand River Dam Authority Enabling Act of 1935 which created the Grand River Dam Authority (GRDA). The GRDA is responsible for construction and operation of dams on the Grand River for the purpose of flood control and hydroelectric power production. The project was initiated in 1936 and was completed in 1940. The reservoir begins at the Pensacola Dam on the Grand (Neosho) River in Mayes County and extends northeast into Delaware and Ottawa Counties in the far western portion of the Central Hardwoods Forest (Rickets *et al.*, 1999). Grand Lake was constructed by the GRDA for flood control and hydroelectric power. The Flood Control Act of 1944 mandated that the Corps minimize downstream flooding. As a result, the reservoir is jointly operated by the GRDA and the Corps. The Corps controls all releases when the reservoir water levels is above the conservation pool elevation (745 msl). The total drainage area of the lake is 10,298 square miles. The normal pool is 46,500 acres.

Hudson Lake: The reservoir (also known as Markham Ferry) was authorized by the Flood Control Act approved August 18, 1941. The GRDA initiated construction of the project in 1954. Hudson Lake was constructed on the Grand River near Locust Grove in Mayes County, Oklahoma, by the GRDA for flood control and hydroelectric power. Construction was completed in 1964. As with Grand Lake, the project is jointly operated by the GRDA and the Corps, with the Corps controlling all releases when the reservoir water surface level is above the conservation pool elevation. The normal pool for the lake is 10,900 acres. The drainage area is 11,533 square miles (Oklahoma Water Resources Board, 1990).

Fort Gibson Lake: This reservoir was authorized by the Flood Control Act approved August 18, 1941. Construction began in 1942 but was suspended due to World War II until 1946. The project was completed in 1953. Fort Gibson Lake is located on the Grand River in Mayes, Wagoner, and Cherokee Counties, about 7.7 miles above the confluence of the Grand and Arkansas Rivers. The reservoir extends upriver to Lake Hudson, and has a drainage of about

12,500 square miles. The conservation pool covers 19,900 acres (Oklahoma Water Resources Board, 1990).

Tenkiller Ferry: Tenkiller Ferry Lake was authorized by the Flood Control Act approved June 28, 1938. Construction began in 1947 and was completed in 1953. The project is located in the Ozark Mountain Forest ecoregion (Ricketts *et al.*, 1999) on the Illinois River in Cherokee and Sequoyah Counties. The reservoir was constructed for flood control and hydroelectric power. The lake drains a 1,610-square mile drainage area. The surface area at the top of the conservation pool is 12,900 acres (Oklahoma Water Resources Board, 1990).

Eufaula Lake: The reservoir was authorized by the River and Harbors Act approved July 24, 1946. Authorized project purposes are flood control, water supply, hydroelectric power, and navigation. Construction began in 1956. The project was in full operation in 1964. The dam is located on the Canadian River in McIntosh County. The reservoir occurs in portions of McIntosh, Pittsburg, Okmulgee, and Haskell Counties. The North Canadian, Canadian, and Deep Fork Rivers converge near the center of the reservoir. The reservoir drains a 47,522-square mile area. The surface area for the conservation pool is about 105,000 acres (Oklahoma Water Resources Board, 1990). Eufaula Lake is the largest reservoir in Oklahoma.

Wister Lake: Wister Lake was authorized by the Flood Control Act approved June 28, 1938. Wister Lake was constructed for flood control, water supply, low flow augmentation, water conservation, and sedimentation. Construction began in 1946. The project was in full operation in 1949. The dam is located on the Poteau River about two miles south of Wister in LeFlore County. The reservoir is located in LeFlore and Latimer Counties, and drains a 993-square mile area (Oklahoma Water Resources Board, 1990). The basic topography of the area is rough, varying from low rounded ridges on the north and northeast to high mountainous ridges in the south, southwest, and central portions of the watershed. The surface area for the conservation pool is about 7,400 acres.

GEOLOGY, SOILS, AND CLIMATE

The geology of the project area is quite variable. Quaternary sand, silt, clay, and gravel occur in the floodplains and terrace deposits of the major rivers (*i.e.*, Arkansas, Verdigris, and White Rivers). Mississippian and Devonian-Silurian marine limestone, sandstone, and shale occur in the Ozark region where karst features such as caves, sinkholes, and underground streams are common. Thick, complexly folded conglomerates of shale, sandstone, limestone and coal characterize the geology of the Ouachita Mountains (Arkansas Geological Commission, 1997; Miser, 1954).

Soil types found in the project area also are quite variable as a result of subsoil variations and climatic differences. Soils vary from rich prairie loams to heavy clay to thin soils overlying bedrock. Alluvial soils are located throughout the project area along the major drainages. Soils in the Ozarks in northeastern Oklahoma and northwestern Arkansas range from sandy loams to heavy clays to rock outcrops. In the southeastern portion of the study area in Arkansas, soil types range from loamy soils along bayou ridge tops to predominantly clay in lower elevations. A more detailed description of soils within the project area can be found in the Natural Resources Conservation Service's Soil Survey publications for the various Counties.

The climate is primarily influenced by movement of moist air from the Gulf of Mexico, hot and dry air from the desert southwest, and cold air from the Arctic. The region undergoes seasonal variations in temperature and precipitation and typically experiences long, humid summers and short, mild winters. Mean annual precipitation increases from west to east and ranges from 36 inches near Keystone Reservoir west of Tulsa, Oklahoma, to 54 inches in eastern Arkansas at the Arkansas River's confluence with the Mississippi River. Average annual temperatures range from about 60–62° Fahrenheit, and the growing season varies from 209 days in the grasslands and crosstimbers of Oklahoma to about 220 days in the Mississippi Alluvial plain of eastern Arkansas.

PROJECT DESCRIPTION

The purpose of the current operating plan for the navigation system is to optimize benefits for navigation, flood control, water supply, fish and wildlife, hydropower, and recreation while minimizing adverse impacts to the environment, farmland, and fish and wildlife resources. The proposed action is to maintain and improve the MKARNS to benefit commercial navigation on the system while maintaining the other project purposes. The alternatives evaluated in detail are associated with three major project features that influence navigation on the system: 1) River Flow Management, 2) Navigation Channel Deepening, and 3) Navigation Channel Maintenance.

RIVER FLOW MANAGEMENT FEATURE

Flows on the MKARNS are modified primarily by Corps operation of the 11 reservoirs in Oklahoma. Each reservoir is linked through their releases to the main stem of the Arkansas River. Each reservoir is not only operated for local conditions but also must be operated as part of the larger system in conjunction with the other controlling reservoirs. The reservoirs are collectively operated to maintain flow targets at the Van Buren, Arkansas, gage because all the regulated flow releases pass this gage. Channel capacity at Van Buren is 137,000 cubic feet per second (cfs) and is the primary control point for the Lower Arkansas River Basin.

For their analysis, the Corps designated flow rates as optimum, moderate, high, or very high based on the flow rate's effect on commercial navigation and farming operations:

- Optimum: River flows less than 61,000 cfs, which correlates to optimum conditions for commercial navigation.
- Moderate: River flows between 61,000 and 100,000 cfs. Under this flow rate, flooding of some cultivated fields along the main stem of the Arkansas River in western Arkansas begins. Agricultural damages have historically occurred in the Van Buren area when

river flows exceed 61,000 cfs. Warnings are issued to operators of small, recreational water crafts when flows exceed 70,000 cfs.

- High: Flow rates between 100,000 and 175,000 cfs. Any flow above 100,000 cfs renders the system non-navigable for commercial barge traffic, and commercial barge traffic is suspended until flows decrease. The 137,000 cfs flow rate represents bank full discharge at Van Buren.

- Very High: Flow rates greater than 175,000 cfs.

OPERATIONAL HISTORY AND SPECIFIC PROBLEMS

The Arkansas River basin encompasses a drainage area of about 138,000 square miles. Forty-eight Federal and two State (Oklahoma) water resource development projects have been constructed on the Arkansas River from the 1940's to the 1980's. The projects have a variety of purposes such as hydropower, water supply, sediment control, navigation, recreation, fish and wildlife, and flood control.

Water storage in the 11 Oklahoma reservoirs represents more than 70 percent of the total flood control storage in the basin. Runoff from about 7,500 square miles of land below the 11 Oklahoma reservoirs and above Van Buren, Arkansas, is uncontrolled.

Construction of the navigation system itself began in 1957. The MKARNS was constructed to enable large vessels to overcome the steep slope of the Arkansas River Valley due to the 420-foot difference in elevation from the Mississippi River to the head of the MKARNS near Catoosa, Oklahoma. The Corps currently maintains a minimum channel depth of nine feet on the system, a minimum width of 250 feet, and a normal current velocity range between two and four miles per hour. There are 18 existing locks and dams on the MKARNS (all 110 feet wide by 600 feet long). Five occur in Oklahoma and 13 occur in Arkansas. The navigation system was completed in 1970 with the development of the Port of Catoosa, Oklahoma. Since that time, the Corps has modified the operating plan of the system to improve the flow regime for navigation.

Flows on the MKARNS are highly influenced by the storage and release of water in the 11 Oklahoma reservoirs. Initially, the existing reservoirs on the system were operated to achieve a target flow of 150,000 cfs at the Van Buren gage. Under this operating plan, shoaling would occur in the river after a flooding event due to rapid recession of flow. The shoaling would restrict navigation until maintenance dredging could occur. A tapered operation that required water to be retained in the flood control pools for longer periods of time was needed to more gradually reduce flows after a flooding event.

Flows at Van Buren depend on the season of the year and percent of flood control storage being utilized. Seasonal guide curves were developed to aid the Corps in regulating flows at Van Buren. The guide curves related flows at Van Buren with the percent of flood control storage being utilized plus three days of forecasted inflow into the 11 controlling reservoirs. To meet the intended objective, a delay in evacuation of the lower portion of the flood control storage would occur. The amount of delay depends on the time of year, hydrologic conditions in the basin, and the amount of flood control storage in the 11 controlling reservoirs. Four release zones were used: 1) 150,000 cfs, 2) 150,000 to 105,000 cfs, 3) 105,000 to 40,000 cfs, and 4) 40,000 to 20,000 cfs. The system was operated under this "Van Buren Guide Curve Plan" from 1979 to 1986.

Successive high flow events in the early 1980s resulted in the flooding of additional agricultural lands near the river and increased costs and delays for navigation interests. In June 1986, the "Fine Tuning Plan" was implemented to address difficulties experienced by navigation interests and farmers as a result of high flows on the system. The objective of the revised operating plan was to provide a different transition from flood releases and increase the number of days where flow was below 80,000 cfs. The new plan included a 75,000 cfs flow bench (*i.e.*, period of time where the flow is held at or below a certain cfs) for 7 to 14 days following flood events. However, problems with sedimentation continue to occur at the 75,000 cfs bench rate, influencing maintenance dredging of the channel.

The 75,000 cfs bench impacts maintenance dredging activities in the lower reaches of the Arkansas River. Dredging is difficult when flows exceed 70,000 cfs and uncontrolled flows during flood events can increase flows to between 85,000 and 90,000 cfs. Therefore, additional delays in the evacuation of the lower portion of the flood control storage are implemented when the system flood storage remaining reaches less than 18 percent. The degree of the delay is dependent on hydrologic conditions, season of the year, and the distribution of the flood control storage within the system.

The "Fine-Tuning Plan" involves five release zones: 1) 150,000 cfs, 2) 150,000 to 135,000 cfs, 3) 75,000 cfs (*i.e.*, the bench), 4) 75,000 to 40,000 cfs, and 5) finally, gradually reducing the target flow at Van Buren from 40,000 cfs to 20,000 cfs when the flood storage in the 11 controlling reservoirs in Oklahoma reaches from 3 percent in the spring to 11 percent in the summer. This plan continued to utilize a 75,000 cfs bench to allow for sediment flush out and to increase the number of days where the flow is held at or below 75,000 cfs to allow dredges to remove flood-induced sedimentation.

CURRENT STUDY AND SPECIFIC PROBLEMS

The purpose of the River Flow Management aspect of the current study is to address various problems, such as flooding, decreased navigation traffic, reduction in hydropower generation, and losses to recreational use along the Arkansas River, influenced by sustained high flows. The study is based upon revisions to the operational flows of the river, as measured at the Van Buren gage. Operational modification of river flows would be accomplished by altering the water storage in the eleven regulating reservoirs.

The objective of the current study is to investigate flow management on the MKARNS to develop solutions that would evacuate high flows through the system at the fastest rate feasible to reduce flood damages, and improve the safety and efficiency of commercial navigation operations while maintaining other project purposes such as recreation, fish and wildlife, water supply, and hydropower. This objective would be achieved by reducing the number of days when river flows exceed 61,000 cfs at the Van Buren gage.

NAVIGATION CHANNEL DEEPENING FEATURE

The proposed Navigation Channel Deepening action would consist of deepening the navigation channel to allow deeper draft tows to operate on the MKARNS. The existing 9-foot navigation channel depth is believed to limit the efficiency and volume of commercial navigation operations on the MKARNS compared to the Lower Mississippi River's authorized 12-foot draft channel. Deepening the channel would remove the disparity between the navigation channel depths of the MKARNS and the Lower Mississippi.

NAVIGATION CHANNEL MAINTENANCE FEATURE

Operation and maintenance of the MKARNS at the existing 9-foot draft channel depth requires periodic dredging at some locations within the navigation system. Some existing authorized dredged material disposal sites have reached capacity and new disposal sites would be required to support continued operation of the existing MKARNS for the 9-foot channel.

FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

The Service's overall planning objective is to conserve important fish and wildlife resources for the benefit of the American people, while facilitating balanced development. This goal is supported by language in the FWCA and other authorities. The FWCA establishes fish and wildlife conservation as a coequal purpose of water resource development projects, and states that fish and wildlife resources shall receive equal consideration with other features of water resource development programs.

Deepening the navigation channel to allow deeper draft tows to operate on the MKARNS and maintaining this navigation channel depth would have significant adverse impacts on both terrestrial and aquatic fish and wildlife resources. In general, these impacts would include the loss of terrestrial habitat due to the disposal of dredged material in upland sites; the loss of aquatic habitat due to disposal of dredged material in aquatic sites and the construction and raising of river training structures; the removal and alteration of gravel bars, which support a variety of aquatic species, due to dredging activity; and adverse effects on freshwater mussel patches and beds (*i.e.,* mussel concentration areas) due to dredging activity and the disposal of dredged material.

The Service has been actively involved with the ARNS over the last several years through participation in numerous site visits, meetings and conference calls pertaining to planning efforts designed to avoid and minimize unnecessary impacts, as well as meetings pertaining to impact assessment analysis and development of appropriate mitigation measures. The Service believes that a complete and thorough analysis for unavoidable project impacts on fish and wildlife resources is necessary to ensure that all losses are adequately and appropriately offset over the project life. Specifically, we believe that a mitigation plan addressing both aquatic and terrestrial resource impacts, developed through interagency coordination, will be necessary to minimize, avoid, and fully compensate for project related impacts.

The Service and our state resource partners have expressed our concern, through the various stages of the study, that the project had been placed on an extremely expedited time schedule, and that, due to the expedited schedule, an adequate assessment of the proposed project's environmental impacts not be possible within the time frame allotted. A more traditional schedule would allow a more thorough evaluation of the project so that full evaluation of all direct, indirect, and cumulative impacts could occur.

Due to the expedited time schedule for the project, the aquatic field studies conducted to describe baseline conditions and evaluate impacts of channel deepening on riverine habitats and associated fish communities throughout the entire 445-mile navigation system was limited to the summer of 2004. Similarly, the study to assess impacts to freshwater mussels was limited in time and scope such that all potential dredging and dredged material disposal areas were not surveyed. While considerable effort has been expended to estimate the overall impact of project implementation, an accurate assessment was impossible due to a lack of detailed baseline information.

The Service alerted the Corps early in project planning stages that the effects of the proposed modifications combined with the continued operation and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, the downstream segments of the rivers, dike fields, oxbows, and other backwater areas, and the main stem of the navigation channel), likely will have long-term consequences that cannot be adequately identified or appropriately assessed without long-term studies and extensive monitoring efforts. We believe that a long-term adaptive monitoring program developed and implemented through interagency coordination is necessary to fully assess the true magnitude of the cumulative impacts from the proposed modifications, ongoing project maintenance and continued system operation. The program also should identify and address any unmet mitigation needs not anticipated due to the expedited study schedule and lack of detailed information.

EVALUATION METHODS

RIVER FLOW MANAGEMENT FEATURE

The effects of the River Flow Management Action components were evaluated using the Corps "Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System," also known as the SUPER Model. The model consists of linked programs designed to "perform" and analyze a period of record for a specific system of reservoirs operated under various plans of regulation. For this study, reservoir elevations and river stages were modeled using 61 years (January 1940 – December 2000) of flow data. This period was considered a good representation of what may be expected in the Arkansas River Basin, because it contains floods with large volumes and high peak flow periods (1943, 1957, 1986, 1990, 1994, and 1995) and drought years (1950's and 1970's).

The following components were examined in detail:

1) No Action Plan (to establish a baseline condition for comparison with the other simulations),

2) the 175,000 cfs Plan: increasing the operating target at Van Buren to 175,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3 percent (*i.e.*, from 18 to 15 percent system full) except from June 15– October 1.

3) the 200,000 cfs Plan: operating Van Buren at 200,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3 percent except from June 15 – October 1.

4) the Operations Only Plan: maintaining the existing operating plan (*i.e.*, operating Van Buren at 150,000 cfs), but replacing the current 75,000 cfs bench with a 60,000 cfs bench beginning at 3 percent lower system storage except from June 15 – October 1.

Information obtained from the SUPER Model for each non-structural alternative included 1) average annual river flow and condition, 2) average annual reservoir stages and duration, and 3) operational damages within the system. This analysis was based on average reservoir elevations and river flows over the above period of record.

We determined, using data obtained through the SUPER Model analysis, possible impacts to fish and wildlife resources resulting from the four non-structural operating alternatives selected by the Corps for detailed analysis. For our analysis, we compared future habitat conditions without the project to future habitat conditions with the project conditions for each alternative. Detailed information associated with the SUPER Model screening runs can be found in Appendix A, Hydrology and Hydraulics Report, of the Corp's draft Integrated Feasibility Report (USACE, 2005b).

The Operations Only plan was selected by the Corps as the component of the River Flow Management feature. We then compared daily reservoir elevations under with and without project conditions over the period of record for the Operations Only component at four of the 11 modifying reservoirs on the navigation system: Oologah, Tenkiller, Eufaula, and Keystone. These reservoirs exhibited the greatest change in the number of days they would be expected to be above conservation pool compared to existing conditions, as indicated by the average reservoir pool elevation over the period of record. This analysis allowed us to conservatively evaluate the effects of flow management operations on reservoir elevations under extreme conditions. These extreme conditions, in any given year or during successive years, potentially would have the most significant effect on fish and wildlife resources. Such effects likely would not be apparent from an analysis that examined only averages of reservoir elevations and river flows over the 60-year period of record.

NAVIGATION CHANNEL DEEPENING FEATURE

Early in the evaluation process, a Multi-agency Ecosystem Evaluation Team was established to evaluate impacts of the proposed Navigation Channel Deepening feature on terrestrial and aquatic habitats and ecological benefits resulting from proposed mitigation measures. The multidisciplinary team included biologists with technical expertise from the Little Rock and Tulsa District Corps, the Service, the Corps Engineer Research and Design Center-Environmental Laboratory (ERDC-EL), ODWC, AGFC, and Parsons, a private consulting firm (Table 2). The team evaluated the environmental impacts of proposed dredging and disposal of dredged material using the Habitat Evaluation Procedures (HEP).

Table 2. Interagency Evaluation Team.

Name	**Agency/Company**
Johnny McLean	Corps, Little Rock District
Tony Hill	Corps, Little Rock District
Sandra Stiles	Corps, Tulsa District
Wesley Fowler	Corps, Tulsa District
Charles Schrodt	Corps, Tulsa District
Antisa Webb	ERDC-EL
Kelly Burks	ERDC-EL
Jack Killgore	ERDC-EL
Catherine Murphy	ERDC-EL
Richard Stark	USFWS, Oklahoma Ecological Services
Kevin Stubbs	USFWS, Oklahoma Ecological Services
Lindsey Lewis	USFWS, Arkansas Ecological Services
Marge Harney	USFWS, Arkansas Ecological Services
Gary Peterson	ODWC
Mike Plunkett	ODWC
Randy Hyler	ODWC
Jeff Quinn	AGFC
Stephen Webber	ODEQ
Richard Hall	Parsons

Table 2 Continued

Table 2 Continued

Name	Agency/Company
Randy Norris	Parsons
Virginia Flynn	Parsons
Enid McNutt	Parsons
Luke Eggering	Parsons

Terrestrial Impacts From Dredged Material Disposal

A modified version of the Service's HEP was used to assess impacts at terrestrial dredged material disposal sites and to determine appropriate mitigation measures. Experienced biologists and staff from ERDC, both Corps Districts, the Service's Oklahoma Field Office, and the ODWC jointly developed three wildlife community based models encompassing the major cover types present at proposed dredged material disposal sites in Oklahoma and at proposed mitigation sites. Major cover types consisted of grassland (open field and old field), forest (bottomland hardwood and floodplain forest), and marsh.

Data used in the analysis were collected at representative dredged material disposal sites and at reference sites for each cover type. Data collected from the field investigations at the reference sites also were used to adjust optimum habitat values for each variable within the three models. Data collected at representative dredged material disposal sites were extrapolated to all other disposal sites so that impacts could be predicted. The team of biologists used best professional judgment to project natural succession at selected target years for the dredge disposal sites.

The ERDC-EL used the HEP models and data provided by the interagency team to evaluate impacts from dredged material disposal and determine mitigation needs. The analysis provided a measure of the habitat value of the proposed impact sites and mitigation sites over the 50-year life of the project using a software package developed by the ERDC Environmental Laboratory known as EXHEP *(i.e.,* EXpert Habitat Evaluation Procedure). Impacts were quantified in non-monetary terms using HEP, and provided a basis for determining the measures needed to mitigate for terrestrial dredged material disposal impacts along the system in Oklahoma.

The evaluation rated the quality of each cover type in the project area on a scale of 0.0 to 1.0. The rating (Habitat Suitability Index – HSI) is based on the habitat's capability to support and sustain a community of wildlife, as determined through the evaluation models and the professional judgment of experienced biologists. Cover types with the highest HSI value have the best capability to sustain associated fish and wildlife populations and communities. Multiplying the HSI (quality) by the extent (*e.g.,* acres) of each cover type provides a measure of the Habitat Units (HUs), the combined quality and quantity of habitat.

The average number of HUs expected to be lost or gained annually for each cover type over the 50 year project life provides the average annualized habitat units (AAHUs). The AAHUs were determined for the with and without project conditions to compare future habitat conditions without the project to future habitat conditions with the project. The AAHUs also were determined for proposed mitigation sites. Preliminary discussion, including locations of mitigation sites, developed in cooperation with the ODWC, was provided in a planning assistance letter from the Service dated June 15, 2004.

The net loss or gain in AAHUs with the project was determined by calculating the difference between annualized loss or gain for the with and without project conditions. The AAHUs at the proposed terrestrial dredged material disposal sites and at the potential mitigation sites were then used to develop a mitigation plan that would completely offset losses of habitat value.

Trade-off rules were developed to ensure appropriate in- and out-of kind mitigation would occur for unavoidable impacts at terrestrial dredged material disposal sites (Table 3). Baseline habitat value (HSI) for agricultural fields managed as food plots for wildlife was assumed to be 0.24 due to the low value provided to evaluation species.

Table 3. Trade-off rules for compensatory mitigation of unavoidable impacts of terrestrial dredge disposal.

Impacted Habitat	**Replacement Habitat**				
	Bottomland Hardwood	**Floodplain Forest**	**Old Field**	**Open Field**	**Marsh Wetland**
Bottomland Hardwood	Yes	No	No	No	No
Flood Plain Forest	Yes	No	No	No	No
Old Field	Yes	No	No	No	Yes
Open Field	Yes	No	No	No	Yes

The following assumptions were made:

- All terrestrial disposal areas would be continuously disturbed and have no fish and wildlife value;

- Under the without project scenario, all mitigation sites remain the same cover type and quality over time;

- Proposed bottomland hardwood and marsh wetland mitigation sites would have restored hydrology and would be maintained over the project life to facilitate attainment of ecological function;

- Bottomland hardwood mitigation sites were considered newly created marsh habitat from the time they were flooded until bottomland hardwood forest would be expected to develop (at project year 11);

- Agricultural land used as food plots would have a low HSI value of 0.24 throughout the 50-year project life;

- Agricultural land not used as food plots were selected for terrestrial disposal sites as a measure to avoid areas that provide quality habitat. These areas were assumed to have no habitat value; and

- All sites selected for compensatory mitigation would currently be agricultural cropland not used as food plots;

Complete details pertaining to the HEP analysis used in this study, including methodology, techniques, graphs and descriptions of the variables assessed for each cover type, cover type acres, HUs, HSI values, and AAHUs, etc., can be found in Appendix C of the Corp's draft Environmental Impact Statement for ARNS (USACOE, 2005a).

Aquatic Impacts: Riverine Habitats And Associated Fish Community

An aquatic field study was conducted by experienced ERDC aquatic biologists to describe baseline conditions and evaluate impacts of channel deepening on riverine habitats and associated fish communities. Due to the expedited time schedule for the project, field data collection was limited to the summer of 2004.

The interagency evaluation team provided input on evaluation procedures through several interagency meetings. The objective of the aquatic evaluation was to provide the greatest amount of information to describe baseline conditions, predict potential impacts, and develop mitigation requirements, all within the allotted time period. Specifically, the objectives of the evaluation were to 1) describe and quantify fish communities and aquatic habitat of representative pools in the MKARNS; 2) quantify amount and location of gravel bars (gravel bars provide spawning habitat for inter-jurisdictional fishes such as paddlefish and shovelnose sturgeon and habitat for many species of aquatic insects, snails, crustaceans, and freshwater mussels) that could be impacted by dredging; 3) quantify relative fishery habitat value of dike fields and other aquatic sites proposed to be used as dredged material disposal sites; and 4) determine appropriate mitigation measures to offset losses in habitat value (Killgore *et al.*, 2005).

The representative pools selected for fish and habitat sampling were: 1) pool 2 and the old channel (representing the lower Delta reaches within the Gulf Coastal Plain); 2) pools 5, 6, and 7 (representing the Ouachita Mountains reaches); 3) pools 9, 10, 11, and 12 (representing the Arkansas River Valley reaches between the Ozark and Ouachita Mountains); and 4) pools 16 and 17 (representing the uppermost reaches of the navigation system).

Sampling occurred during April and May 2004. A minimum of three sections was sampled in most pools in order to collect data from the upper, middle, and lower reaches of each pool. Several sites within each section were sampled to incorporate major habitat features (*e.g.*, tributary mouths, main channel, and backwater habitats), areas frequently dredged for maintenance purposes, and dredged material disposal sites (Table 4).

Table 4. Fish Sampling Sites in Summer 2004 for the Arkansas River Navigation Project (from Killgore *et al.*, 2005)

Site #	Location/Pool	Station	River Mile	Seine	Shock	Trawl
1	Chouteau	Below Newt Graham L&D 18	420.8	v	v	v
2	Chouteau	Channel near Afton Landing	411.0			v
2.5	Chouteau - bw	Afton Landing backwater	BW	v	v	
3	Chouteau	Above Chouteau L&D 17	402			v
4	Chouteau - bw	Backwater at RM 403.2	BW	v		
5	Pool 16	Below Chouteau L&D 17	401.2		v	v
6	Pool 16 - bw	Falls Park Backwater at RM 398	BW		v	
7	Pool 16	Confluence of AR and Verdigris R.	394.5	v	v	v
7.5	Pool 16 - bw	Sandbar Pool at Confluence	394.5	v		
8	Pool 16	Channel at Coody Creek mouth	389.5	v	v	v
8.5	Pool 16 - bw	Backwater at 389.5 (inside sandbar)	BW	v		
9	Pool 16 - trib	Mouth of Coody Creek	389.5		v	
10	Pool 16 - trib	Mouth of Maynard Bayou	387		v	
11	Neosho	Neosho (Grand) River 4 mi. upst. of AR R.	--			v
12	Pool 13	Island above Trimble L&D 13	293.3	v	v	v
13	Pool 13	Right bank upst. of Trimble L&D 13	293.3	v	v	
14	Ozark	Below Trimble L&D 13	289.5	v	v	v
15	Ozark	Channel at mouth of Mulberry River	272	v	v	v
15.5	Ozark	Channel upst. of Mulberry River mouth	277			v
16	Ozark - trib	Lower mouth of Mulberry River	272		v	v
17	Dardanelle	Below Ozark-Jeta L&D 12	256.5	v	v	v
18	Dardanelle	Rock weir at Rogers Cabin	231.5		v	v
19	Dardanelle	Across from Spadra Park	229.8	v	v	v
20	Dardanelle	Mouth of Cabin Creek at ramp nr. old RR bridge	--		v	
21	Pool 9	Below Dardanelle L&D 10	205	v	v	v
22	Pool 7	Below Toad Suck L&D 8 – pool	155.3	v	v	
22.5	Pool 7	Below Toad Suck L&D 8 – channel	155.3	v	v	v
23	Pool 7	Mouth of Fouche La Fave	146.8	v	v	
24	Pool 7	AR @ Fouche La Fave mouth – rt. bank	146.8	v		v
24.5	Pool 7	AR @ Fouche La Fave mouth – lft. bank	146.8	v		
25	Pool 7	2° Channel at Beaver Dam Island	141.5	v	v	v
26	Terry Lake	Below Murray L&D 7 – main channel	124.3	v	v	v
26.5	Terry Lake	Below Murray L&D 7 – side channel	124.3	v		
27	Terry Lake	AR @ downtown Little Rock	120	v	v	
28	Terry Lake - bw	Willow Bend Cutoff nr. Terry L&D 6	108.4		v	
29	Terry Lake	Above David D. Terry L&D 6	109.8	v	v	v
30	Pool 5	Below David D. Terry L&D 6	107.6	v	v	v
31	Pool 2	Below Joe Hardin L&D 3	49.6	v	v	v
32	Pool 2	AR @ Mud Lake entrance	44.6	v		v
32.5	Pool 2 - bw	Inside Mud Lake entrance	44.4	v	v	
33	Pool 2	Upst. of mouth of Big Bayou Meto	31.7	v	v	v
34	Pool 2 - bw	AR @ mouth of Big Bayou Meto	31.2	v	v	
35	Pool 2	Post Canal at Merrisach Lake	14.4	v	v	
36	Pool 2	Above L&D 2	13.4		v	v
37	Wild AR R.	1 mile dnst. of Wilbur D. Mills Dam – channel	--	v	v	v
37.5	Wild AR R.	1 mile dnst. Of Wilbur D. Mills Dam – bw	--	v		
38	Wild AR R.	Below Wilbur D. Mills Dam	--		v	

Multiple sampling gear types were used to collect fishery data from three different aquatic fishery habitats. Seining was employed to collect littoral/shoreline fishes. Electrochocking was used to collect pelagic/slack water fishes. Benthic trawls were used for demersal and main channel fishes (Table 4).

Physical parameters were measured concurrently with fish sampling efforts. Physical parameters recorded include stream width, substrate composition, percent instream cover, water temperature, pH, conductivity, dissolved oxygen, and turbidity. Occurrences of major backwaters adjacent to sampling sites also were recorded.

Multiple regression analysis on seining and electrofishing data was used to identify the influence of project impacts on fish communities. Fish were classified as either pool dwelling/backwater species or gravel associated species. Total number of fish collected at each site was used as the dependent variable. Water depth and amount of gravel were used as the independent variables.

The regression analysis of seining data indicated a positive relationship between fish abundance and the depth of the dike pools and the amount of gravel available. This relationship implies that reducing water depth in a dike field pool and reducing the amount of gravel in the channel would adversely impact pool dwelling and gravel associated fish. Analysis of electrofishing data for pool-dwelling fishes did not provide a significant model. This is likely attributable to the prevalence of pool like habitat throughout the navigation system and the lack of physical habitat variation at the sites sampled needed for the identification of predictive relationships.

An aquatic HEP was developed by the ERDC with input from biologists from the Service, ODWC, AGFC, and the Corps Tulsa and Little Rock Districts (interagency evaluation team). The aquatic HEP was used to assess impacts from the disposal of dredged material and to assess overall potential impacts of the proposed project on aquatic resources. The aquatic HEP also was used to provide a basis for determining the mitigation measures needed to compensate for aquatic impacts. Future with and without the project conditions were predicted to determine habitat value at impact sites and potential mitigation sites over the 50-year life of the project.

The interagency evaluation team evaluated the impacts and benefits that would occur at 185 disposal/mitigation sites in Arkansas and 39 sites in Oklahoma. Existing HSI values at disposal and mitigation sites were determined using best professional judgment of the interagency evaluation team, while examining Red Hen (aerial) video of the navigation system (recorded from August 9 – 13, 2004), from maps, and existing local expertise. HSI values for the with and without out project condition also were predicted for target years 11, 31, and 51. These HSI values for the with and without project conditions then were adjusted downward using an estimated filling coefficient, as explained below.

Dredged material would be placed in dike fields in Arkansas. A filling rate for Arkansas dike field disposal sites was estimated in order to determine the remaining life of the dike fields. The filling rate was calculated based on dredging records from Pools 2, 7, and 12, and averaged over the length of the project.

Corps engineers estimated that complete filling of the dike fields to be used as disposal areas would occur in 117, 79, and 66 years for the 9-, 11-, and 12-foot alternatives, respectively. For example, for the 12-foot alternative, dike fields would be 75 percent full on average at the end of the project life (50/66 = 0.75). Because filling of the dike pools is anticipated to negatively affect habitat quality, as indicated by multiple regression analysis, the estimated annual filling rate was used to reduce the HSI of dike field disposal sites over the life of the project. The value at 25 years was derived from a linear relationship and was used to obtain AAHUs. Sediment accretion in a dike field is extremely variable, but the rate of change was assumed to be linear to simplify the analysis. The adjusted filling rate is called the filling coefficient (Table 5). The without project AAHUs were determined using the filling coefficient for the existing 9-foot channel since maintenance activity would be necessary to maintain the 9-foot channel depth.

Table 5. Conversion of estimated fill rates of dike fields to filling coefficients used to annualize Habitat Suitability Index values over the life of each project alternative (from Killgore *et al.*, 2005).

	Maintain 9-ft channel	Dredge 11-ft channel	Dredge 12-ft channel
Fill rate (percent per year)	0.86 percent	1.35 percent	1.63 percent
Time until 100 percent full	117 years	79 years	66 years
Percent full at 50 years	43 percent	63 percent	76 percent
Percent full at 50 years (notched dikes/revetments)	21.5 percent	31.5 percent	38 percent
Percent full at 25 years	**21.5 percent**	**31.5 percent**	**38 percent**
Percent full at 25 years (notched dikes/revetments)	**10.75 percent**	**15.75 percent**	**19 percent**

The interagency evaluation team proposed dike notching as a mitigation measure that would serve to minimize impacts of the channel deepening component at dike fields that would be used as disposal sites, and at those that would not receive dredged material (*e.g.*, dike fields in Oklahoma). Notches in dikes would facilitate scouring in the dike pools behind the notch, and thereby increase habitat complexity.. Therefore, we assumed that the HSI values of dike fields with notched dikes would decline 50 percent less than that of an un-notched dike field (Table 5).

Three broad types of mitigation measures were proposed by the interagency evaluation team to offset project impacts: 1) Avoid, 2) Minimize, and 3) Compensate. Avoidance measures would consist of avoiding disposal of dredged material at a site estimated to have high habitat quality by relocating the disposal site to a location of lesser habitat value, as determined by best professional judgment of the evaluation team. Minimization projects consisted of features assumed by the team to minimize the impacts of the project. Notching a dike is assumed to minimize impacts to dike field habitat. Compensatory mitigation features consisted of projects that would restore, enhance, or create habitat. Figure 2 provides a flow model describing how benefits were determined under each type of mitigation measure.

Several sources were utilized to preliminarily determine the extent of gravel bars: 1) existing GIS layers of gravel deposits, 2) Red Hen video footage of the navigation system recorded August 9 – 13, 2004, 3) locations of current and historical gravel mining operations, and 4) observations recorded by field crews during fish sampling.

Field observations of gravel bars were conducted when a channel trawl yielded gravel in the sample and during velocity transect measurements. A 16-foot otter trawl with 1-inch mesh was used to sample benthic fishes. Trawls were dragged along the river bottom at 2 – 5 miles per hour for 10 – 20 minute intervals. All occurrences of gravel in the trawl sample were recorded.

Velocity transect measurements were taken at representative cross sections of the channel. A metal weight carrying a velocity meter was lowered to the bottom of the channel. The operator determined the substrate based on the vibration produced by the metal as it hit the river bottom. Substrate was recorded as mud, sand, gravel, bedrock, rip rap, or detritus/woody debris.

GPS coordinates for all potential gravel bar locations were recorded. Potential gravel bed locations were incorporated as a layer in a GIS database. GIS maps were used to examine potential gravel sites for features that influence substrate composition. The features examined were channel width, channel morphology, channel depth, scour, adjacent bars, dike fields, and size of nearby tributaries. The potential proportion of gravel substrate at a site was estimated based on the width of the channel. The potential proportion of gravel for each site was then multiplied by the site area to obtain an estimate of the amount of gravel.

Potential gravel bed locations were compared to the GIS layer of proposed dredging locations to obtain an estimate of project impacts on gravel beds. The potential locations of gravel bars that could be impacted were visited by a hydrographic survey crew from the Corps Memphis District to further examine and map locations of the gravel substrates. The crew used a sounding chain to identify the predominant substrates at the potential gravel bar locations as sand, sand/gravel mix, or pure gravel. The survey boat moved slowly down longitudinal transects within the GIS dredge polygon (*i.e.*, area proposed to be dredged) while dragging the sounding chain along the river bottom. Each substrate type was digitally recorded. The maps were incorporated into the project GIS to determine the estimated acres by pool of sand/gravel mix and pure gravel.

The interagency evaluation team agreed that the goal of mitigation for impacts to pure gravel bars should be no-net-loss when possible. This habitat is a finite resource in the navigation system and is of great importance as a habitat feature for a variety of sensitive fishes such as paddlefish and sturgeon.

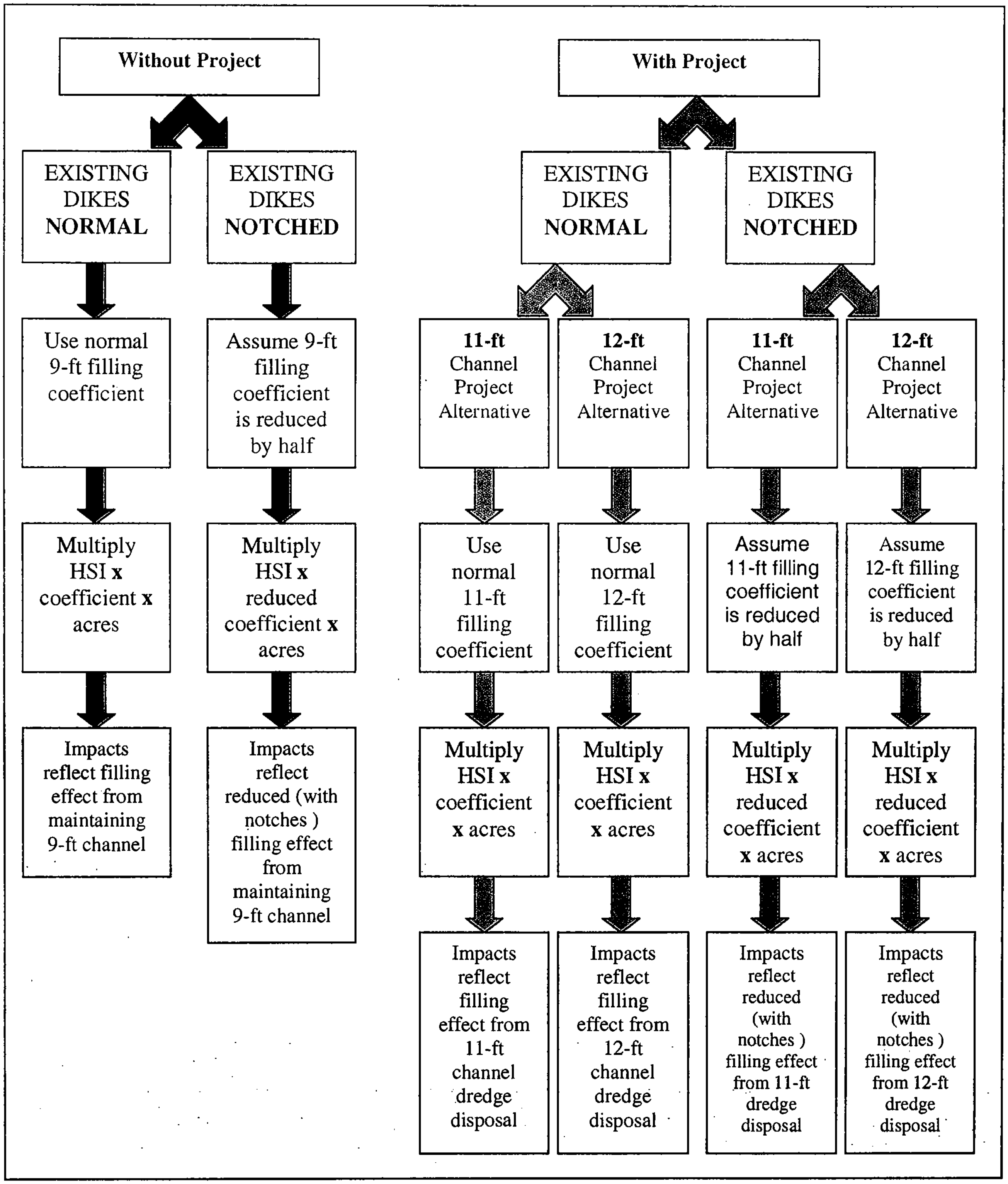

Figure 2. Conceptual model used to calculate project impacts by alternative (from Killgore *et al.*, 2005).

Aquatic Impacts: Freshwater Mussels

A freshwater mussel (unionid) distribution study from the Port of Catoosa, Oklahoma, to the navigation system's confluence with the Mississippi River in Arkansas was conducted during the summer and fall of 2004 by Ecological Specialists, Inc. This study provides unionid species composition and distribution data throughout the MKARNS (Ecological Specialists, 2005). The study was used to assess potential impacts to freshwater unionids and develop mitigation measures to avoid and minimize adverse impacts. Sampling efforts focused on areas proposed to be dredged and on open water dredged material disposal sites. Sampling sites were selected during an interagency meeting among the Corps, Service, and the AGFC.

Sediment Quality Analysis

A screening level analysis of MKARNS sediment quality was performed during September 2004 for both future maintenance dredging needs for the 9-foot channel and for impact assessment for the proposed channel deepening component. The analysis was necessary to determine the types and locations of expected contaminants in dredged sediment, and to develop disposal measures necessary to minimize the environmental impact of disposal of contaminated sediments, if necessary. Detailed information regarding sampling site selection, sampling methods, analytical parameters, threshold values for data interpretation, constituents selected for analysis, and the chemical methods employed can be found in Appendix E of the DEIS for ARNS (USACOE, 2005a).

NAVIGATION CHANNEL MAINTENANCE FEATURE

Impacts anticipated as a result of the Navigation Channel Maintenance feature were assessed using the same methodology as described above for the Navigation Channel Deepening feature.

FISH AND WILDLIFE RESOURCES: EXISTING

This section provides information on the terrestrial and aquatic fish and wildlife resources associated with the MKARNS, the 11 Oklahoma reservoirs and their associated rivers/streams, wildlife management areas, and national wildlife refuges. This section also provides information on federally-listed threatened and endangered species as well as species proposed for listing, species of concern, and state-listed and rare species that occur within the vicinity of the project area. Detailed descriptions of the existing aquatic and terrestrial resources of the individual reservoirs and associated streams/rivers have been provided in previous reports on various individual projects (lock and dams, hydropower, etc.) and will not be repeated here.

ARKANSAS/VERDIGRIS RIVERS AND 11 OKLAHOMA RESERVOIRS: AQUATIC AND WETLAND RESOURCES

Aquatic cover types in the project include lentic habitats (reservoirs and ponds), lotic habitats (rivers and streams) and wetlands. These habitat types support numerous game and nongame fish and wildlife species. A list of indicator flora and fauna for both aquatic and terrestrial habitat types is presented in Table 6.

Fishery Resource

A variety of fish species occur in the project area. Prior to construction of the locks, dams, and reservoirs on the MKARNS, the fish fauna in the various rivers/streams were diverse and unique. However, construction and operation of the MKARNS has altered the magnitude and frequency of flow events, stabilized channel conditions, and created reservoirs that provide habitat for lake fishes, but limit habitat for native riverine species. The overall result is a more homogenous aquatic environment within the MKARNS that benefits particular fish fauna to the detriment of others (Buchanan, 1976). Thus, fishery resources are generally uniform throughout the MKARNS, except in areas where trout are stocked downstream of reservoirs with cold water discharges, such as in the lower Illinois River below Tenkiller Ferry.

Eighty-six fish species are known to occur in the navigation system in Oklahoma. About 108 species are reported from the system in Arkansas (Buchanan, 1976; Limbird, 1993). A list of fish species common to the 11 upstream reservoirs in Oklahoma is provided in Table 7. Table 8 lists fish species known to occur in the MKARNS in Oklahoma and Arkansas.

Killgore *et al.* (2005) collected 65 fish species during the fish sampling effort conducted for this study. This drop in species diversity as compared to previous studies (*e.g.*, Buchanan, 1976) is likely attributable to the relatively limited survey effort conducted by Killgore *et al.* (2005). The limited survey effort was due to time limitations caused by the expedited project schedule. The previous surveys were conducted over a greater period of time (*e.g.*, 7-month period in Buchanan (1976) versus a 2-month period in 2004), consisted of a greater number of collections (75 seine samples in 1976 vs 33 seine samples in 2004), used disparate techniques (rotenone in 1976, trawling in 2004), and included habitats outside the current project area (clear tributaries). Most of the 45 species reported in 1976, but not collected in 2004, were rare (represented by 5 or fewer specimens). Gizzard and threadfin shad were the most abundant species in both the 1976 and 2004 surveys.

Table 6. Cover types, indicator species, and cover type value – index. Indices range from 1 (low habitat potential) to 5 (high habitat potential) (modified from U. S. Fish and Wildlife Service, 1985).

Cover Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Post oak-blackjack oak forest	post oak, blackjack oak, dogwood, red cedar, sumacs, buckbrush	white-tailed deer, fox squirrel, bobwhite, carolina chickadee, black and white warbler, armadillo, garter snake, ground skink	3
Oak-hickory forest	post oak, black hickory, mockernut hickory, bitternut hickory, white oak, sugar maple, winged elm	white-tailed deer, fox squirrel, gray squirrel, eastern woodrat, cottontail rabbit, eastern chipmunk, downy woodpecker, white-breasted nuthatch, fence lizard, black rat snake, American toad	4
Oak-hickory-pine forest	post oak, white oak, northern red oak, mockernut hickory, bitternut hickory, black hickory, shagbark hickory, shortleaf pine, loblolly pine, sweetgum	white-tailed deer, fox squirrel, pileated and hairy woodpeckers, gray fox, three-toed box turtle	4
Tallgrass prairie	big and little bluestem, switch grass, Indian grass, goldenrods, side oats grama	coyote, red-tailed hawk, bobwhite, eastern meadowlark, grasshopper sparrow, dickcissel, ornate box turtle, ribbon snake, great plains rat snake	3

Table 6 continued

Cover Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Mixed-grass prairie	little and big bluestem, purple cone flower, gramas, buffalo grass	thirteen-lined ground squirrel, eastern cottontail, jackrabbit, bobwhite, ornate box turtle, Texas horned lizard, prairie kingsnake, prairie skink, Woodhouse's toad	3
Caves	–	Bats (*Myotis* and *Pipistrellus* spp.), Ozark cavefish, grotto salamander, cave salamander	5
Cropland	wheat, alfalfa, soybeans, sorghums, etc	white-footed mouse, eastern cottontail, mourning dove, eastern meadowlark	2
Introduced grassland	Bermuda grass, fescue, rye, buffalo bur, nightshade, ragweeds	cotton rat, eastern meadowlark	1
Riparian forest	cottonwood, willow, green ash, hackberry, elm, sycamore, dogwood, river birch	white-tailed deer, raccoon, river otter, beaver, red-bellied woodpecker, belted kingfisher, eastern phoebe, fox squirrel, wood duck, herons, cricket frog, green frog	5

Table 6 continued

Cover Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Bottomland forest	oaks, sycamore, elms, pecan, boxelder, greenbriar	white-tailed deer, gray squirrel, pileated woodpecker, wood duck, red-shouldered hawks, spring peeper	5
Mud flats	devoid of vegetation when inundated; barnyard grass, rushes, sedges.	raccoon, lesser yellowlegs, common snipe, great blue heron	2 – 5
Lower hardwood swamp forests	red maple, water hickory, green ash, river birch, hackberry, American holly, sweetgum, willow oak, laurel oak	white-tailed deer, beaver, ducks, warblers, herons, egrets, prothonotary warbler, squirrel, swamp rabbit, spotted salamander, chorus frogs, aquatic snakes	5
Lacustrine fringe wetland	cattails, rushes, smartweeds, muskgrass, sedges	bullfrog, cricket frog, carp, water snakes, belted kingfisher, great blue heron, ducks	4
Palustrine pond wetland	willows, cottonwood, cattails, rushes, pondweed, sedges, buttonbush	beaver, great blue heron, egrets, American bittern, waterfowl, snipe, marsh hawk, marsh wren, red-winged blackbird, grebes, leopard frog, eastern newt	5

Table 6 continued

Cover Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Lentic aquatic habitat	algae, coontail, bladderwort	largemouth bass, bluegill, catfish, crappie, carp	4
Lotic aquatic habitat	algae, other periphyton	minnows, sauger, bass, channel catfish, sturgeon	3 – 5*

* mountain streams = 5; Arkansas River/System and associated tributaries and delta streams = 3.

Table 7. Common fish species found in the 11 Oklahoma reservoirs.

	Copan	Hulah	Oologah	Kaw	Keystone	Grand	Hudson	Fort Gibson	Tenkiller	Eufaula	Wister
Species											
largemouth bass	X	X	X	X	X	X	X	X	X	X	X
spotted bass						X	X	X	X		
smallmouth bass			X			X	X		X	X	
white crappie	X	X	X	X	X	X	X	X	X	X	
black crappie			X		X		X		X		
white bass		X	X		X	X	X	X	X	X	X
striped bass	X/hybid		X/hybrid	X	X	X/hybrid	X		X		
channel catfish	X	X	X	X	X	X		X	X	X	
bluegill	X	X	X	X	X	X	X	X	X	X	X
longear sunfish	X	X	x		X	X	X	X	X	X	
carp		X	X		X	X	X	X	X	X	X
freshwater drum		X	X		X	X	X	X	X	X	
smallmouth buffalo		X			X	X	X	X	X	X	X
bigmouth buffalo		X	X				X	X	X	X	X
river carpsucker		X	X		X	X		X	X	X	
black bullhead								X	X		
spotted sucker									X		
golden redhorse									X	X	

Table 7 continued

	Copan	Hulah	Oologah	Kaw	Keystone	Grand	Hudson	Fort Gibson	Tenkiller	Eufaula	Wister
river redhorse									X	X	
shorthead redhorse									X	X	
flathead catfish	X	X	X	X	X	X	X	X	X	X	X
longnose gar		X							X	X	
spotted gar		X							X	X	
gizzard shad		X	X	X	X	X	X	X	X	X	
walleye			X				X	X	X	X	
paddlefish			X	X		X	X	X			
black bullhead		X			X						
green sunfish		X	X		X	X	X	X	X	X	
warmouth			X		X	X	X	X	X	X	X
orange spotted sunfish		X	X		X		X	X			X
redear sunfish		X	X	X	X	X	X	X	X	X	X

Table 8. Partial listing of fish species known to occur in the MCKARNS and tributaries in Oklahoma and Arkansas (Buchanan, 1976; Jimmie Pigg, unpublished data).

Common Name	Scientific Name
Chestnut lamprey	*Ichthyomyzon castaneus*
Bowfin	*Amia calva*
American eel	*Anguilla rostrata*
blue catfish	*Ictalurus furcatus*
channel catfish	*Ictalurus punctatus*
Flathead catfish	*Pylodictus olivaris*
yellow bullhead	*Ictalurus natalis*
black bullhead	*Ictalurus melas*
tadpole madtom	*Notorus gyrinus*
brindled madtom	*Notorus miurus*
White bass	*Morone chrysops*
striped bass	*Morone saxatilis*
largemouth bass	*Micropterus salmoides*
spotted bass	*Micropterus punctulatus*
black crappie	*Pomoxis nigromaculatus*
white crappie	*Pomoxis annularis*
walleye	*Stizostedion vitreum*
sauger	*Stizostedion canadense*
warmouth	*Lepomis gulosus*
green sunfish	*Lepomis cyanellus*
longear sunfish	*Lepomis megalotis*
luegill	*Lepomis macrochirus*
orangespotted sunfish	*Lepomis humilis*
longnose gar	*Lepisosteus osseus*
spotted gar	*Lepisosteus oculatus*
shortnose gar	*Lepisosteus platostomus*

Table 8 continued

Common Name	Scientific Name
skipjack herring	*Alosa chrysochloris*
shovelnose sturgeon	*Scaphirhynchus platorynchus*
paddlefish	*Polyodon spathula*
blue sucker	*Cycleptus elongatus*
largemouth buffalo	*Ictiobus cyrpinellus*
smallmouth buffalo	*Ictiobus bubalus*
river carpsucker	*Carpiodes carpio*
golden redhorse	*Moxostoma erythrurum*
common carp	*Cyprinus carpio*
freshwater drum	*Aplodinotus grunniens*
gizzard shad	*Dorosoma cepedianum*
threadfin shad	*Dorosoma pentenense*
golden shiner	*Notemigonus crysoleucas*
pallid shiner	*Hybopsis amnis*
redfin shiner	*Lythrurus umbratilis*
emerald shiner	*Notropis atherinoides*
ghost shiner	*Notropis buchanani*
mimic shiner	*Notropis volucellus*
central stoneroller	*Campostoma anomalum*
blackstripe topminnow	*Fundulus notatus*
blackspotted topminnow	*Fundulus olivaceous*
bullhead minnow	*Pimephales vigilax*
suckermouth minnow	*Phenacobius mirabilis*
silver chub	*Macrhybopsis storeriana*
mosquito fish	*Gambusia affinis*
brook silversides	*Labidesthes sicculus*
logperch	*Percina caprodes*
greenside darter	*Etheostoma blennioides*
bluntnose dater	*Etheostoma chlorosomum*
fantail darter	*Etheostoma flabellare*
slough darter	*Etheostoma gracile*
cypress darter	*Etheostoma proeliare*
banded darter	*Etheostoma zonale*
dusky darter	*Percina sciera*
redfin darter	*Etheostoma whipplei*

Electrofishing was conducted in numerous habitats, and allowed for fish species diversity comparisons among the different habitats. Killgore *et al.* (2005) found that dike fields, armored banks, sand bars, and wooded banks yielded high species diversity (> 30 spp.). Fish species diversity was found to be moderate in impoundments, aquatic vegetation, and rock outcroppings (20 - 26 spp.). Sampling in the main channel and along eroded banks yielded the lowest species diversity (< 10 spp.).

However, sampling effort was variable among habitats. The number of observed species collected from each habitat, therefore, could not be directly compared or used to assess the ecological value of the habitat. Killgore *et al.* (2005) used rarefaction (*i.e.,* a statistical method used to compare the number of taxa from samples of different size; Ludwig and Reynolds, 1988; Holland, 2003) to compensate for the uneven sampling efforts. Rarefaction was used to estimate the number of species expected to occur in a sample of 25 randomly drawn individuals from a single habitat. This analysis indicated that dike fields and sand bars are the most species rich habitats (>11 spp./25). Impoundments, rock outcroppings, wooded or armored banks also were identified as species rich (about 10 spp./25). The main channel and along eroded banks were identified as the lowest in species diversity (5 – 7 spp./25). The rarefaction analysis yielded similar species diversity as the electrofishing results.

Management of the fishery resources in the project area is a cooperative effort between the Corps and the respective state wildlife agencies, and involves monitoring studies and stocking programs. Management programs influence all species, but concentrate on those most popular with anglers, such as largemouth bass, crappie, walleye, blue catfish, flathead catfish, white bass, and striped bass.

Commercial fishing within the MKARNS is limited to Arkansas, where commercial fishing has occurred since 1971. Commercial fish include catfish, smallmouth buffalo, drum, carp, gar, carpsucker, bowfin, and paddlefish.

Paddlefish, considered imperiled in both Oklahoma (Natural Heritage S1S2 ranking) and Arkansas (S2), were once common in big rivers in the Mississippi Basin, such as the Arkansas River. Excessive commercial harvest for roe (mass of eggs in the female fish) that is processed and sold as caviar, and water development projects that greatly altered their natural habitat have drastically reduced paddlefish populations in the Arkansas River.

Paddlefish are smooth-skinned fish with an elongated snout that occupy the calmer, open waters of large rivers. They prefer slow moving water behind islands and sandbars because of the abundance of zooplankton, their primary food source. Spawning occurs in mid channel currents over gravel substrates where adhesive eggs stick until hatching. Rising water levels in spring trigger upstream spawning migrations. However, in many cases, migrations are blocked by dams. In addition, dredging, flow alterations, and channelization have reduced the available habitat for spawning.

Restoration attempts through a joint effort of the Tishomingo National Fish Hatchery, Oklahoma Fisheries Resource Office, Oklahoma Ecological Services, and the ODWC have resulted in a self-sustaining population above Kaw Reservoir in Oklahoma, and the stocking of about 80,000 paddlefish in the Arkansas and Verdigris rivers in northeastern Oklahoma. The population in the Verdigris River also is considered stable and self-sustaining. Currently, Service fisheries biologists are conducting surveys on the brood stock in the Arkansas and Verdigris rivers.

Other aquatic resources of significance include oxbow lakes (old river and stream channels that have been cut off from the main channel) adjacent the MKARNS, tributaries of the MKARNS in Arkansas (mountain streams west of Little Rock and delta streams east of Little Rock (Table 9)). Prominent game species inhabiting the oxbow lakes include largemouth bass, catfish, bluegill, and crappie. The fisheries of the mountain streams in Arkansas are considered excellent for smallmouth bass, largemouth bass, spotted bass, bluegill, and sauger. The principal fish species in the delta streams include crappie, catfish, bluegill, largemouth bass, carp, and buffalo.

Four Corps lakes in Arkansas that total 51,360 surface acres (Blue Mountain Lake on the upper reach of the Petit Jean River, Lake Dardanelle and Ozark Lake on the MKARNS, and Nimrod Lake on the upper reach of the Fourche Lafave River) also provide habitat for some fish species. Common game and commercial fish species occurring in the four Corps lakes in Arkansas include largemouth bass, bluegill, crappie spp., and striped bass (U. S. Fish and Wildlife Service, 1988).

Table 9. Major Tributaries of the Arkansas River in Arkansas (U. S. Fish and Wildlife Service, 1988).

Mountain Steams	Delta Streams
Little Maumelle River	Big Bayou Meto
Maumelle River	Little Bayou Meto
Palarm Creek	Plum Bayou
Cadron Creek	Pennington Bayou
Point Remove Creek	
Illinois Bayou	
Spadra Creek	
Big Piney Creek	
Lee Creek	
Petit Jean River	
Fourche Lafave River	
Mulberry River	

Mussel Fauna

Fifty-five species of unionids have been reported to historically occur in the Arkansas River. Thirty-seven of these species were reported from Arkansas, while 49 were reported from Oklahoma (Table 10; Ecological Specialists, 2005). Thirty species were common to both states.

Information on freshwater mussel species (unionids) composition and distribution for the main stem of the MKARNS is limited to a few studies (Isley, 1925 for the Verdigris River; Davison, 1997 for work in Dardanelle and Ozark pools; and Harris, 1992 for a study in Dardanelle pool). Due to limited existing information, a study was conducted during 2004 by Ecological Specialists, Inc. (O'Fallon, Missouri) to determine 1) unionid distribution and composition in the MKARNS, and 2) how the navigation channel deepening component of the proposed project would affect unionids. Sampling areas focused on proposed dredge and dredged material disposal sites (Ecological Specialists, 2005).

Table 10. Mussel species historically recorded from the Arkansas River drainage (from Ecological Specialists, 2005).

Species[1]	AR[2]	OK[3]
Actinonaias ligamentina	x	x
Alasmidonta marginata	x	x
Amblema plicata	x	x
Anodonta suborbiculata	x	-
Arcidens confragosus	x	x
Cyprogenia aberti (OK II)	x	x
Ellipsaria lineolata	x	x
Elliptio complanata	-	x
Elliptio dilatata	x	x
Fusconaia ebena	x	-
Fusconaia flava	x	x
Lampsilis abrupta (FE)	x	-
Lampsilis cardium	x	x
Lampsilis hydiana	x	x
Lampsilis powelli (FE)	-	x
Lampsilis rafinesqueana (FC)	-	x
Lampsilis satura	-	-
Lampsilis siliquoidea	x	x
Lampsilis teres	x	x
Lasmigona complanata	x	x
Lasmigona costata	x	x
Leptodea fragilis	x	x
Ligumia recta	x	x
Ligumia subrostrata	-	x
Megalonaias nervosa	x	x
Obliquaria reflexa	x	x
Obovaria jacksoniana	x	x
Obovaria olivaria	x	-
Plectomerus dombeyanus	x	-
Pleurobema cordatum	x	x
Pleurobema rubrum	-	x
Pleurobema sintoxia	-	x

Table 10 continued.

Species[1]	AR[2]	OK[3]
Potamilus alatus	-	x
Potamilus capax (FE)	-	?
Potamilus ohiensis	x	x
Potamilus purpuratus	x	x
Ptychobranchus occidentalis	-	x
Pyganodon grandis	x	x
Quadrula cylindrica (OK II)	x	x
Quadrula nobilis (aspera)	-	x
Quadrula metanevra	x	x
Quadrula nodulata	x	x
Quadrula p. pustulosa	x	x
Quadrula quadrula	x	x
Strophitus undulates	-	x
Toxolasma lividus	-	x
Toxolasma parvus	-	x
Tritigonia verrucosa	x	x
Truncilla donaciformis	-	x
Truncilla truncate	x	x
Uniomerus tetralasmus	x	x
Utterbackia imbecillis	x	x
Villosa arkansasensis	-	x
Villosa iris	-	x
Villosa lienosa	-	x
Total		
No. species	37	49

[1]Nomenclature follows Turgeon *et al.* (1998); except *Q. aspera (=nobilis)* follows Watters (OSU, pers. comm. 2004)
FE=federally endangered, FC=federal candidate, OK II=Oklahoma category II
[2]Arkansas (Gordon, 1984-White River site below Newport included; Harris and Gordon, 1986)
[3]Oklahoma (Branson, 1982, 1983, 1984; Shepard and Covich, 1982; Vaughan and Spooner, 1994)

Twenty-seven species were collected during the survey effort (Table 11). No federally-listed threatened or endangered species were found. The largest concentration of mussels was found to occur in the Arkansas Post Canal, where as many as 2,000,000 mussels may occur.

Table 11. Number of unionid species and individuals collected within each MKARNS Reach, 2004 (from Ecological Specialists, 2005).

Species	Reach 1		Reach 2		Reach 3		Reach 4		Reach 5		Reach 6		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Amblema plicata	541	17.7	-	-	6	0.6	2	0.5	21	2.3	3	1.69	573	10.5
Anodonta suborbiculata	1	0.0	-	-	10	1.1	1	0.3	9	1.0	-	-	21	0.4
Arcidens confragosus	11	0.4	-	-	-	-	5	1.3	4	0.4	-	-	20	0.4
Fusconaia ebena	8	0.3	-	-	-	-	-	-	2	0.2	-	-	10	0.2
Fusconaia flava	1	0.0	-	-	-	-	-	-	8	0.9	-	-	9	0.2
Lampsilis cardium	2	0.1	-	-	-	-	-	-	-	-	-	-	2	0.0
Lampsilis siliquoidea	1	0.0	-	-	-	-	-	-	-	-	-	-	1	0.0
Lampsilis teres	117	3.8	-	-	7	0.8	-	-	1	0.1	1	0.56	126	2.3
Lasmigona c. complanata	2	0.1	-	-	-	-	-	-	WD	-	-	-	2	0.0
Leptodea fragilis	17	0.6	1	5.0	34	3.7	4	1.0	25	2.8	17	9.6	98	1.8
Megalonaias nervosa	119	3.9	-	-	31	3.3	1	0.3	9	1.0	WD	-	160	2.9
Obliquaria reflexa	250	8.2	4	20.0	207	22.3	84	21.6	213	23.6	88	49.7	846	15.5
Obovaria olivaria	5	0.2	-	-	-	-	-	-	-	-	-	-	5	0.1
Plectomerus dombeyanus	909	29.8	-	-	238	25.7	132	34.0	1	0.1	-	-	1280	23.4
Pleurobema cordatum	-	-	-	-	-	-	-	-	-	-	WD	-	WD	-
Potamilus ohiensis	2	0.1	FD	-	29	3.1	2	0.5	37	4.1	9	5.08	79	1.4
Potamilus purpuratus	204	6.7	WD	-	27	2.9	-	-	7	0.8	12	6.78	250	4.6
Pyganodon grandis	50	1.6	1	5.0	50	5.4	19	4.9	31	3.4	WD	-	151	2.8
Quadrula aspera	122	4.0	-	-	28	3.0	15	3.9	26	2.9	-	-	191	3.5
Quadrula nodulata	27	0.9	-	-	-	-	-	-	-	-	8	4.52	35	0.6
Quadrula p. pustulosa	13	0.4	-	-	1	0.1	-	-	12	1.3	15	8.47	41	0.7
Quadrula quadrula	636	20.8	14	70.0	248	26.8	117	30.2	482	53.4	10	5.65	1507	27.6
Strophitus undulates	-	-	-	-	-	-	-	-	1	0.1	-	-	1	0.0
Toxolasma parvus	-	-	-	-	-	-	-	-	1	0.1	-	-	1	0.0
Toxolasma sp.	WD	WD	-	-	-	-	-	-	-	-	-	-	WD	-
Tritogonia verrucosa	*8*	*0.3*	-	-	-	-	-	-	*8*	*0.9*	*14*	*7.91*	*30*	*0.5*
Truncilla donaciformis	1	0.0	-	-	2	0.2	3	0.8	2	0.2	-	-	8	0.1
Truncilla truncate	1	0.0	-	-	1	0.1	1	0.3	-	-	-	-	3	0.1
Utterbackia imbecillis	5	0.2	-	-	8	0.9	2	0.5	2	0.2	-	-	17	0.3
Total	3053		20		927		388		902		177		5467	
No. live species	25		4		16		14		21		10		27	
Total no. species	26		6		16		14		22		13		29	

Note: FD=freshly dead shell, WD=weathered dead shell. Reach 1 = confluence of Mississippi River to Bunge Corporation dock near Pine Bluff, AR (NM 0 – 75.2); Reach 2 = Bunge Corporation Dock to Union pacific railroad Crossing in Little Rock, AR (NM 75.2 – 119.5); Reach 3 = Union Pacific railroad crossing to near Shoal Creek (NM 199.5 – 220.3); Reach 4 = Shoal Creek to near mouth of Poteau River (Nm 220.3 – 308.7); Reach 5 = from near the Oklahoma/Arkansas border to the Verdigris River (NM 308.7 – 394.0); Reach 6 = junction of Grand and Arkansas Rivers to the head of navigation at the Port of Catoosa (NM 394 -445).

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Based on their sampling efforts, Ecological Specialists (2005) concluded that 1) the MKARNS provides limited habitat for mussels, 2) the navigation system does not support a significant unionid community, and 3) that the species that occurred in the river were common. The mussel study report provides details on methodology, sampling sites, and results, and can be found in Appendix C of the DEIS for the Arkansas River Navigation Study (USACOE, 2005a).

Commercial harvesting of freshwater mussels also occurs on the navigation system, primarily from the Arkansas River in Arkansas. Ft. Gibson Reservoir on the Grand River undergoes most of the relatively limited shelling that occurs in Oklahoma (Limbird, 1993).

Wetlands

Numerous wetlands occur within the study area. Wetlands are transitional lands between uplands and aquatic systems where water is present at least periodically during the growing season each year and for which the flora and fauna and the nature of soil development are primarily influenced by the presence of water or soil saturated with water. Wetlands perform many valuable functions, such as providing crucial habitat for numerous fish and wildlife species, as well as functions such as water quality improvement, flood control and prevention, groundwater recharge and discharge, erosion control, and education, recreation, and aesthetics that benefit people.

Wetlands occur in association with the MKARNS, its tributaries, and the 15 aforementioned reservoirs in Oklahoma and Arkansas. Wetland types include palustrine, riverine and lacustrine wetlands (Cowardin *et al.*, 1979).

Palustrine wetlands include swamps, marshes, forested wetlands (*e.g.*, bottomland hardwoods), bogs, mudflats, fens, and ponds. They can be isolated or occur shoreward of lakes and river channels, on river floodplains, on slopes, or as islands within a lacustrine or riverine system (wetlands within a channel except those dominated by vegetation). They typically are smaller than 20 acres, less than 2 meters deep, and lack significant wave action (Cowardin *et al.*, 1979). Palustrine wetlands provide habitat for a wide variety of game, non-game, and fur-bearing species (Table 2).

Riverine wetlands are confined within a channel in which water usually flows. They are typically bounded by upland, a palustrine forested wetland that occurs within the boundaries of a channel, or a forested floodplain (Cowardin *et al.*, 1979). Riverine wetlands provide valuable habitat for numerous wildlife species (Table 2). Some of the streams and rivers in the study area, however, have diminished value to fish and wildlife due to impoundment, channelization, and water quality degradation from municipal, industrial, and agricultural effluents. Others, including many of the Ozark streams in Arkansas and Oklahoma, are relatively unaltered. The fisheries in most of these unaltered streams are still considered to be in excellent condition. Lacustrine wetlands include permanently flooded lakes, impounded lakes, oxbow lakes, and intermittent lakes, such as playa lakes (depressions on the plains that seasonally pond during events of high rainfall and vary from a few hundred feet to several miles in diameter). Lacustrine wetlands tend to be large areas of deep water with extensive wave action. They are bounded by upland or wetland vegetation such as trees, shrubs, emergents, mosses, or lichens. Lacustrine wetlands typically exceed 20 acres in size, occur in topographic depressions or on a dammed river, lack extensive areal vegetative cover (<30 percent) (Cowardin *et al.*, 1979), and provide valuable habitat for numerous species that require standing water environments (Table 2). Although not as valuable as the pre-impoundment conditions for many species, impoundments have increased the availability of niches for species that utilize large bodies of standing water, such as warm water lake fish species.

ARKANSAS/VERDIGRIS RIVERS AND 11 OKLAHOMA RESERVOIRS: TERRESTRIAL RESOURCES

Numerous important habitats that support a wide variety of wildlife occur within the project area in Oklahoma and Arkansas. A tentative list of habitat types and associated indicator flora and fauna are presented in Table 2 (USFWS, 1985; USFWS, 1988). These habitat types support numerous game and nongame wildlife within the project area. The list is not inclusive of all species typically found in a particular type, considering the exact species that occur in each habitat type can vary from location to location. The habitat types are subjectively ranked (see Table 2) according to their overall value to fish and wildlife resources. The ratings can vary within habitat types. The following description of the habitat types that may occur within the project area is drawn largely from the Service's reports for a similar study by the Corps on the Arkansas River Basin (USFWS, 1985; USFWS, 1988).

The post oak – blackjack oak forest (crosstimbers) occurs on thin soils prone to erosion if disturbed. Plant species diversity is relatively low; however, the juxtaposition of this forest type with native grasslands greatly increases its value to wildlife.

The oak – hickory forest covers a large portion of the Ozark Plateau in Eastern Oklahoma and Western Arkansas. This forest type tends to have higher species diversity than the crosstimbers, resulting in a potentially greater number of ecological niches for fauna. Tracts adjacent to bottomland hardwood forests and/or riparian forests are especially valuable and provide high quality habitat for many wildlife species.

Native grasslands in the project area consist of tallgrass prairie and mixed-grass prairie. Tallgrass prairie occurs in deep, fertile soil on the eastern and western borders of the crosstimbers and in the Flint Hills. Because of highly fertile soils, much of the tallgrass prairie has been converted to cultivated agriculture and introduced grassland pasture (except in the Flint Hills due to extensive limestone sub-surface). The remaining tracts of tall grass prairie provide valuable wildlife habitat (Table 2). Mixed-grass prairie occurs in scattered tracts in central and western Oklahoma. Much of the mixed-grass prairie has been altered by grazing and agricultural practices; however, the prairie that remains supports numerous wildlife species (Table 2).

Grassland habitats in the project area can be divided into two broad categories determined by the amount of woody cover present. Open field describes grasslands for which less than 25 percent of the area is comprised of woody cover, such as trees and shrubs in early succession stages. Old field describes grasslands for which more than 25 percent of the area is comprised of woody cover.

Caves generally occur in areas with karst topography (areas of carbonate rock, especially limestone, where sinkholes, springs, and caves have formed as a result of the dissolution of the rock by chemical action). They provide a stable environment and habitat for many animals such as frogs, salamanders, reptiles, bats, snails, isopods, amphipods, crayfish, fish, spiders, and crickets. Although caves are underground habitats, they face many potential threats from activities above ground because they typically are connected to the surface through many openings.

The areal extent of cropland and introduced grassland has increased greatly since settlement and continue to increase often at the expense of natural terrestrial habitats with higher value for fish and wildlife resources. Cropland adjacent or in close proximity to natural habitats can serve as a food source for wildlife species. However, pastures or rangeland with monotypic introduced grasses tend to provide few life requisites for wildlife.

Bottomland hardwood forests occur in floodplains throughout the study area, although few undisturbed tracts remain. In Oklahoma, over 85 percent of the bottomland hardwood forests have been lost, and only a portion of the remaining forest is undisturbed (Oklahoma Water Resources Board, 1990). At one time, about 8 million acres of bottomland hardwood forests occurred in Arkansas. Today, only about 850,000 acres remain, with almost 160,000 of these acres in a contiguous block in the White River NWR. Due to the presence of productive soils, favorable water regimes, and juxtaposition with other habitats, the bottomland forests are one of the most productive habitats in the U. S. (Clark and Clark, 1981), and may be the most important wildlife habitat in the project area.

Riparian forests occur in frequently flooded areas adjacent to streams that have saturated soils and high water tables. They generally occur along tributary streams that lack a well-defined floodplain. The juxtaposition of riparian forest with other habitat types enhances the value of the forest for many species.

DREDGED MATERIAL DISPOSAL SITES

Navigation channel deepening and navigation channel maintenance would require the disposal of dredged material at approved sites along the navigation system. The Corps, ODWC, and the Service have worked cooperatively to minimize the use of environmentally sensitive sites, such as bottomland hardwoods, other wetlands, and important upland forests, as disposal sites. Habitat types at the selected dredged material disposal sites include open field, old field, pasture, cropland, upland floodplain forest (riparian forest), open water, and a small amount of bottomland forest (Table 12). These habitat types are described in more detail in the previous section on aquatic and terrestrial resources.

Wildlife Management Areas

Wildlife management areas (WMAs) managed specifically for wildlife by the ODWC and Corps occur along the MKARNS in the vicinity of Chouteau Lock and Dam in Wagoner County, Webbers Falls Reservoir in Muskogee County, and Robert S. Kerr Reservoir in Haskell and Sequoyah Counties. Nine of the 11 Oklahoma reservoirs that serve as the MKARNS's primary flow modifiers also have WMAs (Table 13). Wildlife management areas in the project area in Arkansas (managed by the AGFC) include Dardanelle, Bayou Meto, Trusten Holder, and Galla Creek (Table 13). The WMAs in both states provide habitat for species such as white-tailed deer, rabbit, squirrel, migratory birds, bobwhite quail, turkey, songbirds, and many species of reptiles and amphibians. These WMAs provide 276,058 acres of public lands available to sportsmen and other outdoor enthusiasts. Agricultural leases also occur within the WMAs that provide important annual revenue to the wildlife departments. Revenue from these leases partially funds the operation and maintenance of the WMAs. A brief description of each WMA is provided below. Detailed information (including some maps) for each WMA is provided on the ODWC and AGFC websites:

- ODWC : http://www.wildlifedepartment.com/wmas2.htm
- AGFC: http://www.agfc.state.ar.us/wma_lakes/wma_all.html.

Copan WMA: The Copan WMA encompasses about 7,500 acres of cross timbers, bottomland hardwood, and tallgrass prairie habitat around the upper end of Copan Reservoir in Washington County, Oklahoma. Aquatic habitats include the reservoir, numerous wetlands, the Little Caney River and its tributaries. Ongoing management practices include developing about 1,000 acres of food plots as well as controlled grazing, and prescribed burning. Six wetland units consisting of about 460 acres have been developed to provide habitat for migratory birds. The water levels in these units are manipulated annually to provide moist soil habitat. The wetland units are used annually by thousands of migratory birds. Game species of interest include white-tailed deer, fox squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, bobwhite quail, fox and gray squirrel, and waterfowl. The bald eagle and greater prairie chicken *Tympanuchus cupido* also occur on the WMA.

Table 12. Dredged material disposal sites for the navigation channel deepening and navigation channel maintenance elements. Cover type acres were not provided for sites OK 393.1 L-DI and OK 336.3 L-DI. Cover type acres was not fully provided for site OK-318.3 R-DI. For Dredge Disposal Site names: OK = Oklahoma; 398.2 = river mile; R = right bank; L= Left Bank; DI = Direct Impact; PT = Poteau River; SBC = Sans Bois Creek. For Cover Types: OLF = old field; OF = open field; FF = floodplain forest; BLH = bottomland hardwood forest; OW = Open Water; AG = Cropland; BS = barren sand; P = pond.

Disposal Sites	12-ft	9-ft.	Cover Type Acres								Total 12-ft.	Total 9-ft.	Beneficial Use of Dredged Material
			OLF	OF	FF	BLH	OW	AG	BS	P			
OK PR L-DI	X	X		9							9	9	
OK 436.1 L-DI	X			13							13		
OK 422.9 L-DI	X	X		7							7	7	
OK 421.3 R-DI	X			13							13		
OK 312.5 R-DI		X		19								19	
OK 335.9 L-DI	X			22							22		
OK 338.0 R-DI	X			28							28		
OK 443.7 L-DI	X			27							27		
OK 382.0 L-DI	X			23							23		
OK 441.1 L-DI	X			12							12		
OK 401.6 R-DI	X	X		39							39	39	
OK 394.4 L-DI	X							27			27		
OK 393.3 L-DI		X						50				50	
OK 418.5 R-DI	X							33			33		

Table 12 continued

Disposal Sites	12-ft	9-ft.	Cover Type Acres								Total 12-ft.	Total 9-ft.	Beneficial Use of Dredged Material
			OLF	OF	FF	BLH	OW	AG	BS	P			
OK 318.6 L-DI	X								40		40		
OK 375.2 L-DI	X							31			31		
OK 351.9 R-DI	X							14			14		
OK 365.9 R-DI	X							6			6		
OK 396.6 L-DI	X							12			12		
OK 414.2 R-DI (2nd priority)	X							9			9		
OK 429.3 R-DI	X							10			10		
OK 429.4 R-DI	X							14			14		
OK 393.8 L-DI	X							45			45		
OK 391.8 R-DI		X								16		16	
OK 379.1 L-DI	X							31			31		Create wetland
OK 348.3 L-DI (2nd priority)	X	X					20				20	20	Create interior least tern island
OK 389.7 L-DI	X			37							37		
OK 355.0 R-DI		X					31					31	Create interior least tern island
OK 349.4 L-DI		X					20					20	Create interior least tern island
OK 393.1 L-DI		X											Create wetland

Table 12 continued

Disposal Sites	12-ft	9-ft.	Cover Type Acres								Total 12-ft.	Total 9-ft.	Beneficial Use of Dredged Material
			OLF	OF	FF	BLH	OW	AG	BS	P			
OK 336.3 L-DI	X												Beach nourishment
OK 367.2 L-DI	X						32						Marsh creation
OK-SBC 0.4 L-DI	X						100						Marsh creation
OK-SBC 4.8 L-DI	X						94						Marsh creation
OK 336.4 R-DI	X						11						Marsh creation
OK-SBC 6.6 L-DI	X	X					10				10	10	Marsh creation
OK-SBC 6.9 L-DI	X	X					10				10	10	Marsh creation
OK 354 L-DI	X	X					18				18	18	Bank stabilization
OK 345.3 L-DI	X									21	21		Reclaim strip pit
OK 337.2 R-DI	X				28						28		
OK 444.6 R-DI		X			9							9	
OK 444.6 L-DI		X	15									15	
OK 416.4 L-DI	X		14								14		
OK 414.9 R-DI	X		8								8		
OK 366.5 L-DI	X		6								6		
OK 400.0 L-DI		X	23									23	
OK 395.2 L-DI		X	18									18	

Table 12 continued

Disposal Sites	12-ft	9-ft.	Cover Type Acres								Total 12-ft.	Total 9-ft.	Beneficial Use of Dredged Material
			OLF	OF	FF	BLH	OW	AG	BS	P			
OK 394.0 R-DI		X	48									48	
OK 400.7 R-DI	X	X	31								31	31	
OK 434.3 R-DI	X		10								10		
OK 335.8 R-DI	X			14		8					22		
OK-SBC 8.7 L-DI		X	8			2						10	
OK-SBC 9.7 R-DI		X			5	5						10	
OK 383.9 R-DI	X		27	13	2						42		
OK 315.4 R-DI	X	X	28		8						36	36	
OK 318.3 R-DI		X			20							80	
OK-SBC 10.0 R-DI		X	2		16							18	
OK 342.3 L-DI	X		15		14						29		
OK 407.6 R-DI	X		8		2						10		
OK 309.1 R-DI	X	X		23	5						28	28	
OK 420.8 L-DI		X		43	10							63	
OK 398.2 R-DI	X		10	34							44		
Total Acres											**889**	**638**	

Table 13. Wildlife Management Areas associated with the MKARNS in Oklahoma and Arkansas.

Wildlife Management Areas	Acres
Oklahoma	186,229
Copan	7,500
Hulah	16,141
Oologah	14,155
Kaw	16,254
Keystone	16,537
Fort Gibson	21,798
Tenkiller	1,950
Eufaula	48,469
Wister	35,550
McClellan Kerr	7,875
Arkansas	89, 829
Dardanelle	42,500
Bayou Meto	34,000
Trusten Holder	10,000
Galla Creek	3,329
Total	276,058

Hulah WMA: The Hulah WMA consists of about 16,000 acres of bottomland hardwood forest, tallgrass prairie, and post oak/blackjack oak forest in Osage County, Oklahoma.

Aquatic habitats include the reservoir, numerous small ponds, the Caney River and its tributary streams. Ongoing management practices include controlled grazing, agricultural plantings on about 2,200 acres, and prescribed burning. Two wetlands units have been developed that require water level manipulations to provide about 260 acres of moist soil habitat for migratory birds. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, mourning dove, bobwhite quail, and waterfowl. Other species of interest that occur on the WMA include the bald eagle and greater prairie chicken.

Oologah WMA: The WMA consists of about 13,000 acres around Oologah Lake in Rogers and Nowata Counties, Oklahoma. The area primarily provides bottomland hardwood habitat for native wildlife species. Pecan, oak, and willow are the dominant tree species in the bottomlands. Old field and native prairie habitat also occur on the area. Aquatic habitats include emergent wetlands, ponds, and the Verdigris River and its tributaries. Management efforts are directed at maintaining native plant species. About 1,000 acres of food plots and agricultural leases also are utilized to provide additional wildlife food sources. The Overcup Bottoms and Upper Verdigris Units consist of wetland development areas managed for waterfowl. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, mourning dove, bobwhite quail, and waterfowl. The bald eagle occurs in the area during the winter.

Kaw WMA: The WMA is located along the upper 2/3 of Kaw Reservoir including the Arkansas River, Beaver Creek, Little Beaver Creek, and Bear Creek in Kay County, Oklahoma. The area consists of about 16,000 acres of cropland, upland oak forest, bottomland hardwoods, old fields, and tallgrass prairie. Native bluestem grasses predominate on the prairie sites. Post oak, blackjack oak and sand plum are the most common tree species in the upland forested areas. Predominant trees in the bottomlands are hackberry, burr oak, and sycamore. Aquatic habitats include the Arkansas River, Beaver Creek, Little Beaver Creek, Bear Creek and their tributaries, and wetlands. Management practices include: 1) leasing about 4,000 acres to be planted in milo, corn, wheat, and soy beans, 2) planting about 1,000 acres of mud flats in Japanese millet that are inundated when the plants mature (to increase waterfowl habitat), and 3) planting trees and shrubs to enhance upland habitat. Popular game species include white-tailed deer, fox squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, mourning dove, bobwhite quail, pheasant, and waterfowl. The bald eagle occurs at the reservoir/WMA in large numbers during the winter, and also is known to nest in the area. Other species of interest include the greater prairie chicken, osprey *Pandion haliaetus*, upland sandpiper *Bartramia longicauda*, and the Texas horned lizard *Phrynosoma cornutum*.

Keystone WMA: The WMA encompasses about 16,500 acres located along the Arkansas and Cimarron Rivers above Keystone Reservoir in Creek, Osage and Pawnee Counties. Fish and Wildlife habitat include the wide, shallow rivers, their tributaries and sandbars, riparian areas adjacent to the rivers (dominated by cottonwood and willow), wetlands, sloughs, mudflats, bottomland hardwoods, crop fields, fallow crop fields, and some post oak-blackjack oak uplands. Management practices include enhancing/maintaining native vegetation, food plot plantings, agricultural leases, and prescribed burns. Popular game species include white-tailed deer, fox squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, mourning dove, bobwhite quail, and waterfowl. The bald eagle nests and winters in the area.

Fort Gibson WMA: The area consists of a mixture of tallgrass prairie, farm fields, post oak-blackjack oak woods, and bottomlands on about 21,800 acres in Wagoner and Cherokee Counties, Oklahoma. Prescribed burning and row crops enhance upland habitats. A waterfowl refuge with nine wetland units occurs on about 3,500 acres. Popular game species include white-tailed deer, fox squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, mourning dove, bobwhite quail, and waterfowl. The bald eagle winters in the area.

Tenkiller WMA: The WMA contains about 2,590 acres of oak/hickory upland and riparian habitat adjacent to Tenkiller reservoir in Cherokee and Sequoyah Counties, Oklahoma. Riparian species primarily are elm, willow, river birch, hackberry, and sycamore. Management practices include planting food plots and thinning upland wooded areas. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, gray fox, bobcat, beaver, turkey, mourning dove, bobwhite quail, and waterfowl. The bald eagle winters and nests in the area.

Eufaula WMA: The WMA occurs on about 48,615 acres in Latimer, McIntosh, Pittsburg, and Cherokee Counties, Oklahoma. The area consists primarily of floodplain and bottomland hardwoods supporting of a variety of tree species such as pin oak, willow, and sycamore. Numerous natural wetlands and sloughs occur on the WMA. About 780 acres have been developed into wetland units managed for waterfowl. Mixed upland hardwoods, prairie, and old fields also occur on the area. About 1,500 acres are farmed through lease agreements to provide additional food sources for wildlife. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, gray fox, bobcat, beaver, turkey, mourning dove, bobwhite quail, and waterfowl. The bald eagle winters and nests in the area.

Wister WMA: The WMA contains about 35,500 acres of bottomland hardwoods along the Poteau and Fourche Maline Rivers, with prairie and oak/hickory/pine forest in the uplands. The WMA is located in LeFlore and Latimer Counties, Oklahoma. Ongoing management focuses on maintaining openings and controlling woody vegetation. Practices include prescribed burning, strip discing, brush hogging, and planting food plots. Controlled grazing is allowed on about 14,000 acres. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, gray fox, bobcat, beaver, turkey, mourning dove, bobwhite quail, and waterfowl. Black bear are present in low numbers. The bald eagle winters and nests in the area. The golden eagle also winters in the area.

Dardanelle WMA: The area consists of about 45,000 acres of uplands and wetlands in Pope, Yell, Johnson, and Logan Counties, Arkansas. Popular game species include white-tailed deer, coyote, cottontail and swamp rabbit, bobwhite quail, mourning dove, American woodcock, and waterfowl.

Bayou Meto: The WMA consists of about 31,830 acres in Jefferson and Arkansas Counties, Arkansas. The area provides both upland and wetland habitats including six lakes totaling 1,080 acres. Numerous water control structures are used to manipulate water on the area to benefit waterfowl. About 13,000 acres are flooded each fall to provide habitat for migrating waterfowl. Other management practices include controlled burning, brush hogging, strip discing, and planting food plots. Popular game species include whitetail deer, raccoon, cottontail rabbit, fox squirrel, turkey, and waterfowl. The American alligator also occurs on the WMA.

Trusten Holder: The WMA contains about 4,400 acres of overflow bottomland hardwoods adjacent to the White River in Desha and Arkansas Counties, Arkansas. Typical tree species include overcup and nuttal oak, hackberry, ash, and persimmon. Management practices include selective timber harvest, controlled burns, and planting food plots. Popular game species include whitetail deer, squirrel, cottontail and swamp rabbit, bobwhite quail, mourning dove, and waterfowl.

Galla Creek: The WMA contains about 3,330 acres in two tracts located north of Holla Bend NWR and the Arkansas River in Pope and Yell Counties, Arkansas. The area contains both upland forests, wetlands, and a lake on Galla Creek. Popular game species include whitetail deer, fox and gray squirrel, raccoon, cottontail and swamp rabbit, mourning dove, American woodcock, bobwhite quail, and waterfowl.

National Wildlife Refuges

Three NWRs occur along or near the MKARNS. The refuges are the Sequoyah NWR in eastern Oklahoma, and the Holla Bend and White River NWRs in Arkansas.

Sequoyah NWR: The refuge occurs in Haskell, Muskogee, and Sequoyah Counties near the confluence of the Arkansas and Canadian Rivers in Oklahoma. The refuge was established by cooperative agreement between the Service and the Corps in 1970 to provide habitat for waterfowl and other migratory birds. The refuge covers about 20,800 acres and annually hosts the largest concentration of wintering snow geese in Oklahoma. Bottomland hardwood habitat found at the refuge provides habitat for numerous wildlife species such as songbirds, raptors, quail, rabbit, muskrat, deer, bobcat, and squirrels, as well as many species of reptiles and amphibians including the green tree frog, cottonmouth, red-eared slider, diamondback water snake, and bullfrog. The bald eagle is common at the refuge during the fall and winter. The refuge also appears to be one of the last strongholds in Oklahoma for the alligator snapping turtle, a state species of special concern in Oklahoma.

Sequoyah NWR offers the public opportunities for hiking, wildlife photography, bird watching, and freshwater fishing. Public hunting is allowed for waterfowl, deer, and small game (rabbit, grey squirrel, fox squirrel, American coot, snipe, mourning dove, woodcock, and bobwhite quail).

Holla Bend NWR: The refuge is located in west-central Arkansas along the Arkansas River in Pope County. This refuge was established in 1957 and encompasses 7,057 acres of bottomland hardwoods and wetlands. The refuge is bounded to the north by an oxbow lake created when the Corps excavated a channel through the bend in the river to improve the MKARNS for navigation and flood control. Wildlife resources at the refuge include several species of wintering waterfowl, the golden eagle, the federally-listed threatened bald eagle, migratory songbirds, as well as many species of mammals, reptiles, and amphibians. The refuge receives about 40,000 visitors annually and offers the public opportunities for hiking, wildlife photography, hunting, bird watching, and freshwater fishing.

White River NWR: The refuge occurs in Desha, Monroe, and Phillips Counties in eastern Arkansas and lies in the floodplain of the lower White River near the confluence of the Arkansas and Mississippi Rivers. The refuge encompasses 90 of the lower 100 miles of the White River in Arkansas as well as three miles of the Arkansas Post Canal. Established in 1935, the refuge is about 160,000 acres in size, including about 154,000 acres of bottomland hardwood forests forest, 1,000 acres of grassland, 900 acres of cropland, and 4,000 acres of natural and manmade lakes. Although historically about 8 million acres of bottomland hardwood forests occurred in Arkansas, today only about 850,000 acres remain. The bottomland hardwood forest within the refuge represents nearly 20 percent of the state's remaining bottomland hardwood forest acreage. The refuge is one of the largest remaining contiguous bottomland hardwood forests in the lower Mississippi River Valley.

The refuge has been designated as a Wetland of International Importance and is on the American Bird Conservancy list of globally important bird areas. As the host of the largest concentration of wintering mallard ducks in the Mississippi Flyway, the refuge helps bring about 2.5 million dollars per day to the area during the sixty day waterfowl hunting season. Thus, the refuge is a major economic asset to the area. The area provides habitat for wading birds, shorebirds, waterfowl, raptors, a variety of reptiles, amphibians, and mammals, including a healthy population of black bears. The refuge also has four active nests of the federally-listed threatened bald eagle. White River NWR is visited by about 150,000 people annually and offers opportunities for hunting, boating, fishing, wildlife observation and photography, and hiking.

THREATENED AND ENDANGERED SPECIES

Section 7(a)(2) of the Endangered Species Act (ESA) requires federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any federally-listed threatened or endangered species or result in adverse modification or destruction of designated critical habitat. When the federal action agency, in this case the Corps, determines that its action "may affect" a federally-listed threatened or endangered species or designated critical habitat, the agency is required to enter into formal consultation with the Service. The federal agency or their designated non-federal representative would prepare a biological assessment that addresses possible impacts to the federally-listed species that occur within the project area.

Seventeen federally-listed endangered and threatened species and two candidates for federal listing occur within the vicinity of the project area. Specific information relative to these species is included in Appendix B.

Formal consultation under section 7 of the ESA is nearing completion for the following four species: 1) the interior least tern, 2) the American burying beetle, 3) the bald eagle, and 4) the pallid sturgeon. The Service has recommended that the Corps (and the Federal Energy Regulatory Commission) also formally consult with the Service on the operation of Grand Lake to address incidental take related to the operation of this reservoir. This consultation will be conducted separate from the ongoing consultation pertaining to ARNS.

STATE LISTED AND OTHER RARE/DECLINING SPECIES

Other species that also should be considered during project planning include state-listed and rare species, species with restricted ranges, and species of conservation concern that may occur within the project area (Tables 14 and 15). Rare/declining, state-listed threatened or endangered species, and species of concern are not afforded protection under the ESA, unless proposed for federal listing. However, protection of these species now may help prevent the need to list them in the future.

ZEBRA MUSSELS

The zebra mussel *Dreissena polymorpha* is a small (thumbnail size) mussel with alternating light and dark stripes native to the Caspian Sea Region of Asia. This species, native to the Caspian Sea Region of Asia, has spread throughout the eastern United States since its unintentional introduction in the Great Lakes around 1986 in the ballast water of ships and on the hulls of barges. They are now found in at least 20 states, including Oklahoma and Arkansas.

Zebra mussels adversely impact infested aquatic habitats (D'Itri, 1997). They occur in large, dense clusters of up to 30,000 individuals in one square meter (O'Neill and MacNeill, 1991). Zebra mussels are known to smother native mussel fauna. They also can alter the natural food chain by consuming food otherwise available to native species, alter habitat substrates, and impact water quality.

Table 14. State-listed rare and endangered/threatened species that occur or may occur within the project area in Oklahoma.

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Animals		
Gray bat (*Myotis grisescens*)	E	northeastern OK; limestone caves, forests near rivers/lakes
Indiana bat (*Myotis sodalis*)	E	eastern OK; caves, forests
Ozark big-eared bat (*Plecotus townsendii ingens*)	E	northeastern OK; caves (karst areas) in oak-hickory forests
Marsh rice rat (*Oryzomys palustris*)	SS2	eastern OK; near wetlands, grasslands
Golden mouse (*Ochrotomys nuttali*)	SS2	east-central OK; greenbriar thickets, swamps
Long-tailed weasel (*Mustela frenata*)	SS2	variety of habitats statewide
Mountain lion (*Felis concolor*)	SS2	rare in eastern OK
Rafinesque's big-eared bat (*Plecotus rafinesqui*)	SS2	east-central Oklahoma; forests with dense foliage
River otter (*Lutra canadensis*)	SS2	eastern OK, Wister WMA; aquatic
Woodchuck (*Marmota monax*)	SS2	east-central & northeastern OK; open woodlands
Piping plover (*Charadrius melodus*)	T	migrates through central and eastern OK; known to use Winganon Flats at Oologah Reservoir
Bald eagle (*Haliaeetus leucocephalus*)	E	major rivers and reservoirs
Interior least tern (*Sterna antillarum athalassos*)	E	Arkansas and Canadian Rivers
Prairie falcon (*Falco mexicanus*)	SS1	dry plains and prairies
Swainson's hawk (*Buteo swainsoni*)	SS2	grasslands
Migrant loggerhead shrike (*Lanius ludovicianus migrans*)	SS2	open areas with high perches

Table 14 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Barn owl (*Tyto alba*)	SS2	woodlands, savannas, farmlands, suburbs
Bell's Vireo (*Vireo bellii*)	SS2	deciduous thickets along streams, ravines, forest edges
Arkansas darter (*Etheostoma cragini*)	SS2	northeastern Oklahoma; northwestern Arkansas; spring feed vegetated creeks and headwaters typically over mud
Arkansas River shiner (*Notropis girardi*)	T	Canadian River above Eufaula Reservoir
Ozark cavefish (*Amblyopsis rosae*)	T	streams in nutrient rich caves in northeastern OK/Ozark highlands
Blackside darter (*Percina maculata*)	T	eastern OK in pools of creeks of small-medium rivers
Longnose darter (*Percina nasuta*)	E	east-central OK in gravel runs of small-medium rivers
Alabama shad (*Alosa alabame*)	SS2	east-central and northeast OK in open water of medium - large rivers
Alligator gar (*Atractosteus spatula*)	SS2	eastern OK except northeast in pools and backwaters of rivers, lakes, swamps
Peppered chub (*Macrhybopsis tetranema*)	SS2	gravel runs of major rivers and tributaries
Blue sucker (*Cycleptus elongates*)	SS2	Grand lake and tailwaters
Black buffalo (*Ictiobus niger*)	SS2	eastern and central OK in rivers and lakes
Bluntface shiner (*Cyprinella camura*)	SS2	northeastern OK in small clear streams

Table 14 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Harlequin darter (*Etheostoma histrio*)	SS2	mostly Saline, Spavinaw, and Spring Creeks
Kiamichi shiner (*Notropis ortenburgeri*)	SS2	Poteau River and streams in Ouachita Mountains
Pallid shiner (*Hybopsis amnis*)	SS2	Poteau River
Plains topminnow (*Fundulus sciadicus*)	SS2	Grand River drainage
Ribbon shiner (*Lythrurus fumeus)*	SS2	Illinois and Poteau Rivers
River Darter (*Percina shumardi*)	SS2	Grand and Illinois Rivers
Shorthead redhorse (*Moxostoma macrolepidotum*)	SS2	northeastern OK in clear gravel-bottom streams/rivers
Shovelnose sturgeon (*Scaphirhyncus platorynchus*)	SS2	Arkansas River and tributaries
Southern brook lamprey (*Ichthyomyzon gagei*)	SS2	clear streams of Ouachitas and Ozarks
Spotfin shiner (*Notropis spilopterus*)	SS2	Illinois River
Spotted bass (*Micropterus punctulatus)*	SS2	eastern OK in clear, spring- fed streams
Stonecat (*Notorus flavus*)	SS2	northeatern OK in clear bottom, gravel streams
Northern scarlet snake (*Cemophora coccinea*)	SS2	eastern OK in sandy/loamy areas
Alligator snapping turtle (*Macroclemys temminckii*)	SS2	Eastern OK in lakes, rivers, oxbows, and sloughs; known to occur at Seqouyah NWR and near Eufaula Reservoir
Map turtle (*Graptemys geographica*)	SS2	Delaware County; large bodies of water

Table 14 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Texas horned lizard (*Phrynosoma cornutum*)	SS2	grasslands with areas of sparse vegetation
Rich Mountain salamander (*Plethodon ouachitae*)	SS2	north facing talus slopes of Ouachtia Mountains
Grotto salamander (*Typhlotriton spelaeus)*	SS2	northeastern OK in limestone caves with springs
Oklahoma salamander (*Eurycea tynerensis*)	SS2	northeast OK in spring-fed creeks with gravel bottoms
Ouachita dusky salamander (*Desmognathus brimleyorum*)	SS2	southeastern OK in springs, streams
Ringed salamander (*Ambystoma annulatum*)	SS2	eastern OK in moist wooded areas
Scaleshell (*Leptodea leptodon*)	SS2	scattered populations in Arkansas River Basin
Neosho mucket (*Lampsilis rafinesqueana*)	E	Illinois River above Lake Tenkiller
Western fanshell (*Cyprogenia aberti*)	SS2	historically occurred in Verdigris and Caney Rivers ; may be extirpated from Oklahoma
Spectacle-case shell (*Quadrula cylindrica*)	SS2	Illinois River in Cherokee County
Rich Mountain slitmouth (*Stenotrema pilsbryi*)	SS1	talus slope in Ouachita Mountains
American Burying Beetle (*Nicrophorus americanus*)	E	habitat generalist; grasslands, forests
Prairie mole cricket (*Gryllotalpa major*)	SS2	prairies
Plants		
Ozark chinquapin oak (*Castenea pumela* var. *ozarkensis*	R	eastern OK in oak-pine and oak-hickory forests

Table 14 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Waterfall's sedge (Carex latebracteata)	R	mesic slopes in southeastern OK
Hammock sedge (Carex fissa)	R	northeastern OK along edges of ponds/lakes
Ozark wake-robin (Trillium pusillum var. ozarkanum)	R	oak-hickory and oak-pine woodlands in LeFlore County
Ozark spiderwort (Tradescantia ozarkana)	R	eastern OK in deciduous forests in ravines and steep rocky hillsides
Skinner's false foxglove (Agalinis skinneriana)	R	Delaware County in prairies and open areas of oak-hickory forests but may be extirpated from OK
Earleaf false-foxglove (Agalinis auriculata)	R	currently only known from prairie hay meadows bordered by upland woods in Choctaw County
Dwarf pipewort (Eriocaulon kornickianum)	R	sandy hillsides in Atoka, Muskogee, and Pushmataha Counties
Southern Lady's slipper (Cypripedium kentuckiense)	R	southeastern OK in floodplain forests and mesic ravines
Ouachita indigo bush (Amorpha ouachitensis)	R	Leflore, McCurtain, and Pushmataha Counties along rocky creeks, streambanks, and floodplains
Western prairie fringed orchid (Platanthera praeclara)	T	northeastern Oklahoma in moist grasslands; may be extirpated from Oklahoma

E = Endangered
T = Threatened
SS1 = Species of Special Concern where current evidence indicates species is vulnerable because of limited range, low population, or other factors
SS2 = Species of Special Concern that is possibly threatened or vulnerable but with little evidence to document current population levels and range.
R = Rare

Table 15. Arkansas state-listed rare species that occur or may occur within the project area (list of species and their state rank provided by the Arkansas Natural Heritage Commission).

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Animals		
Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)	S2	statewide except Ozark Mountains; occupies buildings, barns, caves, forests
Brazilian free-tailed bat (*Tadarida brasiliensis*)	S3	central and southern Arkansas; occupies buildings, forests
Gray myotis (*Myotis grisescens*)	S2	forests and caves near rivers, lakes
Florida panther (*Puma concolor coryi*)	SH	–
Swainson's warbler (*Limnothlypis swainsonii*)	S3B	possibly statewide; swamp forests, bottomland hardwood forests, riparian forests
Interior least tern (*Sterna antillarum athalassos*)	S2B	sand bars on Arkansas and White Rivers
Bald eagle (*Haliaeetus leucocephalus*)	S2B, S4N	statewide; rivers, reservoirs/lakes
Strecker's chorus frog (*Pseudacris streckeri streckeri*)	S2	eastern and central Arkansas; moist woods, rocky ravines, riparian forests, lagoons, swamp forests, croplands
Plains spadefoot (*Scaphiopus bombifrons*)	S1	isolated population in north-central/northwest Arkansas; grasslands
Arkansas River shiner (*Notropis girardi*)	SX	–
Shorthead redhorse (*Moxostoma macrolepidotum*)	S2	northern half of Arkansas; rocky pools and riffles of small and large rivers, lakes
Slenderhead darter (*Percina phoxocephala*)	S2	western Arkansas; gravel runs and riffles of small creeks to medium rivers

Table 15 continued

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Suckermouth minnow (*Phenacobius mirabilis*)	S1	west-central Arkansas; gravel/rubble riffles and runs of creeks, and in small to large rivers
Flathead chub (*Platygobio gracilis*)	S1?	eastern Arkansas; sandy runs of rivers
Paddlefish (*Polyodon spathula*)	S2?	statewide; slow flowing, deep water of large rivers
Swamp darter (*Etheostoma fusiforme*)	S2?	south and eastern Arkansas; standing of slow-moving water over sand or mud
Goldeye (*Hiodon alosoides*)	S2B, S4N	statewide; occurs in deep open pools, channels, lowland rivers, lakes.
Plains minnow (*Hybognathus placitus*)	SX	west-central Arkansas; shallow sandy runs, pools of creeks, and small to large rivers
Lake sturgeon (*Acipenser fulvescens*)	S1	eastern Arkansas; bottom of lakes and large rivers
Lake chubsucker (*Erimyzon sucetta)*	S2?	southern, east-central, and eastern Arkansas; lakes, ponds, and swamps over silt, sand, or debris
Plants		
San Antonio false-foxglove (*Agalinis homalantha*)	S1	statewide; oak woodlands
Texas bergia (*Bergia texana*)	S2	Johnson , Perry, ansd Desha Coutnies; swamps, mud flats, muddy pond shores
Tissue sedge (*Carex hyalina*)	S3	statewide inventory needed; margins of forested wetlands and swamps
Scratch-daisy (*Croptilon hookerianum* var. *validum*)	S2	limited to the Arkansas Valley and Mississippi Alluvial Plain

Table 15 continued

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Lax hornpod (*Cynoctonum mitreola*)	S3	wetlands
Six-angle spurge (*Euphorbia hexagona*)	S2	known to occur in Franklin and Pope Counties; sandy shores and bottoms
Showy prairie-gentian (*Eustoma russellienum*)	S2	Clark County and Arkansas River Valley
Soapwart gentian (*Gentiana saponaria*)	S3	western and central Arkansas; swamps, bogs
Hairy water-fern (*Marsilea vestita*)	S3	Arkansas River Valley and in Bradley, Chicot, Washington and Polk Counties; wetlands
California bullrush (*Scirpus californicus*)	S1S2	known to occur in Hempstead, Johnson, and Conway Counties; wetlands
Riddell's spike moss (*Selaginella arenicola*)	S3	known from the Ozark Plateau; dry rocks and packed sand
Twistflower (*Streptanthus obtusfolius*)	S3	restricted to Ouachita Mountains

S1 = Extremely rare. Typically 5 or fewer estimated occurrences in the state, or only a few remaining individuals, may be especially vulnerable to extirpation.
S2 = Very rare. Typically between 5 and 20 estimated occurrences or with many individuals in fewer occurrences, often susceptible to becoming extirpated.
S3 = Rare to uncommon. Typically between 20 and 100 estimated occurrences, may have fewer occurrences but with many large number of individuals in some populations, may be susceptible to immediate threats.
S4 = Common, apparently secure under present conditions. Typically 100 or more estimated occurrences but with large number of individuals in some populations, may be restricted to only a portion of the state.
SH = Historical occurrence but may be extirpated
SX = Believed to be extirpated.
? = Indecision regarding rank assignment
B = Breeding status
N = Non-breeding status

Zebra mussels spread primarily by attaching to boats used in infested waters that are then launched on lakes they have not been invaded. The mussels and their veligers can be carried in bilges, minnow buckets, live wells, and engine cooling systems. They populate a new body of water quickly due to their high reproductive rate (*e.g.*, a female can release up to one million eggs each season) and their few natural predators (*e.g.*, diving ducks, blue catfish, red ear sunfish, and freshwater drum).

Eliminating established populations is impossible. Washing and scrubbing boats and equipment that have been used in infested waters currently is the best method to prevent further spread of this species.

Zebra mussels are known to occur throughout the project area with concentrations established at the following locations: 1) lock and dam # 10 (Dardanelle) on the Arkansas River, 2) Arkansas Nuclear One intake canal and effluent bay (Lake Dardanelle), 3) lock and dam # 14 (W. D. Mayo) on the Arkansas River; 4) lock and dam # 15 (Robert S. Kerr) on the Arkansas River; 5) lock and dam # 16 (Webbers Falls) on the Arkansas River; 6) lock and dam # 17 (Choteau) on the Verdigris River; 7) lock and dam # 18 (Newt Graham) on the Verdigris River; 7) at Oologah Lake on the Verdigris River, and 8) Kaw Reservoir.

FISH AND WILDLIFE RESOURCES: FUTURE WITHOUT THE PROJECT

The future conditions for fish and wildlife resources are difficult to accurately predict due to the large areal extent of the project area and complex nature of the project. Habitat improvements along the system, such as riparian restoration and dike notching, are likely to continue through various available means such as section 1135 (Project Modifications for the Improvement of the Environment) of Water Resources Development Act (WRDA) of 1986, Section 206 (Aquatic Ecosystem Restoration) of WRDA 1996, landowner incentive measures of the Farm Bill, and the Service's Partners for Fish and Wildlife Program.

Sixty-two fish species were identified within the navigation system from the aquatic impact assessment conducted during Summer 2004. Although Buchanan's (1976) assessment identified 106 fish species within the navigation system, his study also included tributaries and the White River. The 2004 assessment restricted sampling primarily to tail waters, which largely accounts for the disparity in the number of fish species reported from these sources.

Construction and ongoing operation of the MKARNS has resulted in stabilized channel conditions, and the creation of reservoirs that provide habitat for lake species, but limit habitat for native riverine species. The overall result is a more homogenous aquatic environment within the MKARNS that benefits particular fish and mussel fauna at the expense of others (Buchanan, 1976). The Corps likely would continue to maintain commercial navigation on the MKARNS at the current 9-foot navigation depth if the proposed project were not implemented. Thus, the navigation system and reservoirs would continue to provide a relatively homogenous aquatic environment. The overall fish and mussel fauna would be expected to be similar to existing conditions without the proposed project.

Changes to aquatic resources in the reservoirs on the system would occur as the reservoirs continue to age. The upper ends of the reservoirs will continue to become more shallow and convert to marsh habitat as they fill in with sediments deposited by the incoming watercourse. The natural process of eutrophication also would continue, especially in the shallow reservoir headwaters.

Other changes may occur as newly developed or modified lake level management plans are implemented or stocking/restoration efforts are pursued. Management of biotic resources would continue and are likely to be beneficial to fish and wildlife species.

Wildlife Management Areas and NWRs along the MKARNS in both states and at the Oklahoma reservoirs that serve as the MKARNS's primary flow modifiers are expected to continue to be managed specifically for fish and wildlife resources by the ODWC, AGFC, Corps and the Service. Changes may occur as a result of natural succession and modified management plans, but are anticipated to be beneficial due to continued management practices. Natural species succession also would be expected to occur in most of the terrestrial cover types described previously.

Federally-listed species are afforded protection under the ESA, as amended. The ESA provides a framework for the federal government, states, private industry and individuals to work cooperatively to conserve listed species. Conservation and protection of listed species is anticipated to continue through federal, state, and private recovery actions, future research studies and monitoring efforts, interagency consultations, and the implementation of conservation measures on private land.

Rare/declining, state-listed threatened and endangered species, and other species of concern are not afforded protection under the ESA. Continued population declines may occur, warranting listing and subsequent federal recovery efforts. Protection of these species now will help prevent the need to list them in the future. Various federal initiatives, for example, the State Wildlife Grants program authorized by the Department of the Interior and Related Agencies Appropriations Act, 2004, provide millions of dollars in wildlife conservation grants to the states, tribes, and private organizations. These grants will be used to benefit wildlife and their habitat, including rare/declining, state-listed threatened or endangered species, and other species of concern.

The population of paddlefish within the navigation system likely would remain stable or increase. Existing gravel bars should continue to support spawning habitat for the paddlefish. Also, restoration attempts and surveys on the brood stock of paddlefish in the Arkansas and Verdigris rivers in northeastern Oklahoma are expected to be on-going without the project.

A task force to address the spread of zebra mussels, known as the 100th Meridian Initiative, has been formed with representatives from federal and state agencies, private industry, and user groups. Eliminating an established population of zebra mussels is difficult to impossible. Zebra mussels possess a high reproductive rate and have limited natural predators within the project area. For these reasons, zebra mussels can rapidly populate a new body of water. Further spread of this species within the project area may occur, for example, should a boat from infested waters be moved to non-infested waters.

SUMMARY OF PLAN SELECTION PROCESS AND IDENTIFICATION OF EVALUATED ALTERNATIVES

The proposed action for the study objectives consists of three features that influence navigation: 1) River Flow Management, 2) Navigation Channel Deepening, and 3) Navigation Channel Maintenance. Within each feature, numerous project components were examined as part of the study. Project Alternatives (combinations of components from the three features) were then developed to address the attainment of the study purpose. We briefly describe the components of each feature and the alternatives that were analyzed here. The Corps draft Environmental Impact Statement (USACOE, 2005a) and Feasibility Report (USACOE, 2005b) provides a more detailed description of the components and alternatives evaluated, and the selected plan.

The project can initially be divided into two major elements, the No Project element and the Action element. The "No Project" element would only occur if none of the components within each feature were selected. We do not anticipate this element would be selected due to the lack of existing dredged material containment/disposal areas for anticipated ongoing maintenance activities with the existing nine-foot channel (see discussion under Navigation Channel Maintenance feature).

RIVER FLOW MANAGEMENT FEATURE

The study team initially examined nine structural components and three non-structural components. The structural components were:

- Construction of an extensive levee system in the Oklahoma portion of the study area;
- Evacuation of water from the upper MKARNS;
- Construction of one or more new reservoirs;
- Pre-release of water from the Oklahoma reservoirs based upon short-term weather forecasts;
- Removal of channel restrictions such as training dikes;
- Modification of existing in-stream navigation structures;
- Removal of locks and dams throughout the MKARNS;
- Construction of high flow relief structures; and

- Restoration/enhancement of aquatic and riparian habitats along the MKARNS;

The non-structural project components considered included:

- Modification of flow rates and durations, primarily associated with the operation of the 11 Oklahoma reservoirs;
- Reallocation of reservoir storage from one project purpose to another; and
- Adjustments/increases in flowage easements.

The study team determined that only the non-structural components met the project objectives established for the study and that structural components would be too expensive relative to the associated benefits. A total of twenty-three specific non-structural components were evaluated and compared using the Corps Southwest Division SUPER Model. Detailed information associated with the SUPER Model screening runs can be found in Appendix A, Hydrology and Hydraulics Report, of the draft Feasibility Report (USACOE, 2005b). Four operational components, including a No Action component, were selected from this evaluation and examined in detail.

The "No Action" Component consists of maintaining the current operating plan that includes five release zones: 1) 150,000 cfs, 2) 150,000 to 105,000 cfs, 3) 75,000 cfs, 4) 75,000 to 40,000 cfs, and 5) 40,000 to 20,000 cfs. The No Action Alternative includes a 75,000 cfs bench (*i.e.*, period of time where the flow is held at or below 75,000 cfs.) The bench is adjusted seasonally to minimize flood impacts and maximize benefits to farmland. No changes to the existing rivers or reservoirs would be made.

The detailed analysis of the three action components involved a major hydraulics study, modeling runs of the river system, and an economics study for each proposed alternative (USACOE, 2005a and b). Each action component would change the number of days that river flows would exceed certain flow conditions at Van Buren, Arkansas (Table 16). The components are briefly described below.

Table 16. The difference in the number of days that river flows would exceed certain flow conditions at Van Buren, Arkansas, under the Action Components.

River Flow at Van Buren	Component 2: 175,000 cfs Plan	Component 3: 200,000 cfs plan	Component 4: Operations Only Plan
Difference in days above 60,000 cfs	-9	-9	-14
Difference in Dyas above 100,000 cfs	-16	-17	+2
Difference in days above 137,000 cfs	-4	-5	0
Difference in days above 175,000 cfs	+4.3	+7.1	0

Component 2 consists of increasing the target operating flows at Van Buren to 175,000 cfs with a 60,000 cfs bench (replacing the existing 75,000 cfs bench) lowered 3 percent (*i.e.*, from 18 to 15 percent system full) except from June 15– October 1.

Component 3 consists of operating Van Buren at 200,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3 percent except from June 15 – October 1.

Component 4 is the operations only plan. This component consists of maintaining the existing operating plan (*i.e.*, operating Van Buren at 150,000 cfs), but replacing the current 75,000 cfs bench with a 60,000 cfs bench beginning at 3 percent lower system storage except from June 15 – October 1.

Component 4 is the Corps recommended component for the River Flow Management feature, and was selected based on three primary differences from the existing plan (*i.e.*, the No Action component): 1) a reduction of 14 days below 61,000 cfs (a key level for farming interests in Arkansas and navigation interests), 2) an increase in days between 40,000 cfs and 60,000 cfs (key to scouring flows in the navigation system), and 3) accelerated evacuation of the storage projects when the system exceeds 75 percent full. This component was carried forward for inclusion in the development of project alternatives.

NAVIGATION CHANNEL DEEPENING FEATURE

The screening process included the evaluation of four major components:

- Navigation Channel Deepening via Dredging;
- Navigation Channel Deepening via Pool Raising;
- Navigation Channel Deepening via a combination of Dredging and Pool Raising; and
- Verdigris River Navigation Channel Widening.

Only the Navigation Channel Deepening via dredging component was determined to generate enough benefits, in light of the environmental and economic costs, to merit further evaluation. Four navigation channel dredging components, including a No Action component, were selected for detailed analysis.

Under the No Action component, no segments of the existing nine-foot navigation channel would be deepened. Dredging and new river training structures would not be required.

The three action components consist of deepening the existing navigation channel from 9 feet to 10, 11, or 12-feet, respectively. The MKARNS was divided into six river segments extending from the mouth near the Mississippi River to the Port of Catoosa in Oklahoma to assess the options of deepening the entire system or only specific segments. Each of the four components was considered for each river segment.

Additional dredging and river training structures (dikes and revetments) would be employed to achieve navigation depths between 10 and 12 feet. New dredged material disposal sites would be required to accommodate dredged material for each of the three action components.

Incremental deepening of only certain segments of the navigation system, such as only the lower segments, was determined not to be financially justified. Deepening the navigation channel to a depth of 10-feet also was not financially justified. The Corps' analysis indicated that the 11 and 12-foot components would achieve a positive cost:benefit ratio. These two channel deepening components were moved forward for development of project alternatives.

NAVIGATION CHANNEL MAINTENANCE FEATURE

The screening process included the evaluation of the four following components:

- Cessation of Maintenance Dredging;
- Maintenance Dredged Material Disposal via Transportation to Selected Approved Sites (*i.e.*, areas with high quality habitat would be avoided) in the Original Operation and Maintenance Plan;
- Maintenance Dredged Material Disposal at Approved Sites in the Original Operation and Maintenance Plan; and
- Maintenance Dredged Material Disposal at New Disposal Sites.

Cessation of maintenance dredging was not considered viable due to the inability to maintain a nine-foot navigation channel without maintenance dredging. Dredged material disposal via transportation to selected approved sites would involve movement of dredged material by barge or truck from places on the navigation system where disposal capacity has been reached to areas of low habitat quality where capacity remains. This component was not considered viable due to the lack of perceived benefits in light of the predicted economic costs.

The Maintenance Dredging and Disposal in Approved Areas component would involve movement of dredged material by barge or truck from places on the navigation system where disposal capacity has been reached to areas where capacity remains, regardless of the quality of habitat at the site. This component also would involve new river training structures, and was evaluated in more detail.

The Maintenance Dredging and Disposal at New Disposal Sites component would consist of disposal of dredged material at new sites not included in the original Operation and Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. This component also includes new river training structures, and was evaluated in more detail.

The two action components examined in detail were determined to be very similar financially. However, the Maintenance Dredging and Disposal at New Disposal Sites was the least environmentally damaging component. Only this component of the Navigation Channel Maintenance feature was retained for the development of project alternatives.

DEVELOPMENT OF ALTERNATIVES

Five project alternatives that consist of a combination of components from the three features were developed for further consideration and analysis.

- Alternative A – No Action: The existing flow management plan, navigation channel depth, and maintenance activities would remain unchanged.

- Alternative B – Navigation Channel Maintenance Only: The existing flow management plan and navigation channel depth would remain unchanged. Disposal of dredged material would occur at new sites not included in the original Operation and Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable.

- Alternative C – Navigation Channel Maintenance and Operations Only Flow Management: The existing navigation channel depth would remain unchanged. Disposal of dredged material would occur at new sites not included in the original Operation and

Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. The existing flow management plan would be replaced with the Operations Only Flow Management Plan.

- Alternative D – Navigation Channel Maintenance, Operations Only Flow Management, and 11-Foot Navigation Channel: Disposal of dredged material would occur at new sites not included in the original Operation and Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. The existing flow management plan would be replaced with the Operations Only Flow Management Plan. The current 9-foot navigation channel would be deepened to an 11-foot navigation channel throughout the entire length of the MKARNS.

- Alternative E – Navigation Channel Maintenance, Operations Only Flow Management, and 12-Foot Navigation Channel: Disposal of dredged material would occur at new sites not included in the original Operation and Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. The existing flow management plan would be replaced with the Operations Only Flow Management Plan. The current 9-foot navigation channel would be deepened to a 12-foot navigation channel throughout the entire length of the MKARNS.

DESCRIPTION OF THE ALTERNATIVES EVALUATED AND A FEATURE DEVELOPED BY THE SERVICE

The plan recommended by the Corps is Alternative E. According to the analysis conducted by the Corps, this alternative maximizes national economic development (NED) benefits (has the greatest excess benefits over cost) according to the federal objective, and was therefore identified as the NED Plan.

The selected plan and a feature developed by the Service is briefly described here. The Corps draft Environmental Impact Statement (USACOE, 2005a) and Feasibility Report (USACOE, 2005b) provides a more detailed description of the selected plan.

A brief discussion of anticipated impacts for each project alternative is provided in the following section with emphasis on evaluation of Alternative E. Because Alternative E maximizes NED benefits consistent with the federal objective, the Corps has indicated Alternative E will be selected for implementation unless there are compelling reasons not to do so. Furthermore, Alternative E encompasses the features and components of all other alternatives (river flow management changes, channel deepening, and channel maintenance) and would have the most significant impacts on the environment. A discussion of impacts anticipated to occur as a result of Alternative E, therefore, also would cover impacts anticipated to occur under the other alternatives.

ALTERNATIVE E: – NAVIGATION CHANNEL MAINTENANCE, OPERATIONS ONLY FLOW MANAGEMENT, AND 12-FOOT NAVIGATION CHANNEL

The Navigation Channel Deepening component of Alternative E would consist of deepening the current 9-foot navigation channel to a 12-foot navigation channel throughout the length of the MKARNS. The River Flow Management component would entail operating under the current plan with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3 percent lower system storage, except from June 15 through October 1. The Navigation Channel Maintenance component would consist of maintaining the navigation channel through dredging and river training structures; dredging sediment from the navigation channel in volumes consistent with current annual rates; disposal of dredged material associated with navigation channel maintenance in existing and new disposal sites not included in the original Operation and Maintenance Plan, after existing disposal sites reach holding capacity (new disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided, where practicable); and the construction of river training structures and revetments. Alternative E would include the construction of 68 new dredged material disposal sites; 91 new and 142 modified river training structures; and 7 new and 13 modified revetments. A summation of the aspects of Alternative E that will cause impacts to fish and wildlife resources is provided in Tables 17 - 21.

The Corps conducted a hydrographic survey to locate areas along the channel that would require deepening. Pipe line dredges with cutter head equipment would be used to deepen the channel.

Construction of the terrestrial disposal sites would consist of excavating a pit and utilizing the excavated material to form a dike around the pit. The pits would include a discharge pit to return dredge water to the channel after settling. Submersible pumps would be used at pits where gravity or overland flow is not possible. The pits are designed to store twice as much as the initial channel dredging volume to allow for future operation and maintenance dredging. The design of terrestrial disposal sites can be found in the Dredge Disposal Site Sketches in Appendix C of the draft Feasibility Report (USACOE, 2005b).

Table 17. The difference in the number of days that river flows would exceed certain flow conditions at Van Buren, Arkansas, under Alternative E compared to existing conditions.

River Flow Management (change in days)		
At or above 60,000	At or above 100,000	At or above 137,000
-13.6	+1.7	0

Aquatic disposal areas would be created by installing a floating silt curtain around the disposal area to control the release of silt. Some open water disposal pits would be designed to provide

Table 18. Dredged material volumes by river segment and for Alternative E and the 11-foot channel depth for comparison.

	River Segment						
Navigation Channel Depth	Mouth to Pine Bluff (N. M. 0.0 –75.2)	Pine Bluff to Little Rock (N.M. 75.2-119.5)	Little Rock to Dardenelle (N.M.119.5-220.3)	Dardenelle to Ft. Smith (N.M.220.3-308.7)	Ft. Smith to Muskogee (N.M. 308.7-394.0)	Muskogee to Catoosa (N.M. 394.0-445.2)	**Total (cubic yards)**
No Action	0	0	0	0	0	0	0
11-foot depth	1,299,276	225,517	387,227	643,500	2,255,323	2,026,333	6,837,176
12-foot depth (Alternative E)	2,066,876	445,995	925,439	1,226,500	3,256,749	3,063,790	10,985,349

Table 19. Projected volume of dredged material and acres of both new and existing aquatic and terrestrial disposal sites for the Navigation Channel Deepening and Maintenance Features of Alternative E.

Dredge Volume (Cubic yards 000s)			**Dredge Area (Surface Acres)**			**Terrestrial Disposal Sites (Acres)**			**Aquatic Disposal Sites (Surface Acres)**		
Maint	**Deep**	**Total**	**Maint**	**Deep**	**Total**	**Maint Exist**	**Deep (New Only)**	**Total New**	**Maint Exist**	**Deep Exist**	**Total New**
						New		**Grand Total**	**New**	**New**	**Grand Total**
37,704	10,985	48,689	1,429	5,645	7,074	3,840	1,065	1,602	3,020	3,329	385
						537		5,442	148	237	6,734

Note: The Corps predicts that the same number and acres of aquatic and terrestrial disposal sites would be needed to deepen and maintain both an 11- and 12–foot navigation channel. The rate of fill, however, would differ due to the projected volume of dredged material required to obtain and maintain the two depths.

Table 20. New and modified river training dikes proposed to facilitate maintenance of the deeper navigation depth by river segment.

	River Segment					
	Mouth to Pine Bluff (N. M. 0.0 -75.2)	Pine Bluff to Little Rock (N.M. 75.2-119.5)	Little Rock to Dardenelle (N.M.119.5-220.3)	Dardenelle to Ft. Smith (N.M.220.3-308.7)	Ft. Smith to Muskogee (N.M. 308.7-394.0)	Muskogee to Catoosa (N.M. 394.0-445.2)
Existing Structures	278	201	392	236	195	12
New Structures Needed	4	30	5	6	44	0
Length of New Structures (ft.)	2,040	9,700	2,050	1,850	48,729	0
Number of raised or extended structures	36	4	31	24	0	0

Note: Structures required for the 11-foot channel component would be about 2/3 the length of those required for the 12-foot channel component.

Table 21. New and modified river training structures and revetments required for the Navigation Channel Deepening and Maintenance Features of Alternative E.

New River Training Structures			Modified River Training Structures			New Revetments			Modified Revetments		
Maint	Deep	Total	Maint	Deep	Total	Maint	Deep	Total	Maint	Deep	Total
2	89	91	50	92	142	2	5	7	4	9	13

Note: The same number of structures would be required for the 11-foot channel component. The structures would be about 2/3 the length of those required for the 12-foot channel component.

marsh habitat for fish and wildlife species. These open water disposal sites also would contain riprap breakwater dikes to protect the habitat created. The design of aquatic disposal sites can be found in the Dredge Disposal Site Sketches in Appendix C of the Corps draft Feasibility report (2005b).

ALTERNATIVE F: FISH AND WILDLIFE CONSERVATION INITIATIVE

The Service recommends that the Corps investigate the feasibility of adding a Fish and Wildlife Conservation feature to their existing alternatives. (We are not advocating the deepening of the navigation channel to a particular depth under this alternative.) We have provided a description of a conceptual Fish and Wildlife Conservation feature in the concept paper, " Arkansas River Navigation Project Mitigation Proposal and the Arkansas River Conservation Initiative." This concept paper is provided in Appendix C.

When implemented, calculation of the benefit-to-cost ratio should include the annual federal cost of implementing the initiative and the annual net benefits associated with the fish and wildlife and other outdoor-related recreational activities that are likely to increase in the project area (*e.g.,* hunting, fishing, photography, camping, hiking, etc.). We believe this alternative would serve to conserve important fish and wildlife resources for the benefit of the American people, while facilitating balanced development.

Table 22. Impacts Matrix.

	Features of Proposed Navigation Project				
Impact	**Terrestrial Disposal of Dredged Material**	**Aquatic Disposal of Dredged Material**	**Dredging**	**Training Structure Modification/ Addition**	**Flow Management**
Negative effects to protected and sensitive species	X	X	X	X	X
Reduction in invertebrate biomass and diversity	X	X	X	X	X
Reduction of fisheries biomass and diversity		X	X	X	X
Loss of upland hardwoods and grasslands	X				
Loss of bottomland hardwoods	X				
Loss of wetlands	X	X		X	X
Reduction of gravel habitat			X		
Reduction of backwater habitat		X		X	X
Alteration of river hydrology and morphology		X	X	X	X
Reduction in water quality		X	X	X	X
Increased sedimentation and accretion		X	X	X	X
Increased flooding of riparian habitat		X			X
Resuspension/Exposure of contaminants from sediment	X	X	X		
Loss of large woody debris, aquatic vegetation, and shallows habitats		X	X	X	
Benefits to non-native and invasive species			X	X	X

DESCRIPTION OF IMPACTS OF THE SELECTED PLAN

The selected alternative would result in significant impacts to important terrestrial and aquatic fish and wildlife resources. An impact matrix is provided in Table 22 to summarize the major impact types and demonstrate the relationship between the features of the selected plan and the anticipated impacts. We also provide a written description of anticipated impacts, by feature, below.

RIVER FLOW MANAGEMENT FEATURE

Based on an analysis of average annual pool levels and river flows, reservoir pool levels are expected to deviate only slightly from those observed under current operations.

Duration of storage between 0 and 10 feet above conservation pool changes slightly at all operational reservoirs with the exception of Copan, Kaw, and Hulah (Table 23). The greatest change, for example, is expected to occur at Tenkiller, Keystone, and Oologah reservoirs. At Lake Tenkiller, the reservoir pool elevation is expected to be two feet above the conservation pool elevation for four additional days per year as compared to existing conditions. At Keystone and Oologah, the conservation pool would be four feet above the current conservation pool elevation three additional days per year.

Table 23. Annual change in the number of days reservoirs are expected to be above conservation pool compared to existing conditions (No Action Alternative).

Alternative 4: Operations Only	0 feet	2 feet	4 feet	6 feet	8 feet	10 feet	12 feet
Copan	0	0	0	0	0	0	0
Eufaula	1	0	0	0	0	0	0
Gibson	0	0	1	1	1	-2	-2
Grand	1	1	0	0	-1	0	0
Hudson	0	1	0	0	0	0	0
Hulah	0	0	0	0	0	0	0
Kaw	0	0	0	0	0	0	0
Keystone	1	2	3	2	2	0	0
Oologah	2	1	3	2	0	0	0

Table 23 Continued

Alternative 4: Operations Only	0 feet	2 feet	4 feet	6 feet	8 feet	10 feet	12 feet
Tenkiller	2	4	2	1	1	0	0
Wister	1	1	0	0	0	0	0

Prolonged higher water levels during the growing season could adversely affect vegetation in portions of the conservation and flood control pools by drowning or weakening established plants not adapted for those hydrological conditions. Impacts would occur to both aquatic and terrestrial habitats. Although most bottomland hardwood trees are tolerant of flooding during the dormant season, intermittent inundation during the growing season may injure or kill trees (Black, 1980; Bell and Johnson, 1974; Hall and Smith, 1955). See Appendix D for data on reservoir pool elevations under existing conditions and with the recommended plan during the growing season, April – September.

Although average annual impacts at these reservoirs are expected to be minimal, it is important to note that the occurrence extreme conditions in even a single or a few consecutive years could significantly affect fish and wildlife resources. These effects are not likely to be evident from an analysis based on average annual reservoir levels and river flows. The effects would be dependent upon the time of the year in which inundation occurs, duration of inundation, and the elevation, soil characteristics, existing vegetation, and topography of the areas experiencing inundation. Impacts could include altering the littoral zone, altering or eliminating vegetated areas adjacent to the reservoirs, adversely impacting fish spawning and recruitment, and reducing available habitat for migrating birds, such as waterfowl.

Increased frequency and duration of flooding of agricultural lease lands on the WMAs also would decrease the value of the lease to farmers/lessees. The revenue gained from these lands, which is vital for continued operation and maintenance of the WMAs, would, in turn, decline. Farmers also likely would be less willing to plant wildlife food crops due to increased financial risks from flooding of crops.

Analysis of conditions that would occur in extreme high and low water years (rather than only on average annual lake levels and river flows) is more appropriate for considering potential effects to fish and wildlife resources. However, because water releases from each reservoir depend on numerous complex factors, such as weather conditions, water storage capacity, inflow rates, river flow rates downstream, power requirements, and navigation water requirements, accurately predicting the effects of the operating plan on fish and wildlife resources associated with the system reservoirs would be especially difficult. Predicting variables, such as weather patterns and power requirements, with complete accuracy, for example, is impossible. Long-term monitoring, consequently, would be necessary to accurately assess the impacts of changes in river flows and reservoir pool levels, as explained below in the section titled Discussion, Mitigation, and Recommendations.

The frequency of annual out-of-bank flows (*i.e.*, flows of 137,000 cfs or greater as measured at Van Buren) would not change from existing conditions. There would not be an increase in erosion potential or impacts to lower elevation wetlands and backwater areas over impacts currently occurring. River flow days above 175,000 cfs would, on average, increase only one day per year. Impacts to higher elevation wetland habitats also would not differ significantly from current conditions.

This alternative would, however, decrease the number of days per year for which flows would be greater than 61,000 cfs by 14 days. This would reduce the duration of flooding in the floodplain. Because the hydrology of wetlands in the floodplain would be altered, important wetland habitats may be adversely impacted.

River Flow Management: Summary Of Anticipated Impacts

Impacts anticipated from project implementation include:

- Increased inundation of portions of the flood control pools at the 11 controlling reservoirs in Oklahoma which may kill or injure vegetated areas adjacent to the reservoirs, alter the littoral zone, adversely impact fish spawning and recruitment, and reduce available habitat for migrating birds such as waterfowl;

- Increased frequency of flooding of agricultural lease lands which would decrease the value of the leases and their long-term revenue;

- Changes in the depth, temperature, turbidity, and velocity of the river downstream of each reservoir;

- Conversion of wetlands along the navigation system to agricultural production as a result of increased flood protection; and

- Increased potential for the accidental release of pollutants as a result of increased barge traffic.

NAVIGATION CHANNEL DEEPENING FEATURE

Under the proposed action, the entire 445 mile navigation channel would be maintained for a navigation depth of 12 feet. This would require dredging and/or construction or modification of channel training structures to deepen areas currently shallower than 12 feet. To achieve the desired navigation depth, many existing shoals would require in excess of 3 feet of substrate removal. Disposal of dredged material in Oklahoma would occur in both open water and terrestrial out of bank containment areas. In Arkansas, most of the disposal will occur in open water areas behind dike fields and revetments.

Early in the evaluation process, a multidisciplinary Multi-agency Ecosystem Evaluation Team was established to evaluate impacts of the proposed Navigation Channel Deepening feature on terrestrial habitats and ecological benefits resulting from proposed mitigation measures. The multidisciplinary team included various interests and technical expertise from the Little Rock and Tulsa Corps Districts, the Service, ERDC-EL, and Parsons, a private consulting firm. The team evaluated the environmental impacts of proposed dredging and disposal of dredged material using HEP analysis.

Terrestrial Resources

Dredging to achieve the 12-foot navigation depth would require numerous disposal areas along the navigation system in Arkansas and Oklahoma. The Service and ODWC worked closely with the Corps during the selection of new dredged material disposal sites to minimize and avoid impacts to high quality habitat such as bottomland hardwoods, native grasslands, and wetlands. The majority of the areas being impacted by dredged material disposal would be previously degraded habitats, such as agricultural lands and old field, thus minimizing direct impacts to higher quality terrestrial habitats. Wetlands and high quality bottomland hardwoods were avoided where possible.

Dredged material disposal would occur at 43 new terrestrial sites located within the floodplain of the Verdigris and Arkansas rivers. The existing terrestrial habitat would be lost due to the conversion of the site to a dredge spoil containment area (a pit surrounded by an earthen dike). Vegetation eventually would become established within the disposal pits. Willows, river birch, cottonwood, and a few species of sedges and grasses are likely to be early colonizers of the disposal pits (Allen and Hardy, 1980). However, the new community will generally be less diverse and have lower value to the terrestrial wildlife due to loss of terrestrial habitat, low plant species diversity and slow colonization by native plants (McMahon and Eckbald, 1975; Ziegler and Sohmer, 1977) and frequent disturbance over the project life due to disposal of dredged material.

The disposal of dredged material in terrestrial sites is expected to result in the conversion of about 1,602 acres along the MKARNS. The terrestrial dredge disposal sites in Arkansas would occur in cropland along the Arkansas Post Canal, which should reduce impacts to fish and wildlife habitat. Over the 50-year life of the project, the disposal of dredged material at terrestrial sites would result in the loss of about 15 acres of bottomland hardwood forest, 121 acres of upland forest, 300 acres of open field habitat, 315 acres of old field habitat, 790 acres of agricultural land, and 61 acres of barren/sand habitat.

Wetlands

National Wetland Inventory (NWI) maps were used to identify and help avoid wetland areas when choosing dredged material disposal sites. No impacts to wetlands are expected to occur. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be deposited in new disposal sites designated in the 2003 20-year Dredge Material Management Plan. Areas with high quality habitat, such as forest, wetlands, and high quality grassland, would be avoided for dredged material disposal wherever practical. This alternative would maintain the existing conditions, including the hydrology and species composition of wetlands.

The Service and our state partners were concerned during early planning stages of the study that channel incision could further eliminate floodplain hydrology causing loss of wetlands and seepage of water from adjacent oxbows. However, ERDC-EL evaluated sediment transport and flow models to assess the potential for channel incision and found no indication that this would result from channel deepening associated with this project (USACOE, 2005a).

Aquatic Resources

The navigation channel deepening feature would adversely affect important aquatic habitats and species. Backwaters, such as oxbows and dike fields, would be impacted as a result of dredged material disposal, construction and modification of river training structures, and sediment deposition. Gravel shoals would be removed by dredging. Freshwater mussels and fish would be impacted by dredging and disposal of dredged material.

Backwaters are essential to numerous species that are both ecologically and economically important to the system. Degradation and loss of backwater habitats would adversely impact numerous wildlife species. Some waterfowl (*e.g.*, mallard, wood duck) utilize backwater areas for roosting and feeding. Backwater areas also provide important feeding, breeding, and nursery habitat for reptiles (*e.g.*, river cooter, common snapping turtle), amphibians (*e.g.*, leopard, chorus, cricket, and tree frogs), and invertebrates (*e.g.*, freshwater unionids).

Degradation and loss of backwater habitats also would adversely impact numerous species of fish. Species such as largemouth bass, crappie, catfish, and gar depend on backwater areas for foraging habitat and as nurseries (Buchanan, 1976). Loss of this habitat due to dredge spoil disposal, sedimentation, and revetments could substantially affect densities of these species and fish community structure. Largemouth bass are important predators within fish communities and are highly valued recreationally. Reductions in densities of largemouth bass would alter fish community structure and negatively affect the local economies related to recreational tourism.

In addition, many fish species once common to large river systems have experienced sharp population declines following impoundment and channelization (Gilbert 1992; Herkert 1992; Etnier and Starnes 1993; Pflieger 1997). For example, the alligator gar is now very rare in the Arkansas River (Buchanan, 1974 and 1976; Robinson and Buchanan, 1988). Many of these adversely impacted species relied on large backwater floodplains, floods, and uninhibited rivers.

Further loss of backwater habitat could adversely impact the alligator gar and other species dependent on backwater habitats.

Gravel substrates support a diverse array of fishes, many of which are obligate riverine species and sensitive to habitat degradation (Buchanan, 1976). Gravel bars provide important habitat for sturgeon, suckers, benthic minnows, madtoms, darters, and other species. For example, paddlefish, a species of concern in Oklahoma and Arkansas, migrate upstream to spawn over gravel bars in spring (Purkett, 1961; Wallus, 1986).

Loss of these habitats in similar navigation projects has demonstrated their importance to fish species and communities. Species such as paddlefish, shovelnose sturgeon, and numerous darters may be impacted by the loss of gravel substrates associated with dredging. Paddlefish are an ecologically important plankton foraging species and their roe has a high commercial value (Graham, 1997). This species is of particular concern due to the cumulative affects of dams inhibiting fish passage, loss of habitat from channelization, and commercial harvesting. Further loss of habitat could have dire consequences to this species within the Arkansas River system.

Additional sediment accretion and loss of surface waters will result from construction and modification of channel training structures, increased filling rates, and increased dredged material disposal. This will increase the rate of habitat loss and add to the cumulative loss of fisheries backwater habitat, side channels, and islands due to land bridging that has occurred since the initial project completion.

The effects of the deepening feature on the hydrologic and geomorphic characteristics of the Arkansas River ecosystem have not been fully assessed. ERDC-EL conducted a geomorphic assessment to evaluate potential project impacts (USACOE, 2005a). However, as indicate in the Corps report, the results should be considered preliminary due to data limitations of the model. The long-term impacts could be substantial, and would require further study to more accurately ascertain the impacts. For example, over the project life, unanticipated deepening and scouring of the channel during high flow periods could eliminate remaining gravel shoals, an essential habitat component for numerous aquatic species, as discussed above.

Increases in dredging and barge traffic could have additional deleterious effects, including entrainment of aquatic species in the dredge cutter head (Reine and Clark., 1998), increased fish passage through dams, and increased zebra mussel and other invasive species immigration. Fish and mussel entrainment currently occurs with existing maintenance dredging; however, this project would require substantially more initial dredging in addition to long-term maintenance dredging, that will in turn increase the amount of entrainment. While increasing the passage of fish through dams is usually encouraged, in some circumstances increasing passage of non-native or invasive species can have serious consequences. Paddlefish, freshwater eels, alligator gar, sturgeon, and numerous other species likely would benefit from increased passage through locks. However, increased lockage also would allow further introduction and/or immigration of non-native and invasive species, such as zebra mussels, big head carp, and yellow bass. The additional lockage would increase the likelihood of non-native introductions upstream of locks and dams and enhance the ability for species like zebra mussels to maintain high densities.

Waves created by the wakes of more numerous and deeper draft barges could increase the volume and rate of bank failure and subsequent erosion along the river. Currently, waves caused by barges, recreational boats, and wind blowing across wide pools contribute to bank failures and erosion. Increasing the volume and frequency of waves due to barge traffic could exacerbate the extent and rate of bank failure and erosion, further contributing to cumulative losses of riparian and aquatic habitat within the system.

Aquatic Disposal Sites

The multidisciplinary team collectively evaluated the environmental impacts of the proposed dredging and disposal on the MKARNS through HEP analysis. The HEP analysis was used to determine impacts on aquatic habitats and ecological benefits resulting from the proposed mitigation. According to GIS data compiled by the Corps, dredged material would be deposited on approximately 3,020 acres of existing aquatic maintenance dredged disposal sites in Arkansas during continued operation of the navigation system. Under the channel deepening feature of Alternative E, aquatic disposal would occur on an additional 148 acres of aquatic habitat for maintenance dredging, 3,329 acres of shallow water dike field habitat in Arkansas and 237 acres of aquatic habitat in Oklahoma for a total of 6,734 acres. Approximately 5,645 acres and 10,985,340 cy of navigation channel substrate would be dredged for deepening along the MKARNS. In addition, approximately 1,429 acres and 37,704,000 cy of substrate would be dredged for maintenance along the MKARNS for this alternative for a total of 6,238 acres and 44,541,000 cy. Additionally, construction of 92 new and modification of 89 existing river training structures, and the additional 5 new and modification of 9 existing revetments is proposed for this project (USACOE, 2005a).

Because the main channel of the MKARNS currently has numerous training structures and has been previously degraded through establishing and maintaining the navigation channel, prime aquatic substrate habitat loss due to maintaining and deepening the channel to 12 feet, and from adding and modifying river training structures, would be quantitatively less than if the river were in a natural state. However, the cumulative loss of habitat from this system only increases the qualitative value of the remaining habitat.

Gravel Bars

Estimates of the total available acres of gravel substrate along the project length were 6,984 acres. Gravel surveys found 165 acres of gravel and 620 acres of sand/gravel mix substrate in proposed dredging areas that would be impacted by the project (Table 24).

Freshwater Mussels

A freshwater mussel survey was conducted by Ecological Specialists, Inc., (ESI) during September, October and December 2004. The new surveys by ESI found no federally-listed or proposed threatened or endangered species within the MKARNS, but did find productive, diverse (29 species total) mussel communities within most reaches of the system.

Table 24. Location and area of gravel and sand/gravel mix substrates in the Arkansas River Navigation Project. All locations coincide with proposed dredging sites for the 11 and 12-ft channel.

Pool	River Mile	Gravel (acres)	Total per pool	Mix sand/gravel (acres)	Total per pool
	108	1.6		7.47	
Pool 5			1.6		7.47
	140	0.11		4.94	
	146	3.42		36.45	
Pool 7	150	17.44		36.88	
	150.5	20.43		1.4	
			41.4		79.67
	186	23.36		144.25	
Pool 9	205	27.8		6.77	
			51.16		151.02
Pool 10	229	0.61		54.15	
			0.61		54.15
Pool 15	361	36.7		154.15	
					154.15
	374	1.23		55.81	
Pool 16	393	0.83		41.06	
	395	3.54		32.93	
			5.6		129.8
Pool 17	402	7.24		32.14	
	421	20.69		11.82	
			27.93		43.96
Total		**165**		**620.22**	

The proposed project would impact mussels and mussel habitats, most directly by dredging and disposal of dredged materials in conjunction with constructing a minimum 12-foot channel depth. The potential exists not only for direct removal and burial of mussels, but also for effects on nearby mussels from dispersion of temporarily suspended sediments and destabilization of substrates adjacent to the excavated channel. In addition, the expected operation of larger barges in the MKARNS would increase re-suspension of sediments and other turbulence-related effects in the system (Sparks *et al.,* 1980).

The largest impact to freshwater mussels would occur as a result of dredging impacts to beds found in the Arkansas Post Canal. Recent survey efforts indicate about 2 million mussels may occur in the canal (Ecological Specialists, 2005). The estimate is based on qualitative sampling (41 five minute samples) and there may be considerable variability in the number of mussels present (Ecological Specialists, 2005). Additional mussel concentrations would be impacted by the project. Ecological Specialists (2005) provided specific information on other mussel concentrations that would be affected by proposed dredging and disposal activity. This report can be found in the draft Environmental Impact Statement for the Arkansas River Navigation Study (USACOE, 2005a).

Water Quality and Sediment Analysis

Deepening the channel, constructing or modifying training structures, and increasing the channel volume could concentrate flows and increase the instability of channel substrates. This could result in increased turbidity, oxygen reduction, channel incision, bank failure, headcutting, and backwater sediment deposition. Increased turbidity would affect reproduction of some fish and mussel species, reduce primary productivity, impact foraging, and alter water quality. The construction and modification of new river training structures would have a short-term minor adverse impact on surface water as sediment suspension may increase during construction.

Channel incision, bank failure, and head cutting would contribute to additional habitat loss, suspension of sediments, and sediment accretion in dike fields. Channel incision further eliminates floodplain hydrology causing loss of wetlands and seepage of water from adjacent oxbows. Hydrologic and morphologic modeling of flows and substrates suggest that velocities and water elevations should not cause long-term channel instability that would result in incision or tributary headcutting (USACOE, 2005a). However, these results should be considered preliminary due to the data limitations of the model and lack of prototype information (DEIS Appendix C.8 Geomorphic Assessment). Long-term monitoring should be performed to validate the predictive capability of these models.

Dredging conducted to achieve a 12-foot channel would require the removal of approximately 10,985,340 cy above the volume of material removed by maintenance dredging, which could negatively affect water quality within the MKARNS if any contaminants occur within riverbed sediments. Release and resuspension of contaminants into the water that have been accumulating in sediments for many years could have toxic effects to both aquatic and terrestrial species along the Arkansas River. Additionally, contaminants could be introduced into backwater or adjacent terrestrial habitats through dredge disposal sites.

The Corps conducted a limited sediment analysis along the MKARNS during September 2004 and February 2005. The results of the sediment sampling can be found in Appendix E of the DEIS (USACOE, 2005a). Results of the sediment sampling suggest that the composition and extent of contaminants currently trapped in sediments from Arkansas and Oklahoma are insufficient to cause concern. An Inland Testing Manual Tier I evaluation would be performed along watercourses before dredging is conducted. The Service's comment and recommendation letter regarding the Oklahoma portion of the sediment analysis is provided in Appendix E of this report.

The ODWC has specific concerns regarding dredging activities and sediment analysis within the vicinity of the Sequoyah Fuels Corporation Industrial site located in Gore, Oklahoma. Their comments and recommendations can be found in their concurrence letter in Appendix A.

Increased dredging and barge traffic likely would lead to increased turbidity and sediment deposition (Sparks *et al.*, 1980). These impacts would further contribute to the poor water quality that currently is observed during late summer and fall in the lower ends of pools and in tailwater releases. Low dissolved oxygen concentrations and high nutrient levels often exceed current state water quality standards. Increasing the volume and rate of deposition, sedimentation, and nutrient transport will contribute to further water quality degradation and impacts to aquatic communities.

NAVIGATION CHANNEL DEEPENING: SUMMARY OF ANTICIPATED IMPACTS

Accurately identifying the nature and magnitude of anticipated impacts is difficult to impossible given the limited amount of data available. Further study prior to project implementation and initiation of long-term monitoring studies would be required to more precisely describe the various impacts that would occur due to deepening the navigation channel. Potential impacts anticipated as a result of this project are provided in Table 22 and summarized below.

- Numerous protected and sensitive species may be affected by this project; however, through long-term monitoring, adaptive management, mitigation, and conservation these species can be protected and preserved;

- Many freshwater mussels and beds throughout the system will be affected either directly by dredging and dredged material disposal or indirectly by increased turbidity and sedimentation;

- Numerous species of fish and associated fish community structure could be affected by additional loss of gravel and backwater habitats associated with dredging and dredges material disposal;

- Various types of terrestrial habitats would be impacted by dredged material disposal;

- Wetlands would be impacted by dredge spoil disposal, sediment deposition, and hydrologic alteration;

- Reduction of gravel and sand shoal habitats would impact important habitat for fish spawning, foraging, and reproduction;

- Loss of backwater and adjacent terrestrial habitat would occur with dredged material disposal;

- Changes in water depth, temperature, turbidity, and velocity of the river downstream of each reservoir would occur;

- An increase in the sediment deposition rate in backwaters, shallows, side channels, and dike fields;

- A reduction in the habitat value of backwater areas, such as oxbow lakes and sloughs, that provide important waterfowl and fish spawning habitat for a variety of species;

- Large woody debris, aquatic vegetation, and vegetated shallows may be further lost to sediment deposition in back waters and side channels; however, these habitats may be conserved or restored through project design and mitigation;

- Impacts to additional lands and habitats will continue and increase;
- Increased potential for the accidental release of pollutants as a result of increased barge traffic.
- Geomorphological changes, such as channel incision, bank failure, headcutting, and scouring are not likely to occur, but should be monitored;
- Increased habitat loss and erosion from bank failures caused by increased barge wake frequency and magnitude;
- Water quality degradation in lower pools and tailwaters from increased sedimentation, turbidity, and deposition, resulting in increased nutrient loading and dissolved oxygen depletion;
- Increased fish entrainment during dredging; and
- Increased non-native and invasive species passage through locks and dams.

Navigation Channel Maintenance Feature

Although smaller volumes of material would be removed more frequently, impacts anticipated from recurring maintenance of the navigation channel depth would generally be the same as those anticipated from the proposed navigation channel deepening feature described in the preceding section. Adverse impacts would occur due to the loss of both terrestrial and aquatic habitats as a result of dredging activities, construction of river training structures, and disposal of dredged material.

DISCUSSION, MITIGATION, AND RECOMMENDATIONS

The Service's overall mitigation goal is to protect and/or enhance important fish and wildlife resources while facilitating balanced development. The Service's Mitigation Policy (*Federal Register* 46(15):7644-7663) provides guidance for formulating measures to avoid, reduce and offset environmental impacts. These guidelines follow the sequenced approach to mitigation presented in the Council on Environmental Quality's National Environmental Policy Act (NEPA) regulations (40 CFR 1508.20). The mitigation definition found in the NEPA regulations consists of five sequential steps: 1) avoiding the impact altogether by not taking a certain action or parts of an action; 2) minimizing impacts by limiting the degree or magnitude of the action; 3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; 4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and 5) compensating for the unavoidable impacts by replacing or providing substitute resources or environments. The primary focus of the Service's Mitigation Policy is mitigation of losses in habitat value, with the degree of mitigation corresponding to the value and scarcity of impacted habitats.

CATEGORIZATION OF FISH AND WILDLIFE HABITATS

Fish and wildlife resources have been categorized in accordance with the Service's Mitigation Policy. Category 2 resources, as defined in the policy, include high quality habitats that are scarce or becoming scarce in the ecoregion or nationwide. Habitats considered category 2 resources within the project area are high quality native prairies, caves, streams (mountain), submerged gravel bars, oxbow lakes and river cuttoffs, bottomland hardwood forests, riparian forests, and other high quality palustrine and lacustrine wetlands, such as river swamp forests. The mitigation goal for this category is no net loss of in-kind habitat value. Section 906(d) of WRDA 1986 also requires that mitigation for impacts to bottomland hardwood forests be in-kind, to the extent possible.

Areas of somewhat lesser quality riparian forests, upland forests, prairies, the Arkansas River proper and its associated tributaries and delta streams, man-made wetlands and reservoirs are assigned to category 3. Category 3 resources include habitat of high to medium value that is abundant on a national basis. The preferred mitigation goal for category 3 habitat is no net loss of habitat value while minimizing loss of in-kind habitat value. Mitigation in-kind for category 3 resources is preferred, but out-of-kind mitigation with no net loss of habitat value is acceptable. The Service's Mitigation Policy is used as a basis for both our impact analyses and in development of conservation recommendations and measures.

FISH AND WILDLIFE MITIGATION MEASURES

River Flow Management Feature

Based on average annual lake levels and river flows, reservoir level fluctuations are expected to change only slightly from current operations. The biological change resulting from implementation of the selected alternative at the controlling reservoirs, as indicated by average water level conditions, would not constitute a significant adverse impact for which mitigation would be required.

The Service believes, however, that in order to fully address potential impacts to fish and wildlife resources at the 11 Oklahoma reservoirs, extreme conditions that could occur during high and low water years also must be considered. As discussed previously, the conditions that occur during extreme high and low years could significantly affect fish and wildlife resources. These effects are not likely to be evident from an analysis based on average annual reservoir levels and stream flows. The effects of changes to the resulting reservoir pool levels would be dependent upon the time of the year in which they occur, duration of inundation, and the elevation, soil characteristics, existing vegetation, and topography of the areas experiencing inundation. Impacts could include altering the littoral zone, killing or injuring vegetated areas adjacent to the reservoirs, adversely impacting fish spawning and recruitment, and reducing available habitat for migratory birds.

Water releases from each reservoir depend on numerous, complex factors such as weather conditions, water storage capacity, inflow rates, river flow rates downstream, hydropower generation requirements, and navigation water demands. Accurately predicting the effects of the proposed operating plan on the fish and wildlife resources downstream of the reservoirs on the system would be especially difficult. For example, weather patterns which ultimately influence fluctuations in river flow and reservoir pool elevations cannot be predicted with complete accuracy. However, operational changes superimposed upon hydrologic data from a period of record can provide meaningful insight into potential impacts to natural resources.

Uncertainty is an unavoidable component of managing and maintaining the natural resources associated with the system. Unexpected detrimental events are likely to occur. These events will alter fish and wildlife resource values associated with this large and dynamic system.

We believe that the mitigation goal for the fish and wildlife resources associated with the 11 primary flow modifying reservoirs in Oklahoma likely could be met through pro-active conservation actions and monitoring. Therefore, to avoid and minimize potential adverse effects as a result of the Corps recommended River Flow Management feature, and to provide appropriate compensation, the Service recommends that the Corps:

- Incorporate minimum instream flow releases for each reservoir into the selected plan (Orth and Maughan, 1981);
- Conduct angler surveys for a minimum period of five years after the plan has been implemented to assess economic impacts;
- Implement a monitoring program to assess realized impacts to the littoral zones and vegetated areas adjacent to the reservoirs, including the WMAs and agricultural leases managed by the ODWC, at each of the 11 controlling reservoirs in Oklahoma;
- Assess the impacts of the plan on dissolved oxygen concentrations and stream morphology in the rivers below the dams; and
- Develop and implement lake level management plans for the 11 Oklahoma reservoirs, where feasible, to enhance the fishery resources and the migratory bird habitat of these areas.

The lake level management plans should be designed to ensure that unnecessary negative impacts to aquatic fish and wildlife habitat due to seasonal fluctuations in conservation pools are avoided and/or minimized to the greatest extent practicable. We recommend determining, in cooperation with the Service and the ODWC, the most appropriate rule curve management for each reservoir to enhance fish and waterfowl populations. Shallow water habitat that provides spawning and nursery habitat for fish should be made available by making every reasonable effort at holding reservoir pool levels relatively stable during the fish spawning season. Slight seasonal draw downs in summer and early fall would provide areas to seed waterfowl food plants, such as millet or sorghum, on suitable exposed mudflats around the reservoirs and would facilitate the natural establishment of wetland vegetation. Flooding these areas during late fall then would provide foraging habitat for wintering waterfowl. The Service's Waterfowl Management Handbook (USFWS, Fish and Wildlife Leaflet 13) provides a single source of information regarding the management of waterfowl and their habitat. This handbook is available as a series of chapters and can be accessed at the following website: <http://www.nwrc. usgs.gov/wdb/pub/wmh/preface.html>.

Implementation of the selected plan would reduce the duration of flooding in the floodplain. Because the hydrology of floodplain wetlands would be altered, important wetland habitats may be adversely impacted. Unfortunately, sufficient information to determine the extent of those impacts is lacking. In order to adequately assess impacts to these wetlands and to compensate for any unavoidable losses, we recommend that the Corps:

- Identify the specific lands that would receive flood protection benefits;
- Determine the quantity (acres) and quality (habitat type and value) of wetlands that the selected operating plan would alter;
- Obtain conservation easements in floodplain areas that would be protected from flooding to deter floodplain development;
- Determine the quantity (acres) and quality (habitat type and value) of wetlands that should be acquired and/or managed to compensate for wetland losses; and
- Provide compensatory mitigation for any unavoidable wetland impacts.

Navigation Channel Deepening and Maintenance Features

Dredging and disposal of sediments would be necessary to achieve and maintain a 12-foot navigation channel. These actions would have substantial direct and indirect effects to both the aquatic and terrestrial sites in which they would occur. Impacts anticipated from deepening and maintaining the proposed navigation channel depth would occur as a result of losses to both aquatic habitat, due to dredging and construction of river training structures, and to terrestrial habitat due to disposal of dredged material. Because the impacts of maintaining the navigation channel depth generally would be similar in nature as those anticipated from the proposed navigation deepening feature, we discuss mitigation recommendations for these project features together.

Presently the interagency evaluation team has completed the impact assessment for the terrestrial disposal sites in Oklahoma. Unfortunately, the team does not have complete assessments for in-stream dredged material disposal sites in Oklahoma or Arkansas. There is great potential for this action to substantially and continually impact the habitat and species along and within the Arkansas River ecosystem. We anticipate substantial direct and indirect effects to both the aquatic and terrestrial sites in which they will occur.

Terrestrial Resources

The Service, Corps, and ODWC worked cooperatively during the planning process to avoid unnecessary impacts to high quality fish and wildlife habitat. Potential disposal sites were either relocated or reconfigured during project planning stages in order to avoid impacts to bottomland hardwoods, wetlands, and high quality floodplain forest.

For example, four of the 43 originally proposed dredged material disposal sites in Oklahoma were proposed to be located on lands licensed to the State for fish and wildlife management. Disposal of dredged material on these sites would have directly impacted about 109 acres of land in the Choteau and Webbers Falls units of the McClellan-Kerr WMA, which largely consist of bottomland habitat along the channel and scattered agricultural fields.

The HEP models and data provided by the interagency team were used by ERDC-EL to evaluate impacts from dredged material disposal and determine mitigation needs. Out of bank disposal of dredged material in Oklahoma is expected to result in the loss of 220 acres of old field grassland and 170 acres of open field grassland over the 50-year project life. Fifteen acres of bottomland hardwood forest and 287 acres of floodplain forest also are anticipated to be lost with the proposed project over the 50-year project life. Most of the forested acres expected to be lost is an artifact of the natural succession of many old field sites along the navigation system to early forest stages over the project life.

A plan for mitigating unavoidable terrestrial disposal impacts in Oklahoma was developed through interagency cooperation by biologists with the Corps, Service, and the ODWC. The proposed mitigation plan was developed in accordance with the Service's Mitigation Policy with the primary focus on concerns for potential habitat value losses. The plan was developed to ensure that losses, as measured in habitat value, rather than in acres, would be offset over the 50-year project life.

The compensatory mitigation plan currently endorsed by the Service and ODWC consists of bottomland hardwood restoration and marsh creation at two sites along the Verdigris River that currently are agricultural fields: OK 405.0 and OK 408.9 (Figure 3). The proposed mitigation plan would consist of a total of 248 acres of marsh creation and 130 acres of bottomland hardwood restoration. Recommended compensatory mitigation at the site near river mile 405.0 would consist of 157 acres of marsh creation and 61 acres of bottomland hardwood restoration. Recommended compensatory mitigation measures at the site near river mile 408.9 would consist of about 91 acres of marsh creation and about 69 acres of bottomland hardwood restoration. The restored bottomland hardwood forests and marsh wetlands would compensate for impacts associated with disposal of dredged material on terrestrial sites. Although the number of acres restored would be less than the acres impacted, the quality of habitat anticipated to be gained through this mitigation plan (HSI range 0.7 – 0.75) is much higher than that lost through disposal of dredged material (HSI range 0.28 – 0.50). This plan should completely offset losses of habitat

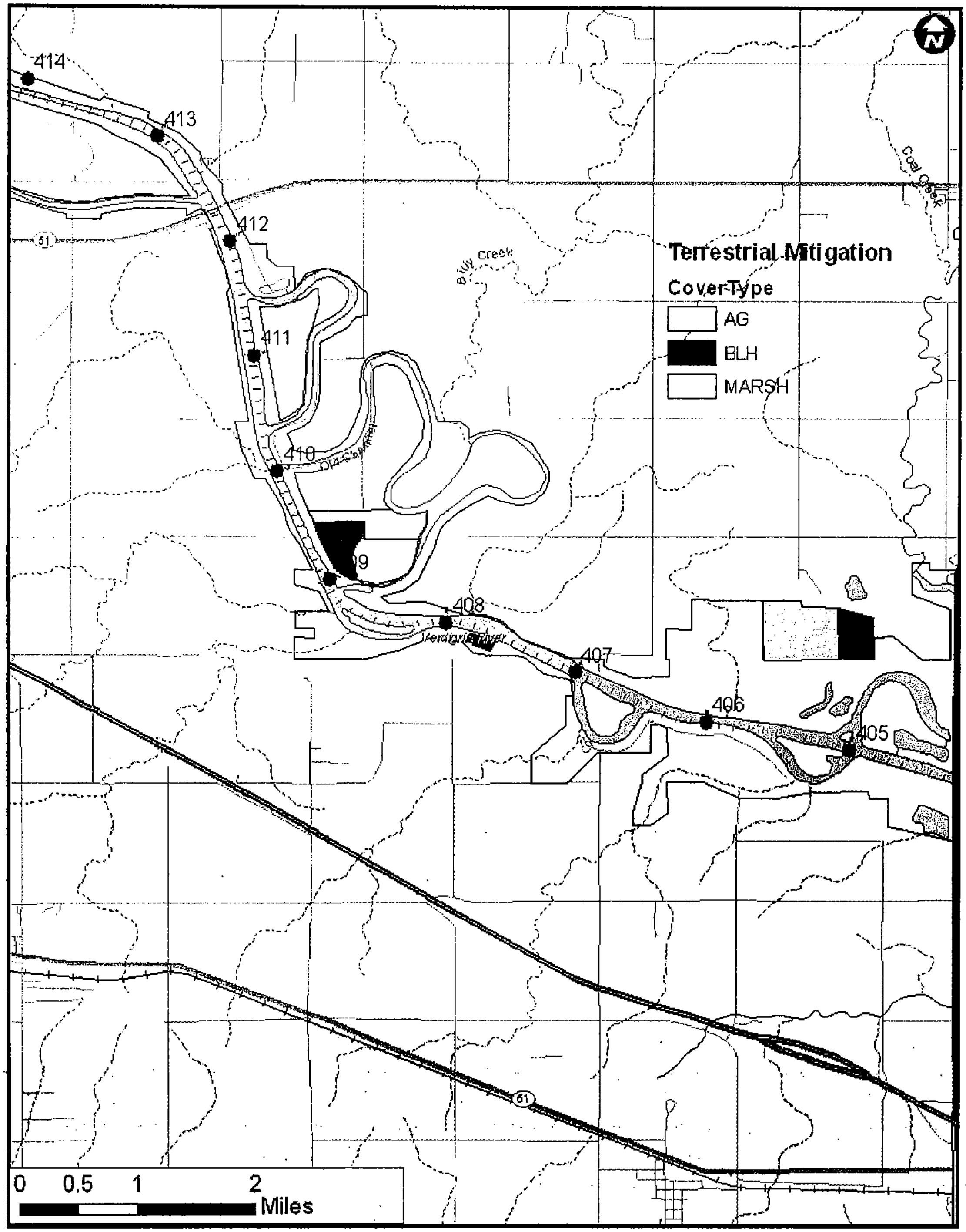

Figure 3. The terrestrial compensatory mitigation plan currently endorsed by the Service and ODWC consists of bottomland hardwood restoration and marsh creation at two sites along the Verdigris River that currently are agricultural fields.

value over the 50-year project life that would occur as a result of terrestrial disposal of dredged material in Oklahoma (Tables 25, 26, and 27).

Appendix F provides additional preliminary recommendations pertaining to tree plantings, monitoring, and remedial actions for bottomland hardwood restoration. We recommend developing detailed restoration, monitoring, and contingency plans through interagency coordination for both the bottomland hardwood and marsh wetlandrestoration sites. The resource agencies should be afforded the opportunity to review the final mitigation plan prior to implementation.

Dredged material disposal sites OK 379.1 L-DI and OK 389.7 L-DI occur on land allocated to the ODWC for fish and wildlife resource management. These lands are currently in agricultural leases. The ODWC utilizes revenue gained from agricultural leases to support management activities on WMA lands. Construction of dredged material disposal pits at these locations would result in the loss of 80 acres of WMA lands currently in agricultural leases and the important revenue gained from these leases. Because agricultural land used as food plots is assumed to have a constant HSI value of 0.24 throughout the project life, recommended compensatory mitigation for this impact is to replace this land at a 1:1 acre ratio with agricultural land adjacent to the recommended mitigation sites (Figure 2).

Table 25. Summary of terrestrial acres and AAHUs anticipated to be lost as a result of the selected plan.

	Bottomland Hardwoods	**Upland Forest**	**Forest Total**	**Old Field**	**Open Field**	**Grassland Total**
Sum of Acres Lost	-15	-287	-302	-220	-170	-390
Sum of AAHUs Lost	-7.3	-76.4	-83.7	-123.8	-71.0	-194.0
Average Annual HSI Value			0.28			0.50

Table 26. Summary of terrestrial habitat acres and AAHUs anticipated to be gained as a result of the recommended mitigation plan for unavoidable impacts to terrestrial resources.

Mitigation Site	Bottomland Hardwoods			Marsh		
	Acres gained	Net AAHUs Gained	HSI Value of Mitigation Sites	Acres Gained	Net AAHUs Gained	HSI Value of Mitigation Sites
408.9	69	48.3		91	66.6	
405.0	61	42.7		157	131.3	
Total	130	91.0	0.7	248	197.9	0.75

Table 27. Summary of the Net Loss and Gain of AAHUs anticipated as a result of the selected alternative and the recommended terrestrial mitigation plan.

Compensatory Mitigation for Forest Impacts Anticipated to be Realized through Bottomland Hardwood Restoration		Compensatory Mitigation for Grassland Impacts Anticipated to be Realized through Marsh Restoration		Compensatory Mitigation for Grassland Impacts Anticipated to be Realized through Bottomland Hardwood Restoration	
Bottomland and Upland Forest AAHUs loss	-83.7	**Grassland AAHUs Loss**	-194.0	**Carry over AAHUs from BLH gain**	+7.3
Bottomlnad Hardwood AAHUs Gain	+91.0	**Marsh AAHUs Gain**	+187.0	**Deficit AAHUs for Grassland Impacts after Marsh Benefits Applied**	-7.0
Net Gain or Loss	+7.3	**Net AAHUs Gain or Loss**	-7.0	**Surplus of AAHUs after Net Bonus BLH AAHUs Applied**	+0.3

Eight additional sites were selected by the interagency team for which appropriate mitigation measures likely could be developed to improve habitat value and offset losses, such as river cutoffs and oxbows along the Verdigris River (Table 28). The Service has repeatedly sought conservation for the oxbows because they represented some of the most valuable habitat remaining after the original construction of the navigation system. Additional potential mitigation features and sites also were identified in the Service's planning assistance letter dated June 15, 2004. More information pertaining to additional mitigation sites, including locations and potential AAHUs, also can be found in the HEP Appendix of the Corp's draft Environmental Impact Statement for ARNS. Alternative mitigation plans would be acceptable to the Service and ODWC provided that the plan was 1) developed through interagency coordination, and 2) demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

Table 28. Potential mitigation sites for unavoidable impacts to terrestrial resources as a result of disposal of dredged material in the floodplain.

Potential Mitigation Area by River Mile	River Bank	Bottomland Hardwood Restoration (acres)	Marsh Wetland Restoration/Creation (acres)
406.0	Left	162	38
408.9	Left	69	91
405.0	Left	61	157
410.4	Left	124	46
412.4	Right	570	224
415.2	Right	626	500
410.11	Left	106	38
419.5	Left	1,074	176
420.5	Left	140	44
422.8	Right	332	70
379.1	Left	40	0
379.1 Alternative	Left	0	40
389.7	Left	40	0
389.7 Alternative	Left	0	40

Maintaining the habitat value of compensatory mitigation lands likely would require on-going maintenance and management efforts. Without these efforts, the habitat value of the lands is likely to decrease and fail to meet mitigation projection goals. Losses in habitat value as a result of the project, therefore, would not be offset by appropriate mitigation without ongoing maintenance and management. In accordance with section 2 (d) of the FWCA, costs to carry out fish and wildlife conservation measures are to be considered project costs. Furthermore, section 906 (c) WRDA 1986 states that the costs of fish and wildlife mitigation are to be cost-shared at the same rate as the project purpose causing the impact. Navigation projects are fully federally-funded. The Corps should seek full congressional funding for Operation and Maintenance (O and M) needs. These funds should be provided to the managing entity on an annual basis. An O and M budget should be developed in cooperation with the managing entity prior to project implementation.

Aquatic Resources

Deepening the navigation channel would have significant adverse impacts on aquatic fish and wildlife resources. The primary impacts would include the loss of back water and side channel aquatic habitat due to dredging, dredged material disposal in aquatic sites and the construction and raising of river training structures; the removal and alteration of gravel bars through dredging; and direct adverse effects on freshwater mussel patches and beds *(i.e.,* mussel concentrations) due to dredging activity and the disposal of dredged material.

Additional impacts to important aquatic fish and wildlife resources are certain to occur as a result of the proposed plan, including impacts to water quality, re-suspension of contaminants in dredged areas, impacts to mussel concentrations near dredging and disposal areas, and incision and headcutting in tributary streams. However, an adequate assessment of these types of impacts cannot presently be conducted and will require long-term monitoring. Our recommendations for long-term monitoring can be found in the "Environmental Management Program" section below.

The impacts to aquatic fish and wildlife resources anticipated as a result of disposal of dredged material in dike fields and backwater areas, and the construction/modification of river training structures, are being evaluated using HEP. The Corps, Service, ODWC, and AGFC have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening would have on aquatic fish and wildlife resources. The ERDC-EL is using HEP to determine aquatic impacts and necessary mitigation features using data provided by the interagency team. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report.

The Service understands that the Corps intends to fully mitigate for aquatic resource impacts. The Service is willing to continue coordination with the Corps and our State partners to assist in the analysis and development of an appropriate aquatic resource mitigation plan that would ensure aquatic resource impacts would be offset. The following sections discuss the need for fish and wildlife mitigation measures, discuss the current status of the impacts analysis, and recommend measures that would avoid, minimize, and compensate for anticipated project impacts.

Aquatic Resources: Aquatic Disposal Sites and River Training Structures

Disposal of dredged material in backwater habitats will have significant adverse impacts to aquatic fish and wildlife resources. The rate and extent of loss of backwater areas will increase as a result of increased sedimentation from dredged material disposal and deposition associated with this project. Results from the aquatic habitat impacts analysis illustrate a positive relationship between fish abundance and the depth of dike pools. This implies that reducing water depth in a dike field through dredged material disposal and new training structure construction and modifications would have a major adverse impact to fishes. However, high quality habitat could be avoided, thereby minimizing the impact of this action.

There has been an ongoing effort to restore and maintain many backwater areas in Arkansas through dike notching to facilitate removal of accreted sediments. Additional dredged material disposal in these areas would contribute to the cumulative loss of habitat and the overall degradation of fish and wildlife resources within the MKARNS.

Careful planning prior to open water disposal, however, could provide opportunities to enhance and/or create important fish and wildlife habitat. Areas that already provide high quality habitat, such as backwater channels and oxbows, should not be considered for the disposal of dredged material. Dredged material also could be used to create, rebuild, or enhance island and/or marsh habitat in existing areas of low habitat quality.

Island creation or enhancement generally requires the disposal of suitable dredged material on existing islands or in shallow water areas. Although substrate preferences vary by target species, coarse material generally should be used in island creation or enhancement due to its greater stability. The elevation of created islands should be high enough to minimize flooding of nesting areas, but low enough to minimize excessive wind erosion. Generally, islands that provide the highest benefits for wildlife have similar characteristics. These islands tend to: 1) be separated from the mainland a sufficient distance or with a surrounding water depth of about 1.5 - 2 feet to provide relatively predator-free nest sites, 2) have a high ratio of water edge to land mass, and 3) be in close proximity to loafing sites and food sources.

Marsh habitat development would consist of utilizing the dredged material to change a deep water area into a shallow water wetland. Achieving the desired elevation requires detailed management of the quantity and configuration of dredged material disposed at the site.

The guidelines and criteria followed for a particular habitat development/creation project ultimately should be based on the target species for which the habitat is being created. For example, islands created specifically for interior least tern nesting habitat should be separated from the mainland to reduce access by predators. The portion of the island above the water surface should be capped with a sandy substrate. A vegetation management program designed to control vegetation would be necessary to ensure appropriate nesting requirements are met over the project life.

The Service's "Resource Publication 149: Mitigation and Enhancement Techniques for the Upper Mississippi River System and Other Large River Systems" (Schnick *et al.*, 1982) provides valuable information on the use of dredged material to develop high quality island and marsh habitat. This information includes guidelines, disposal techniques, required equipment and materials, and references to many other important scientific papers and reports concerning the use of dredged material to enhance or create habitat.

Additionally, the Sandtown Bottoms area along the Arkansas River and within the Sequoyah NWR has experienced heavy shoreline erosion due to wind-driven wave action, river current erosion, and boat/barge traffic. The Service recommends that the Corps investigate the feasibility of using dredged material and structures, such as geo-tubes, in order to: a) provide long-term erosion control, b) provide a substrate for riparian vegetation establishment, and c) increase the aesthetic value of the area. The use of such structures would restore wildlife habitat value to the area by facilitating the development of riparian vegetation and, thereby, contributing to the environmental quality of the refuge's natural resources. We believe that dredged material could be used as fill for the tubes. The use of dredged material as bank stabilization material would sufficiently minimize shoreline erosion due to ongoing and future operations of the MKARNS.

Numerous dike fields currently occur along the navigation system and many new dikes would be constructed or modified as part of the proposed project. These structures will be used to guide the river and maintain the navigation channel. Adding notches to rock dikes would increase the habitat quality and diversity of dike fields and allow the dikes to continue to provide their navigation function. The river would be allowed to move in and out between the notches, while sediment build up would likely result in small islands between dikes.

Traditionally, side channels and oxbows were closed with rock structures to divert flow into the main channel. Re-opening side channels and oxbows would serve to minimize and rectify project impacts by reestablishing fish access to important habitats used for foraging, breeding, and refuge.

Aquatic Resources: Status of the HEP Analysis and Recommended Mitigation for Disposal Sites and River Training Structures

The interagency evaluation team has developed a mitigation plan based on the following avoidance, minimization, and compensatory features:

- Relocate disposal areas to alternate sites that avoid valuable aquatic habitat;
- Notch dikes and revetments to reduce fill rates and create side channel habitat;
- Re-open connections to oxbows/backwaters and side channels;
- Create islands for aquatic diversity and tern habitat;
- Create marsh habitat at aquatic disposal sites to offset disposal impacts;

The following assumptions were made in developing the plan:

- Alternative disposal sites would be feasible provided they were within one mile of the proposed dredge area;
- Raising dikes and revetments would accelerate filling by 50 percent;
- Notching dikes and revetments would reduce the rate of fill by 50 percent;

- Notches would be one per structure, in the middle third of the structure, 20 feet wide, and to a depth of 3-feet below the normal pool elevation;

- Backwater areas could be reconnected after addressing landowner and section 404/401 Clean Water Act issues;

- Island and marsh habitat could be created where adequate volumes of dredged material allowed; and

- Due to the uncertainty of the success of mitigation features, the Corps and ERDC would develop a long-term monitoring plan and adaptive management strategies through interagency coordination.

Habitat Suitability Index values were determined for the aquatic mitigation sites based on best professional judgment of the biologists on the interagency team. Red Hen flight video footage, local expertise, and familiarity with the areas were used to assist in the selection of HSI values. Acreages for the sites were digitized by the Corps. The results of this interagency effort resulted in a detailed database containing quantitative and qualitative data on impact and mitigation sites.

Dike field impacts would result in an overall loss of 1021.6 AAHU along the entire length of the project. Benefits from approved and partially approved mitigation projects resulted in a gain of 636.8 AAHU. However, the mitigation and avoidance/minimization efforts of the project fail to fully compensate for anticipated project impacts to aquatic resources. The existing HEP analysis indicates a net deficit of 429.4 AAHU (Table 29).

The filling rate coefficient (*i.e.,* rate of fill anticipated to occur in dike fields; see evaluation methods section for more information) used for the current analysis was initially based on dredging maintenance records over the last eight years from Arkansas pools only. The interagency team concluded that filling rates should be derived from dredging maintenance records over the last 24 years for representative pools in Arkansas and Oklahoma to more accurately reflect future conditions. The filling rate coefficients are currently being modified.

Aquatic mitigation features considered to date would result in a net gain of habitat units in Oklahoma, but a deficit in Arkansas. The Little Rock District, Service staff from Arkansas, and the AGFC have recently developed additional and modified mitigation features for the Arkansas portion of the project. Future HEP analysis of impacts and mitigation features should incorporate the new filling rate and the additional mitigation features for the Arkansas portion of the project. Additional and modified compensatory mitigation recommendations for aquatic resource impacts for the Corps consideration during development of the complete mitigation plan is provided in Appendix G. Incorporating these mitigation features into the mitigation plan would serve to adequately offset aquatic resource impacts. The final mitigation plan for aquatic resource impacts would be acceptable to the Service, ODWC, and AGFC provided that it was demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

Table 29. Aquatic impacts and benefits by project alternative for the Arkansas and Oklahoma portions of the Arkansas River Navigation Project.

	Arkansas	Oklahoma	Total
WITHOUT PROJECT	**5797.8 AAHU**	**782.9 AAHU**	**6580.7 AAHU**
IMPACTS[1]			
11-ft Channel	**- 583.7 AAHU**	**- 35.4 AAHU**	**- 619.2 AAHU**
12-ft Channel	**- 963.1 AAHU**	**- 58.5 AAHU**	**- 1021.6 AAHU**
BENEFITS[2]			
Approved Mitigation			
11-ft Channel	**+ 459.1 AAHU**	**+ 199.0 AAHU**	**+ 658.2 AAHU**
12-ft Channel	**+ 439.4 AAHU**	**+ 197.3 AAHU**	**+ 636.8 AAHU**
Avoid/Minimize			
11-ft Channel	**+ 299.3 AAHU**	**+ 22.8 AAHU**	**+ 322.1 AAHU**
12-ft Channel	**- 43.3 AAHU**	**- 1.3 AAHU**	**- 44.6 AAHU**
NET GAIN/LOSS[3]			
11-ft Channel	**+ 174.7 AAHU**	**+ 186.3 AAHU**	**+ 361.1 AAHU**
12-ft Channel	**- 566.9 AAHU**	**+ 137.5 AAHU**	**- 429.4 AAHU**

[1] With Project AAHU – Without Project AAHU = Impacts AAHU

[2] Mitigation AAHU – Without Project AAHU = Benefits AAHU

[3] Benefit AAHU - Impact AAHU = Deficit/Gain AAHU

Aquatic Resources: Gravel

Gravel bar surveys in proposed dredging locations indicated that 165 acres of gravel substrate potentially could be impacted. Gravel is a finite resource and limited in distribution and abundance within the system. Any impacts from dredging would be a primary concern because of the inherent habitat value of gravel bars. Gravel substrate has been documented as important spawning habitat for numerous species of fish, such as paddlefish, darters, and shovelnose sturgeon. Results from the aquatic habitat impacts analysis illustrates a positive relationship between fish abundance and the amount of gravel and sand/gravel mixture available. It implies that reducing the amount of gravel substrate in the channel through dredging and construction or modification of training structures would have a major adverse impact to fishes.

Conservation of imperiled species and the overall loss of gravel substrates from anthropogenic disturbances fully justify creation or relocation of gravel bars as a mitigation feature. The mitigation goal should be no net loss of pure gravel bars. Appropriate mitigation should involve either relocating gravel that is dredged to a nearby, suitable area or establishing gravel bars by transporting dredged gravel to other more distant but suitable sites within the project area. Through project design modifications and mitigation, important gravel habitats can be conserved and possibly even restored to many locations along the river. Relocation efforts should be followed with long-term monitoring and adaptive management to ensure mitigation features can provide both conservation and restoration of these habitats within this system. Specific recommendations are provided in Appendix G to minimize and rectify impacts to gravel bars over the project life.

Aquatic Resources: Mussels

Dredging and disposal of sediments would directly affect freshwater mussels inhabiting this system. Indirectly, mussels are likely to be impacted by changes in water quality, sediment destabilization, host fish impacts, and increased invasive species introductions. A mussel survey of the MKARNS was conducted in 2004 by Ecological Specialists (Ecological Specialists, 2005). Service comments on the study and recommendations to avoid, minimize, and compensate for freshwater mussel impacts were provided in planning aid letters dated April 29 and May 11, 2005, respectively. These letters can be found in Appendix H.

Many of the anticipated aquatic resources impacts from navigation channel maintenance would be similar in nature to those anticipated from the proposed navigation deepening feature. Potential impacts would include reduction of gravel bar habitat, loss of terrestrial and backwater habitat due to dredged material disposal, changes in water quality, adverse impacts to fish spawning and recruitment, a change in the habitat value of backwater areas (*e.g.*, oxbow lakes and sloughs that provide important waterfowl and fish spawning habitat), morphological changes (*e.g.*, channel incision, bank failure, head cutting, and scouring), potential for contaminant re-suspension and relocation within the water column and adjacent habitats that could affect organisms, and continued water quality degradation in lower pools and tailwaters from increased sedimentation, turbidity, and deposition resulting in increased nutrient loading and dissolved oxygen depletion.

Sediment Analysis

The fish and wildlife agencies strongly recommend further analysis of dredged material for contaminants prior to disposal. Specific disposal measures to minimize the environmental impact of disturbance, transport, and disposal of contaminated sediments should be developed and utilized where necessary. The resource agencies should be afforded the opportunity to review and comment on these measures. This issue is not only relevant from the standpoint of impacts to fish and wildlife resources, but also is a public health concern.

The ODWC has specific concerns regarding dredging activities and sediment analysis within the vicinity of the Sequoyah Fuels Corporation Industrial site. Their comments and recommendations can be found in their concurrence letter in Appendix A.

In summary, a complete mitigation plan for terrestrial impacts at disposal sites in Oklahoma has been proposed. Aquatic mitigation features considered to date would result in a net gain of habitat units in Oklahoma, but a deficit in Arkansas. Additional and modified compensatory mitigation recommendations for aquatic resource impacts for the Corps consideration during development of the complete mitigation plan is provided in Appendix G. Incorporating these mitigation features into the mitigation plan would serve to adequately offset aquatic resource impacts.

Many of the effects of this project cannot be mitigated in-kind due to the nature of the project and its impacts. Compensation for impacts occurring from the filling of terrestrial and aquatic disposal areas can and should be achieved by restoring and maintaining habitats that are lost. Loss of main channel gravel shoals may not be adequately mitigated and restored in-kind because these habitats must be dredged and continuously maintained at a 12-foot navigation channel depth. Side channel or out-of-channel gravel substrate and shoals may not naturally be sustained or remain suitable as habitat for some aquatic species. Therefore, out-of-kind mitigation may be necessary to maintain these species within the system.

There are many indirect effects to habitats and species that cannot be quantified or qualified due to time constraints, data limitations, and our lack of knowledge regarding the functions of large river ecosystems and the effects of navigation projects. Initiation of long-term analysis and ecosystem monitoring is necessary to adequately assess potential impacts to fish and wildlife resources (see Environmental Management Program below). Only in time can the necessary data be collected and assessed to fully comprehend and establish correlations indicating the extent of project impacts to habitat, water quality, fish communities, productivity, and individual species.

Should further analysis indicate that adverse impacts to fish and wildlife resources along the river likely would occur, we believe that the mitigation goal for Category 3 resources likely could be met through enhancement and conservation actions throughout the river such as:

- creation and seeding of shallows and backwater areas to restore and enhance habitat lost for migrating waterfowl and fisheries;

- providing ODWC and AGFC funds for the construction and/or enhancement and management of islands, floodplains, green tree reservoirs, marshes, and/or other fisheries and waterfowl resources affected by the project in a coordinated and comprehensive conservation program;

- providing funds for monitoring studies by ODWC, AGFC, and/or ERDC in a coordinated and comprehensive monitoring program to assess impacts, identify correlations, and develop future adaptive management and mitigation options;

- providing funds for fish management, stocking, and habitat mitigation based on future impact assessments and recommendations for maintaining species viability;

- providing funds to ODWC and AGFC or assisting in the restoration and maintenance of in-stream habitat and improvement of habitat diversity by notching dikes, constructing hardpoints, and restoring connections with oxbows and side channels where possible; and

- creating, restoring, and maintaining vegetation free islands at suitable elevations for the least tern along the entire length of the MCKARNS to aid species recovery and guarantee species viability.

In order to adequately assess impacts and to compensate for unavoidable losses, we recommend that the Corps:

- Continue to work with the interagency evaluation team to finalize the aquatic impact assessment. The assessment should determine the quantity (acres) and quality (habitat type and value) of resources that would be impacted and that would require mitigation; and determine the quantity and quality of habitats that would be acquired and/or managed to compensate for habitat losses;

- Implement mitigation for identified and quantifiable impacts by restoring, enhancing, and/or creating substitute habitats within the project area; and develop a long-term coordinated and comprehensive environmental monitoring and assessment program to collect baseline data, identify additional impacts, develop recommendations, and propose future adaptive management and mitigation measures. A conceptual environmental monitoring and assessment program is discussed in more detail below in the section titled Environmental Management Program. We also provide a paper on a conceptual program in Appendix C.

ENVIRONMENTAL MANAGEMENT PROGRAM

The effects of the development, operation and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, the downstream segments of the rivers, wetlands, backwater areas, and in the main stem of the navigation channel) likely would have long-term consequences that cannot be adequately identified, predicted , or appropriately assessed without long-term studies and extensive monitoring efforts. Due to the large project area and complex variables that can influence the navigation system, uncertainty is an unavoidable component of managing and maintaining the natural resources associated with this large river ecosystem. For example, predicting weather patterns which ultimately influence fluctuations in river flow and reservoir pool elevations is not possible with complete accuracy. Furthermore, unpredictable potential impacts to the aquatic environment could result from a number of factors: 1) an increase in commercial shipping would increase the risk of potential spills of pollutants (*e.g.*, oil, fertilizers, chemicals, etc.) into the aquatic environment; 2) an increase in municipal and industrial development along the system would increase the number of discharges (point and non-point) into the system and cause direct loss of habitat; 3) dredging and aquatic dredged material disposal would modify the amount and type of fish and wildlife habitat available in impacted areas. These events would alter fish and wildlife resource values associated with this large and dynamic system.

Due to the potential for future impacts to the natural resources associated with the navigation system, sustained, long-term monitoring efforts appear to be warranted (Buchanan, 1976). Section 306 WRDA 1990 made environmental restoration one of the primary missions of the Corps, permitting the Corps to undertake studies and implement projects that restore habitat. Section 906 (b) of WRDA 1986 authorizes the Secretary of the Army to mitigate damages to fish and wildlife resources resulting from any water resource project under Corps jurisdiction, whether completed, under construction, or proposed to be constructed. The long-term studies and monitoring program could serve as an adaptive strategy to: 1) facilitate the development of appropriate conservation measures that would restore and maintain the habitat value of the fish and wildlife resources associated with the navigation system over the project life, 2) assess the true magnitude of the cumulative impacts from the development, maintenance, and continued operation of the system, and 3) identify and address any unanticipated mitigation needs. Assessing unforeseen beneficial and adverse impacts to fish and wildlife resources may be the only guaranteed means to ensure that the important fish and wildlife resource values associated with the system, as discussed throughout this report, are restored and maintained.

Therefore, to maintain and restore the habitat value of the fish and wildlife resources affected by the MKARNS, we recommend that the Corps utilize the authority provided under section 906 (b), WRDA 1986 and section 306, WRDA 1990 to:

1) (a) Seek full Congressional authorization and funding for a Cooperative and Comprehensive Environmental Management Program. The program would be based on long-term monitoring and relevant environmental studies that would occur before, during and following project implementation and extending until such time as sufficient data have been collected to clearly accurately determine the full extent of environmental impacts, establish any needed post project mitigation measures, and develop a coordinated and comprehensive management plan encompassing the life of the proposed project. (Table 30 provides a preliminary example of needed long-term monitoring studies developed by the interagency team to date). The purpose of the program would be to monitor Arkansas River resources to assess project impacts and develop proposed recommendations for adaptive management and mitigation measures. Cooperation and partnerships are essential to effectively assess, comprehend and manage the complexities of this large river ecosystem. The establishment of a coordinated

monitoring program that combines the efforts and resources of local, state, federal, and private natural resource agencies would be ideal. The waters, islands, and floodplain riparian corridor owned by the Corps, along with the NWRs, state wildlife management areas, state parks, and/or non-governmental organization conservation lands comprise an extensive complex of important fish and wildlife resources in the Arkansas River Valley. Coordinated, comprehensive management of these important lands and waters would provide benefits for habitat diversity, species viability, and corridor connectivity that likely could not be achieved by independent management efforts alone.

1) (b) Establish multiple resource monitoring stations along the navigation system as an effective means of meeting the objectives of a monitoring program. Monitoring stations would facilitate the following:

    - Identification and quantification of project impacts to fish and wildlife resources that are attributable to construction and operation of the MKARNS for the entire navigation system (including the upstream reservoirs, rivers, and wetland and terrestrial habitats);

    - Planning to address these impacts and the development of an interagency mitigation plan for any unmet mitigation needs. The mitigation plan should include: a) actions discussed in this report, such as habitat restoration, enhancement, and creation projects within the project area for habitats used by federally-listed species, rare/declining species, and species popular with local anglers and hunters; and b) acquisition of ecologically valuable habitats that are scarce in the ecoregion and/or provide quality fish and wildlife resource-associated recreational opportunities. These lands should be considered for addition to the national wildlife refuge system, state wildlife management areas, or other appropriate natural resource agencies' holdings for fish and wildlife resource management purposes; and

    - Identification of undesirable, on-going or future impacts and trends, unexpected adverse effects, and the necessary remedial actions to compensate for impacts, restore habitat, or reverse undesirable trends.

2) Establish an interagency McClellan-Kerr Arkansas River Navigation System Conservation Committee to coordinate efforts and oversee the Environmental Management Program. The committee would serve to formulate and assist in implementation of plans, studies, and necessary conservation measures designed to enhance, restore, compensate for losses, and maintain the fish and wildlife habitat value associated with the navigation system. A coordinated and comprehensive approach is necessary to effectively manage a large river ecosystem and maintain the corridors and species viability within the system. The committee should be made up of biologists from the ODWC, AGFC, Corps, the Service (refuge and ecological services staff), and experts from local and regional universities. The committee would evaluate reports from the Corps, ODWC, AGFC, and the Service regarding impacts to fish and wildlife resources associated with the system as identified through the Environmental Management Program. Examples include adverse impacts to terrestrial

and/or aquatic resources managed by the ODWC during extreme high and low water years, backwater areas, and gravel shoals. The reports also would include the conservation measures needed to adequately compensate for the loss of fish and wildlife habitat value and to assure continued effectiveness of mitigation features.

3) Establish a mitigation fund that would be utilized to address mitigation needs identified through the long-term monitoring program.

The cost of any long-term monitoring program and the recommended mitigation fund should be considered in the Corps benefit:cost analysis for ARNS. A long-term monitoring program and associated mitigation fund is necessary to ensure adequate compensation for impacts to fish and wildlife resources and to maintain the quality of fish and wildlife resources. Significant benefits to local, state, and regional economies likely could be realized as a result of the Environmental Management Program through an increase in fish and wildlife resource-associated recreational activities within the project area. Outdoor recreation continues to be popular with a large segment of the American people. For example, in 2001, U.S. residents nationwide spent more than $108 billion dollars while pursuing fish and wildlife related activities. In Oklahoma alone, wildlife observers, hunters, and anglers spent over $193, $248, and $476, million dollars, respectively (USDOI and USDOC, 2001). In 2002, over 35 million people visited national wildlife refuges throughout the country. Their expenditures (*e.g.*, lodging, food, equipment, etc.) generated over $809 million in regional economies (USFWS, 2003). An increase in outdoor recreation activities is likely to occur within the project area should the objectives of the Environmental Management Program be realized. Increases in the quality of habitat supporting fish and wildlife populations would lead to more opportunities for outdoor enthusiasts over the 50-year project life.

FISH AND WILDLIFE ENHANCEMENT MEASURES

The Service recommends making every possible effort to operate the MKARNS in a manner that promotes the health and diversity of the various ecosystems associated with and impacted by the MKARNS. Today, there are innovative river structures and concepts that can be used to improve navigation, while still providing positive benefits to the environmental resources of a highly altered area, such as the MKARNS (USFWS, 1982). For example, backwater areas adjacent to the MKARNS, such as sloughs, oxbows, river cutoffs, dike fields, and side channels, that serve as important spawning and nursery areas for many fish species are being negatively impacted or lost due to enclosed dikes, revetments, and accreted sediments blocking connection to the channel. Notching the dikes and revetments allows flow behind the structure to scour out areas that have silted in, and allows fish access to important spawning, nursery, foraging, and flow refugia areas. In addition, geotubes and chevrons could aid in creating braided side channels and diversifying bottom contours and substrates. Creating sand islands on or downstream of these structures could restore least tern habitat in areas where sand islands have been lost due to wave action, reductions in flows, and/or vegetative encroachment.

Table 30. Preliminary list of monitoring needs for the Arkansas River Navigation Project.

Task/Activity	Annual Cost (x1000)[1]
1 – Sediment dynamics in dike fields and backwaters • Bathymetry • Substrate sampling • Lidar, GIS	220
2 – Relationships between fish diversity and physicochemical characteristics of dike fields and backwaters • Seasonal sampling in trend pools • Comparison of notched and un-notch dikes • Comparison of mitigation and reference sites	190
3 - Potamological characteristics of impacted and mitigated gravel bars • Substrate borings and classification • Substrate profiling	110
4 - Seasonal use of gravel bars as fish spawning, feeding, and resting areas • Comparison of natural and mitigated bars • Limited invertebrate sampling	145
5 - Head-cutting of important tributaries • Six tributaries • Establish gages and cross sections	110
6 - Habitat characteristics and fish communities in tributary mouths of the Arkansas River	40
7 – Success of freshwater mussel relocation efforts	undetermined

[1] Costs are based on rates provided by EDRC-EL, and include labor to manage the project, analyze data, and prepare reports.

Efforts to identify potential fish and wildlife habitat enhancement projects in Arkansas began in the fall of 2000 with staff from the AGFC, representatives of Ducks Unlimited, and local anglers. Dike notching to allow water to flow behind the dikes and re-open fish spawning areas in Arkansas began in July 2001. In Oklahoma, potential enhancement and restoration sites have been identified in meetings with representatives from the Service, Corps, and the ODWC. The Service commends the Corps for your participation in these efforts. However, there is still much that could be accomplished. Dike notching in Arkansas has currently ceased due to legal complications and budget restraints. Additional funding and assistance is needed to continue restoring backwater areas and to improve fisheries, wildlife, and recreational management of this resource. Dredged material disposal can be used to create islands, shallows, and vegetated substrates that improve waterfowl and fisheries habitat. Backwater habitats also can be restored using dredged material and notching dikes. Created islands could serve many purposes, such as habitat for least tern colonies, aquatic vegetation substrates to increase available forage and cover, and as recreation sites for camping and swimming. Some islands could be managed as wildlife habitat to provide forage and cover for many mammals, reptiles, amphibians, and birds, in addition to increasing the available acreage for hunting, bird watching or hiking. We also recommend the Corps continue these enhancement efforts by scheduling a trip on the Verdigris River to conduct a preliminary investigation of potential restoration and enhancement projects for river cutoffs and oxbows.

As a result of the ARNS investigation, an opportunity exists to initiate and develop a coordinated and comprehensive management plan to enhance important wildlife habitat, to improve and restore fisheries habitat, protect riparian buffers, and protect and restore wetlands throughout the entire 445 mile MCKARNS corridor. The management of this system could be improved substantially through a cooperative and coordinated effort among the many state, federal, and private resource agencies and organizations responsible for, or having a stake in, the conservation of the Arkansas River ecosystem. The Corps could initiate this effort as part of the design or mitigation efforts associated with this project to promote the improvement of recreation, management, conservation, and protection of fish and wildlife resources, including five federally-listed threatened and endangered species. Personnel from the Corps, along with the NWRs, state WMAs, state parks, and/or non-governmental organization conservation areas could coordinate their management efforts under one plan for habitat diversity, species viability, and corridor connectivity. This cooperatively managed corridor would 1) be the longest conservation complex in the lower 48 states, 2) manage most of the Arkansas River Valley ecoregion, 3) cross two states, and 4) join two Service regions.

In addition to focusing funds and efforts, this partnership could assist with bio-monitoring of the river; fish, wildlife, habitat, and recreational research and management throughout the system; and provide improved management and habitat conservation for federally-listed threatened and endangered species, other rare species, the sport fishery, migratory birds, and other game and non-game fish and wildlife resources. This complex also would improve recreational opportunities and accessibility along the shorelines of the river by cooperatively maintaining and improving parks, access areas, and adding multi-use facilities. In the end, this partnership could provide the long term coordinated biological assessment the Arkansas River Navigation Project needs, while preserving and enhancing the fish and wildlife resource, accessibility, tourism, economic, and educational opportunities along the Arkansas River. Additional funding may be necessary to make this plan a reality, but having a plan in place that reflects stakeholder needs could assist in achieving the necessary support. A conceptual paper on this type of plan is provided in Appendix C.

The Service, ODWC, and AGFC are excited about the opportunity to enhance fish and wildlife habitat along the navigation system. The Service has published a guide that identifies and describes numerous enhancement and mitigation techniques that could be used to offset and reduce impacts of the development and maintenance of a navigation channel on large riverine systems (Schnick *et al.*, 1982). We recommend utilizing this valuable resource as potential environmental enhancement projects and ideas continue to be developed.

The Service also recommends that the Corps consider restoring and enhancing habitat by acquiring land through fee title interests, conservation easements, flowage easements, or management agreements in habitats that are known to have high values, including lands adjacent to the MKARNS that are susceptible to flooding, but currently being farmed. These properties could be added to state wildlife management areas, to the national wildlife refuge system, or other appropriate land holdings to conserve the environmental resources of the area and be used by the general public.

Enhancement of Recreational Opportunities

Although the Service does not recommend measures to increase recreational values as a means of compensating for losses of habitat value, losses to recreational use that would not be offset through habitat mitigation measures should be addressed through other distinct measures. We provide the following potential measures that could be used to offset project-related human use losses of fish and wildlife resources.

The Service recommends that the Corps consider enhancing recreational opportunities at the NWRs along the navigation system. We provide some current needs at the Sequoyah NWR below. Projects at Holla Bend and White River NWRs also should be investigated in coordination with refuge staff.

a) Fishing/Observation Piers: Permanent piers at the Sandtown Woods parking lot and at Fisherman's Point would provide refuge visitors additional opportunities for fishing, wildlife observation, and photography. The piers should be constructed adjacent to the shoreline and would be about 30 – 40 feet long. The estimated cost of the project is $75,000.

b) Vian Ramp Courtesy Dock and Fishing Pier: The existing courtesy dock at the Vian Public Use area has deteriorated. A new floating or permanently anchored courtesy dock would enhance recreational opportunities for boaters and anglers on the NWR and in Robert S. Kerr Reservoir. The estimated cost of the project is about $75,000.

THREATENED AND ENDANGERED SPECIES

The Corps has determined that proposed changes to the MKARNS as a result of the current study may affect federally-listed threatened and endangered species. The project's potential effects on federally-listed species and measures to avoid and minimize any adverse effects are being addressed separately as part of a formal consultation pursuant to section 7 of the ESA for the following four species: 1) the interior least tern, 2) the American burying beetle, 3) the bald eagle, and 4) the pallid sturgeon.

Because several federally-listed species occur in the project area, the project also offers the Corps an opportunity to carry out section 7 (a) 1 responsibilities, as mandated by the ESA. Section 7 (a) 1 of the ESA requires that all federal agencies use their authorities to carry out programs for the specific purpose of conserving threatened and endangered species. Island construction for interior least terns represents one such opportunity.

UNMET MITIGATION NEEDS

The MKARNS is a large and complex system that impacts rivers, tributaries, oxbows, reservoirs, wetlands, and other important natural resources. The original construction of the navigation project destroyed a considerable amount of highly valuable fish and wildlife habitat along the Verdigris and Arkansas rivers. About 28,200 acres of project lands (Sequoyah NWR, McClellan-Kerr WMA units) were allocated for fish and wildlife management after construction of the MKARNS. These lands are still owned by the Corps, but managed either by the Service, AGFC, or ODWC under license agreement. No Corps funding is provided for ongoing management of these properties.

Losses of fish and wildlife habitat as a result of construction, operation and maintenance of the MKARNS were not evaluated using habitat value as a basis for determining compensation needs. The Service believes it is likely that the total combined habitat value of the impacted areas far exceeds the value obtained from lands established through cooperative agreement to compensate for lost fish and wildlife habitat due to the MKARNS (*i.e.*, the 28,200 acres discussed above).

In addition to lands licensed to the Service, ODWC, and AGFC, some MKARNS lands were classified as "Recreation-Low Density Use" and as "Natural Areas," with the Corps retaining responsibility for management. Decreasing budgets over the past decade have not allowed the Corps to manage these lands effectively, or at a level anticipated during original MKARNS planning efforts. As a result, the expected fish and wildlife resource benefits have not materialized.

Furthermore, since the initial navigation project was completed, many acres of additional impacted lands and waters have been identified. Impacts to these areas were never fully assessed or mitigated for by the initial navigation project. In addition, the proposed project likely would increase the impacts to these areas. The full extent of unmitigated impacts associated with the original project and the current proposed project impacts should be considered within this project assessment and mitigated for appropriately at this time.

Section 906 (b) WRDA 1986 authorizes the Secretary of the Army to mitigate damages to fish and wildlife resources resulting from any water resource development project under Corps jurisdiction, whether completed, under construction, or to be constructed. The Service recommends that the Corps seek Congressional authorization and funding to initiate a study to address unmet fish and wildlife mitigation needs of the original MKARNS project and implement conservation measures previously recommended by the Service. The study should assess the impacts of the original construction and subsequent operation and maintenance of the MKARNS to determine whether existing mitigation is adequate to compensate for losses of fish and wildlife habitat. Fish and wildlife resource based recreational use and needs should be an integral part of this investigation. Application of HEP and geographic information system databases could be used to assess value of the impacted habitat and that of the existing areas allocated for wildlife management (*e.g.*, Sequoyah NWR, McClellan-Kerr WMAs).

Section 3 (a) of the FWCA provides for the use of project lands for fish and wildlife conservation purposes. The Service recommends the re-allocation of high quality project lands along the navigation system in Oklahoma and Arkansas to fish and wildlife management as potential compensatory mitigation. The Corps cumulatively owns large areas of project lands that provide important fish and wildlife habitat, but currently are not protected from potential adverse impacts, such as disposal as surplus Federal property or future development. These lands include such high value habitats as oxbows, islands, wetlands, and riparian areas. The remaining 23 oxbows and cutoffs along the Verdigris River, for example, comprise the last portions of the river in its natural state. These areas have become some of the most highly productive and essential habitats along the river for many species of fish, waterfowl, and other native fauna. The oxbows and cutoffs provide resting areas for waterfowl and important spawning areas for fish. The bottomland hardwood and riparian forests adjacent to and surrounding these oxbows and cutoffs also provided high quality habitat no longer found along much of the river as a result of the MKARNS project.

Many of the oxbows and cutoffs, however, were not afforded protection from future development at the time of project construction. The Service sought protection for all of these areas because they represented the most valuable remaining habitat along the Verdigris River. During the spring of 1980, Verdigris area industrial interests, including the Arkansas Basin Development Association, requested that the Corps leave all oxbows and cutoffs along the Verdigris River portion of the navigation system open for industrial development. The Corps identified seven oxbows and cutoffs for re-allocation to preclude their industrial development. Ultimately, only four oxbows and cutoffs were re-allocated and provided protection from future development, far short of the habitat conservation level envisioned during MKARNS planning efforts.

The Service and ODWC also recommend that the Corps consider as mitigation lands the thousands of acres of floodplain habitat adjacent to the Verdigris River portion of the navigation system between U. S. Route 412 and State Highway 51 in Oklahoma that have been altered by the development of the navigation system, drained, and converted to agricultural use. These properties represent excellent opportunities for wetland and bottomland hardwood restoration efforts, especially the large contiguous tract of agricultural lands in the Big, Goodhope, and Guinn Bottoms. Section 906 (a) WRDA 1986 and section 3 (c) of the FWCA authorizes the Corps to purchase lands for mitigation purposes. We recommend investigating the feasibility of acquiring fee title interests to lands in this area. The lands could then be licensed or deeded to the ODWC as additions to their wildlife management areas or to the Service as additions to the national wildlife refuge system.

The ARNS presents the Corps the opportunity to provide the needed protection, restoration and enhancement of project lands with high fish and wildlife habitat value and potential, such as the river cutoffs and oxbows along the Verdigris River in Oklahoma and altered floodplain habitat.

LIST OF RECOMMENDATIONS

Section 906 (d) WRDA 1986 requires that all post-1986 Corps projects submitted to Congress have either 1) a specific mitigation plan or 2) a determination that the project will have negligible impacts to fish and wildlife resources. Such mitigation plans should be implemented prior to or concurrent with project construction, as mandated by section 906(a) WRDA 1986. This report has demonstrated that the proposed project would result in substantial impacts to important fish and wildlife resources. These impacts would constitute a significant biological change for which mitigation would be required to offset losses. In view of the information provided, the Service provides the following list of recommendations for the purposes of mitigating adverse impacts to fish and wildlife resources attributable to the ARNS selected alternatives:

1) Minimum Instream Flow Releases: Incorporate minimum instream flow releases (based on Orth and Maughan, 1981) for all system reservoirs into the plan selected for implementation. Minimum flow releases should be conducted in a manner that maintains water quality standards as set by the Oklahoma Water Resources Board.

2) Lake Level Management Plans: Develop and implement lake level management plans for the 11 primary flow modifying reservoirs on the MKARNS in Oklahoma in coordination with the Service and ODWC.

3) Impacts to Floodplain Habitat: Identify the specific lands that would receive flood protection benefits, determine the quantity (acres) and quality (habitat type and value) of wetlands that the selected operating plan would alter, determine the quantity (acres) and quality (habitat type and value) of wetlands that would be necessary to compensate for wetland losses, and obtain conservation easements in floodplain areas that would be protected from flooding to deter floodplain development and compensate for losses of wetland habitat.

4) Contaminant Analysis: Conduct additional analyses of dredged material for contaminants prior to disposal. The ODWC has specific concerns regarding dredging activities and sediment analysis within the vicinity of the Sequoyah Fuels Corporation Industrial site, which can be found in their concurrence letter in Appendix A. Disposal measures to minimize the environmental impact of disturbance, transport, and disposal of contaminated sediments should be developed and utilized where necessary. This issue is not only relevant from the standpoint of impacts to fish and wildlife resources, but also is a public health concern.

5) Beneficial Use of Dredged Material and Disposal Sites: Use dredged material to create, rebuild, or enhance island and/or marsh habitats in areas that currently have low habitat quality. As an example, the Sandtown Bottoms area (secs. 6, 7, and 18, T. 11 N., R. 22

E.) within the Sequoyah NWR along the Arkansas River has experienced severe erosion from wind-driven wave action, river current erosion, and wakes from boat/barge traffic. The Service recommends that the Corps investigate the feasibility of using dredged material and structures such as geo-tubes that would provide long-term erosion control and increase the aesthetic and wildlife habitat value of the area by providing a substrate that would facilitate the growth of riparian vegetation.

6) Unavoidable Terrestrial Impacts: Implement the mitigation plan for unavoidable terrestrial disposal impacts in Oklahoma that was developed through interagency cooperation by biologists with the Corps, Service, and the ODWC. The plan was developed to ensure that losses in habitat value, rather than in acres, would be offset over the 50-year project life. The compensatory mitigation plan currently endorsed by the Service and ODWC consists of bottomland hardwood restoration and marsh creation at two sites along the Verdigris River that are currently agricultural fields. This plan or an acceptable alternative should be implemented prior to, or concurrent with, project construction as mandated by section 906 (a) WRDA 1986. Alternative mitigation plans would be acceptable to the Service and ODWC, provided that the plan 1) was developed through interagency coordination, and 2) demonstrated that losses in habitat value were fully offset over the project life through a HEP or similar analysis. Specific details for bottomland hardwood and marsh restoration/creation, such as tree plantings and exact measures to restore hydrology, should be finalized through interagency coordination with the Service and ODWC.

7) Impacts of Aquatic Dredged Material Disposal and the Construction/Modification of River Training Structures in Oklahoma and Arkansas: The Corps, Service, ODWC, and AGFC have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening would have on aquatic fish and wildlife resources. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report. The Corps should continue to work with the interagency evaluation team to assess the impacts of the project on aquatic fish and wildlife resources.

8) Mitigation Plan for Aquatic Impacts: The Corps should continue to work with the interagency evaluation team to develop a complete compensatory mitigation plan that would offset losses to habitat value over the 50-year project life caused by dredging, river training structures, and disposal of dredged material in aquatic sites in Oklahoma and Arkansas. This report provides additional and modified mitigation recommendations for the Corp's consideration during development of the final mitigation plan (Appendix G). We believe incorporating these recommendations into the final plan would help ensure that losses of aquatic habitat value would be adequately offset. The final mitigation plan for aquatic resource impacts would be acceptable to the Service, ODWC, and AGFC provided that it was demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

9) Impacts to Freshwater Mussel Communities: Implement mitigation measures to avoid and minimize impacts to freshwater mussel concentrations. The Service's Arkansas and

Oklahoma Ecological Services field offices provided recommended mitigation measures for freshwater mussels in planning aid letters dated April 29 and May 11, 2005, respectively.

10) General Plans for Terrestrial Mitigations Sites: In accordance with section 3 and 4 of the FWCA, the Service requests that the Corps begin coordination with the Service and the ODWC on the development of a General Plan (*i.e.*, agreements that make project lands available to the Service or State for fish and wildlife management purposes) for the terrestrial mitigation sites.

11) Operation and Maintenance Funds for Compensatory Mitigation Lands: Maintaining the habitat value of compensatory mitigation lands likely will require on-going maintenance and management efforts. Without these efforts, the habitat value of the lands is likely to decrease and fail to meet mitigation goals. Losses in habitat value as a result of the project, therefore, would not be adequately offset by intended mitigation. In accordance with section 2 (d) of the FWCA, costs to carry out fish and wildlife conservation measures are to be considered project costs. Furthermore, section 906 (c) WRDA 1986 states that the costs of fish and wildlife mitigation are to be cost-shared at the same rate as the project purpose causing the impact. Navigation projects are fully federally-funded. The Corps should seek full Congressional authorization and funding for Operation and Maintenance (O and M) needs. These funds should be provided to the managing entity on an annual basis. An O and M budget should be developed in cooperation with the managing entity prior to project implementation.

12) Environmental Management Program, Conservation Committee, and Mitigation Fund: Seek full Congressional authorization and funding for an Environmental Management Program. The effects of the modifications to river flow management and channel depths, and the continued operation and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, downstream segments of the rivers, wetlands, backwater areas, and the main stem of the navigation channel), likely will have long-term consequences that cannot be adequately identified or appropriately assessed without long-term studies and extensive monitoring efforts. The Service believes the Corps should utilize the authorities provided under section 906(b) WRDA 1986 and section 306 WRDA 1990 to seek full Congressional authorization and funding for an Environmental Management Program. This would enable the Corps to perform long-term studies and monitor fish and wildlife resources associated with the navigation system that would occur before, during and following project implementation and extending until sufficient data have been collected to clearly and accurately determine the full extent of environmental impacts. The long-term monitoring program would serve to 1) facilitate the development of appropriate conservation measures that would maintain and restore the habitat value of the fish and wildlife resources associated with the navigation system, 2) assess the ultimate magnitude of the cumulative impacts from the proposed modifications to channel depths and river flow management, and from maintenance and continued operation of the system, 3) identify and address any unmet mitigation needs not identified as a result of the expedited study schedule, 4) coordinate and comprehensively manage and improve recreation, fisheries, wildlife, and natural resource conservation throughout the system, and 5) improve the efficiency and maximize resource potential through cooperative operation and management of the system. The Service believes that it would be necessary to establish a mitigation fund that would be utilized to address mitigation needs identified through the long-term monitoring program. Due to the necessity of the long-term monitoring program and mitigation fund to ensure adequate compensation is provided for impacts to fish and wildlife resources and to maintain and restore habitat value, the cost of the long-term monitoring program and the mitigation fund should be considered in the Corp's benefit:cost analysis for ARNS. Benefits to local, state, and regional economies as a result of the likely increase in expenditures for outdoor recreational pursuits (*e.g.*, wildlife photographers/observers, hunters, and anglers) also should be considered in the analysis. A paper on a conceptual Environmental Management Program is provided in Appendix C.

13) Invasive Species**:** The Corps should continue public awareness efforts to increase knowledge and concern about the spread of the zebra mussel and other invasive species by distributing outreach materials that summarize the life history of these species, the adverse environmental consequences caused by their establishment, and recommended measures to help prevent the further spread of these species. This material should be available at project offices and boat ramps throughout the navigation system. The Service also recommends that the Corps consider installing washing and scrubbing stations that provide appropriate water solution and temperature (*e.g.*, a 10 percent water and chlorine solution and water temperatures of 140° F) for removal of zebra mussels at appropriate locations on all reservoirs that support the navigation system to help prevent further spread of zebra mussels.

14) Unmet Mitigation Needs: The Corps should seek full Congressional authorization and funding to initiate a study to identify and address any unmet mitigation needs of the original project. The study should assess the impacts of the original construction and subsequent operation and maintenance of the MKARNS to determine whether existing mitigation is adequate to compensate for losses of fish and wildlife resources.

15) Enhancement/Restoration of Fish and Wildlife Habitat: The Service recommends that the Corps continue efforts to identify and implement potential fish and wildlife habitat enhancement projects in Arkansas and Oklahoma, such as bottomland hardwood restoration and dike notching projects.

16) Endangered Species: Implement projects under authority of section 7 (a) 1, as mandated by the ESA, to help conserve threatened and endangered species, such as island creation and management for interior least terns.

SUMMARY AND POSITION OF THE SERVICE

The project area contains a variety of high quality fish and wildlife resources. These resources include wetlands, bottomland hardwoods, floodplain forest, backwater areas such as oxbows, several streams and rivers, numerous reservoirs, wildlife management areas, and national wildlife refuges. The effects of modifying the current operating plan were evaluated using the Corps "Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System," also known as the SUPER Model. For this study, reservoir elevations and river stages were modeled using 61 years (January 1940 – December 2000) of stream flow data. Information obtained from the SUPER Model for each non-structural alternative included 1) average annual river flow and condition, and 2) average annual reservoir stages and duration.

Reservoir level fluctuations are expected to change only slightly from current operations under the selected plan. Impacts to fish and wildlife resources at the reservoirs would not likely differ significantly from current conditions based on average annual lake levels and stream flows. The Service believes, however, that conditions that would occur during extreme high and low years (rather than only on average annual lake levels and river flows) also should be considered in order to appropriately consider potential effects to fish and wildlife resources. These effects are not likely to be evident from an analysis based on average annual reservoir levels and stream flows. Conditions that occur during these extreme years could significantly affect fish and wildlife resources.

Impacts could include altering the littoral zone, eliminating or reducing vegetated areas adjacent to the reservoirs, adversely impacting fish spawning and recruitment, and reducing available habitat for migratory birds. We believe that the mitigation goal for the fish and wildlife resources associated with the 11 primary flow modifying reservoirs in Oklahoma could be met through pro-active conservation actions and adaptive management. Examples are lake level management plans, minimum in-stream flow releases, and monitoring to identify any needed management alterations.

The selected River Flow Management alternative would reduce the duration of over bank flooding in the floodplain. Because the hydrology of floodplain wetlands would be altered, important wetland habitats may be adversely impacted. Therefore, the Service recommends that the Corps identify the specific lands that would receive flood protection benefits, assess adverse impacts to habitat value, and provide compensatory mitigation for unavoidable wetland-related impacts.

Deepening and maintaining the navigation channel would have significant adverse impacts on important fish and wildlife resources. Potential impacts are diverse but primarily would include the direct loss and degradation of terrestrial and aquatic habitat through dredging and dredged material disposal, and degradation of backwater habitats. An assessment of adverse impacts and a complete mitigation plan have been developed for impacts due to disposal of dredged material at terrestrial sites in Oklahoma. The Corps, Service, ODWC, and AGFC have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening would have on aquatic fish and wildlife resources. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report.

The Service understands that the Corps intends to fully mitigate for aquatic resource impacts. The Service provides additional and modified compensatory mitigation recommendations for aquatic resource impacts for the Corps consideration during development of the complete mitigation plan in Appendix G. We believe that incorporating these mitigation features into the mitigation plan would serve to adequately offset aquatic resource impacts. The final mitigation plan for aquatic resource impacts would be acceptable to the Service, ODWC, and AGFC provided that it was demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

The effects of the development, operation, improvement, and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, the downstream segments of the rivers, wetlands, backwater areas, and the main stem of the navigation channel) will have long-term consequences that cannot be adequately identified or appropriately assessed without long-term studies and extensive monitoring efforts. The Service believes the Corps should perform long-term studies to assess the true magnitude of the development, operation, and maintenance of the MKARNS on important fish and wildlife resources. These further studies also would help identify and address any unfulfilled or unanticipated mitigation needs.

Fish and wildlife resources and associated recreational activities are an important aspect of American culture. In 2001, for example, U. S. residents spent more than $108 billion dollars while pursuing fish and wildlife related recreational activities. In Oklahoma alone, wildlife observers, hunters, and anglers spent $193,248, 000, $248,071,000, and $476,019,000, respectively (USDOI and USDOC, 2001). The Service's overall goal is to conserve these important fish and wildlife resources for the benefit of the American people, while facilitating balanced development. This goal is supported by language in the FWCA. The FWCA establishes fish and wildlife conservation as a coequal purpose of water resource development projects and states that fish and wildlife resources shall receive equal consideration with other features of water resources development programs.

Section 906 (d) of WRDA 1986 requires that all post-1986 Corps projects submitted to Congress must have either 1) a specific mitigation plan or 2) a determination that the project will have negligible impacts to fish and wildlife resources. This mitigation plan should be implemented prior to, or concurrent with, project construction as mandated by section 906(a) WRDA 1986. We have demonstrated in this report that the proposed project would result in substantial impacts to important fish and wildlife resources. These impacts would constitute a significant biological change for which mitigation would be required to offset losses.

Therefore, the Service believes that in order to ensure that fish and wildlife resources receive equal consideration, as mandated by the FWCA, the Corps should:

- Continue to work with the interagency team to fully assess potential impacts to terrestrial and aquatic fish and wildlife resources, and develop a specific mitigation plan through interagency coordination that would avoid, minimize and compensate for project impacts;

- Utilize the authorities provided under section 906(b) WRDA 1986 and section 306 WRDA 1990 to seek full Congressional authorization and funding for an Environmental Management Program in order to perform the long-term studies and monitoring of the fish and wildlife resources associated with the navigation system. The long-term monitoring program would serve to 1) facilitate the development of appropriate conservation measures that would maintain and restore the habitat value of the fish and wildlife resources associated with the navigation system, 2) assess the true magnitude of the cumulative impacts from the proposed modifications to channel depths and river flow management, and from maintenance and continued operation of the system, 3) identify and address any unfulfilled or unanticipated mitigation needs not identified due to the expedited study schedule, 4) coordinate and comprehensively manage and improve recreation, fisheries, wildlife, and natural resource conservation throughout the system, and 5) improve the efficiency and maximize resource potential through cooperative operation and management of the system; and

- Establish a mitigation fund that would be utilized to address mitigation needs identified through the long-term monitoring program. Due to the necessity of the long-term monitoring program and mitigation fund to ensure adequate compensation for impacts to fish and wildlife resources, the Service strongly believes that the cost of the long-term monitoring program and the mitigation fund should be considered in the Corps benefit:cost analysis for ARNS. Benefits to local economies attributable to expenditures for outdoor recreational pursuits, such as wildlife observation, hunting, and fishing, also should be considered.

The Service could support the recommended change to river flow management and deepening of the navigation system up to a 12-foot navigation depth, provided that appropriate mitigation measures that would serve to offset losses in aquatic and terrestrial habitat value, such as those developed by the interagency team and recommended in this report, are implemented. We further believe that an Environmental Management Program and Mitigation Fund should be established to ensure that adverse effects continue to be rectified over time and that unidentified mitigation needs could be met. The cooperation of the Corps during our investigation of the proposed action is greatly appreciated.

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APPENDIX A

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Concurrence Letters

Arkansas Game & Fish Commission

2 Natural Resources Drive Little Rock, Arkansas 72205

David Goad
Deputy Director

Loren Hitchcock
Deputy Director

Scott Henderson
Director

June 23, 2005

Richard Stark
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Oklahoma Ecological Service
Tulsa Field Office
222South Houston Avenue
Tulsa OK 74127

Dear Mr. Stark:

Our agency has reviewed your Fish and Wildlife Coordination Act Report that evaluates the Arkansas River Navigation Study, Arkansas and Oklahoma. We appreciate the efforts of the dedicated U.S. Fish and Wildlife Service biologists that completed this report under an expedited project schedule.

Biologists from our agency have reviewed this report and concur with the recommendations. Our agency will have further comments regarding the aquatic impact assessment and mitigation plan (Appendix G). We believe that the Corps should seek ideas for proposed mitigation features from user groups (e.g., BASS, Arkansas Bass Association, Arkansas Bass Federation, Arkansas Wildlife Federation). Our agency would like to see experts from the U.S. Geological Survey and universities be contracted to perform some of the monitoring projects.

We appreciate the opportunity to review this Coordination Act Report.

Sincerely,

Robert K. Leonard

Robert K. Leonard, Biologist
River Basins Division

Cc: Doyle Shook
Mike Gibson

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APPENDIX B

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Federally-listed Species

Endangered species that occur within the project area include the fat pocketbook mussel, *Potamilus capax*, pink mucket pearly mussel *Lampsilis abrupta*, scaleshell mussel *Leptodea leptodon,* American burying beetle *Nicrophorus americanus*, pallid sturgeon *Scaphirhynchus albus,* interior least tern *Sterna antillarum athalassos*, whooping crane *Grus americana*, Indiana bat *M. sodalis*, gray bat *Myotis grisescens*, Ozark big-eared bat *Corynorhinus townsendii ingens*, and the Harperella *Ptilimnium nodosum*. The endangered ivory-billed woodpecker *Campephilus principalis*, recently rediscovered at the Cache River National Wildlife Refuge in Arkansas, also occurs in the study area. Threatened species include the Neosho madtom *Noturus placidus*, Arkansas River shiner *Notropis girardi*, Ozark cavefish *Amblyopsis rosae*, bald eagle *Haliaeetus leucocephalus*, piping plover *Charadrius melodus*, *Geocarpon minimum* (no common name), and the western prairie fringed orchid *Platanthera praeclara*. The Neosho mucket *Lampsilis rafinesquana* and the Arkansas darter *Etheostoma cragini*, federal candidate species, also occur within the vicinity of the study area.

We provide a description of all listed and candidate species known to occur in the vicinity of the project below.

Invertebrates: Mussels

<u>Fat pocketbook</u>

The fat pocketbook is an endangered mussel that historically occurred in approximately 200 miles of the St. Francis River system, including the Floodway and associated drainage ditches; the lower Wabash River, Indiana; the mouth of the Cumberland River, Kentucky; and the Mississippi River, Missouri. Over 2,000 individuals were transplanted from the St. Francis Floodway to the Mississippi River by the Missouri Department of Conservation in 1989 to augment that population in an effort to enhance viability. Fresh dead shells have been collected from the Ohio River in Kentucky. The historic records of this species from the Green River, Kentucky, are questionable. The only known viable population of the fat pocketbook is in the St. Francis Floodway, Arkansas.

The greatest impact on the habitat of the fat pocketbook throughout its historic range has been from activities related to navigation and flood control. Channel maintenance dredging has been particularly destructive. Impacts include the loss of stable sandbars and other suitable habitat, increased siltation, and reduced numbers of fish hosts. The upper Mississippi River has been impounded for navigation and is dredged routinely to maintain a 9-foot navigation channel. The fat pocketbook, once widespread in this river, has disappeared in recent years even from areas where other species (including the endangered species *Lampsilis hicioinsi*) continue to exist. The largest populations occur in the St. Francis River and associated ditches. Smaller populations occur in the Ouachita and Little River systems. Within the vicinity of the project, it has been collected near river mile 12 on the White River and downstream on the Mississippi River.

<u>Pink mucket pearly mussel</u>

The pink mucket pearly mussel is an endangered mussel that historically occurred in 25 river systems in 13 states in the eastern United States. The shell of this mussel is thick and smooth with a tan, yellow, or yellowish-brown color. Shells of males are circular in shape while female shells may be nearly square. Faint broad, green rays may cover the shell, but rays are frequently absent from adult shells (Oesch, 1995). This species occurs in medium to large rivers having a medium to strong current over a gravel or sand substrate.

The pink mucket has declined as a result of habitat modification (*e.g.*, dam construction and dredging), water quality degradation, and overharvest by the commercial mussel industry. By 1990, it was known to occur in only 16 river systems, including rivers in Arkansas (Mathews and Moseley, 1990). The largest populations occur in the Spring and White Rivers. Smaller populations occur in the Ouachita and Little River systems. Within the vicinity of the project, it has been collected primarily from the middle and upper portions of the White River (Harris *et al.*, 1997.).

Scaleshell

The endangered scaleshell is a relatively small mussel that possesses a thin, oblong olive-colored shell with faint green wavy rays. The scaleshell occurs in small to medium rivers with stable channels and high water quality. The scaleshell occurs in riffle areas that have a substrate of sand and gravel, where it partially buries itself and siphons the water for food (Oesch, 1995).

This species was historically known from 55 streams in 13 states in the eastern United States. Over the last fifty years the species has declined due to pollution, increased sedimentation (suffocates the mussels and makes feeding difficult), and dams (act as barriers to host fish, isolate populations, and destroy habitat). There are only 13 known scattered populations in the Mississippi River basin in Missouri, Oklahoma, and Arkansas. In Oklahoma, the scaleshell is known from the Kiamichi, Mountain Fork, and Little River systems in the southeastern corner of the state. A single specimen was located in the Poteau River, a tributary to the MKARNS, in Leflore County, but it is unlikely that the species persists in the Poteau River due to habitat modification. Within the study area in Arkansas, the scaleshell is known to occur in two tributaries to the MKARNS: the Fourche LaFaye River and Frog Bayou. Living specimens have not been collected at the confluence of the Mississippi with the Arkansas River (Gordon, 1980). Its occurrence within the project area is unlikely.

Neosho mucket

The Neosho mucket, a candidate for federal listing and a state-listed endangered species in Oklahoma, is an endemic freshwater mussel species known to inhabit both large and small river channels in the upper Arkansas River system in southeast Kansas, southwest Missouri, northwest Arkansas, and northeast Oklahoma. Recent status surveys indicate that this species has experienced a drastic decline, possibly as a result of reservoir construction and siltation.

In Oklahoma, the Neosho mucket is currently believed to only occur in the Illinois River, a tributary to the MKARNS, above Lake Tenkiller. Larger concentrations were observed in silty, backwater areas (Mather, 1990; NatureServe, 2003). It has not been located below the reservoir, and is unlikely to occur within the project area.

Invertebrates: Snails

Magazine Mountain Shagreen

The brown to buff-colored threatened snail is known only from one slope in the Ozark National Forest in Arkansas (Natureserve, 2003). The snail requires a cool, moist climate, and is known to move deeper into rock crevices during dry weather. This extremely limited range makes the species particularly vulnerable to extirpation.

Invertebrates: Insects

American burying beetle

The endangered American Burying Beetle (ABB) is a habitat generalist and has been found in a variety of habitat types including grasslands, grazed pasture, bottomland forest, riparian zones, and oak-hickory forest (Creighton et al., 1993; Lomolino and Creighton, 1996; Lomolino et al., 1995; NatureServe Explorer, 2003; U. S. Fish and Wildlife Service, 1991). Populations of the endangered American burying beetle are known to occur within Arkansas and Oklahoma. Suitable habitat for the ABB exists within the project area.

American burying beetles are nocturnal (active only at night) and have a life span of about one year. American burying beetles enter an inactive period underground when the nighttime low temperatures are $60^{o}F$ or below. This typically occurs from mid-September through late-May in Oklahoma. Once the nighttime low temperatures are consistently (at least 5 consecutive days) above $60^{o}F$, ABBs become active. Consequently, the timing of project implementation is crucial to the selection of conservation measures and influences how effectively those measures achieve project goals and compliance with the ESA.

Vertebrates: Fish

Pallid sturgeon

The endangered pallid sturgeon is a large primitive fish with a cartilaginous skeleton and several easily recognizable characteristics: a shovel-like snout, large skutes on the head and along the back, and four large fleshy barbells near the ventrally located mouth. The species is restricted to the deep, large channels of the Mississippi-Missouri River system and is considered very rare throughout its range (NatureServe, 2003). Sturgeon inhabit turbid main channels with a strong current over firm sand or gravel. The pallid sturgeon feeds on insects, crustaceans, mollusks, annelids, other fish, and fish eggs. The pallid sturgeon has drastically declined due to habitat degradation caused by impoundments, channelization, and modified flow regimes. This species also has been adversely affected by over harvesting for their meat and eggs (caviar).

The pallid sturgeon is not currently known to occur in the MKARNS or the White River in Arkansas. Collection records from the Corps Waterways Experiment Station show that this species has been collected from the Mississippi near the confluences of the Arkansas and White Rivers (U. S. Army Corps of Engineers, 2003).

Neosho madtom

The threatened Neosho madtom is a small, short-lived catfish with a mottled appearance and characteristics typical of other catfish (*i.e.,* scaleless skin, a wide head, and barbells). The madtom occurs in large streams with a moderate to strong current. Adults prefer shallow riffles over loosely-packed gravel and pebbles. Young are found in deeper pools (Bulger and Edds, 2001; Natureserve, 2003; Wenke et al., 1992).

Historically, this species occurred in the Neosho, Cottonwood, Spring, and Illinois rivers in Kansas, Missouri, and Oklahoma. The Neosho madtom has been adversely impacted by dredging of gravel, water pollution, an increase in water demand, and by habitat degradation caused by the construction of dams. Impoundments on the Illinois and Grand Rivers in Oklahoma have eliminated about one-third of the former range of this species. Although the Neosho madtom historically occurred in the Illinois River in Oklahoma, it has not been collected from that stream since the construction of Tenkiller Reservoir. The species no longer occurs downstream of reservoirs in the project area that generate hydropower (Grand Lake, lake Hudson, Fort Gibson Reservoir, and Tenkiller Reservoir).

Today, this species is divided into three distinct populations separated by reservoirs: 1) the Cottonwood and Neosho River population above John Redmond Reservoir in Kansas, 2) the Spring River population in Kansas and Missouri, and 3) the Neosho River population below John Redmond Reservoir downstream to the headwaters of Grand Lake in Oklahoma. Thus, within the vicinity of the project, the Neosho madtom persists in the Neosho River above Grand Lake in Ottawa County, Oklahoma (Luttrell, 1991; NatureServe, 2003). Under current operations, portions of the known range are periodically inundated by Grand Lake's flood pool. The more frequently that Grand Lake is in the flood pool, the greater the potential to adversely impact this population of the Neosho madtom (U. S. Fish and Wildlife Service, 1992).

Arkansas River shiner

The Arkansas River shiner is a threatened species native to wide, sandy streams in the Arkansas River drainage in Arkansas, Kansas, New Mexico, Texas, and Oklahoma. Historically, this species would have occurred in the project area. However, the fish has disappeared from over 80% of its former range. The shiner currently is limited to about

500 miles in the Canadian River in Oklahoma, Texas, and New Mexico, and to the Cimarron River in Kansas and Oklahoma.

Threats to the shiner include habitat destruction and modification resulting from the construction of impoundments, stream water depletion due to groundwater pumping and diversion of surface water, and water quality degradation (U. S. Fish and Wildlife Service, 1998). Proposed critical habitat for the shiner includes portions of the Canadian and Cimarron Rivers in Oklahoma (69FR 59859). Eufaula Reservoir is located on the Canadian River at river mile 27.0 downstream of proposed critical habitat.

Ozark cavefish

The threatened Ozark cavefish is one of the most cave adapted vertebrates known. It is a small, blind fish with rudimentary eyes, but no optic nerve. The Ozark cavefish occurs in the waters of limestone solution caves in the Springfield Plateau of the Ozarks in Arkansas, Missouri and Oklahoma.

The Ozark cavefish is extremely sensitive to ground water quality deterioration caused by pesticides and other contaminants within cave recharge areas. Collection by scientists and curiosity seekers also has impacted this species (Willis and Brown, 1985).

The cavefish historically occurred in 24 caves in 9 counties in Oklahoma, Missouri and Arkansas (Brown and Todd, 1987; U. S. Fish and Wildlife Service, 1989). Recent estimates indicate that it is found in 14 caves in 6 counties in the White, Neosho, and Osage River drainage (Willis and Brown, 1985; U. S. Fish and Wildlife Service, 1989). Within the immediate project area, the cavefish occurs in Twin Cave located in Delaware County, Oklahoma near Grand Lake. Water levels in Twin Cave are affected by water levels in Grand Lake, but these fluctuations are not believed to adversely impact the Ozark cavefish (Benham-Holway, 1988; U. S. Fish and Wildlife Service, 1992).

Arkansas darter

The Arkansas darter is a federal candidate species that occurs in the Arkansas River drainage in Missouri, Colorado, Kansas, Arkansas, and Oklahoma. This darter is a small, strongly bi-colored fish (upper half dark brown, lower half white to orange). Within the vicinity of the project, it occurs in northeastern Oklahoma and northwestern Arkansas. This fish inhabits spring-fed creeks and headwaters with abundant herbaceous aquatic vegetation such as watercress *Nasturtium officinale*.

Vertebrates: Birds

Interior Least Tern

The endangered interior least tern inhabits major river systems in the interior United States. Reasons for the decline of this species include anthropomorphic causes (U. S. Fish and Wildlife Service, 1990) such as impoundments and irrigation, overgrowth of vegetation, the recreational use of sandbars by humans, and flooding of nesting areas caused by unpredictable water discharge patterns below reservoirs (U.S. Fish and Wildlife Service, 1993). Low river flows that result in a land bridge between river islands and the streambank also can adversely impact terns by facilitating predator and human access to nesting sites.

The interior least tern nests on sandbars and sandy islands of major rivers and sandy shorelines of reservoirs. Within the project area, interior least terns forage and nest along the Arkansas River in Oklahoma and Arkansas from April through late August to early September. Terns nest in small colonies and prepare nests by making small scrapes in the sand where two or three eggs are usually laid. Both parents feed the young, which are fairly mobile upon hatching.

Terns prey on small fish, crustaceans, and insects. They prefer to forage in shallow water habitats on small surface schooling fish (2.0 to 9.0 cm long for adults and 1.5 to 4.0 cm long for chicks) (Atwood and Minsky, 1983; Schweitzer and Leslie, Jr., 1996; Wilson et al., 1993). They are considered "surface plungers" (Erickson, 1985) because they hunt for prey while hovering five to ten meters over water bodies, and plunge into the water to capture the fish. Distance to water bodies with available food highly influences reproductive success. Density of surface schooling fish and aquatic vegetation, and water transparency affect the suitability of an area for this species (Schweitzer and Leslie, Jr., 1996).

Interior least terns nest within three main areas in the Oklahoma portion of the study area: 1) the Arkansas River between Kaw Dam and Keystone Lake, 2) the Arkansas River between Keystone Dam and Muskogee, Oklahoma, and 3) the Canadian River between Eufaula Dam and the upper end of Robert S. Kerr Lake. Nesting populations are monitored annually by the Corps, Tulsa District, in accordance with the Service's Biological Opinion on the effects of the operation of Keystone and Kaw Reservoirs on this species. The Corps, Tulsa District, and the Service update specific management practices and guidelines on a continual basis to account for annual variations in nesting patterns and water management needs.

In Arkansas, nesting locations vary between years depending upon river conditions. Nesting areas observed in 2004 were at river miles 32, 35, 38, 42, 100, 105,106, 147, 151, 161, 170, 175, 188, 189, 232, 239, and 282. Management practices in Arkansas include restrictions on dredging near nesting areas, notching dikes, and building new islands using dredged material.

Whooping crane

The whooping crane is a tall, mostly white migratory bird with red facial skin. This species utilizes freshwater marshes, wet prairies, shallow lakes, lagoons, salt flats, and grain fields during the summer and during their spring and fall migration period. Whooping cranes occur in coastal marshes, salt flats, and along barrier islands during the winter. They feed on insects, crustaceans, and berries during the summer. During the winter, their diet consists of grains, insects, crustaceans, mollusks, fish, reptiles, and marine worms (U.S. Fish and Wildlife Service, 1986).

The whooping crane was once widespread over North America. However, it has declined drastically primarily due to 1) the loss of nesting and wintering habitat to agriculture, 2) human disturbance of nesting areas, and 3) uncontrolled hunting. Other causes for their decline include disease, natural events such as storms, and collision with power lines (U. S. Fish and Wildlife Service, 1986; NatureServe, 2003).

Currently, the only self-sustaining population consists of about 200 individuals. This population breeds in one small area in Canada and winters primarily along the Texas coast. These cranes migrate each spring and fall between their breeding and summer grounds primarily through the Great Plains area of the central United States. Their migration route includes western Oklahoma. Salt Plains NWR is a very important stopover area for this population of migrating whooping cranes and is designated critical habitat. The whooping crane is considered a migrant through the study area in the following five Oklahoma counties: Osage, Rogers, Tulsa, Muskogee, and Wagoner.

Bald eagle

The bald eagle was once declining due to pesticide-induced reproductive failure, loss of habitat, and human disturbances such as shooting, poisoning, and trapping, and was originally listed as endangered in 1967. Nationwide, populations have increased due to habitat protection, a reduction in the use of organochlorine pesticides (*e.g.*, use of DDT was banned by the EPA in 1972), and conservation programs. Accordingly, the bald eagle was reclassified as threatened in all 48 conterminous states in 1995. The Service has proposed to remove the bald eagle from the list of Endangered and Threatened Wildlife in the lower 48 states of the United States.

The bald eagle breeds and winters in Oklahoma and Arkansas. Eagles utilize large, mature trees, such as cottonwoods, near rivers and reservoirs for perching and roosting. Trees used for diurnal perching are usually tall, with large diameters and stout branches. Trees used for communal night roosts are usually secluded, and provide protection from adverse weather conditions and human disturbance. Roosting areas are often located near their feeding areas. The eagles along the MKARNS and reservoirs feed mainly on fish, but also may eat waterfowl and carrion.

The MKARNS and associated reservoirs provide suitable habitat for the bald eagle. Eagles are known to occur at each of the 11 Oklahoma reservoirs (and the associated WMAs) that modify flow on the MKARNS. Several of these upstream reservoirs support sizeable concentrations of wintering bald eagles: Keystone, Eufaula, Wister, Grand, Fort Gibson, and Kaw. Bald eagles have used a protected area at Keystone Lake as a communal roost during the winter and spring for over 20 years (U. S. Army Corps of Engineers, 2003). Bald eagles also are known to occur at Sequoyah and Holla Bend NWRs, along the Arkansas River/MKARNS, and at large reservoirs in Arkansas. More than 1,000 bald eagles are counted in Arkansas each winter. Large numbers occur at Lake Dardanelle and the White River National Wildlife Refuge.

Bald eagles are known to nest at numerous locations within the project area, especially along the main stem of the Arkansas River. Bald eagles have occupied over 30 known nests within the study area in Oklahoma during recent years including below Kaw and Keystone dams and along the Canadian River below Eufaula Reservoir. Numerous nests also are documented from the Arkansas River Valley in Arkansas.

Piping Plover

The piping plover is a small migratory shorebird with a tan back and white belly. The plover has bright yellow legs that distinguish it from similar species. The piping plover breeds from southern Canada to the northeastern and central United States along the Atlantic Coast, on the Northern Great Plains, and around the Great Lakes. Breeding habitat consists of sparsely vegetated, sandy shores of lakes, ponds, and rivers. The plover winters along the southern Atlantic and Gulf coasts, and in the Bahamas and West Indies. Non-breeding habitats include ocean beaches and sand, mud, and algal flats (NatureServe, 2003). Piping plovers use sandy rivers, reservoir beaches and mudflats during migration. Some birds may fly nonstop between breeding and wintering grounds.

Threats to this species are primarily human induced. Drastic declines have occurred due to loss of beach habitat resulting from recreational and commercial development, unfavorable water management, and the modification of riverine habitat through channelization and the construction of dams. The Great Lakes population is endangered. Populations in the northern Great Plains, along the Atlantic and Gulf coasts, in the Bahamas, and west Indies are considered threatened.

The threatened northern Great Plains population migrates through the study area in Oklahoma each spring and fall. They are known to use the Winganon Flats, a shallow water mudflat area at Oologah Reservoir, during their migration (U.S. Fish and Wildlife Service, 1993).

Ivory-billed woodpecker

The ivory-billed woodpecker was recently rediscovered in the Cache River NWR in Arkansas after being presumed extinct for more than 60 years. Following credible sight reports from the NWR, an intensive year long survey for the species resulted in the rediscovery, including feeding marks, and audio and video recordings.

The ivory-billed woodpecker historically occurred in mature, bottomland hardwood forests in the southeastern United States and Cuba. The woodpecker primarily feeds on beetle larvae found beneath the bark of recently dead trees. The usual feeding method consists of the bird using its bill to strip away pieces of bark to locate beetle larvae and tree boring insects (Jackson, 2002).

The ivory-billed woodpecker nests in a cavity in a dead or partly dead tree. No data exists pertaining to the incubation period, but it may be similar to other woodpeckers, which generally have a short incubation period of about 10 – 15 days (Jackson, 2002).

The Department of the Interior has created the "Corridor of Hope Conservation Plan" to save the ivory-billed woodpecker. The "Corridor of Hope" refers to the Big Woods of Arkansas, an area about 120 miles long and up to 20 miles wide in eastern Arkansas where the Ivory-billed woodpecker has been sighted.

The Interior Department, along with the Department of Agriculture, has proposed that more than $10 million in federal funds be committed to conserve the bird. This amount would supplement $10 million already committed to research and habitat protection efforts by private sector groups and citizens, an amount expected to grow once news of the rediscovery spreads. Federal funds will be used for research and monitoring, recovery planning and public education. In addition, the funds will be used to enhance law enforcement and conserve habitat through conservation easements, safe-harbor agreements and conservation reserve agreements.

Vertebrates: Mammals

Indiana Bat

The endangered Indiana bat is a grayish-brown migratory bat with blackish brown wing membranes and ears. This bat occurs in the Midwest and the eastern United States. The western edge of the Ozark region in Oklahoma marks the western limit of their range. Indiana bats migrate between winter and summer areas. They hibernate in caves during the winter and occur in wooded areas near streams during the summer. They mate during fall before they enter hibernation while swarming around cave entrances.

Indiana bats require specific temperature and humidity conditions within caves for hibernation. Consequently, the entire species concentrates in only those caves that provide the appropriate conditions for hibernation. While hibernating, they congregate into tight clusters of hundreds or thousands of individuals. Most bats leave their hibernation caves in March and April.

Rivers and streams and their associated vegetated riparian zones and floodplains provide important summer foraging habitat (Humphrey et al., 1977; U. S. Fish and Wildlife Service, 1985). Indiana bats prey on flying insects such as moths, beetles and flies (Humphrey et al., 1977; Black and LaVal, 1985). During summer, maternity colonies roost under tree bark or in hollow trees usually near streams. Males tend to forage over floodplain ridges and hillside forests. They roost in caves (Humphrey et al., 1977; Humphrey, 1978; U.S. Fish and Wildlife Service, 1993).

The Indiana bat has declined primarily due to human disturbances. These disturbances include commercialization of roosting caves, destruction of caves by vandals, disturbance to hibernating bats and pregnant females (disturbances can result in death of hibernating adults in winter and abortion of young in the summer), and possibly insecticide poisoning. About 87% of the species hibernates in only seven caves. Therefore, the Indiana bat is especially vulnerable to human disturbance during winter (U. S. Fish and Wildlife Service, 1983). Another probable factor in Indiana bat decline is loss of summer habitat such as native forest along waterways (NatureServe, 2003).

The Indiana bat is a migrant through the project area and may occur in riparian and floodplain habitats in the project area during the summer. This species utilizes limestone caves in northern Arkansas and sandstone talus caves south of Lake Wister in the Winding Stair Mountain National Recreation and Wilderness Area, Leflore County, Oklahoma, during the winter hibernation period (Saugey et al., 1990). Summer caves are not known to occur in the project area.

Gray bat

The endangered gray bat is a medium sized bat that occupies a limited geographic range in limestone karst regions of the southeastern United States. Populations are found mainly in Alabama, northern Arkansas, Kentucky, Missouri, and Tennessee. Gray bats also occur in Florida, western Georgia, southeastern Kansas, southern Indiana, southern Illinois, northeastern Mississippi, western Virginia, and northeastern Oklahoma (Barbour and Davis, 1969; Tuttle, 1979).

Gray bats utilize caves year round (Tuttle, 1976). They migrate seasonally between maternity and hibernacula, where mating occurs (U.S. Fish and Wildlife Service, 1993). Only a small percent of the caves within the bat's range provide needed conditions for hibernation (Tuttle, 1979). Consequently, about 95% of the known gray bat population hibernates in only nine caves each winter with more than half utilizing a single cave. Gray bats enter hibernation some time between September and November and emerge in late March or April to migrate to summer caves. Summer caves are typically located within 1 km of lakes and rivers. Undisturbed colonies contain from 5,000 to 250,000 or more bats, while most colonies number between 10,000 and 50,000 bats (Tuttle, 1979).

Gray bats feed on insects almost exclusively over water along reservoir edges and rivers and, to some extent, in adjoining riparian forest canopy during spring and summer. They also use associated forest canopy as a travel corridor and escape route between caves and feeding sites. This behavior provides protection from predators such as owls (U.S. Fish and Wildlife Service, 1982).

The major reasons for the gray bat's decline are human disturbance and habitat or environmental disturbance such as introduction of pesticides, impoundment of waterways, cave commercialization, improper gating, and natural calamities such as cave-ins (Tuttle, 1979). Due to the gray bat's preference for caves near rivers, flooding of caves as a result of man-made impoundments also can be problematic. For example, in summer bats often will move deeper into caves and select areas over water to avoid human disturbance. These areas are more likely to be affected by rising water levels (Tuttle, 1979).

The total gray bat population is estimated at 1,575,000 individuals. Due to conservation measures such as the acquisition of priority caves, many populations are now stable or increasing.

In Oklahoma, gray bats occur in five summer maternity caves in Delaware, Adair, Ottawa, and Cherokee counties. These caves support about 60,000 to 70,000 bats. Known maternity caves are located in close proximity to Tenkiller, Grand, and Fort Gibson reservoirs. Gray bats utilizing these caves likely forage along the reservoir margins, the Illinois and Neosho rivers, and associated streams. These bats migrate to southern Missouri and northern Arkansas to hibernate during the winter.

Ozark big-eared bat

The endangered Ozark big-eared bat is a medium sized, cave dwelling bat with distinctively long ears and facial glands on either side of the face. The bat is endemic to the Ozark region where it inhabits limestone and sandstone caves in oak–hickory Ozark forest (Clark, 1991; U. S. Fish and Wildlife Service, 1995). Ozark big-eared bats often forage in edge habitat between forested and open areas (Clark et al., 1993; Wethington et al., 1996*)* Their diet consists primarily of moths and other flying insects such as flies and beetles (Clark, 1991).

Caves used by the Ozark big-eared bat occur in a variety of surroundings, ranging from large tracts of contiguous forest to smaller forested tracts adjacent to open areas. Ozark big-eared bats do not migrate. They generally return to the same maternity caves and hibernacula each year. Maternity colonies begin to form in late April to early June (Clark, 1991). Ozark big-eared bats hibernate in locations with high humidity and cold temperatures in areas of total darkness deep within a cave, but they also have been known to occasionally hibernate in twilight areas near the entrance (Clark, 1991; Clark et al., 2002). They usually hibernate in clusters of up to 100 individuals, but also will hibernate in small groups or even singly (Clark et al., 1996).

The vulnerability of the geographically isolated Ozark big-eared bat to extinction is high because of its susceptibility to disturbance. Fragmentation and loss of habitat, vandalism, and increased human activity in maternity roosts and hibernacula have caused population declines (U. S. Fish and Wildlife Service, 1995). Recent counts indicate a population of roughly 1,800 individuals in eastern Oklahoma and about 500 in western Arkansas.

The Ozark big-eared bat was historically found throughout the Ozarks in southern Missouri, Arkansas, and northeastern Oklahoma. However, today this species is found only in Arkansas and Oklahoma (Elliot et al., 1999; U. S. Fish and Wildlife Service, 1995). In Arkansas, the bats are known to primarily occur in Marion, Crawford, and Washington counties. They also occur in Franklin County, and potentially may occur in Benton, Searcy, Logan, Newton, Johnson, and Madison counties. In Oklahoma, Ozark big-eared bats occur in Adair, Delaware, Cherokee, Ottawa, and Sequoyah counties. Caves in Adair County support some of the largest maternity colonies and numbers of hibernating Ozark big-eared bats. Except for a small portion of Spavinaw Creek, in Delaware County, Oklahoma, Ozark big-eared bat caves are not associated with any major water bodies in the project area.

Plants

Harperella

Harperella is an endangered, annual herb with slender stems, small white flowers, and hollow, quill like leaves. It is known to occur in two habitat types: 1) rocky/gravel shoals of swift, clear streams, and 2) the edges of intermittent pine-land ponds. This species is dependent on a narrow range of hydrologic conditions. Causes for its decline include alterations of water regime from use changes and impoundments, water withdrawal, upstream development, and the draining or deepening of ponds. Harperella is currently known to occur in only 13 extant populations, including populations in Yell and Scott counties, Arkansas (NatureServe, 2003). However, this species is not likely to occur along the MKARNS due to numerous impoundments and the highly modified water regime.

Geocarpon minimum

Geocarpon minimum (no common name) is a small succulent annual plant that is known to only occur at 53 sites in Missouri, Louisiana and Arkansas, including a small population in Franklin County, Arkansas. This threatened species typically occurs on sandstone glades and saline prairies. Typical sites are high in sodium and magnesium and are low in species diversity. This plant completes its entire life cycle within a four week period during spring. Threats include habitat modification, trampling and grazing by livestock, and off-road vehicle use. The species is vulnerable to extirpation due to its limited range and limited available habitat (NatureServe, 2003). Although the species occurs within the project area, it is not likely to be found along the MKARNS.

Western prairie fringed orchid

The threatened western prairie fringed orchid is a perennial herb that produces a tall white inflorescence. It occurs in moist areas in tallgrass prairie or sedge meadows in western portions of the tallgrass region of North America. The orchid once occurred in the vicinity of the project area. However, it has experienced a drastic decline due to conversion of habitat to cropland and pasture, and overgrazing. Currently, extant populations are found from 172 known locations in Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and Manitoba, Canada (NatureServe, 2003; U.S. Fish and Wildlife Service, 1993).

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APPENDIX C

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Concept Paper: Fish and Wildlife Conservation Feature

Concept Paper

May 27, 2005

Arkansas River Navigation Project Mitigation Proposal and the Arkansas River Conservation Initiative

Monitoring Arkansas River Resources Stations (MARRS) & Arkansas River Valley Resource Complex (ARVRC)

Background : The Arkansas River Navigation Study (Impacts and Assessment)

The U.S. Army Corps of Engineers is in the process of finalizing the Arkansas River Navigation study to consider deepening the navigation channel for the entire length of the McClellan-Kerr Arkansas River Navigation System (MKARNS) in Arkansas and Oklahoma. If authorized, the project will increase the depth of the navigation system from 9 feet to 12 feet for approximately 445 miles from the confluence with the Mississippi River to the Port of Catoosa on the Verdigris River near Tulsa, Oklahoma.

Achieving a 12-foot channel will require additional removal of approximately 10,985,340 cubic yards of dredge material at 140 locations along the MKARNS and disposal into 68 new aquatic and terrestrial dredged material disposal sites encompassing 10,189 acres. Gravel bar surveys indicate that 165 acres of gravel could potentially be lost. This represents the removal of the last remaining shoal habitat within the main channel of the lower Arkansas River and additional loss of backwater habitats. The project would remove shoaling areas to increase the navigation channel depth, however, the inadvertent consequence of this project will be the removal of most of the main channel shoals and the further cumulative loss of backwaters along the entire length of the navigation system.

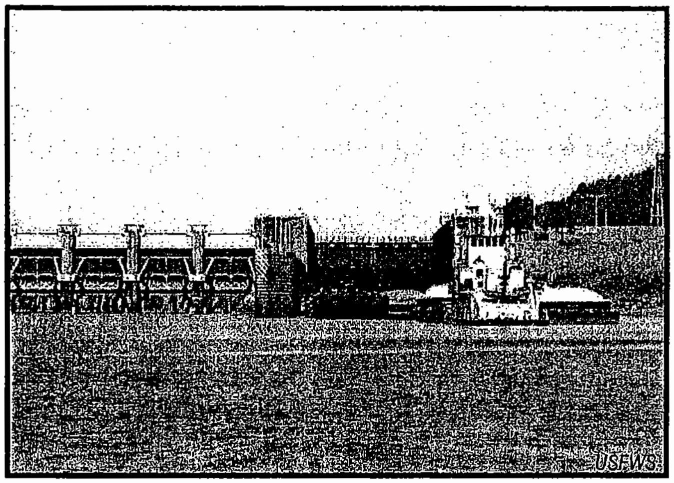
Shoals on the Arkansas River are typically composed of gravel and sand substrates which are important habitat for numerous fish species. In addition, they play an important role in the water quality, hydrology, and morphology of the river. What effect the removal of most of the existing main channel shoal habitat will have on fish species, communities, and ecosystems is uncertain. Gravel is a finite resource, and any impacts from dredging should be a primary concern because of the inherent habitat value of gravel to water quality and aquatic species. Conservation of these species and the cumulative loss of gravel substrates due to dredging and channelization fully justify creation or relocation of gravel as a mitigation technique. The goal of the mitigation should be to have no net loss of gravel by relocating gravel that is dredged to a suitable site within the project area.

Disposal of dredged material in backwater habitats will have significant impacts. Results from the aquatic habitat impacts analysis illustrates a positive relationship between fish abundance and the depth of dike pools. Reducing water depth in a dike field through dredged material disposal and new training structure construction and modifications would have major adverse impact to fishes. Additional loss of backwater habitats could have substantial impacts on fish abundance and diversity.

In total impacts will result in the loss of 1066.2 average annual habitat units (AAHU) and mitigation benefits will yield 636.8 AAHU. Therefore, a net mitigation deficit of 429.4 AAHU remains following exhaustive efforts to avoid, minimize, and mitigate in-kind.

Most of the data and mitigation planning required for impacts from dredging, aquatic and terrestrial dredge

The Arkansas River winding through rural Arkansas downstream of Ozark. Corps owned riparian buffers maintain a 445 mile corridor of habitat and wildlife along America's sixth longest river in Arkansas and Oklahoma.



A grain barge enters the Dardanelle Lock headed up river. By deepening the channel barges will be able to operate more efficiently, saving energy and money. However, environmental costs must be fully mitigated.

disposal, loss of fresh water mussels, and affects to threatened and endangered species has been completed. However, the mitigation deficit for aquatic impacts, the need for long term monitoring, and the ability to adaptively mitigate and manage the system based on results of the monitoring is essential to this project. Many unforeseen impacts may be identified through monitoring and some assessments may have been under- or over-estimated, thus requiring more or less mitigation in the future. In addition, mitigation techniques and sites may require modification to ensure success. There is little precedence for relocating or creating habitats and maintaining mitigation sites on a large river ecosystem of this magnitude. Maintenance of the mitigation features is essential to compensate for the perpetual losses resulting from maintenance of dikes, dredging, and disposal necessary to sustain a 12ft channel.

The consequences of large scale and long term changes to an entire river ecosystem are difficult, if not impossible, to completely predict. The extent of the impact may be predicted and quantified in acres and cubic yards of sediment to be removed and disposed, however, assessing and quantifying the direct, indirect, short, and long term impacts of habitat alteration and loss to an entire ecosystem is a practical impossibility. Further replacement of these habitats through one time in-kind mitigation may not be an option, as available habitat for restoration is limited. Mitigating out-of-kind will not benefit or restore the habitats or the fish and wildlife resources affected, therefore, fully assessing and quantifying the effects of the project and providing applicable mitigation to fisheries will require innovative and long term monitoring and subsequent mitigation and adaptive resource management to fully compensate for project impacts and to restore the Arkansas River ecosystem.

The Service believes that a long term monitoring plan is essential to addressing these uncertainties and evaluating the success of the proposed mitigation. Completion of the navigation project will likely take 4-6 years and for many years following the project will require extensive maintenance adjustments. Likewise, effective and viable mitigation will require additional maintenance to ensure success.

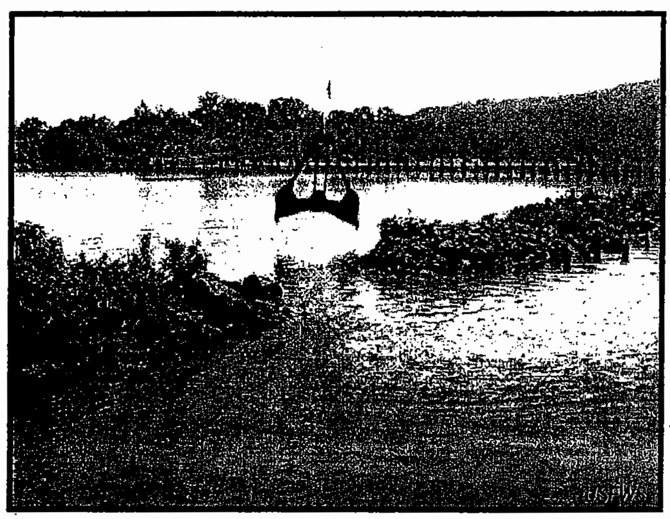
Feasibility

Currently the feasibility of the project based on cost:benefit assessment is uncertain. However, combining wildlife conservation with navigation as coequal project goals would allow for inclusion of economic benefits resulting from recreation and tourism dollars to be included in the feasibility calculations.

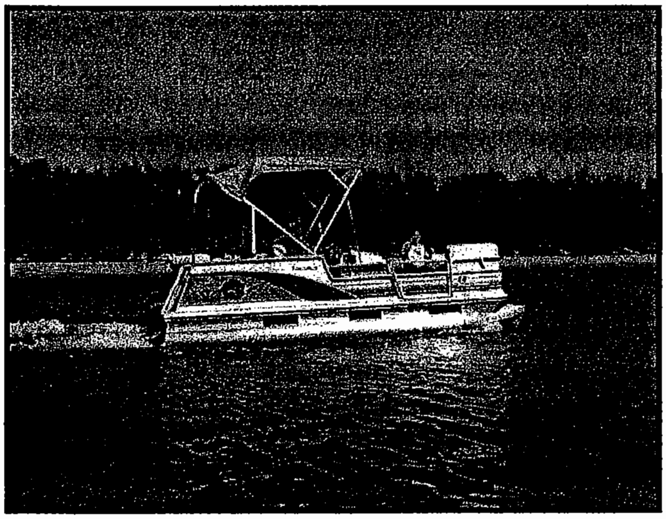
The Corps has the ability to seek full Congressional authorization and funding for an "Environmental Management Program" in order to include ecosystem restoration under section 906(b) of WRDA 1986 and section 306 of WRDA 1990. Furthermore, this goal is supported by the Fish and Wildlife Coordination Act and other authorities that have established fish and wildlife conservation as a coequal purpose of water resource development projects by stating "wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs".

Alternative Models

The Upper Mississippi River National Wildlife and Fish Refuge and the Long Term Resource Monitoring Program are perfect examples of monitoring, mitigating,



Backwater habitat restoration through dike notching is already happening along the river and the mitigation plan calls for more to be done. However, the number of dikes available for notching as mitigation and the ability to maintain these important fisheries habitats into the future is uncertain.



Recreational fishing and boating is popular with many locals and fishing tourists, however, recreational businesses, shoreline accessibility, river viewing, and other recreational and educational opportunities are lacking.

restoring, and managing natural resources on a large river ecosystem. The Upper Mississippi River NWFR is the longest refuge in the lower 48 states, extending 261 miles along the Mississippi River. It was established in 1924 to protect bottomland habitat for migratory birds and fish.

The Upper Mississippi River NWFR provides essential habitat for a wide variety of plants, fish, migratory birds, and other animals. Over 3 million people visit the refuge and contribute an estimated $1 billion in recreational benefits to the region. Its attractiveness to recreationalists is directly related to its rich fish and wildlife populations and natural scenic beauty.

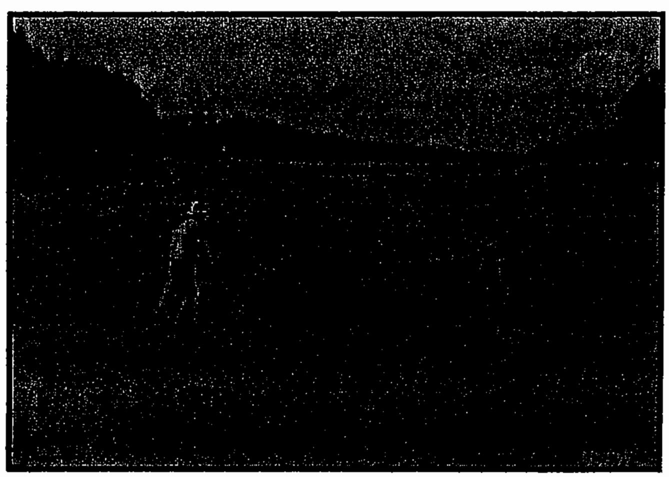
An integral part of maintaining and monitoring this system and the effects of the navigation project is the Long Term Resource Monitoring Program. The program was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The program is implemented by the U.S. Geological Survey (USGS) in cooperation with the five Upper Mississippi River System states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), with guidance and overall program responsibility provided by the U.S. Army Corps of Engineers. A directive outlining the mode of operation and the respective roles of the agencies is embodied in a 1988 Memorandum of Agreement (MOA).

In the 1986 WRDA, Congress recognized the Upper Mississippi River System as nationally significant both ecologically and economically and furthermore appropriated funding for this program. The mission of the program is to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable multiple-use large river ecosystem. The long term goals of the program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.

The Arkansas River Opportunity

The Corps of Engineers presently owns over 5,000 acres of closed, closing, and/or undeveloped parks at 49 locations along the length of the navigation system in Arkansas and Oklahoma. Many of these parks have existing roads and infrastructure such as trails, benches, boat ramps, and toilets, while others are entirely forested or in pasture. These parks range in size from a few acres to over 100 acres with most averaging around 20 acres. The Corps does not manage these areas for fish and wildlife, nor are they open to public access accept by boat or foot. Most of these areas provide limited or no recreational, educational, or management opportunities under the Corps' ownership.

The Corps also owns over 50,000 acres of islands and floodplain lands, which are important riparian habitats and serve as an invaluable buffer along the river. As with the park lands, neither the islands, riparian floodplains, the associated habitats, nor the wildlife within them are managed for recreation, education, enhancement, protection, or restoration. Generally, budget restrictions have prevented the Corps from more detailed management of these sites. The Corps could use the authorities provided under the 1986 and 1990 WRDAs to seek authorization and funding for an "Environmental Monitoring and Management Program".



Coordinating research and management of backwater waterfowl habitat, fisheries, and nurseries will prevent species extirpation and enhance non-game and game waterfowl and fisheries conservation.

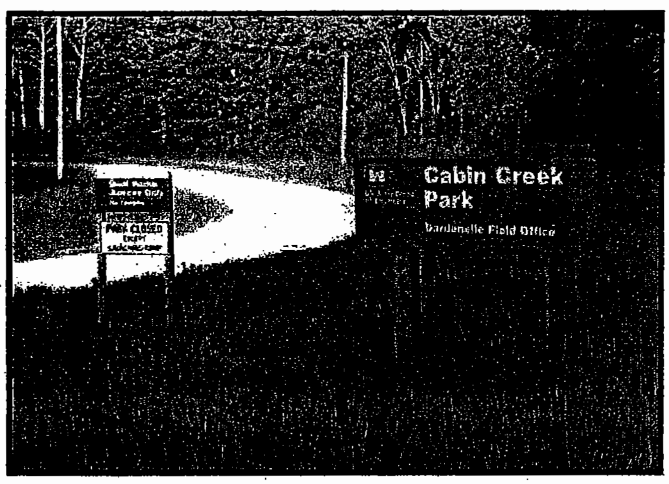
The MARRS Concept

The Arkansas River Navigation Study will have numerous impacts on both terrestrial and aquatic ecosystems, with limited opportunity for in-kind mitigation. One option would be to follow the model of the Upper Mississippi River and mitigate for these impacts through the creation of the Monitoring Arkansas River Resources Stations (MARRS), which would identify aquatic resource mitigation and management needs through long term monitoring for application of future adaptive management and mitigation based on coordinated and cooperative research among resource agencies.

With proper funding management of closed and/or undeveloped parks could be transferred to state or federal natural resource agencies as part of the mitigation package to establish a series of biological monitoring stations through property transfer or MOA. The MARRS stations could be constructed incrementally along the river to provide a comprehensive and coordinated monitoring system. With cooperation of the Arkansas and Oklahoma state wildlife resource agencies and the state university systems these sites could be operated and maintained by the state universities. Research and monitoring for the entire length of the navigation system can then be coordinated and administered by the state and federal resource agencies to provide a comprehensive assessment of the project impacts over time and to expand our knowledge and understanding of the Arkansas River and large river ecosystems.

The Universities of Arkansas (UA) at Monticello, UA at Pine Bluff, UA at Little Rock, University of Central Arkansas (Conway), Arkansas Tech University (Russellville), UA at Fort Smith, Oklahoma State University at Okmulgee, Tulsa University, and the University of Oklahoma at Tulsa are ideally located to provide the necessary students, staff, and expertise. Many of these universities have established programs capable and willing to perform this function, but currently lack the coordination, funding, and facilities to conduct such monitoring and research.

Education, tourism, and visitor's centers are few a far between along the nation's 4th longest river. Interstate 40 provides the access and the river is the attraction, what people need is a way to experience it and learn.



One of the many parks closed due to budget restraints. An all too familiar site for local users and tourists. Closing parks affects local economies and parks are often the only tourist attraction and public recreational resource for small rural communities. Conservation is directly related to use.

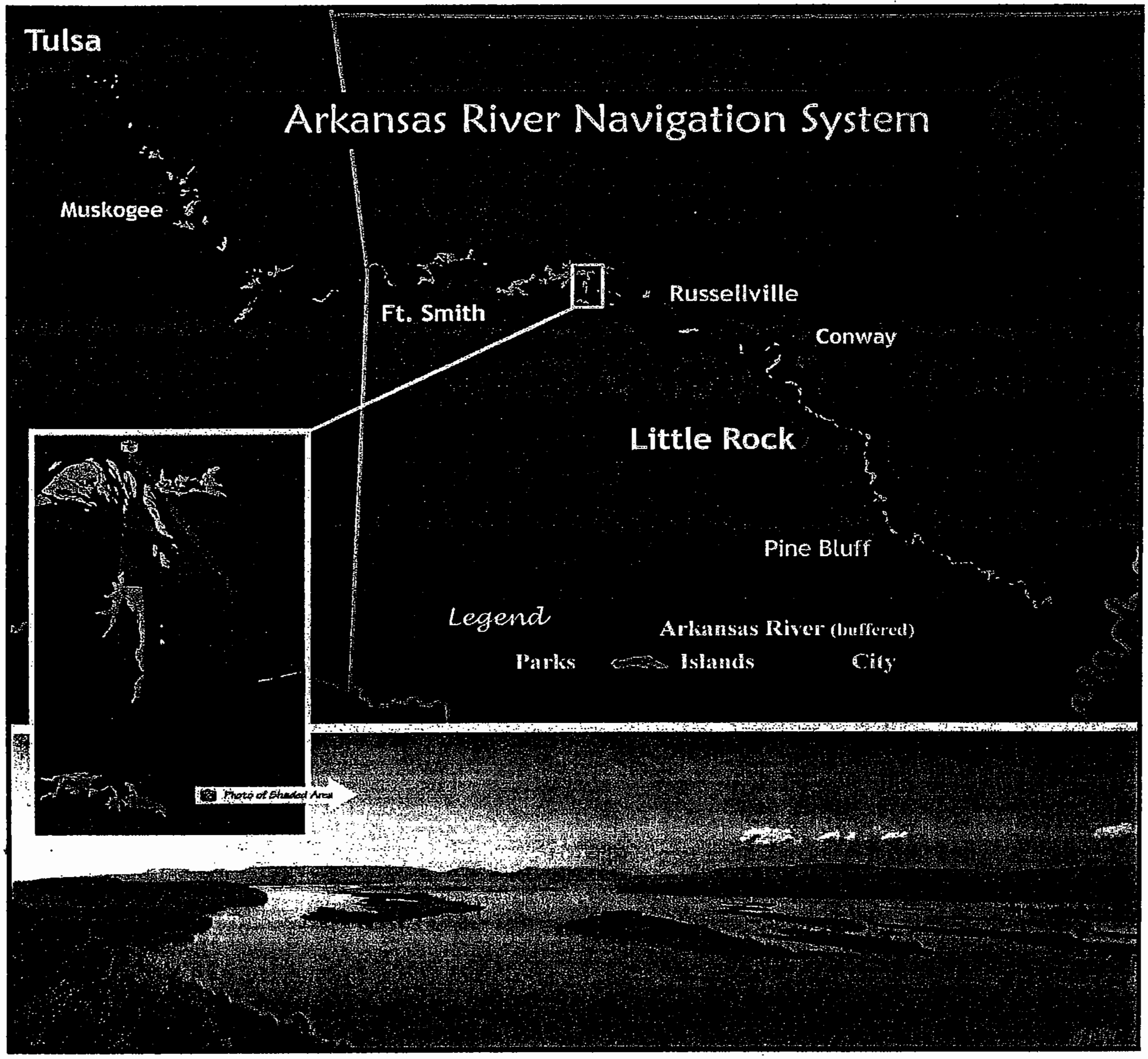
Facilities for these stations could be constructed as part of the out-of-kind mitigation for aquatic impacts to provide the necessary laboratories and housing for staff and students to provide long term monitoring, implement reasonable and prudent measures, and to produce the data to support recommendations for future adaptive management and mitigation.

The ARVRC Concept

In addition to the park areas there are over 50,000 acres of additional lands and islands within the Corps owned floodplains along the Arkansas River Navigation System that are potentially available for transfer to conservation organizations, state, and/or federal resource agencies in either ownership, easement, and/or management through an MOA. These areas are important wildlife habitat, riparian buffers, and wetlands that could be managed as mitigation for this project or independently as a measure to simply improve management, conservation, and protection of fish and wildlife resources, including five threatened and endangered species.

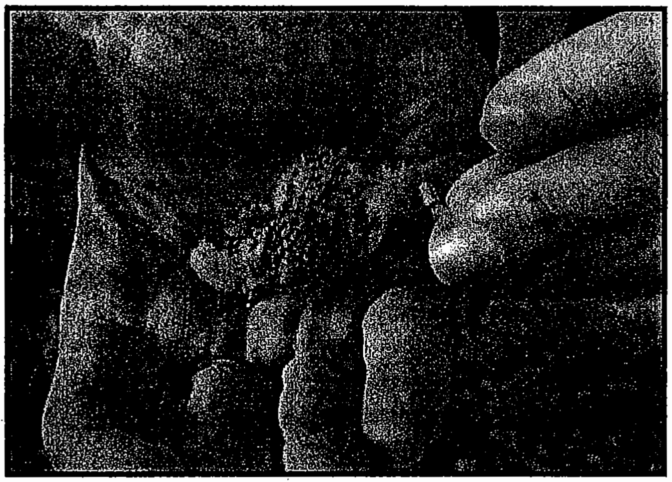
These islands and the floodplain riparian corridor stretching over 445 miles and encompassing a significant amount of habitat within the Arkansas River Valley could either become part of the National Wildlife Refuge (NWR) system, National Park System, state wildlife

The blue area indicates the Arkansas River Navigation System from the Arkansas/White River confluence with the Mississippi River to the Port of Catoosa on the Verdigris River near Tulsa, Oklahoma; red areas indicate closed or undeveloped Corps parks; and yellow areas indicate islands and large floodplain Corps lands. Magnification of the Lake Dardanelle project area within the inset provides greater detail of Corps parks and lands. The photo inset illustrates the Corps owned islands within the area known as the Spadra Straits on Lake Dardanelle, Arkansas River, Arkansas.



management areas, state parks, and/or a non-governmental organization conservation areas. Another option would be to coordinate and manage these lands in cooperation with the over 489,000 acres of existing state conservation areas, wildlife management areas, Department of Defense lands, and White River, Sequoya, and Holla Bend NWRs as the Arkansas River Valley Resource Complex (ARVRC). The ARVRC would be the longest conservation complex in the lower 48 states, manage most of the Arkansas River Valley ecoregion, and cross two states.

The MARRS stations, in addition to biomonitoring the river, could assist with the wildlife, habitat, and recreational research and management of these areas, and serve as public education/visitor centers along the Arkansas River corridor in Arkansas and Oklahoma. The ARVRC could provide improved management and habitat conservation for game, T&E species, and migratory birds. In addition, this complex will promote tourism through improved recreational opportunities and accessibility along the shorelines of the river. In the end this complex could provide the long term coordinated biological assessment, mitigation, and balance the Arkansas River Navigation Project needs, while improving the fish and wildlife resources, accessibility, tourism, economics, and educational opportunities along the Arkansas River.



Riparian habitat research and least tern tagging by Arkansas Tech University students are a few examples of how the MARRS stations, in addition to biological monitoring, will provide the universities and the resource agencies with research and conservation centers to expand our knowledge and ability to conserve ecosystems and species.

Monitoring, Mitigating, and Adaptive Management

The Service believes that a long term monitoring program is necessary to address the uncertainties in predicting impacts and success of proposed mitigation projects. Completion of the navigation project will take 4-6 years and for many years following the project will require extensive maintenance adjustments.

A monitoring program has been recommended that includes both biological and engineering studies. These studies address sediment dynamics in dike fields and backwaters, developing a better understanding of biological responses of fish and other aquatic organisms to dike modifications such as notching, field surveys of gravel bar characteristics and fish utilization, potential of headcutting and associated impacts to fish in tributaries, water quality monitoring, and habitat assessments to determine if the impact predictions were accurate, if mitigation worked, and make recommendations for further mitigation needs if necessary. Furthermore, a more detailed monitoring program should be developed in cooperation with state and federal agencies to insure that each of these issues is addressed in detail.

Monitoring and assessing the gravel habitat relocations for sustainability and viability is essential to insuring successful mitigation. Dike notching and island creation may succeed initially in restoring backwaters and a braided channel to the river, but there are no guarantees that these areas will remain and function as designed. Unlike the navigation channel there are no funds currently planned for adaptive management, mitigation, or maintenance. Understanding how the river functions and which mitigation measures work will require observation and the ability to adapt techniques and strategies.

The Service believes that at least 10 years of monitoring is necessary to fully assess all aspects of the project and mitigation. Some components will not require monitoring in consecutive years and may be broken up into incremental assessments as warranted. Pre-construction baselines and post-construction assessments are essential. A partial baseline assessment has been completed, however, completion of the project will take many years allowing for time to complete baseline and seasonal studies. In addition, it is essential that the details of the monitoring plan be coordinated with the resource agencies to insure consensus and a comprehensive assessment.

In general, the monitoring plan should include:

1 - Sediment dynamics in dike fields and backwaters
- Bathymetry
- Substrate sampling
- Lidar, GIS
- Headcutting assessment

2 – Relationships between fish diversity and physicochemical characteristics of dike fields and backwaters
- Seasonal sampling in trend pools
- Water quality sampling
- Comparison of notched and un-notch dikes
- Comparison of mitigation and reference sites

3 - Potamological characteristics of impacted and mitigated gravel bars
- Substrate borings and classification (1-year only)
- Substrate profiling (3-years)

4 - Seasonal use of gravel bars as fish spawning, feeding, and resting areas
- Comparison of natural and mitigated bars
- Limited invertebrate sampling

5 - Habitat characteristics and fish communities in tributary mouths of the Arkansas River

6 - Mussel assessment and relocation monitoring

A net mitigation deficit of 429.4 AAHU remains following exhaustive efforts to avoid, minimize, and identify up front in-kind on-site mitigation. The Service in cooperation with the Corps, state agencies, and private consultants have identified numerous alternative mitigation sites along the river. These sites include restoring and maintaining fish access to backwaters, notching dikes and revetments, and creating aquatic habitat. Selection of these sites for mitigation should correspond proportionally to impacts by navigation pool and coordinated with the resource agencies. The final mitigation plan should include a description of all of these features.

Considering the expediency of the environmental impact study, the absence of precedence, and a project and innovative mitigation plan of this magnitude it is unlikely that we will achieve "no net loss" of habitat with our initial efforts. It is reasonable to assume that gravel relocation will likely fail in some locations and require additional and costly relocation. It is also reasonable to assume that some dike notches will fail, will require modification, or will require filling to maintain dike integrity. Because of these likely failures adaptive management and continuing implementation of additional mitigation measures is essential.

Ecosystem Restoration

There has been insufficient time to complete an appropriate impact assessment, develop a complete mitigation plan, and include mitigation costs in the feasibility assessment. With monitoring, time, and money a complete assessment can be completed and adequate mitigation can be achieved, however, the feasibility of this project to meet economic and mitigation requirements is currently in question.

Control burns on islands and in riparian areas could improve habitat diversity for migratory birds, reduce dense ground vegetation to restore bottomland hardwood species, enhance game management, and enable access. Oxbows, wetlands, and island ponds could be used for fishing and managed as nurseries with increased accessibility.

Hundreds of miles of bottomland hardwood corridor could be restored to islands and in riparian areas currently fragmented by old fields and early successional habitat dominated by cattail, willows, sycamore, and cottonwoods. Many game species and migratory birds, such as the Ivory-billed Woodpecker, could benefit from reconnecting these fragmented habitats.

There are multiple options for resolving these issues. One option is to extend the EIS to resolve these issues with a complete and comprehensive assessment and mitigation plan as previously discussed prior to finalization of the EIS. Another option is to add ecosystem restoration as part of the project plan. Through ecosystem restoration this project would extend its goal of modifying the river for navigation to include restoring many of the ecological functions that have been lost or are in decline as a result of channelization and impoundments, thereby erasing and surpassing the mitigation deficits with positive environmental benefits. Additionally, ecosystem restoration would benefit recreation and tourism, economies of local communities, and could be included as a project benefit when calculating project feasibility.

In summary, the Arkansas River Navigation Project along with an Ecosystem Restoration Project would benefit energy conservation; national, state, and local economies; education; recreation; and conservation. This is a rare opportunity to recognize the full potential of the Arkansas River as a national resource.

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APPENDIX D

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Reservoir Elevations

Copan Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
712.0	28.89	30.94	30.24	16.90	5.74	2.26
714.0	17.95	22.23	22.18	13.37	4.56	1.30
716.0	11.94	15.24	15.45	10.87	3.08	1.00
720.0	5.50	7.93	8.63	6.20	0.80	0.17
725.0	0.64	2.98	4.68	1.74	0.00	0.00
730.0	0.00	0.76	1.57	0.09	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
712.0	8.7	9.6	9.1	5.2	1.8	0.7
714.0	5.4	6.9	6.7	4.1	1.4	0.4
716.0	3.6	4.7	4.6	3.4	1.0	0.3
720.0	1.7	2.5	2.6	1.9	0.2	0.1
725.0	0.2	0.9	1.4	0.5	0.0	0.0
730.0	0.0	0.2	0.5	0.0	0.0	0.0

Copan Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
712.0	29.01	30.95	30.43	17.03	5.75	2.28
714.0	18.07	22.30	22.20	13.28	4.65	1.30
716.0	11.96	15.45	15.47	10.78	3.08	1.00
720.0	5.41	8.02	8.51	6.14	0.80	0.17
725.0	0.03	2.92	4.72	1.67	0.00	0.00
730.0	0.00	0.76	1.58	0.09	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
712.0	8.7	9.6	9.1	5.3	1.8	0.7
714.0	5.4	6.9	6.7	4.1	1.4	0.4
716.0	3.6	4.8	4.6	3.3	1.0	0.3
720.0	1.6	2.5	2.6	1.9	0.2	0.1
725.0	0.0	0.9	1.4	0.5	0.0	0.0
730.0	0.0	0.2	0.5	0.0	0.0	0.0

Hulah Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
734.0	46.09	51.47	46.08	26.92	10.03	9.73
736.0	37.30	40.17	36.83	19.08	7.55	6.01
738.0	30.16	32.62	29.01	15.23	5.81	4.41
740.0	23.74	26.14	23.68	12.93	4.69	3.17
750.0	2.08	4.91	6.49	3.25	0.67	0.39
760.0	0.00	0.00	0.90	0.10	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
734.0	13.8	16.0	13.8	8.3	3.1	2.9
736.0	11.2	12.5	11.0	5.9	2.3	1.8
738.0	9.0	10.1	8.7	4.7	1.8	1.3
740.0	7.1	8.1	7.1	4.0	1.5	1.0
750.0	0.6	1.5	1.9	1.0	0.2	0.1
760.0	0.0	0.0	0.3	0.0	0.0	0.0

Hulah Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
734.0	46.09	51.37	46.18	27.12	10.23	9.84
736.0	37.23	40.07	36.90	19.33	7.83	6.04
738.0	30.16	32.41	29.11	15.33	6.01	4.46
740.0	23.67	26.16	23.68	13.03	4.96	3.17
750.0	2.01	4.91	6.48	3.25	0.67	0.39
760.0	0.00	0.00	0.90	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
734.0	13.8	15.9	13.9	8.4	3.2	3.0
736.0	11.2	12.4	11.1	6.0	2.4	1.8
738.0	9.0	10.0	8.7	4.8	1.9	1.3
740.0	7.1	8.1	7.1	4.0	1.5	1.0
750.0	0.6	1.5	1.9	1.0	0.2	0.1
760.0	0.0	0.0	0.3	0.0	0.0	0.0

Oologah Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
640.0	18.57	24.32	48.77	48.53	16.71	13.62
642.0	10.72	16.42	33.66	32.39	10.44	4.14
644.0	6.04	12.92	16.92	9.41	1.46	0.00
645.0	4.64	11.35	10.55	5.54	0.35	0.00
650.0	2.45	5.81	4.95	2.30	0.00	0.00
660.0	0.00	0.50	1.46	0.28	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
640.0	5.6	7.5	14.6	15.0	5.2	4.1
642.0	3.2	5.1	10.1	10.0	3.2	1.2
644.0	1.8	4.0	5.1	2.9	0.5	0.0
645.0	1.4	3.5	3.2	1.7	0.1	0.0
650.0	0.7	1.8	1.5	0.7	0.0	0.0
660.0	0.0	0.2	0.4	0.1	0.0	0.0

Oologah Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
640.0	17.27	22.27	46.24	48.76	18.95	14.56
642.0	10.51	16.22	32.87	35.86	13.42	5.15
644.0	5.95	13.02	19.94	12.90	2.70	0.28
645.0	4.66	11.39	11.36	5.86	0.36	0.08
650.0	2.40	5.81	4.95	2.35	0.00	0.00
660.0	0.00	0.50	1.45	0.28	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
640.0	5.2	6.9	13.9	15.1	5.9	4.4
642.0	3.2	5.0	9.9	11.1	4.2	1.5
644.0	1.8	4.0	6.0	4.0	0.8	0.1
645.0	1.4	3.5	3.4	1.8	0.1	0.0
650.0	0.7	1.8	1.5	0.7	0.0	0.0
660.0	0.0	0.2	0.4	0.1	0.0	0.0

Kaw Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
1010.0	45.13	64.48	62.10	51.46	10.68	11.00
1012.0	13.01	20.23	21.93	19.45	6.34	5.13
1014.0	8.72	11.67	15.72	13.97	4.10	1.90
1020.0	3.95	6.75	7.86	5.55	2.00	0.08
1030.0	0.94	2.50	2.83	2.19	0.03	0.00
1040.0	0.00	0.58	0.82	0.38	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
1010.0	13.5	20.0	18.6	16.0	3.3	3.3
1012.0	3.9	6.3	6.6	6.0	2.0	1.5
1014.0	2.6	3.6	4.7	4.3	1.3	0.6
1020.0	1.2	2.1	2.4	1.7	0.6	0.0
1030.0	0.3	0.8	0.8	0.7	0.0	0.0
1040.0	0.0	0.2	0.2	0.1	0.0	0.0

Kaw Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
1010.0	44.75	63.83	61.98	52.51	10.50	10.88
1012.0	12.75	19.92	21.47	19.26	6.41	5.26
1014.0	8.42	11.56	15.25	13.87	4.32	2.16
1020.0	3.65	6.75	7.41	5.57	2.08	0.00
1030.0	0.75	2.35	2.85	2.45	0.00	0.00
1040.0	0.00	0.60	0.82	0.31	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
1010.0	13.4	19.8	18.6	16.3	3.3	3.3
1012.0	3.8	6.2	6.4	6.0	2.0	1.6
1014.0	2.5	3.6	4.6	4.3	1.3	0.6
1020.0	1.1	2.1	2.2	1.7	0.6	0.0
1030.0	0.2	0.7	0.9	0.8	0.0	0.0
1040.0	0.0	0.2	0.2	0.1	0.0	0.0

Keystone Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
724.0	32.50	50.71	62.99	59.39	28.60	24.54
726.0	13.17	24.93	49.35	49.01	20.65	14.95
728.0	9.56	18.36	37.09	30.98	12.14	6.21
730.0	7.33	15.83	23.53	16.14	4.94	2.18
740.0	2.70	6.32	5.10	2.21	0.00	0.00
750.0	0.36	2.03	2,90	0.43	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
724.0	9.7	15.7	18.9	18.4	8.9	7.4
726.0	3.9	7.7	14.8	15.2	6.4	4.5
728.0	2.9	5.7	11.1	9.6	3.8	1.9
730.0	2.2	4.9	7.1	5.0	1.5	0.7
740.0	0.8	2.0	1.5	0.7	0.0	0.0
750.0	0.1	0.6	0.9	0.1	0.0	0.0

Keystone Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
724.0	32.44	50.65	63.77	59.97	29.46	24.72
726.0	12.50	24.07	48.53	49.91	21.01	15.83
728.0	10.03	17.86	37.93	33.86	14.07	7.41
730.0	7.66	15.83	26.17	20.79	7.00	2.58
740.0	2.60	6.51	5.10	2.40	0.00	0.00
750.0	0.23	2.03	2.90	0.43	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
724.0	9.7	15.7	19.1	18.6	9.1	7.4
726.0	3.8	7.5	14.6	15.5	6.5	4.7
728.0	3.0	5.5	11.4	10.5	4.4	2.2
730.0	2.3	4.9	7.9	6.4	2.2	0.8
740.0	0.8	2.0	1.5	0.7	0.0	0.0
750.0	0.1	0.6	0.9	0.1	0.0	0.0

Pensacola (Grand) Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
745.0	26.79	31.76	85.97	34.88	8.33	5.27
748.0	5.35	10.90	8.28	4.32	0.21	0.50
749.0	4.16	8.15	6.66	2.77	0.00	0.40
750.0	3.20	6.37	5.44	1.67	0.00	0.20
751.0	2.34	4.63	4.24	0.89	0.00	0.20
752.0	1.65	3.37	3.24	0.22	0.00	0.20

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
745.0	8.0	9.8	25.8	10.8	2.6	1.6
748.0	1.6	3.4	2.5	1.3	0.1	0.2
749.0	1.2	2.5	2.0	0.9	0.0	0.1
750.0	1.0	2.0	1.6	0.5	0.0	0.1
751.0	0.7	1.4	1.3	0.3	0.0	0.1
752.0	0.5	1.0	1.0	0.1	0.0	0.1

Pensacola (Grand) Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
745.0	27.32	30.64	86.05	34.60	8.66	5.47
748.0	5.48	11.03	8.22	4.50	0.23	0.51
749.0	4.26	8.33	6.55	2.87	0.00	0.49
750.0	3.20	6.10	5.44	1.84	0.00	0.20
751.0	2.43	4.68	4.24	1.15	0.00	0.20
752.0	1.55	3.24	3.24	0.27	0.00	0.20

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
745.0	8.2	9.5	25.8	10.7	2.7	1.6
748.0	1.6	3.4	2.5	1.4	0.1	0.2
749.0	1.3	2.6	2.0	0.9	0.0	0.1
750.0	1.0	1.9	1.6	0.6	0.0	0.1
751.0	0.7	1.5	1.3	0.4	0.0	0.1
752.0	0.5	1.0	1.0	0.1	0.0	0.1

Hudson Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
620.0	19.16	20.42	21.75	13.32	6.98	6.69
622.0	9.53	14.76	12.27	7.92	0.75	1.01
624.0	6.09	12.38	8.99	5.19	0.30	0.80
626.0	4.59	9.17	6.88	3.43	0.00	0.40
630.0	1.77	4.68	4.31	1.44	0.00	0.00
635.0	0.00	0.50	0.30	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
620.0	5.7	6.3	6.5	4.1	2.2	2.0
622.0	2.9	4.6	3.7	2.5	0.2	0.3
624.0	1.8	3.8	2.7	1.6	0.1	0.2
626.0	1.4	2.8	2.1	1.1	0.0	0.1
630.0	0.5	1.5	1.3	0.4	0.0	0.0
635.0	0.0	0.2	0.1	0.0	0.0	0.0

Hudson Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
620.0	19.05	20.51	21.07	14.52	7.92	7.35
622.0	9.68	14.81	12.73	8.06	1.05	0.95
624.0	6.09	12.29	9.09	5.19	0.40	0.70
626.0	4.69	9.18	6.83	3.49	0.00	0.40
630.0	1.71	4.38	4.24	1.54	0.00	0.00
635.0	0.00	0.50	0.30	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
620.0	5.7	6.4	6.3	4.5	2.5	2.2
622.0	2.9	4.6	3.8	2.5	0.3	0.3
624.0	1.8	3.8	2.7	1.6	0.1	0.2
626.0	1.4	2.8	2.0	1.1	0.0	0.1
630.0	0.5	1.4	1.3	0.5	0.0	0.0
635.0	0.0	0.2	0.1	0.0	0.0	0.0

Fort Gibson Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
556.0	41.43	37.95	48.75	33.67	11.70	12.41
558.0	18.12	21.18	28.34	16.41	4.66	3.16
560.0	8.34	16.36	16.10	7.95	1.72	0.60
565.0	4.00	10.60	8.00	3.90	0.10	0.10
570.0	2.98	6.84	5.56	2.26	0.00	0.00
580.0	0.00	0.93	1.07	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
556.0	12.4	11.8	14.6	10.4	3.6	3.7
558.0	5.4	6.6	8.5	5.1	1.4	0.9
560.0	2.5	5.1	4.8	2.5	0.5	0.2
565.0	1.2	3.3	2.4	1.2	0.0	0.0
570.0	0.9	2.1	1.7	0.7	0.0	0.0
580.0	0.0	0.3	0.3	0.0	0.0	0.0

Fort Gibson Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
556.0	42.03	37.38	49.20	33.70	12.15	12.23
558.0	16.83	21.07	29.19	19.05	4.96	3.72
560.0	8.50	16.08	16.77	10.21	2.16	1.24
565.0	4.30	10.60	8.00	4.10	0.10	0.10
570.0	2.98	6.82	5.46	2.42	0.00	0.00
580.0	0.00	0.93	1.07	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
556.0	12.6	11.6	14.8	10.4	3.8	3.7
558.0	5.1	6.5	8.8	5.9	1.5	1.1
560.0	2.5	5.0	5.0	3.2	0.7	0.4
565.0	1.3	3.3	2.4	1.3	0.0	0.0
570.0	0.9	2.1	1.6	0.8	0.0	0.0
580.0	0.0	0.3	0.3	0.0	0.0	0.0

Tenkiller Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
634.0	39.66	42.75	49.68	43.06	16.62	8.70
636.0	17.37	22.90	34.52	27.26	8.60	2.41
638.0	8.92	17.19	22.20	11.63	2.78	0.39
640.0	6.91	14.75	13.65	6.08	0.74	0.00
650.0	2.79	7.72	5.33	1.94	0.00	0.00
660.0	1.26	2.37	2.26	0.56	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
634.0	11.9	13.3	14.9	13.3	5.2	2.6
636.0	5.2	7.1	10.4	8.5	2.7	0.7
638.0	2.7	5.3	6.7	3.6	0.9	0.1
640.0	2.1	4.6	4.1	1.9	0.2	0.0
650.0	0.8	2.4	1.6	0.6	0.0	0.0
660.0	0.4	0.7	0.7	0.2	0.0	0.0

Tenkiller Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
634.0	39.47	43.40	48.23	44.21	18.66	9.14
636.0	17.04	22.67	32.46	29.41	9.62	3.30
638.0	8.94	16.89	22.71	15.37	4.45	0.63
640.0	7.05	14.37	14.80	7.74	1.20	0.00
650.0	2.82	7.75	5.32	1.94	0.00	0.00
660.0	1.20	2.36	2.25	0.55	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
634.0	11.8	13.5	14.5	13.7	5.8	2.7
636.0	5.1	7.0	9.7	9.1	3.0	1.0
638.0	2.7	5.2	6.8	4.8	1.4	0.2
640.0	2.1	4.5	4.4	2.4	0.4	0.0
650.0	0.8	2.4	1.6	0.6	0.0	0.0
660.0	0.4	0.7	0.7	0.2	0.0	0.0

Eufaula Lake - Monthly Pool Elevation Duration
Existing Operation

	Percent of Time Elevation Equaled or Exceeded					
Pool Elevations	**April**	**May**	**June**	**July**	**August**	**September**
586.0	23.90	44.88	54.67	45.72	17.01	10.01
587.0	9.99	23.30	36.03	22.89	5.83	2.81
588.0	6.70	16.63	19.81	6.47	1.17	0.92
590.0	4.33	12.15	8.33	3.22	0.36	0.40
595.0	1.45	3.51	3.05	0.45	0.00	0.00
598.0	0.17	0.91	1.25	0.00	0.00	0.00

	Number of Days per Month Elevation Equaled or Exceeded					
Pool Elevations	**April**	**May**	**June**	**July**	**August**	**September**
586.0	7.2	13.9	16.4	14.2	5.3	3.0
587.0	3.0	7.2	10.8	7.1	1.8	0.8
588.0	2.0	5.2	5.9	2.0	0.4	0.3
590.0	1.3	3.8	2.5	1.0	0.1	0.1
595.0	0.4	1.1	0.9	0.1	0.0	0.0
598.0	0.1	0.3	0.4	0.0	0.0	0.0

Eufaula Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

	Percent of Time Elevation Equaled or Exceeded					
Pool Elevations	**April**	**May**	**June**	**July**	**August**	**September**
586.0	24.04	45.58	53.96	46.83	17.79	11.10
587.0	9.90	23.00	35.07	26.70	6.97	2.93
588.0	6.52	16.96	21.26	9.37	1.74	0.86
590.0	4.09	12.19	9.75	3.36	0.39	0.40
595.0	1.45	3.61	3.05	0.45	0.00	0.00
598.0	0.17	0.91	1.25	0.00	0.00	0.00

	Number of Days per Month Elevation Equaled or Exceeded					
Pool Elevations	**April**	**May**	**June**	**July**	**August**	**September**
586.0	7.2	14.1	16.2	14.5	5.5	3.3
587.0	3.0	7.1	10.5	8.3	2.2	0.9
588.0	2.0	5.3	6.4	2.9	0.5	0.3
590.0	1.2	3.8	2.9	1.0	0.1	0.1
595.0	0.4	1.1	0.9	0.1	0.0	0.0
598.0	0.1	0.3	0.4	0.0	0.0	0.0

Wister Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
478.0	90.06	92.52	77.54	48.78	27.93	31.90
480.0	36.32	49.24	34.85	10.56	2.44	2.37
482.0	26.33	38.34	26.58	6.49	1.38	1.53
485.0	16.76	26.55	19.98	4.65	0.61	0.52
490.0	8.58	15.41	12.41	2.74	0.30	0.00
500.0	2.04	5.01	4.04	0.51	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
478.0	27.0	28.7	23.3	15.1	8.7	9.6
480.0	10.9	15.3	10.5	3.3	0.8	0.7
482.0	7.9	11.9	8.0	2.0	0.4	0.5
485.0	5.0	8.2	6.0	1.4	0.2	0.2
490.0	2.6	4.8	3.7	0.8	0.1	0.0
500.0	0.6	1.6	1.2	0.2	0.0	0.0

Wister Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
478.0	89.39	92.14	77.89	50.47	28.86	31.91
480.0	36.34	49.18	35.65	13.29	2.73	2.35
482.0	26.45	38.24	27.10	7.24	1.21	1.55
485.0	16.92	26.91	20.17	4.72	0.61	0.51
490.0	9.16	15.49	12.26	2.54	0.30	0.00
500.0	2.03	4.99	4.03	0.56	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
478.0	26.8	28.6	23.4	15.6	8.9	9.6
480.0	10.9	15.2	10.7	4.1	0.8	0.7
482.0	7.9	11.9	8.1	2.2	0.4	0.5
485.0	5.1	8.3	6.0	1.5	0.2	0.2
490.0	2.7	4.8	3.7	0.8	0.1	0.0
500.0	0.6	1.5	1.2	0.2	0.0	0.0

Elevations of the Conservation, Flood, and Surcharge Pools at the Eleven Primary Flow Modifying Reservoirs in Oklahoma

Reservoir	Top Conservation Pool	Top Flood Pool	Top Surcharge Pool
Copan	710.0	732.0	738.0
Hulah	733.0	765.0	767.0
Oologah	638.0	661.0	666.0
Kaw	1010.0	1044.5	1047.5
Keystone	723.0	754.0	757.0
Pensacola (Grand)	745.0	755.0	NA
Hudson (Markham Ferry)	619.0	636.0	NA
Fort Gibson	554.0	582.0	NA
Tenkiller	632.0	667.0	671.0
Eufaula	585.0	597.0	600.0
Wister	478.0	502.5	NA

APPENDIX E

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Comments on Sediment Analysis and
Recommendations for Future Sediment Analysis

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
222 South Houston, Suite A
Tulsa, Oklahoma 74127
918/581-7458 / (FAX) 918/581-7467

In Reply Refer To:
FWS/R2/OKES/
02-14-01-I-0385

February 11, 2005

Stephen Nolen
Chief, Environmental Analysis and Compliance Branch
U.S. Army Corps of Engineers
1645 S. 101st East Ave.
Tulsa, Oklahoma 74128-4609

Dear Mr. Nolen:

This letter transmits planning information for the U.S. Army Corps of Engineers (Corps) Arkansas River Navigation Study (ARNS), Arkansas and Oklahoma. The U.S. Fish and Wildlife Service (Service) previously provided planning information in a Planning Aid Report dated April 2, 2001, and planning assistance letters dated May 5, 2004 (pertaining to aquatic habitat assessment methodology), and June 15, 2004 (pertaining to dredging, dredged material disposal sites, and mitigation for disposal impacts). The Service is currently preparing a detailed coordination act report (CAR) that would provide more specific planning information related to ARNS. The forthcoming CAR will 1) provide information on existing fish and wildlife resources, 2) identify fish and wildlife–related issues, opportunities, and planning objectives; 3) provide the Service's evaluation of impacts to fish and wildlife resources as a result of the proposed project, 4) discuss measures to avoid and minimize environmental impacts, and 5) provide recommendations to appropriately compensate for unavoidable impacts to fish and wildlife resources.

The Service has most recently been working cooperatively with Corps staff on the aquatic impact assessments for impacts that would be associated with dredging, disposal of dredged material in aquatic environments, and construction of new river training structures. We appreciate the Corps staff's receptiveness to previous comments and concerns provided by the Service and our state partners, the Oklahoma Department of Wildlife Conservation and the Arkansas Game and Fish Commission to date.

The comments provided here serve to 1) identify fish and wildlife–related concerns pertaining to the sediment quality of material that would be dredged during maintenance of the nine-foot navigation channel and for the proposed channel deepening component of the ARNS, and 2) to provide recommendations for future sediment analyses. The comments are based on our review of the information pertaining to the sediment sampling analysis for most of the Oklahoma portion of the McClellan Kerr ARNS you provided by electronic mail on January 21, 2005. This letter is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. et seq.), but is not intended to fulfill the reporting requirements of Section 2 b) of the Act.

The Service believes that the study design (sample site selection, sample size, field sampling methods, constituents selected for analysis, chemical methods employed, and the quality control and assurance procedures) and rationale for data interpretation were adequate to meet the objectives of the screening level analysis. The Service believes additional analyses for pre-disposal characterization should be performed prior to project implementation in order to ensure that unnecessary impacts to the environment are avoided or minimized, as discussed below.

Particle Size Analysis

Concentrations of trace elements do not appear to be at levels that would represent a threat to the aquatic environment if the samples are from areas of deposition and not sand substrate. We believe information pertaining to the particle size of the sediments would be necessary before a more definitive conclusion could be made (de Groot, 1995). The Service recommends that particle size analysis for the samples be employed to 1) facilitate comparison of elemental concentrations in sediment among locations within the navigation system and 2) identify areas of concern, as necessary.

Cadmium

The majority of the sediment samples indicate non-detection for cadmium at concentrations ranging from 0.5 and 1.0 ppm. Although sediment quality standards do not exist in the U. S., the detection limits for cadmium are very near the sediment quality threshold value of 1 ppm recommended by the guideline used to interpret the data (MacDonald et al., 2000), and the 0.6 ppm value established by the Province of Ontario sediment quality standards (Persaud et al., 1993). Therefore, the Service believes that cadmium levels have not been adequately evaluated by the subject screening level analysis. We recommend more sensitive procedures be utilized to adequately detect cadmium levels in sediment prior to implementation of dredging activities.

Organochlorine Pesticides

Concentrations of organochlorine pesticides in the sediment samples were low and below the threshold levels used for data interpretation. These findings suggest an overall lack of existing significant contamination from these compounds. However, we believe that the potential for biomagnification of organochlorine pesticides in the food chain (*e.g.*, water - fish – bald eagles) as a result of the proposed channel deepening project has not been fully addressed by the subject screening level sediment analysis.

Dredging activities and the disposal of dredged material in aquatic disposal sites could remobilize any organochlorine pesticides in the navigation channel and, thereby, make the compounds more available to fish. Although we do not have any evidence that suggests ongoing detrimental effects of organochlorine pesticide contamination on fish and wildlife species that occur in or within the vicinity of the navigation channel, the dredging that would occur for the proposed channel deepening project would greatly exceed current levels performed for operation and maintenance purposes.

Organochlorines reach subsequently higher concentrations in the fats of animals as they are moved up through the food chain (*i.e.*, biomagnification) in the aquatic environment (Gobas et al., 1993; Suedel et al., 1994). Fish are better indicators of adverse effects of organochlorine contamination on fish and wildlife species than sediment due to biomagnification. Therefore, the Service recommends that the Corps examine the concentrations of organochlorine pesticides in fish (*e.g.*, blue catfish *Ictalurus furcatus*, and carp *Cyprinus carpio*) taken from areas that have recently been dredged for operation and maintenance of the 9-foot channel. We believe this analysis in conjunction with the subject screening level sediment analysis would more thoroughly answer whether there are likely to be any concerns pertaining to biomagnification of organochlorine pesticides in the food chain as a result of the proposed channel deepening project.

We appreciate the opportunity to participate in this study during the planning phase, and look forward to further coordination. If you have any questions, please contact Richard Stark or Dan Martin at 918-581-7458, extensions 240 and 233, respectively.

Sincerely,

Jerry J. Brabander
Field Supervisor

cc: FWS, Regional Director (ARD-ES), Attn: Dean Watkins, Albuquerque, NM
FWS, Arkansas ES Field Office,Field Supervisor, Attn: Marge Harney, Conway, AR
FWS Sequoyah National Wildlife Refuge, Manager, Vian, OK
FWS White River National Wildlife Refuge, Manager, DeWitt, AR
FWS Holla Bend National Wildlife Refuge, Manager, Dardanelle, AR
ODWC, Director, Attn: Fisheries and Natural Resources, Oklahoma City, OK
ODWC, Director, Attn: Water Quality Programs Division 0207, Oklahoma City, OK
ODWC, Northeast Regional Office, Attn: Mike Plunkett and Randy Hyler,Porter, OK
US Army Corps of Engineers, Chief, Planning and Environmental, , Tulsa, OK
US Environmental Protection Agency, Attn: 6WQ-EM , Dallas, TX
Arkansas Game and Fish Commission, Director, Attn: Craig Uyeda, Little Rock, AR
Arkansas Waterways Commission, Director, Little Rock, AR
Department of Arkansas Heritage, Director, Little Rock, AR

References

De Groot, A. J. 1995. Metals and sediments: a global perspective. Pp. 1 – 20. in H. E. Allen (Ed.) Metal contaminated aquatic sediments. Ann Arbor Press, Inc., Ann Arbor.

Gobas, F.A.P.C., J.R. McCorquodale, and G.D. Haffner. 1993. Intestinal absorption and biomagnification of organochlorines. Environ. Toxicol. Chem 12: 567-576.

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Persuad, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy, Toronto, Ontario. 27 pp.

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APPENDIX F

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Recommendations for
Tree Plantings, Monitoring, and Remedial Actions
for Bottomland Hardwood Restoration Sites

Recommended Trees

Hydrology and soil characteristics will be the most important factors for determining suitability of the recommended species. Species selection for each area should be based on soil and anticipated hydrologic conditions. The Service recommends the following species to provide quality habitat for wildlife:

Shumard oak *Quercus shumardii*
Bur oak *Q. macrocarpa*
Northern red oak *Q. rubra*
Pin oak *Q. palustris*
Black walnut *Juglans nigra*
American plum *Prunus americana*
Mexican plum *P. mexicana*
Pecan *C. illinoensis*
Bitternut hickory *C. cordiformis*
Sugarberry *Celtis laevigata*
Hackberry *C. occidentalis*
Red mulberry *Morus rubra*
Deciduous holly *Ilex decidua*
Rusty blackhaw *Virburnum rufidulum*
Persimmon *Diospyros virginiana*

Planting Recommendations.

Establishing a greater number of oak species, other non-oak hard mast species, and additional light seeded woody species will produce restorations with species diversity and function comparable to natural sites (Allen, 1997). The practice of establishing only a few species should be avoided because it will likely limit the overall diversity, which will, in turn, limit the overall function of the restored bottomland hardwood wetland.

Many of the recommended species are shade intolerant. Dense plantings can lead to rapid canopy closure that can actually limit naturally derived species diversity. Openings and gaps in plantings will foster richer species diversity derived from adjacent or dispersed seed sources (Allen, 1997). Openings and gaps also will break-up the "plantation" appearance that row planting often generates.

The Service recommends the following specific planting recommendations to provide quality habitat for wildlife:

- Plant 2 – 4-inch diameter trees.
- Plant a bottomland hardwood community type that is based on the soil-moisture regime (*i.e.*, degree of inundation, timing and duration of flooding, soil texture and color, probability of annual flooding) at the site.
- Avoid straight-line rows such as used in a pecan orchard. The trees should be stagger-planted or planted in curved rows with openings and gaps.

- Leave openings and/or gaps unplanted to allow for some natural colonization and the slower establishment of randomly dispersed, shade intolerant woody species that will not establish after canopy closure.
- Plant a much higher proportion of hard mast species (*i.e.*, the oaks, black walnut, and hickory) than soft mast species (e.g., 75 hard:25 soft). The soft mast species will likely come in through natural colonization.
- Use spacings of 12 x 12 or 15 x 15 feet to avoid rapid canopy closure that can limit naturally derived species diversity and provide quality habitat for wildlife.
- Mix species within rows to avoid homogeneous stands.

Trees per acre can be determined by:

43,560/spacing.

For example, 15 x 15 spacing = 43,560/225 = 194 trees per acre.

<u>Monitoring Plan</u>

The Corps should develop a monitoring plan for the bottomland hardwood restoration sites through interagency coordination to determine progress, mitigation success, and need for remedial actions. We offer the following recommendations for the development of a monitoring plan:

- Monitor the bottomland hardwood restoration sites by conducting at least two surveys per year for a minimum of five years.
- The monitoring protocol should include vegetation surveys and restored hydrology verification, and should document the following
    - tree survival rates
    - natural regeneration of native tree and shrub species
    - new species colonization
    - tree growth and condition
    - hydric soil morphology and development according to the Corps standard protocol for performing hydric soil determinations.
- Survival of 75% of the planted trees would indicate successful woody vegetation establishment.
    - Replacement of trees should occur at the end of each monitoring year to maintain the appropriate number. However, should natural colonization of native bottomland hardwood tree species offset the loss of any planted trees, additional plantings would not be necessary.

<u>References</u>

Allen, J.A., 1997. Reforestation of bottomland hardwoods and the issue of woody species diversity. Restoration Ecology, vol. 5 No. 2, pp. 125-134.

BRAD HENRY, GOVERNOR
GREG D. DUFFY, DIRECTOR

DEPARTMENT OF WILDLIFE CONSERVATION

1801 N. LINCOLN P.O. BOX 53465 OKLAHOMA CITY, OK 73105 PH. 521-3851

June 16, 2005

Mr. Richard Stark
US Fish and Wildlife Service
Oklahoma Ecological Services
222 S. Houston, Ste A
Tulsa, OK 74127

Re: Arkansas River Navigation System (ARNS) Study response to the Draft Coordination Act Report (CAR)

Dear Mr. Stark,

This is in response to the draft CAR submitted to the Oklahoma Department of Wildlife Conservation (ODWC) for review on June 8, 2005. The final CAR will be included in the US Army Corp of Engineers (USACE) feasibility report on the Arkansas River Navigation System (ARNS) project. The final CAR will identify the effects of the proposed actions on fish and wildlife resources within the project area, provide recommendations to appropriately compensate for unavoidable impacts to fish and wildlife resources, and provide recommendations conducive to maintaining the value of the fish and wildlife resources associated with the navigation system. The CAR reflects the fish and wildlife issues of concern to ODWC as modified by the following comments.

In September 2004, a draft CAR was reviewed and comments were provided by the ODWC to the USFWS along with a copy of the August 2004 correspondence to the USACE concerning revisions to the scope of the Environmental Impact Statement (EIS). These comments have been adequately incorporated into both the draft EIS dated April 2005 and the draft CAR. However, incomplete aquatic impacts analysis and mitigation plan provisions remain significant deficiencies of the CAR. It is understood by the ODWC that these issues will be addressed as a supplement to the CAR.

The ODWC concurs with the position of the USFWS concerning the ARNS, mitigation goals and recommendations as set forth in the CAR. The ODWC further agrees with and supports the compensatory mitigation plan for terrestrial impacts and the identification of potential aquatic impacts. The ODWC supports recommendations 2, 5, 7, 8, 9 and believe these issues have been adequately addressed by the working group and in the CAR. However, several issues continue to persist and are listed below:

1. **The ODWC supports the designation of Pool 15 as a mussel sanctuary and will continue to work cooperatively with the USACE in this matter**. Impacts to mussel populations and associated mitigation efforts have been addressed in a letter from the USFWS to the USACE dated May 11, 2005. This letter was in response to a report prepared by Ecological Specialists, Inc. (ESI) based on a study that was conducted to determine unionid distribution and species composition in the navigation system. In general, the mitigation recommendations provided by the USFWS appear to be adequate to help avoid and minimize project impacts to freshwater mussels.

2. **The final mitigation plan should include fully funded, long-term monitoring efforts for the life of the project (approximately 50 years) and should be modeled after the concept paper in appendix C of the CAR**. Further, a mitigation bank should be fully funded to compensate for aquatic and terrestrial long term impacts. Such funds should be available for maintaining all mitigation measures for the life of the project. All funds should be appropriated at the beginning of the project to insure that mitigation recommendations are met. The following recommendations are in response to specific language in the CAR and the need for compensatory mitigation and long term monitoring:

   a. **Page 167, paragraph 2: The USACE should attempt to restore all gravel habitat removed during the construction process; however, it is unlikely the USACE will be able to maintain the quantity and quality of gravel habitats necessary to fully mitigate for losses.** The USFWS states "The Service believes that through project design and modifications and mitigation, these gravel habitats can be conserved and possibly even restored to many locations along the river. Relocation efforts should be followed with long-term monitoring and adaptive management to ensure mitigation features can provide both conservation and restoration of these habitats within this system." Current plans call for the USACE to place gravel behind notches in dikes or to over-dredge within the channel and backfill with gravel at a lower depth. It is likely that only small areas of gravel habitat will be maintained behind notches in dikes due to annual variability in hydrologic conditions. Further, in-channel restorations are unlikely to succeed due to changes in the hydraulic conditions caused by dredging the channel to a deeper depth.

   The ODWC does support the proposed gravel restoration efforts if proper long-term monitoring studies are conducted to evaluate the quantity and quality of restoration attempts and if a mitigation bank is set up during initial funding to mitigate for unsuccessful mitigation events. If gravel restoration efforts fail, the funds in the mitigation bank should be used to restore stream and reservoir habitat located outside of the navigation channel but within the overall navigation system.

b. **Page 177: Long term monitoring should be conducted throughout the life of the project.** The table on page 177 recommends a shorter period (less than 5 years) for long-term monitoring of gravel restoration projects, substrate boring and classification, and substrate profiling. This recommendation should be changed to reflect a longer monitoring period of at least 10 to 20 years or a 50-year flood event.

c. **Pages 192 and 193:** The ODWC supports recommendation12, however, long term monitoring should be defined as the life of the project which is 50 years.

e. **The USACE should obtain additional agricultural land and license it to the ODWC for dredged material disposal sites.** The ODWC should have an opportunity to review and provide input into the location of the disposal pits, associated access roads, and any necessary mitigation. .

f. **Operation and maintenance of constructed wetlands and bottomland hardwood forests should be funded annually by the USACE.** Mitigation options at disposal sites 379.1 L-DI and 389.7 L-DI were previously agreed upon by cooperating agencies; however the CAR does not specify funding for operation and maintenance.

d. **A Memorandum of Understanding (MOU) between USACE, USFWS, ODWC and other appropriate entities should be employed to help ensure funding for mitigation and long term monitoring will be available for the duration of the project.** This MOU should contain a funding plan for mitigation, long term monitoring and a means of communication among cooperating agencies.

3. **Page 188: Recommendation 4 suggests further contaminant analysis of the dredged material will be performed by the USACE in order to minimize environmental and human health impacts. The CAR should contain additional language that describes: 1) a short term and long term monitoring plan for dredging activities and 2) an emergency response protocol for sites located near the Sequoyah Fuels Corporation industrial site (SFP) in Gore, Oklahoma and other areas of interest within the project boundaries.** The SFP and other areas of interest will require additional sediment sampling to assess the extent that dredging activities will cause resuspension and dispersal of contaminants into the ecosystem . More specific methodology and parameters to address these issues can be agreed upon in a Memorandum of Understanding (MOU) between the USACE and cooperative agencies .

Of particular concern is the SFP which is a decommissioned uranium conversion facility. The facility's primary function during operation was to convert uranium oxide into uranium hexafluoride and further processed into fuel resources for commercial nuclear power reactors. Although the plant has been decommissioned, there continues to be an industrial discharge which includes but is not limited to raw water basin overflow, process area storm water, storm water overflow from the South Yellowcake sump emergency overflow and Calcium Fluoride Clarifier overflow, the laundry, storm water runoff from an on site building, pond no. 2, solid waste burial areas and facility grounds. The outfall is a commingled outfall that discharges into the Illinois River upstream of the confluence with the Arkansas River.

Recently, Sequoyah Fuels Corporation applied for an industrial wastewater discharge permit renewal. Changes from the previous permit include the addition of discharge limits for Uranium and Thorium230, a monitoring requirement for Chemical Oxygen Demand (COD), technology based limit for TSS, an effluent monitoring requirement for Total Selenium, and background monitoring requirements for Cadmium and Total Mercury. Except for these supplemental requirements, existing monitoring and parameter requirements will remain the same. The new discharge limits are based on the results of a pollutant screen submitted by the discharger and reflect pollutants found in the water column. Other documentation assesses land application of Raffinate and other potential pathways for contaminants. Based on this and other historical information , it is likely that contaminants remain on site and thus, plausible pathways may still exist.

Due to new recommended discharge limits, and lack of current baseline data, the USACE should implement a work plan for sediment analysis in accordance with Annual Book of ASTM Standards (Volume 11.05) and/or *EPA Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manua*l (EPA-823-B-01-002). Sample locations should include at a minimum sites above, below, and adjacent to the SFP sufficient to capture the extent of pollutant dispersal into the water column and sediment deposition.. Baseline data should be collected prior to, concurrent with, and upon completion of dredging activities. This monitoring effort is a proactive attempt at preventing contaminants from being released into the ecosystem. While the USACE is not responsible for the source, a release of contaminants from dredging activities could result in delayed completion of the proposed ARNS project, emergency remediation, restoration and loss and/or injury to fish and other wildlife resources.

Appendix E of the EIS contains information regarding USACE sediment sampling and testing. During a sediment study conducted along the ARNS, samples were analyzed for the following parameters: semi-volatile organics, organics, organ chlorine pesticides, PCBs, total cyanide, TOC, total metals (As, Ba, Cd, Cu, Cr, Pb, Fe, Mn, Hg, Ag, Se and Zn. Additional parameters to be monitored at the SFP location should include a Nitrogen series, Uranium, Thorium 230, Radium 226, other radio-isotopes if deemed appropriate.

4. **Page 182**: In order to enhance recreational opportunities, the USACE should install fishing piers located on National Wildlife Refuge's (NWRs), Wildlife Management Areas (WMAs) and local government owned property.

5. **Pages 193 and 194**: The ODWC supports recommendations 13, 14, 15, and 16, but feels that the following language should be incorporated into the last sentence of number 13: "scrubbing stations for zebra mussel control should be constructed at appropriate locations on all reservoirs that support the navigation system".

6. **Page 188:** The ODWC supports recommendation number 1; however, specific language needs to be included that indicates minimum flow releases will be conducted in a manner that maintains water quality standards set by the Oklahoma Water Resources Board (OWRB).

7. **Lake level management plans should be developed for affected Oklahoma reservoirs in coordination with the ODWC.** Above normal water levels could have an effect on the composition of vegetation available to wildlife on ODWC WMAs. Further, increased water levels could have a derogatory effect on leased agricultural land by decreasing crop yield available for revenue and to wildlife. Further, fluctuating water levels in reservoirs affected by ARNS could have detrimental reproduction and recruitment effects on fisheries resources. These impacts can be ameliorated with properly developed water level management plans.

In general, the ODWC agrees with the contents of the CAR; however significant issues still persist. While most issues have been adequately addressed and incorporated into the CAR, a complete mitigation plan, long term monitoring and sediment analysis for contaminants remain deficient. Therefore, the ODWCs position on this matter is summarized as follows:

- In general, the ODWC supports the contents of the CAR
- Although the ODWC supports the contents of the CAR, significant deficiencies remain as a result of an expedited time schedule for the project.
- Deficiencies include impacts to freshwater mussels, incomplete mitigation plan, lack of a long term monitoring plan and agreed upon time frame for such monitoring, sediment sampling for contaminants analysis, and funding commitment by the USACE for mitigation and long term monitoring
- The ODWC will concur with the CAR contingent upon the following commitments from the USACE:

    - a commitment from the USACE that mussel sanctuaries will be considered and established in agreed upon areas of the navigation system

    - a commitment by the USACE that the deficiencies in the CAR will be resolved by the USACE and approved by all cooperative agencies

    - a commitment from the USACE that all mitigation, mitigation banking, and long term monitoring will be implemented

- a commitment from the USACE and USFWS that issues unable to be resolved at the time of concurrence by the ODWC will be provided as a supplement at a later date and incorporated into the CAR

Thank you for the opportunity to review the CAR and provide comments. If questions arise, please do not hesitate to call the ODWC Natural Resources Section at (405)521-4663

Greg D. Duffy,
Director

cc: Miles Tolbert, Oklahoma Secretary of the Environment
USACE, Tulsa District
USACE, Little Rock District

APPENDIX G

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Recommended Mitigation Features for Aquatic Impacts Caused by Dredging, Aquatic Disposal of Dredged Material and Construction/Modification of River Training Structures

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
Canal								
15.3R	Reconnect Lower Merrisach Lake to Canal with culvert or water control structure for fish passage	540	0.5	0.4	0.3	0.1	0.1	0.1
15.3 L	Place woody habitat in Merrisach Lake	10	0.6	0.5	0.4	0.9	0.8	0.7
18.9 L	Place woody habitat in Arkansas Post bay	10	0.6	0.5	0.4	0.9	0.8	0.7
Pool 2								
19.0 R	Construct fish passage through lower Merrisach Lake	n/a	n/a	n/a	n/a	n/a	n/a	n/a
19.0R	Construct island	56	0.3	0.3	0.2	0.3	0.3	0.3
19.8L	Notch existing revetment (1)	31	0.5	0.3	0.1	0.7	0.7	0.7
22.8R	Maintain entrance to Coal Pile by periodically dredging	724	0.8	0.6	0.4	1	1	1
23.6 R	Avoid RB disposal	15	0.5	0.5	0.5	0.5	0.5	0.5
23-24L	Construct string of islands	48	0.7	0.5	0.3	0.8	0.9	1
23-24L	Construct string of islands	40	0.7	0.5	0.3	0.8	0.9	1
24.7 R	Maintain fish passage/entrance to Echubby Lake through culvert modification, control structures, and/or dredging	302	0.6	0.3	0.1	1	1	1
25.1 L	Place woody habitat in backwater bay	10	0.6	0.5	0.4	0.9	0.8	0.7
25.1 L	Restore/maintain fish passage to Moody Old River Lake through culvert modification, control structures, and/or dredging	206	0.2	0.1	0.1	0.9	0.9	0.9

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
24-25L	Notch modified revetment (2) and modified dike (1)	455	1	0.9	0.8	1	1	1
26.5 R	Restore/maintain fish passage to unnamed cutoff through culvert modification, control structures, and/or dredging	145	0.2	0.1	0.1	0.9	0.9	0.9
27L	Avoid aquatic disposal, utilize land	20	0.2	0.2	0.2	0.2	0.2	0.2
27.5-29R	Notch modified dikes (4) and existing dike (1)	88	0.8	0.6	0.4	0.8	0.8	0.8
27.8-28.5L	Notch modified revetment (1) and existing dike (1)	54	1	0.8	0.6	1	1	1
31.7-32.8R	*Existing tern island – enhance/create islands where feasible and avoid June-August construction, utilize disposal area and extend d/s to NM 31.0R	64	0.7	0.7	0.7	0.7	0.8	0.9
32.2R	Restore/maintain fish passage/entrance to Bicker Lake backwater channel by avoiding disposal, culvert modification, control structures, and/or periodically dredging	383	0.2	0.1	0.1	0.9	0.9	0.9
32L	Notch revetment (4) and existing dike (1)	275	0.5	0.3	0.1	0.5	0.5	0.5
31.8-33.1L	Avoid LB disposal, utilize RB, notch modified revetment (4) and existing dike (1) across backwater	62	1	0.8	0.6	1	1	1
35 R	Notch modified dikes (2)	21	0.5	0.4	0.3	0.5	0.5	0.5

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
36.5 R	Restore/maintain fish passage/entrance to Jones Lake through culvert modification, control structures, and/or dredging	189	0.2	0.1	0.1	0.9	0.9	0.9
35.3-36.5 L	*Existing tern island – enhance/create islands where feasible and avoid June-August construction	97	0.3	0.4	0.5	0.7	0.7	0.7
36-36.5 L	Notch modified dikes (3) and existing dike (1)	63	0.2	0.2	0.1	0.2	0.2	0.2
36.4	Mussel bed monitoring adjacent to disposal area	n/a	n/a	n/a	n/a	n/a	n/a	n/a
36.4-37.0 R	Extend disposal area u/s to 38.1R, avoid blocking entrance to chute at 36.4R	24	0.5	0.4	0.3	0.5	0.5	0.5
36.4 R	Avoid blocking entrance to chute	19	0.5	0.4	0.3	0.5	0.5	0.5
37.8-38.4 L	Avoid disposal, utilize RB.	20	0.6	0.6	0.6	0.6	0.6	0.6
38.8 L	Avoid disposal, utilize RB, notch modified revetment	15	0.6	0.6	0.6	0.6	0.6	0.6
38.5-38.8 R	Extend islands downstream, increase island, RB disposal	47	0.4	0.4	0.3	0.6	0.6	0.6
39.8L	Notch modified revetment at 39.3L and 39.7L	57	0.7	0.6	0.5	0.7	0.7	0.7
38.8-39.6R	Existing tern island, notch existing dikes (5) and enhance/construct tern islands where feasible	37	0.1	0.1	0.1	0.5	0.6	0.7
40R	Notch existing revetment/dike (1)	5	0.5	0.5	0.4	0.5	0.5	0.5

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
39.8-40.0L	Avoid disposal, utilize RB, investigate terrestrial disposal if needed	16	0.2	0.2	0.2	0.2	0.2	0.2
42.1-42.7L	Existing tern island, use disposal to enhance/construct tern islands, notch backside of existing dikes to maintain flow and islands 42.5L	38	0.2	0.2	0.2	0.3	0.3	0.3
42.3-43.3L	Construct islands and notch existing (3) dikes	100	0.1	0.1	0.1	0.3	0.3	0.3
42.8-44.6R	Notch existing and modified dikes (10-12)	58	0.3	0.3	0.2	0.3	0.3	0.3
42.8-43R	Utilize this disposal area, notch existing and modified dikes (10-12) and extend disposal u/s	10	0.3	0.3	0.2	0.3	0.3	0.3
43.4-44.1L	Avoid disposal in LB aquatic areas, utilize land and RB disposal, notch existing dikes/revetments (3)	73	0.3	0.3	0.3	0.4	0.4	0.4
44-44.7	Utilize AR44.3R-D for disposal and extend d/s to 43.0R	18	0.1	0.1	0.1	0.1	0.1	0.1
44.6L	Maintain a 1/2 mile boating lane at the entrance to Little Bayou Meto (44.6L) and 1/2 mile lane at u/s end of Bayou Meto by periodically dredging	344	0.4	0.3	0.2	0.5	0.5	0.5
46.2R	Notch modified revetment/dike (1)	6	0.1	0.1	0.1	0.1	0.1	0.1
45.4-46L	Avoid disposal in aquatic areas of AR45.3L-D, dispose on land or preferably on RB	44	0.4	0.4	04	0.4	0.4	0.4
45.4-47.3 R	Construct islands where feasible in AR46.5R-D, utilize two most d/s cells for disposal first, notch dikes/revetments (4-8)	170	0.4	0.3	0.2	0.6	0.6	0.6

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
48.7-48.9R	Notch modified dikes (4)	25	0.3	0.2	0.1	0.3	0.3	0.3
46.8-49.2L	Utilize land within cells for disposal at AR48.0L-D, avoid aquatic areas	119	0.2	0.2	0.2	0.2	0.2	0.2
48.8 L	Restore/maintain fish passage to English Lake through culverts modification, control structures, and/or dredging.	246	0.2	0.1	0.1	0.9	0.9	0.9
49.0 L	Construct fish passage structure through levee, ditches, and English Lake tributary around dam 4.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
48.7-50.2R	Utilize land within cells for disposal in 49.4R-D, avoid aquatic areas, notch existing revetments/dikes in two most u/s cells (2)	108	0.3	0.3	0.2	0.4	0.4	0.4
49.6-49.9	Utilize existing in-channel disposal	11	0.2	0.2	0.2	0.2	0.2	0.2
Pool 3								
50.9L	Maintain entrance to Swan Lake by periodically dredging	388	0.7	0.6	0.5	0.7	0.7	0.7
51.0 L	Place woody habitat in backwater	10	0.7	0.6	0.5	0.9	0.8	0.7
58.3L	Notch revetment at 58.3L	48	0.5	0.5	0.4	0.7	0.7	0.7
61.0-62.1L	Probable tern island on RB, avoid aquatic areas in AR61.4L-D, utilize land within disposal cells or enhance/create tern islands on RB	47	0.4	0.4	0.4	0.4	0.4	0.4
61.5-62.5R	Place disposal in string of islands along RB	30	0.2	0.2	0.1	0.2	0.2	0.3
64-65R	Avoid disposal in AR64.5R-D, notch existing revetments and/or dikes (3)	44	0.5	0.5	0.4	0.6	0.6	0.6

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
64.8-65.3L	Utilize AR65.2L-D or in-channel disposal at AR65.5Channel-D	38	0.5	0.5	0.5	0.5	0.5	0.5
66.0-66.4 L	Construct fish passage structures through levees around dam 4.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
65.2-65.6L	Utilize AR65.2L-D or in-channel disposal at AR65.5Channel-D	12	0.4	0.4	0.4	0.4	0.4	0.4
Pool 4								
69.3 L	Construct fish passage structure through Plum Bayou around dam 4.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
70.0-70.7	Notch two longest existing dikes (2)	132	0.6	0.5	0.4	0.7	0.7	0.7
70.6	Maintain channel to backwater by periodically dredging	56	0.4	0.3	0.2	0.5	0.5	0.5
71.3	Dredge canals at Island Harbor Estates	20	0.5	0.5	0.4	0.6	0.7	0.7
72.0 R	Place woody habitat in Lake Langhofer	10	0.5	0.5	0.4	0.9	0.8	0.7
75.3L	Maintain channel to backwater by periodically dredging	10	0.5	0.4	0.3	0.6	0.6	0.6
78.7L	Dredge mouth of Pastoria Bend chute and periodically dredge to maintain and notch existing dike (1) if needed to open access to backwater	123	0.5	0.4	0.3	0.7	0.7	0.7
78.9-79.7L	79.0L - First option - Inquire about upland disposal on Pine Bluff Arsenal property first to avoid any impacts, second option - investigate island disposal upstream on LB at 80.1, third option to place in proposed location and notch modified dikes (4)	20	0.2	0.2	0.1	0.2	0.2	0.2

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
80.0-82.0L	Place disposal along dike fields to create islands and notch backside of dikes (9) at 80-82L	96	0.2	0.2	0.1	0.2	0.2	0.2
82.6R	Notch existing dike and maintain entrance to backwater at 82.6R by periodically dredging	82	0.4	0.4	0.3	0.6	0.7	0.8
82.5-85.5R	Notch existing dikes along RB (14)	252	0.5	0.4	0.3	0.6	0.6	0.6
84.7 L	Construct fish passage structure through levee around dam 5 and restore/maintain fish passage through Hensley Island Old River Lake	n/a	n/a	n/a	n/a	n/a	n/a	n/a
85.5-85.8R	Avoid disposal if possible and utilize in-channel disposal	33	0.7	0.7	0.7	0.7	0.7	0.7
85.9L	Construct boat ramp immediately d/s of Dam No. 5 if feasible							
85.6-85.8	Utilize in-channel disposal	4	0.4	0.4	0.4	0.4	0.4	0.4
Pool 5								
87.7L	Investigate dredging channel into oxbow lake to restore/maintain fish passage to Hensley Island Old River Lake and to accommodate construction of a fish passage structure through the levee around dam 5.	219	0.5	0.4	0.3	0.9	0.9	0.9
90.5-91.0L	Construct island(s) at 90.5-91.0L behind underwater revetment	21	0.2	0.2	0.1	0.2	0.2	0.2
91.4-91.7R	Recommend constructing island downstream at 90.5-91.0L behind underwater revetment, if proposed location must be utilized, place disposal off bank and create island(s) and notch backside of existing dikes	78	0.6	0.5	0.4	0.7	0.7	0.7

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
91.5L	Bank stab and revetment at 91.5 is needed (current – 0.3)	12	0.3	0.2	0.1	0.5	0.5	0.5
92.6L	Notch existing revetment (1) and maintain entrance to backwater by periodically dredging	13	0.4	0.3	0.2	0.6	0.6	0.6
94L	Notch existing revetment (1)	5	0.5	0.5	0.5	0.6	0.6	0.6
94.3-96.3L	Avoid aquatic disposal in uppermost cells of AR95.5L-D, extend disposal area d/s to create a series of islands for a braided system and terns, notch existing dikes (5) to enhance backwater areas	144	0.8	0.8	0.7	0.9	0.9	1
96.0-98.2R	Enlarge and utilize RB disposal, investigate disposing behind modified revetment and dikes, investigate terrestrial disposal if needed	42	0.2	0.2	0.2	0.2	0.2	0.2
98.5R	Notch existing revetment to access backwater (1)	2	0.5	0.1	0	0.6	0.6	0.6
99.4L	Notch existing revetment to access backwater (1)	2	0.3	0.1	0	0.4	0.4	0.4
100.3-101.1L	Notch existing dikes (2)	156	0.4	0.3	0.2	0.5	0.6	0.7
100.6-101.3	Utilize this area as alternative disposal site	74	0.1	0.1	0.1	0.1	0.1	0.1
101L	Existing tern island on LB, avoid work during nesting season	104	0.1	0.1	0.1	0.1	0.1	0.1
102-104R	Utilize RB disposal as alternative, construct/enhance tern islands if feasible	83	0.1	0.1	0.1	0.1	0.1	0.1

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
101.5-103.7L	Avoid disposal, notch existing dikes (10-12) for flow-through and to enhance diversity	161	0.9	0.9	0.8	1	1	1
103.7 L	Restore/maintain fish passage to Georgetown Lake through culvert modification, control structures, and/or dredging	249	0.2	0.2	0.1	0.8	0.8	0.8
105.2-106.0L	Existing tern island(s), avoid work during nesting season, construct high water notches in dikes (4) to restore and maintain islands	102	0.1	0.1	0.1	0.8	0.8	0.8
106.1 R	Construct fish passage structures through series of chutes around dam 6.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
106.5-107.7L	Avoid aquatic disposal in AR107.1L, utilize land areas or in-channel disposal	78	0.8	0.8	0.8	0.8	0.8	0.8
Pool 6								
108.2 L	Place woody habitat in backwater	10	0.6	0.5	0.4	0.9	0.8	0.7
110.4L	Notch dike and reconnect Willow Beach Park backwater and oxbow to river (current – 0.1)	42	0.1	0.1	0	1	1	1
113-114L	Notch underwater dikes on backside of islands (4)	31	0.5	0.5	0.5	0.6	0.6	0.6
116.2R	Dredge backwater at 116.2R	6	0.1	0.1	0.1	0.2	0.2	0.2
116.6-116.8R	Notch existing dikes 116.6 to 116.8R (2) *may have already been done	10	0.4	0.4	0.4	0.5	0.5	0.5
117.1-117.7R	Notch existing dikes (3)	10	0.3	0.3	0.2	0.4	0.4	0.4
122.9-123.6R	Notch existing dikes (2-4) for flow-through and access	25	0.3	0.2	0.1	0.4	0.4	0.4

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
123.7L	Notch existing dike for access and fish passage	5	0.3	0.2	0.1	0.3	0.3	0.3
124.8L	Prefer in-channel disposal	2	0.6	0.6	0.6	0.6	0.6	0.6
124.8-124.2	Avoid disposal in AR124.8L-D, utilize in-channel disposal	10	0.6	0.6	0.6	0.6	0.6	0.6
124.8-125.1	Utilize in-channel disposal at AR124.8 Channel-D	12	0.4	0.4	0.4	0.4	0.4	0.4
125.0 L	Construct fish passage structures through series of chutes around dam 7.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pool 7								
126.7-127.4L	Utilize LB disposal and notch modified dikes (4)	45	0.2	0.2	0.2	0.5	0.5	0.5
127.0 L	Mussel bed monitoring adjacent to disposal area	n/a	n/a	n/a	n/a	n/a	n/a	n/a
127.5 L	Restore/maintain fish passage to backwater through vegetation management, control structures, and/or dredging	100	0.6	0.3	0.1	1	1	1
128.0 R	Place woody habitat in Maumelle River bay	10	0.5	0.5	0.5	0.9	0.8	0.7
131.0 L	Dredge upper end of Rector Brake to improve habitat	41	0.3	0.2	0.1	0.6	0.6	0.6
131.0 L	Place woody habitat in Rector Brake	10	0.3	0.2	0.1	0.9	0.8	0.7
131.8-132.5R	Notch upper end of modified revetment (1)	31	0.2	0.2	0.2	0.6	0.6	0.6

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
133.5-135.2L	Avoid aquatic disposal on LB, utilize land disposal on island or construct another island on RB, notch longest existing dike for flow-through (*potential existing tern site)	82	0.7	0.7	0.7	0.8	0.8	0.8
134.2R	Notch existing revetment (1) at 134.2R and existing dike (1) at 134.7R for fish passage and access to Mill Bayou	213	0.4	0.4	0.3	0.5	0.5	0.5
135-138.2R	Avoid disposal in aquatic areas, utilize island disposal, (*potential existing tern site), notch two lower dikes	270	0.8	0.6	0.4	0.9	0.9	0.9
139.5-141R	Avoid disposal from 140R u/s to 141R to prevent blockage of opening between islands, utilize 140R d/s to tip of island	36	0.9	0.9	0.8	0.9	0.9	0.9
141.5-142.5R	Utilize disposal behind raised and extended L-dikes at 142.0R	86	0.2	0.2	0.1	0	0	0
142.5-143.4R	Notch modified dikes (2) at entrance to beaver dam channel for flow-through	30	0.7	0.5	0.3	0.8	0.8	0.8
143.7-144.2	Construct L-dike or revetment and use disposal to slope and protect bank	38	0.3	0.2	0.1	0.4	0.4	0.4
145.2-146.2L	Notch modified dikes (7)	50	0.6	0.5	0.4	0.7	0.7	0.7
146.5	Mussel bed monitoring adjacent to disposal area	n/a	n/a	n/a	n/a	n/a	n/a	n/a
146.5-147.5L	* Existing tern island – enhance/construct a series of islands along LB where feasible, notch dikes (5), move disposal from LB to RB for excess disposal	102	0.4	0.3	0.2	0.5	0.5	0.5
146.3R	Avoid disposal in this area	37	1	1	1	1	1	1

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
146.8-147.8R	Utilize land within disposal cells	29	0.4	0.2	0	0.4	0.4	0.4
147.8-150L	Avoid disposal from 149-150L that would block the entrance to backwater area, utilize disposal area d/s of 149L	124	0.4	0.3	0.2	0.3	0.3	0.3
148.7-150.4R	Avoid disposal, notch dike at 149R	49	0.8	0.7	0.6	0.9	0.9	0.9
150-151.7L	Avoid disposal from 150-151L that would block side channel and backwater entrance, construct a series of tern islands where feasible, notch existing dike at 150.8L for fish passage and backwater entrance	220	0.5	0.5	0.4	0.8	0.8	0.8
154-154.6L	Utilize land disposal within cells at AR154.1L-D	16	0	0	0	0	0	0
155.4L	Utilize land within cell at AR155.4L-D	7	0	0	0	0	0	0
155.6R	Notch existing revetment (2)	9	0.3	0.3	0.3	0.5	0.5	0.5
Pool 8								
158.8-159.2	Utilize existing island for disposal and/or construct tern islands	9	0.5	0.5	0.4	0.5	0.5	0.5
161.2-162.2L	Notch dikes from 161.2-162.2L 161.2	36	0.7	0.5	0.3	0.8	0.8	0.8
163.6-165.2R	163.6-165.3 - Revetment is needed for bank stabilization		0.1	0.1	0.2	0.3	0.4	05
164.2-164.7	Avoid LB disposal, investigate moving RB revetment out and utilizing disposal as bank stabilization	43	0.5	0.5	0.4	0.5	0.5	0.5
164.5-165.2	Maintain fish passage by placing a notch on upstream end of revetment for flow in and out of Plummerville cutoff, and notch raised dikes (3), maintain entrance by periodically dredging	61	0.9	0.7	0.5	1	1	1

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
165.5-166.2	Avoid disposal in AR166.0R-D	53	0.8	0.8	0.8	0.8	0.8	0.8
165.8-167.0	Avoid aquatic disposal, dispose on land within cells, notch existing revetment (4)	25	0.7	0.6	0.5	0.8	0.8	0.8
169.2-169.8	Utilize AR169.4R-D for disposal first	58	0.1	0.1	0.1	0.1	0.1	0.1
168.7-169.5	Utilize AR169.4R-D for disposal first, AR169.0L-D second, construct tern islands where feasible	33	0.1	0.1	0.1	0.3	0.3	0.4
169.4-169.7	Notch raised dikes (4)	34	0.1	0.1	0	0.3	0.3	0.2
169.6-172	Notch raised dike at 170.1L and existing dikes at 170.7L and 171L, utilize land within cells for disposal or create/enhance tern island, (*existing tern island)	144	0.6	0.5	0.4	0.7	0.7	0.7
174.1-176.7R	Utilize land disposal on Lentz property, notch dikes 4 feet from top for high water (4)	138	0.4	0.4	0.4	0.5	0.5	0.5
176.2-176.4	Avoid disposal in AR176.2L-D, utilize RB land disposal on Lentz property	14	0.4	0.4	0.4	0.4	0.4	0.4
Pool 9								
177.7 R	Restore/maintain fish passage to oxbow through control structure and levee.	76	0.2	0.2	0.2	0.9	0.9	0.9
179.3-179.7R	Utilize disposal at 179.6R behind recommended revetment	17	0.6	0.6	0.6	0.6	0.6	0.6
180.2	Notch existing dike at 180.2R for fish passage and access to backwater	30	0.7	0.7	0.6	0.9	0.9	0.9

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
180.4-181.3	Extend disposal area upstream to raised dike at 181.5R and dispose along bank downstream of dike, notch dikes (2)	18	0.4	0.3	0.2	0.4	0.4	0.4
181.8-184.9	Notch existing and raised dikes (8-10) and create a series of islands for braided system and terns	256	0.7	0.7	0.6	0.8	0.9	0.9
185.8-186.4	Avoid disposal in AR186.2L-D, create artificial gravel bar downstream of dikes from 185L-186L	20	0.6	0.6	0.5	0.7	0.7	0.7
187.2	Notch long L-dike at 187.2R (2)	112	1	0.9	0.9	1	1	1
186.9-189.9	*Existing least tern island - avoid construction during nesting, limited disposal to avoid elevating island and maintain fish access to backwater, notch revetment and dikes (3-6) for flow-through, fish passage and access	325	1	0.8	0.6	1	1	1
189.2	189.2 - Notch revetment and dikes for fish passage and access to backwater	347	0.8	0.7	0.6	0.9	0.9	0.9
188.9-190.4	*Existing least tern island, avoid disposal, notch raised revetment (1) and existing dike (1), utilize area upstream at 191R for disposal	82	0.8	0.7	0.6	0.8	0.8	0.8
190R	Notch Sweeden island dike in chute on RB lowest for fisheries access	46	0.8	0.5	0.3	1	1	1
190.5-192R	New dredge disposal alternative to 189.5L will create elevated vegetated shoreline on Sweeden Island	67	0.1	0.1	0. 1	0.1	0.2	0.2
189.9-190.5	Notch modified revetment in two places	26	0.6	0.6	0.5	0.6	0.6	0.6
194.0 R	Restore/adjust Holla Bend Weir	546	0.8	0.7	0.7	0.9	0.9	0.9

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
193.6-195L	Notch existing dikes (5) in AR194.1L-D	112	0.2	0.2	0.2	0.3	0.3	0.3
197.2-197.9	Utilize approved disposal area	7	0.1	0.1	0.1	0.1	0.1	0.1
200.2	Utilize land disposal within cells from 200.8L d/s to 200L, avoid disposal u/s of 200.8L	69	0.5	0.5	0.5	0.5	0.5	0.5
204.6-205.1	Utilize in-channel disposal (gravel)	60	0.8	0.8	0.8	0.8	0.8	0.8
Pool 10								
206.2R	206.2 - Utilize in-channel disposal on right bank	33	0.8	0.8	0.8	0.8	0.8	0.8
208.9 R	Place woody habitat in Dardanelle Bay	10	0.6	0.6	0.6	0.9	0.8	0.7
211.5 R	Place woody habitat in Delaware Bay	10	0.6	0.6	0.6	0.9	0.8	0.7
217.5 L	Place woody habitat in Kenner Cove	10	0.7	0.6	0.5	0.9	0.8	0.7
222.0 R	Place woody habitat in Dublin/Shoal Bay	10	0.8	0.7	0.6	0.9	0.8	0.7
222.5R	Construct islands along RB if feasible	10	0.3	0.3	0.3	0.6	0.7	0.8
225.5L	Construct islands along LB if feasible	10	0.3	0.3	0.3	0.6	0.7	0.8
227.0 L	Place woody habitat in Cabin Creek bay	10	0.9	0.8	0.7	1	1	0.9
230.5 L	Place woody habitat in Spadra Creek bay	10	0.3	0.3	0.2	0.8	0.7	0.6
227.2, 229, 230, 233.5, 233.3, and 234	Construct islands where feasible	20	0.5	0.5	0.5	0.6	0.7	0.8
232R	No adverse impact, bank stabilization is needed at this area	2	0.4	0.4	0.4	0.7	0.8	0.8
232.5 R	Place woody habitat in Cane Creek bay	10	0.6	0.6	0.5	0.9	0.8	0.7

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
233	Utilize land disposal in AR233.0L-D if needed	6	0	0	0	0	0	0
235-236.8R	Notch existing dike and raised dike (2-3) in AR236.0R-D	288	0.6	0.3	0.1	0.6	0.6	0.6
236.6	236.6L - Dispose in terrestrial site preferred at 236.6L	40	0.6	0.6	0.6	0.6	0.6	0.6
238.5-239.9L	*Existing tern island at 239.5L, avoid disposal in AR238.5L-D, alternately use 240.1-241.0 L, investigate terrestrial disposal, create and/or extend island, notch land side of dikes, do not cut off backwater at 241.1L	162	0.9	0.9	0.8	0.9	0.9	0.9
238.5-241.2	Maintain and/or notch existing and modified dikes (3)	383	0.8	0.7	0.6	0.9	0.9	0.9
239.5R	239RB-Maintain fish access through revetment. Modified revetment along RB will have no adverse impacts	176	0.8	0.7	0.6	0.8	0.8	0.8
241.8-242.2	Prefer to use this low value area for disposal	31	0.3	0.3	0.3	0.3	0.3	0.3
242-244.1L	Avoid disposal in AR242.2L-D at entrance to Hartman Lake, utilize AR241.8R-D and AR244.0R-D if needed, deepen notch in modified revetment	41	0.5	0.5	0.4	0.6	0.6	0.6
243.7-244.2L	243.8L - Notch revetment and dike at u/s end to Hartman lake to allow flow-through and fish passage	100	0.3	0.3	0.2	0.8	0.8	0.8

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
244R	Utilize two downstream cells for disposal if needed and notch two existing upper dikes for fish passage and access	10	0.4	0.3	0.3	0.4	0.4	0.4
243.8-246.8L	Avoid disposal (none currently scheduled) in AR245.6L-D, notch dike d/s of most d/s island at 244.5L	202	0.6	0.6	0.5	0.7	0.7	0.7
249R	Alternate disposal site for AR248.0R-D	16	0.1	0.1	0.1	0.1	0.1	0.1
249.7L	Alternate disposal site for AR248.0R-D	16	0.1	0.1	0.1	0.1	0.1	0.1
254.1-254.5	Alternative disposal site inside closed revetment at 254.1L, no previously approved disposal area indicated on map	4	0.1	0.1	0	0	0	0
251.8-253.8L	Notch dikes (5-10) on left and right bank up and downstream	103	0.6	0.5	0.4	0.7	0.8	0.8
255.7-256.1R	Use AR256.2L-D for disposal instead of AR256.0R-D	8	0.3	0.2	0.1	0.5	0.6	0.6
255.9-256.2L	Prefer to use this terrestrial area for disposal	9	0	0	0	0	0	0
Pool 12								
257.5 L	Place woody habitat in Gar Creek bay	10	0.6	0.5	0.5	0.9	0.8	0.7
268.0 L	Place woody habitat in White Oak Bayou bay	10	0.8	0.8	0.7	0.9	0.9	0.8
271.2-273R	Recommend disposal site along RB	40	0.1	0.1	0.1	0.1	0.1	0.1
272.0 L	Place woody habitat in Mulberry River bay	10	0.7	0.6	0.6	0.9	0.8	0.7
273.7-276L	Avoid disposal in AR274.0L-D and AR275.0L-D, alternatively use RB disposal to create or enlarge islands,	48	0.4	0.4	0.3	0.4	0.4	0.5

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
275-276	Notch modified dikes (3)	48	0.4	0.4	0.3	0.4	0.4	0.4
275.7-276.4R	Notch modified dikes (2) that connect to shoreline and extend RB disposal downstream within dike field	56	0.1	0.1	0.1	0.6	0.6	0.7
275.2-276.6R	Notch dikes (2) that connect to shoreline	120	0.5	0.5	0.4	0.6	0.6	0.6
276.8-277.5R	Avoid backwater disposal in 277.0R-D, place disposal on land and d/s along bottom end to extend island	17	0.2	0.2	0.2	0.2	0.2	0.2
278.9-280.3L	At AR279.5L-D avoid disposal in aquatic areas, utilize land within disposal area and AR280.0R-D	384	1	1	1	1	1	1
279-280.1L	Notch modified revetment at 279L and 280.2L to maintain high value for backwater area	384	1	1	1	1	1	1
279-280.1R	Utilize AR280.0R-D for disposal and construction of string of islands, notch modified dikes (4) to create and maintain backwater channel	57	0.5	0.5	0.4	0.5	0.5	0.5
280.6-280.9	280.8L - Notch modified dikes (3)	32	0.7	0.7	0.6	0.7	0.7	0.7
281.9-283.3L	Place disposal on lower end of disposal area on existing sand bars, construct islands where feasible, avoid disposal from 283.2-283.5L	140	0.7	0.7	0.6	0.7	0.7	0.7
283.1-283.9L	283.9L - Notch modified revetment in upper cell (High priority)	175	0.7	0.6	0.5	1	1	1
283.5-284.7R	Recommend constructing new disposal at 284R	33	0.1	0.1	0.1	0.1	0.1	0.1

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
284.7-287.4	Avoid disposal in d/s cells on LB and RB, prefer disposal d/s in new area	126	0.7	0.7	0.6	0.7	0.7	0.7
285.6-286.2L	Extend disposal area to 286.2L dike, place disposal behind dikes on LB from 286.2-285.6L to create islands and maintain gravel instream, notch modified (2) and existing (2) dikes	19	0.7	0.7	0.6	0.7	0.7	0.7
288.4-289L	Avoid disposal in AR289.0L-D and place dredged gravel along right bank downstream and extend downstream gravel bar at 289.7R	21	0.7	0.7	0.6	0.7	0.7	0.7
288.8-289.8	Recommended alternate disposal site	20	0.4	0.4	0.4	0.4	0.4	0.4
290R	Notch existing dike if feasible	10	0.1	0.1	0	0.6	0.6	0.6
290.5-291.4R	Utilize dry cells in this disposal area	48	0.1	0.1	0.1	0.1	0.1	0.1
291.8-292.3L	Avoid disposal at 292.3L	22	0.7	0.7	0.7	0.7	0.7	0.7
Pool 13	Extend disposal area to 286.2L dike	19	0.7	0.7	0.6	0.7	0.7	0.7
293.0 R	Place woody habitat in Massard Creek bay	10	0.6	0.6	0.6	0.9	0.8	0.7
307.5 L	Dredge channel and notch dike at 307.0 L bank	20	0.1	0.1	0	0.6	0.6	0.6
305.3-306R	Notch revetment at 305.7 and 306R	60	0.7	0.6	0.5	0.8	0.8	0.9
OK								
Pool 13	downstream and extend downstream							
309.8-310.3	Notch 4 dikes for scour	24	0.5	0.4	0.3	0.8	0.8	0.8
310.4	Notch parallel dikes (1) for scour	13	0.3	0.2	0.2	0.6	0.6	0.6
311.5-313.7	New Dikes, designed to maintain variable habitat (J-hook)	13	0.1	0.1	0.1	0.4	0.3	0.2

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
314.8-315.8	New & existing dikes LD recommend J-hook design	5	0.3	0.3	0.3	0.6	0.5	0.5
Pool 14								
320-321	Notch 3 interior dikes	34	0.6	0.5	0.4	0.8	0.8	0.8
321-323	Notch 5 dikes	128	0.8	0.8	0.8	0.9	0.9	0.9
323.7 - 323.9	Notch 2 dikes	7	0.6	0.4	0.3	0.7	0.7	0.7
323-324	Notch 9 dikes	208	0.6	0.4	0.3	0.8	0.8	0.8
326.7-328.1	notch 7 dikes interior/exterior	48	0.5	0.4	0.3	0.7	0.7	0.7
Pool 15								
336.4	Create marsh & fish nursery habitat; variable depth 6in - 2ft/ riprap protection, NOTE: Site will be avoided to preserve mussel bed	11	0.4	0.4	0.4	0.7	0.7	0.7
348.3	Add to existing island	20	0.6	0.6	0.6	0.6	0.6	0.6
353.5-354.3	aquatic area converted to terrestrial with rip rap	3	0.6	0.6	0.6	0.6	0.6	0.6
355	Create 3 - 10 acre tern island w/riprap in Sequoyah National Wildlife Refuge	31	0.6	0.5	0.4	0.7	0.6	0.5
360.6	Notch 2 dike	12	0.5	0.4	0.4	0.7	0.7	0.7
361-363	Relocate gravel to dike field on left descending bank at 360.6. Relocate downstream between rm 360 - 361; monitor & adapt as needed	36.7	1.0	1.0	1.0	1.0	1.0	1.0

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
Sans Bois Creek								
sbc 0.4	Aquatic disposal area; create high quality marsh; variable depth 6-in - 2 ft; mussels should be protected from impacts resulting from disposal	100	0.4	0.3	0.2	0.6	0.6	0.6
sbc.4.8	Create HQ marsh; variable depth 6-in - 2 ft. Note: Site should be redesigned to preserve mussel patch; aquatic disposal will only occur if mussels won't be impacted	90	0.4	0.4	0.4	0.6	0.6	0.6
sbc 6.6	Expand island, design to avoid impacts to mussels; height of disposal will be 6 in - 2 ft below water surface	10	0.4	0.4	0.4	0.4	0.4	0.4
sbc 6.9	Expand island, design to avoid impacts to mussels; height of disposal will be 6 in - 2 ft below water surface	10	0.4	0.4	0.4	0.4	0.4	0.4
Pool 16								
367.5-367.7	1st priority avoid designated site, move disposal to outside of lock guide wall, armored protection; notch 1 dike	38	0.8	0.7	0.6	0.9	0.9	0.9
367.4	Alternative disposal site for 367.5 - create tern island/w riprap	38	0.3	0.3	0.3	0.3	0.3	0.3
374-375	Relocate gravel downstream to rm 373; monitor & adapt as needed	1.23	0.8	0.8	0.8	0.8	0.8	0.8
379-380	Dredge upper end of oxbow; maintain upper/lower openings	405	0.4	0.3	0.2	0.6	0.6	0.6
383.2	Dredge mouth of Hopewell Creek	1	0.4	0.3	0.2	0.4	0.4	0.4
392.1-393.0	Notch dikes, create tern island in middle cell	40	0.8	0.4	0.2	0.8	0.8	0.8

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
393	Relocate gravel to dike fields created on Right descending banck at rm 392.1-393.0; monitor & adapt as needed	0.83	0.8	0.8	0.8	0.8	0.8	0.8
393.2 - 394.1	1st priority dispose in terrestrial cell, notch internal & lower end dikes; 2nd priority dispose in dike cell above and below bridge. L	39	0.7	0.6	0.5	0.9	0.9	0.9
393.8-394.6	Notch added dikes to avoid fill; design to minimize fill (J-hook)	35	0.5	0.4	0.3	0.5	0.5	0.5
395	Relocate gravel to dike fields on left descending bank at rm 393.8; monitor & adapt as necessary	3.54	0.8	0.8	0.8	0.8	0.8	0.8
398.8	Dredge upper/lower end Okay oxbow install culvert structure	1	0.4	0.3	0.2	0.5	0.5	0.5
Pool 17								
402	Relocate gravel upstream to rm 403.5 – 404; monitor & adapt as necessary	7.42	0.8	0.8	0.8	0.8	0.8	0.8
407	Dredge Upper/lower end Tullahassee Loop; rework culvert structure	1	0.4	0.4	0.4	0.5	0.5	0.5
408.8	Dredge mouth of Strawberry Creek	23	0.4	0.3	0.2	0.5	0.5	0.5
408.9	dredge mouth of Billy Creek Cutoff	138	0.4	0.3	0.2	0.6	0.6	0.6
414.7	Dredge at culvert structure	87	0.4	0.3	0.2	0.6	0.6	0.6
416.7	Dredge/rework culvert structure	122	0.4	0.4	0.4	0.6	0,6	0.6
418.8	Dredge/rework culvert structure	36	0.4	0.4	0.4	0.6	0.6	0.6
419.5	Dredge mouth of Bull Creek	34	0.4	0.3	0.2	0.4	0.4	0.4
421	Relocate gravel to rm 417-418.5; monitor & adapt as needed	20	0.8	0.8	0.8	0.8	0.8	0.8

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
Pool 18								
426.7	Dredge mouth of Commodore Creek	9	0.4	0.3	0.2	0.4	0.4	0.4
439.7	Dredge lower end of oxbow	8	0.4	0.3	0.2	0.4	0.4	0.4
442	Dredge lower end of oxbow	22	0.4	0.3	0.2	0.4	0.4	0.4

* n/a indicates not applicable non-habitat specific mitigation and/or biological mitigation

APPENDIX H

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Recommended Mitigation Features for

Freshwater Mussel Impacts

IN REPLY REFER TO:

United States Department of the Interior

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

April 29, 2005

Johnny McLean
U. S. Army Corps of Engineers
Environmental Section
P. O. Box 867
Little Rock, Arkansas 72203-0867

Dear Mr. McLean:

The U. S. Fish and Wildlife Service (Service) has completed our review of the Draft *McClellan-Kerr Arkansas River Navigation Study: Freshwater Mussel (Unionid) Study* prepared by Ecological Specialists, Incorporated (ESI). The Little Rock and Tulsa Districts of the U. S. Army Corps of Engineers (Corps) are preparing an Environmental Impact Statement that evaluates the modification of flows and deepening the channel from nine to twelve feet in the McClellan-Kerr Arkansas River Navigation System (MKARNS) from the Port of Catoosa near Tulsa, Oklahoma to the confluence with the Mississippi River in Arkansas. The Service (Conway and Tulsa Field Offices) and Arkansas Game and Fish Commission (AGFC) met with the Corps and ESI in June, 2004 to select and prioritize mussel sampling sites based on dredge and dredge disposal locations, potential mussel habitat, past surveys, and personal knowledge of the study area.

ESI conducted mussel surveys from September through December, 2004 and submitted their draft findings from the mussel survey in March, 2005. Preliminary discussions on the draft mussel report and mitigation recommendations were discussed during a conference call between the Service (Conway and Tulsa Field Offices), Corps (Little Rock and Tulsa Districts), AGFC, and ESI on April 20, 2005. The Arkansas Field Office (AFO) of the Service submits the following comments regarding the draft mussel study report and our recommendations for minimizing impacts to the Arkansas River freshwater mussel fauna (Arkansas portion only; Tulsa Field Office will submit comments for the OK portion). Our comments are separated into three categories: 1) Revisions, edits, and comments to the ESI draft mussel study report, 2) mitigation recommendations for freshwater mussels, and 3) long term monitoring and protection recommendations.

Recommendations for Revisions, Edits, and Comments to the ESI Draft Mussel Study Report

To date, only one *Potamilus capax* has been found in the lower White River system and their primary range in Arkansas includes the St. Francis River basin and dike fields along the Mississippi River. Therefore, the reach of MKARNS downstream of Lock and Dam 3 has the greatest likelihood of harboring *Potamilus capax*, not just Bed B1-1. This mistake needs to be corrected on page 6.

The report needs to include species area curves for all beds downstream of Lock and Dam 3.

The ability of a survey to detect a species depends on sampling design and effort. For cryptic animals like mussels, presence-absence can rarely be established absolutely, except for small areas. In a large area such as the canal, it is not possible to say with certainty that *Potamilus capax* is truly absent from the area. Instead, one must say that *Potamilus capax* was not detected given *X* effort and *Y* design. The challenge is to reduce the chance of missing *Potamilus capax* to an acceptable level. This is where species area curves are of importance to indicate the likelihood of encountering additional species with more effort.

Depending on results from species area curves for mussel beds between Bed B1-1 and Lock and Dam 3, additional sampling effort may be required to ensure that no *Potamilus capax* are present. Given the number of mussels in the canal it is questionable without seeing a species area curve whether a 5 minute sample every 317 meters (m) is sufficient to detect *Potamilus capax* considering the number of mussels present in the canal. If curves show that extensive effort may be required to detect another species then additional sampling may not be required. A decision will be determined by the Service and AGFC and will be dependent upon the amount of effort required to significantly reduce the likelihood of encountering an additional species. Consideration to sample effort and design, species area curves, and the likelihood of encountering additional species should be incorporated in the final report.

Page 2, line 17 delete *Lampsilis powellii* (Neosho and Illinois River, Branson, 1984). *Lampsilis powellii* is an endemic to the upper Ouachita River system in Arkansas. Any reference to this species occurring in the Neosho and Illinois Rivers by Branson (1984) is a misidentification.

State in the methods section the criteria used to distinguish "Patches" from "Beds".

Work with the Service, Corps, and AGFC to incorporate mitigation and monitoring recommendations into the final report.

Mitigation Recommendations for Freshwater Mussels

Very few mussel beds and patches were discovered during 2004 surveys within the permitted and proposed dredge disposal sites. These mussel beds and patches collectively represent a major portion of the MKARNS mussel fauna and are a significant resource. However, relocation of mussel beds and patches outside of the Arkansas Post Canal is not prudent because it is a greater priority to preserve the few disjunct areas of suitable mussel habitat in the system than preserve individuals. The Corps indicated in the March 20, 2005 conference call that there would be some flexibility with the location of disposal sites. The Corps should work closely with the Service, AGFC, and ESI to establish alternate disposal areas or restrict disposal in permitted and new sites to no closer than 100 m lateral and downstream and 300 m upstream of defined patches and beds.

The largest concentration of mussels (approximately 2 million) in the MKARNS occurs in Mussel Beds B2-1, B2-2, and B2-3 located in the Arkansas Post Canal (canal). The estimate of 2 million mussels is based on qualitative sampling (41 five minute samples) and there may be considerable variability in the number of mussels present. Quantitative samples would have yielded more validity to mussel community estimates in the canal, but are not available at this time. However, the recommendations presented below should be sufficient to help reestablish the canal.

The Corps intends to dredge the entire Arkansas Post Canal using a cutter head dredge. To mitigate and compensate for the mussel and mussel habitat losses in MKARNS, the Service's AFO is recommending the following combination of translocation and propagation.

Arkansas Post Canal and Merrisach Lake – Merrisach Lake is adjacent to the Arkansas Post Canal and may serve as a refugia or temporary holding location for mussels that will be used to reestablish the canal should suitable habitat persist post-dredging. Approximately 12,000 m of shoreline habitat (excluding shallow areas in the back of coves) is available in Merrisach Lake. A thorough survey of the lake is required to determine the exact amount of suitable habitat and should be conducted prior to any relocation. Either floating cages or metal cages placed on the substrate should be used to hold mussels in the lake. The decision on what type of cage to use should be based on habitat suitability in the lake. Assuming that a 1 m wide area of suitable habitat exists along the shoreline and five mussels/m^2 are relocated into the lake, 60,000 mussels could be temporarily held at this location. Composition of the relocated mussels should closely resemble that which occurs in the canal at this time (refer to Table 3-6 in ESI's draft report). These mussels will be relocated back to the canal following dredging activities and when it is determined by the Service and AGFC that suitable habitat exists. The use of cages should greatly reduce the amount of time and effort required to move mussels back into the canal.

Propagation and the subsequent release of juveniles, in addition to the relocated individuals, will help compensate for the mortality of approximately 1.9 million mussels and any mortality associated with relocation and temporary holding in Merrisach Lake. A bottleneck occurs in the life cycle of freshwater mussels due to their dependency of a suitable fish host to complete their life cycle. Essentially, we are not recommending captive breeding but rather the collection of gravid females from the wild, providing access to a suitable fish host to allow glochidia to transform to juveniles, and subsequently releasing 2 month old juveniles back to the canal. With juvenile survival rates often low, a 3 year propagation effort at a rate of 1 million juveniles per year is needed. The proportion of juveniles released should be as close as practical to mussel community composition in the canal prior to dredging. American Fisheries Society Special Publication 30, *Investigation and Monetary Values of Fish and Freshwater Mussel Kills*, provides replacement costs per juvenile for each species.

If suitable habitat does not exist in the canal following dredging activities, the AFO and AGFC will determine relocation and juvenile release sites at other locations in the Arkansas portion of the MKARNS as needed.

White River – Several species that occur in the canal are components of the White River mussel fauna. These include *Fusconaia ebena*, *F. flava*, *Lampsilis cardium*, *L. siliquoidea*, *L. teres*, *Quadrula aspera*, *Q. nodulata*, and *Truncilla truncata*. These species should first be moved into Merrisach Lake at the same composition that they currently occur in the canal. All excess individuals encountered during relocation efforts will be relocated to mussel beds in the lower

White River portion of the MKARNS. However, the number relocated should not exceed 10,000 individuals and extra effort to find these species is not required.

Lake Dardanelle – The mussel community in Lake Dardanelle has been devastated in recent years by commercial shelling and zebra mussels. However, the lake still has a vast amount of suitable mussel habitat along the shoreline and on shallow flats adjacent to the river channel. The lake's mussel community would benefit from individuals being relocated from the canal to the lake. Piney Bay (approximately 215 acres of suitable habitat) would be the top priority in the lake since it historically had lower densities of zebra mussels compared to other locations in the lake. Thirty thousand (30,000) mussels should be relocated from the canal to Piney Bay. The species relocated should consist only of those species which are known to occur in Lake Dardanelle and that are sublegal harvest size (see AGFC regulations). Mussels should be stocked at an average density not to exceed 3 mussels/m^2. By relocating mussels to Lake Dardanelle, the amount of occupied mussel habitat will be increased in the MKARNS thereby helping to offset any habitat loss related to dredging activities.

Long Term Monitoring and Protection Recommendations

Monitoring is critical to determine success or failure of relocation and juvenile release efforts. Each mussel relocation site should have a plan developed for monitoring. At a minimum the monitoring plan should consist of explicit monitoring goals, reporting requirements, and monitoring responsibilities. Monitoring goals at a minimum should include two components: 1) relocation site monitoring should be conducted annually for the first three years following relocation (required) and once every other year thereafter for seven years or until there is evidence of success or failure, 2) at least three mussel beds, to be determined by the AFO and AGFC, adjacent to disposal sites in Arkansas should be monitored within six months following a high water event (100,000 cfs) and should include monitoring associated with a minimum of 3 high water events. Monitoring should include quantitative components and be statistically comparable across years.

Additionally, the relocation sites should be protected to ensure that the mitigation goal can be achieved. Efforts to relocate the mussels, establish replacement beds, and monitor these sites will be in vain if the mussels are harvested. The AGFC and/or the Corps should implement regulations and/or habitat mitigation easements for these areas to prevent mussels from being harvested. We believe failure to provide protection to these sites is inadequate to meet mitigation goals.

We request that a meeting be scheduled for early May between the AFO, AGFC, and Corps to discuss in more detail the relocation of disposal areas and potential for avoiding impacts to mussel beds near disposal areas. We also strongly encourage the Corps to use a dredge other than a cutter head in the Arkansas Post Canal. A less destructive dredge would increase the likelihood of mussels passing through the dredge unharmed. Scientists have expressed an interest in collecting unharmed mussels from the disposal material at Arkansas Post Canal for use in taxonomic studies with specimens to be housed at the Arkansas State University Museum of Zoology Mollusk Collection.

We thank you for your interest in the conservation of freshwater mussels. If you have any questions or project plan changes, please notify Chris Davidson at 501-513-4481. Thank you for your continued cooperation with our agency.

Sincerely,

David H. Kampwerth
Acting Field Supervisor

cc w/encl: Heidi Dunn, Ecological Specialists Inc.
Bill Posey, Arkansas Game and Fish Commission
David Martinez, USFWS Tulsa Field Office
Sandy Stiles, USACE Tulsa District

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In Reply Refer To:
FWS/R2/OKES/0
2-14-05-I-0419
0385

May 11, 2005

Johnny McLean
U.S. Army Corps of Engineers
Environmental Section
P. O. Box 867
Little Rock, Arkansas 72203 – 0867

Dear Mr. Mclean:

This letter transmits planning information for the U.S. Army Corps of Engineers (Corps) Arkansas River Navigation Study (ARNS), Arkansas and Oklahoma. The U.S. Fish and Wildlife Service (Service) has most recently been working cooperatively with Corps staff on the assessment of potential impacts to aquatic resources as a result of the proposed channel deepening feature of ARNS and the development of mitigation measures for these impacts. Freshwater mussels (unionids) could be impacted by proposed dredging and disposal activities.
Ecological Specialists, Inc. (ESI) conducted a study to determine unionid distribution and species composition in the navigation system. The Tulsa and Conway Field Offices of the Service and the Arkansas Game and Fish Commission participated in a preliminary planning session with the Corps and ESI during June 2004 to select and prioritize mussel sampling points. ESI conducted mussel surveys during September, October and December 2004. The Oklahoma Ecological Services Field Office of the Service has reviewed the draft McClellan – Kerr Arkansas River Navigation Study: Freshwater Mussel (Unionid) Survey prepared by ESI.

The comments provided here pertain to freshwater mussel resources in the Oklahoma portion of the study area. The Conway field office is preparing comments for the Arkansas portion of the study. Our comments serve to provide 1) suggested revisions to the draft report, 2) preliminary ideas for mitigation of potential impacts on freshwater mussels and 3) long-term monitoring needs. This letter is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. et seq.), but is not intended to fulfill the reporting requirements of Section 2 (b) of the Act.

General Comments

The new surveys by ESI found no federally-listed or proposed threatened or endangered species within the MKARNS, but did find productive, diverse (29 species total) mussel communities within most reaches of the system. As the ESI authors point out, unionids are an important ecological component of many freshwater ecosystems (Strayer *et al.* 1999, Vaughn *et al.* 2004). They are additionally valued by humans for their significant commercial, scientific, cultural and aesthetic importance (Stansbery and Stein 1971, Williams *et al.* 1993). Of the multiple factors listed by the ESI authors as contributing to recent mussel declines, all but commercial harvest are associated with development and operation of major navigation systems such as the MKARNS.

The proposed project would affect mussels and mussel habitats, most directly by dredging and disposal of dredged materials in conjunction with producing a minimum 12-foot channel depth. The potential exists not only for direct removal and burial of mussels, but also for effects on nearby mussels from dispersion of temporarily suspended sediments and destabilization of substrates adjacent to the excavated channel. In addition, the expected operation of larger barges in the MKARNS would increase re-suspension of sediments and other turbulence-related effects in the system. The Service does not anticipate that flow-modification features of the project would adversely affect mussel resources in the MKARNS.

The survey results verify that mussel resources are not distributed uniformly throughout the MKARNS, but rather occur in relative concentrations, the larger of these described as beds and patches. In general, efforts should be made to avoid effects on mussel habitats by locating dredge and disposal sites away from identified mussel concentrations. Open water distances necessary to protect mussels from dispersing sediments would vary by substrate type, with 30 horizontal meters probably sufficient for predominantly sandy substrates but 100-150 horizontal meters probably needed for silty substrates. Other site-specific factors (*e.g.*, currents, vertical separation of mussels and channel activities) may alter minimum distances needed; however, distances of these or similar magnitudes should be adopted as a general standard.

Where constraints (*e.g.*, location of the existing channel) prevent use of such distances, silt curtains or other obstructions should be employed to protect mussel concentrations from dispersing sediments. Effectiveness of the distances indicated for protecting mussel habitats in the MKARNS is not known specifically, and should be evaluated during project implementation. Based on initial evaluations, standard distances should be enlarged if necessary.

Where it is not possible to avoid mussel concentrations (*e.g.*, where these are in close proximity to required dredging sites) the Corps should attempt relocation of mussels and restoration of habitats not threatened by the current project. These measures are needed to compensate for unavoidable losses. Because effectiveness of such measures can vary widely, their use should include provisions for monitoring and remedial efforts, to ensure that mitigation levels sought using these approaches are met. In most cases, the Service does not place a high priority on relocation of low mussel concentrations ("few" or "scattered" mussels). Instead, we believe that efforts would be better directed into mussel habitat restoration to compensate for impacts to low mussel occurrences.

The survey found that mussel resources vary widely across the breadth of the MKARNS. In general, the more downstream reaches of the system contain more and larger mussel concentrations, whereas upper reaches of the system contain fewer and smaller concentrations. Species richness and occurrence of particular species also ranged widely, with 11 of the 29 species found in the survey being detected in only one or two of the six surveyed reaches. This variation demonstrates a differing status of mussel resources in different parts of the MKARNS, which is relevant to conservation planning. Natural factors, including biogeographical distinctions, partly underlie the observed differences. Van der Schalie and Van der Schalie (1950) and Parmalee and Bogan (1998) both recognized an Ozarkian unionoid province, distinct from the surrounding Interior Basin province, based on presence of added, endemic taxa within a definable region. The Ozarkian province of those authors overlies the Arkansas River mainstem from southern Kansas into western Arkansas.

Accordingly, the Service believes it is not appropriate to treat mussel resources equally or interchangeably throughout the MKARNS. Surveyors found very limited mussel occurrences in the Verdigris River, for example, but recommended that any unionids found within that river be protected. The Verdigris River once constituted one of Oklahoma's most productive and diverse mussel streams (Isely 1914, 1925), and mussel habitats and communities remaining there probably are vital to sustaining a remnant of the historical fauna. In contrast, lower portions of the MKARNS likely could suffer loss of limited patches or beds without jeopardizing the status of their mussel fauna. As a result, the Service recommends that a higher resource value be placed on mussels in the Oklahoma portion of the project, based on relative scarcity. Impacts to all mussel patches and beds in Oklahoma should be avoided, minimized, and compensated to the extent practicable.

Suggested Revisions to the Draft Report

The review of past unionid studies on the Arkansas River and species of special status includes a few mostly minor errors. Most significant of these is the inclusion of *Lampsilis powellii*, the Arkansas fatmucket. This species is currently considered to occur in upper portions of the Saline and Ouachita rivers and the Caddo River (Gordon and Harris 1985, Harris et al. 1997). Several erroneous records of the species exist from the Arkansas River system, all or most based on specimens of *Lampsilis rafinesqueana*, the Neosho mucket. Lorraine Frierson described the latter species fairly recently (1927, 1928) compared to most mussel species, prior to which Neosho mucket specimens were assigned to *L. powellii*, first described in 1852. Gordon and Harris (1985) sorted out the confusion of records involving these species; their published interpretation has been followed by others.

The erroneous report of *Potamilus capax* from the Verdigris River was not Branson (1983) but Branson (1963), and the recovery plan questioning that record was USFWS (1989), not (1985). Branson (1984) described his and other Oklahoma records as erroneous. Branson reported *Quadrula cylindrica* from the Neosho and Verdigris rivers in his 1982 paper, not the 1984 paper. Other minor errors include citing Davidson (1997) as Davison (1997), Shepard and Covich (1982) as Shepard (1982), and Vaughn and Spooner (2004) as Vaughan and Spoooner (in press). These errors should be corrected.

The authors do not provide definitions for a mussel patch and a mussel bed. Please identify the differences used to distinguish between a patch and bed.

The report states, on page 28, that "407 samples were collected" from Reach Five on page 28. However, on page 29, the report states "that 21 species were collected in 417 samples within this reach." This inconsistency should be corrected.

The report states on page 30 that four mussel patches were found at Site 35. Table 3-37 identifies these areas as mussel beds. This inconsistency should be corrected.

Preliminary Mitigation Recommendations

The Service's overall conservation goal is to protect, conserve, and/or enhance important fish and wildlife resources. Our objective is to avoid or minimize habitat value losses, and where appropriate to mitigate/compensate for unavoidable resource losses.

The Service recommends the Corps consider the following preliminary mitigation ideas to avoid and minimize project impacts to freshwater mussels in Oklahoma.

1) A variety of additional surveys should be performed prior to project implementation. Certain project dredge sites, maintenance dredge sites, and aquatic disposal sites were not included in the initial surveys. Prior to finalizing project plans, many omitted sites should be surveyed where conditions indicate a reasonable probability for mussel concentrations to be present. Initial surveys identified many parameters useful for indicating probable mussel occurrences (*e.g.*, presence of certain substrates, vegetation, tributary mouths, bathymetry, etc.). In addition, large or incompletely surveyed mussel concentrations may require additional surveys for complete delineation. Alternative disposal sites selected to avoid impacts to known mussel patches/beds also should be surveyed. Should a bed or patch be located, mitigation features should be developed through interagency coordination to avoid, minimize or compensate impacts.
2) The single mussel bed and 6 of the 17 mussel patches located in the Oklahoma portion of the MKARNS would be impacted by the proposed channel deepening feature. Additionally, unionids were found in at least 50% of the samples in dredge areas DR-1 and DR-2. The Service recommends that the

3) Corps consider the preliminary mitigation measures provided in the following table to avoid and minimize impacts to freshwater mussel concentrations in Oklahoma.

Mussel Patch/Bed	Impact	Recommended Mitigation Measure
B33-1	The bed occurs within proposed dredged material disposal site OK336.4R-DI.	Do not use disposal site OK336.4R-DI. Dispose of dredged material planned for that location at proposed disposal area OK336.3L-DI (beach nourishment site) by expanding site OK336.3L-DI.
P35-1	The patch occurs within proposed dredged material disposal site OKSBC4.8L-DI.	Reduce the area of the proposed disposal site so that disposal would not occur within 100 meters of the mussel patch. Investigate the feasibility of a) increasing the amount of dredged material that would be disposed of at OKSBC6.6L-DI and OKSBC6.9L-DI; and b) disposing of dredged material at the smaller of the two islands located about 0.25 miles east of OKSBC4.8L-DI.
P35-2	The patch is primarily along the riverward edge of an island and extends into the channel where dredging is proposed.	Investigate the feasibility and effectiveness of employing silt curtains during dredging activity to minimize impacts.
P35-4	The patch occurs within 100 meters of a proposed dredge area.	Investigate the feasibility and effectiveness of employing silt curtains during dredging activity to minimize impacts.
P39-3	The patch occurs within 100 meters of a proposed dredge area.	Investigate the feasibility and effectiveness of employing silt curtains during dredging activity to minimize impacts.
P39-4	The patch occurs within 100 meters of a proposed dredge area.	Investigate the feasibility and effectiveness of employing silt curtains during dredging activity to minimize impacts.
P50-1	The patch occurs within a proposed dredge area.	Either a) temporarily relocate mussels to P49-2 (closest patch) utilizing holding cages and return to original site if suitable substrate remains after dredging; or b) permanently relocate mussels to P49-2 if suitable habitat/substrate would not remain at P50-1 after dredging activity.
DR-1	Unionids were found in 50% of samples collected from this proposed main channel dredge area.	Relocate mussels to P36-1(area which should not be impacted by the proposed project), or B33-1 (area which would not be impacted by the proposed project if the recommended mitigation measure for this site is implemented).
DR-2	Unionids were found in over 50% of samples collected from the proposed Sallisaw Creek dredge area.	Relocate mussels to P36-1(area which should not be impacted by the proposed project), or B33-1 (area which would not be impacted by the proposed project if the recommended mitigation measure for this site is implemented).

3) The Corps should work with the State of Oklahoma to designate Pool 15 as a mussel sanctuary due to the relative abundance of habitat conducive to mussel patches and beds in the area.
4) The draft report indicated that areas conducive for mussels were found throughout site 40; however, only a few mussels were located. We believe this may be due to the limited sampling effort dictated by time constraints. We recommend a more thorough investigation of disposal site OKOK367.2L-DI prior to project implementation.
5) Mussel habitat restoration projects should be implemented to compensate for impacts to areas of low mussel occurrences ("few" or "scattered" mussels). Candidate sites for mussel relocations or restoration of mussel habitat include the old river channel at NM 400 - 403 and in the Verdigris River upstream of NM 445 (Port of Catoosa). Additional surveying and evaluation is needed at these sites to assess current limiting factors and restoration potential.

The eventual effectiveness of many measures recommended by the Service to address mussel impacts cannot be predicted accurately at present. As a result, it will be important for the Corps to provide for short-term and long-term monitoring to verify levels of effectiveness achieved. Avoidance distances, shielding with silt curtains, relocation of mussels to new locations, and maintenance/restoration of mussel habitats all should be included in the monitoring programs. Monitoring results should be evaluated and where mitigation measures fall short, remedial steps should be taken to fulfill resource objectives.

The costs for wildlife resource mitigation measures should be cost-shared at rates for the purpose causing the loss, in accordance with section 906 (c) WRDA 1986, section 333 WRDA 1992, and section 2 (d) of the FWCA. Additionally, in accordance with sections 906 (a) (1) (A) and 906 (a) (1) (B) WRDA 1986, mitigation should be performed prior to or concurrent with project implementation.

We appreciate the opportunity to participate in this study during the planning phase, and look forward to further coordination. If you have any questions, please contact Richard Stark or David Martinez at 918-581-7458, extensions 240 and 228, respectively.

Sincerely,

Jerry J. Brabander
Field Supervisor

cc: Regional Director (ARD-ES), FWS, Albuquerque, NM (Attn: Dean Watkins)
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ODWC, Northeast Regional Office, Porter, OK (Attn: Mike Plunkett and Randy Hyler)
U.S. Army Corps of Engineers Planning and Environmental, Tulsa, OK (Attn: Sandra Stiles)
Director, ODEQ, Oklahoma City, OK (Attn: Water Quality Programs Division 0207)
Regional Administrator, Environmental Protection Agency, Dallas, TX (Attn: 6WQ-EM)
Field Supervisor, U. S. Fish and Wildlife Service, Conway, AR (Attn: Marge Harney)
Manager, Sequoyah National Wildlife Refuge, Vian, OK

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C.3

Biological Assessment

BIOLOGICAL ASSESSMENT
ADDRESSING

SIXTEEN FEDERALLY LISTED THREATENED OR ENDANGERED SPECIES ON THE ARKANSAS, CANADIAN, AND RED RIVERS; ARKANSAS, OKLAHOMA, AND TEXAS;
AND
ON THE
MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM ARKANSAS AND OKLAHOMA

U.S. Army Corps of Engineers
Tulsa and Little Rock Districts

November 2003

BIOLOGICAL ASESSMENT
ADDRESSING
SIXTEEN FEDERALLY LISTED SPECIES ON THE
ARKANSAS, CANADIAN, AND RED RIVERS,
ARKANSAS, OKLAHOMA, AND TEXAS;
AND
ON THE
MCKELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM
ARKANSAS AND OKLAHOMA

EXECUTIVE SUMMARY

This Biological Assessment (BA) provides the information required pursuant to the Endangered Species Act (ESA) and its implementing regulations. It documents and incorporates new and additional information not previously provided by the U.S. Army Corps of Engineers (USACE), and describes all the current and proposed actions of the USACE to comply with the ESA.

Since issuance of a Biological Opinion (BO) by the USFWS dated March 16, 1998, which established “take “ for the Interior least tern on the Arkansas River in Oklahoma, the USACE has been operating the Kaw and Keystone reservoirs under the provisions of the 1998 BO and the established levels of “take”.

In August 1998, the USFWS requested the USACE to initiate consultation efforts on the Canadian River below Eufaula Lake and the Red River below Denison Dam with respect to the Interior least tern, and the USACE agreed. Biological Assessments concluding a “may affect” were subsequently prepared and furnished to the USFWS. After several meetings and review of operating conditions for the Arkansas River with respect to nesting success and “take” levels established in the 1998 BA, it was decided to reinitiate consultation on the Arkansas River and combine it with the two separate ongoing consultations on the Red and Canadian rivers. This combined Section 7 consultation would result in the preparation of a comprehensive BA and BO covering all three-river systems.

Also, the existing 1998 consultation covered only one species, the Interior least tern. Due to the presence of two other species, the bald eagle (*Haliaeetus leucocephalus*) and the American burying beetle (*Nicrophorus americanus*), which were not addressed in the previous BA, both agencies mutually agreed to include these species in the comprehensive consultation as well.

The USACE is also conducting two additional studies along the McClellan-Kerr Arkansas River Navigation System (MCKARNS) that could have potential impacts on Federally listed species. The first study is the Arkansas River Navigation Feasibility Study, which consists of two phases. Phase I will address system operations of the MCKARNS, and Phase II will address proposed channel modifications. The second study involves revising the Dredge Material Disposal Management Plan for the Oklahoma portion of the MCKARNS. Since cumulative effects must be addressed as a component of the BA, it was deemed prudent to include these proposed actions in the comprehensive BA as well.

Recently, Tulsa District initiated a reallocation study on Lake Texoma. This study will address reallocating 300,000 acre-feet of existing hydropower storage into water supply storage. The potential impacts of the proposed reallocation will also be considered in this BA and addressed as cumulative impacts.

Since issuance of the 1998 BO, additional information has become available that supports preparation of this BA and the USFWS request for re-initiation of consultation. Additional surveys have been conducted on the three river systems, and the results of these surveys need to be addressed in the BA and considered in a new BO. Also, the USACE formed a multi-agency Least Tern Committee in 2002 to develop and provide comprehensive guidelines for management and protection of Interior least terns nesting below USACE water resource projects on the Arkansas, Canadian, and Red rivers. These management guidelines and strategies have been implemented by the USACE and need to be considered and addressed in a new BO.

PROPOSED ACTION

The proposed action is to prepare a comprehensive BA addressing all Federally listed species for those portions of the Arkansas River, Red River, and Canadian River impacted by operation and maintenance of USACE projects while taking into consideration other Congressionally authorized uses of the river and cumulative impacts. The proposed action will evaluate the impacts of operating the following projects on Federally listed species:

- Arkansas River System Operations
- Arkansas River Navigation Study, Phases I and II
- MCKARNS Dredge Material Disposal Management Plan
- Canadian River Operations
- Red River Operations

This BA will address sixteen (16) endangered species with respect to the following areas, USACE studies, and operational and management activities on projects within these areas:

- The main stem of the Arkansas River from below Kaw Lake to Muskogee, Oklahoma, and the MCKARNS, and the impacts of 11 operational Oklahoma lakes associated with releases into the MCKARNS downstream to the mouth of the White River in Arkansas and then to the Mississippi River. These lakes include Keystone Lake, Oologah Lake, Grand Lake, Lake Hudson, Fort Gibson Lake, Tenkiller Ferry Lake, Eufaula Lake, Kaw Lake, Hulah Lake, Copan Lake, and Wister Lake.

- A total of 27 miles of the Canadian River from below Eufaula Dam to the confluence of the MCKARNS.

- Lake Texoma and approximately 240 miles of the Red River from below Denison Dam to Index, Arkansas.

LISTED SPECIES AND CRITICAL HABITAT

The species listed under the ESA that are addressed in this BA include:

- American alligator (*Alligator mississippiensis*)
- Gray bat (*Myotis grisescens*)
- Indiana bat (*Myotis sodalis*)
- Ozark big-eared bat (*Corynorhinus townsendii ingénues*)
- American burying beetle (*Nicrophorus americanus*)
- Whooping crane (*Grus americana*)
- Bald eagle (*Haliaeetus americana*)
- Pink mucket pearly mussel (*Lampsilis abrupta*)
- Scaleshell mussel (*Leptodea leptodon*)
- Arkansas River shiner (*Notropis girardi*)
- Piping plover (*Charadrius melodius*)
- Pallid sturgeon (*Scaphirhynchus albus*)
- Interior least tern (*Sterna antillarum)*
- *Geocarpon minimum* (No common name)
- Western prairie fringed orchid (*Platanthera praeclara*)
- Harperella (*Ptilimnium nodosum*)

ANTICIPATED EFFECTS OF THE PROPOSED ACTION

Continued operation of the Red River, Arkansas River, and Canadian River projects for their authorized project purposes and denoted studies were evaluated, and the anticipated effects of the proposed actions and cumulative impacts were determined in accordance with the ESA. The potential direct, indirect, and cumulative impacts identified with respect to the listed species and proposed actions area summarized as follows:

1) It was determined that the proposed actions would have "no affect" on the American alligator, Gray bat, Indiana bat, Ozark big-eared bat, whooping crane, pink mucket pearly mussel, scaleshell mussel, piping plover, Arkansas River shiner, *Geocarpon minimum*, and Harperella. The finding of "no affect" was determined based on the fact that the range of many of these species is not associated with the projects, the species are no longer found in the project area, suitable habitat is not present on project lands, or the impacts were considered to be inconsequential.

2) There is a potential for the proposed actions to have an "adverse affect" on the American burying beetle and its habitat if it is found to occur on project lands located within its range. Indirectly, operation of the 11 supporting reservoirs may also have an indirect adverse impact on this species through implementation of land use changes associated with operational activities.

3) The proposed actions were determined to have both positive and negative impacts on the Interior least tern. Continued operation of operational projects for their authorized project purposes would adversely affect nesting Interior least terns and their habitat on the Arkansas, Canadian, Red rivers, and the MCKARNS. Implementation of the proposed Dredge Material Disposal Management Plan and Arkansas River Navigation Project may create additional nesting habitat for this species, which have a positive impact on the species. Also, operation of projects for flood control and hydropower can have a positive affect on this species from the fact that the USACE has some control on flows.

4) The bald eagle occurs throughout all the proposed action areas. Most of the proposed actions were determined to have "no affect" on this species. However, implementation of the Dredge Material Disposal Management Plan and Phase II of the Arkansas River Navigation Study have the potential to negatively impact this species directly by removal and loss of habitat, and indirectly by disturbing sediments that may contain contaminants.

5) No records exist for occurrence of the pallid sturgeon in either the Arkansas or White rivers. However, since this species has been collected from the Mississippi River near the mouth of the White River, it is reasonable to assume that at times it could be found in the lower White River. Consequently, implementation of the Arkansas River Navigation Study, Phase II, Channel Modification, could have an "adverse affect" on the species if it is found to occur in this area. Additional seasonal surveys would be required to confirm the presence of this species.

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INTRODUCTION

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, requires that,

"*Each Federal agency shall, in consultation with and with the assistance of the secretary, insure that any action authorized, funded, or carried out by such agency…. is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species…*".

This Biological Assessment (BA) provides the information required pursuant to the ESA and implementing regulations (50 CFR 402.14), to comply with the ESA.

NEED FOR BIOLOGICAL ASSESSMENT

In February 1987, the U.S. Army Corps of Engineers (USACE) initiated informal Section 7 consultation with the U.S. Fish and Wildlife Service (USFWS) under the ESA for operation of Kaw and Keystone dams on the main stem of the Arkansas River in Oklahoma with respect to the Interior least tern (*Sterna antillarum*). This culminated in issuance of a Biological Opinion (BO) by the USFWS dated March 16, 1998, which established "take " for this species. The USACE has been operating the two reservoirs since 1998 under the provisions of the 1998 BO and the established levels of "take".

In August 1998, the USFWS requested the USACE to initiate consultation efforts on the Canadian River below Eufaula Lake and the Red River below Denison Dam with respect to the Interior least tern, and the USACE agreed. Biological Assessments concluding a "may affect" were subsequently prepared and furnished to the USFWS. After several meetings and review of operating conditions for the Arkansas River with respect to nesting success and "take" levels established in the 1998 BA, it was decided to reinitiate consultation on the Arkansas River and combine it with the two separate ongoing consultations on the Red and Canadian rivers. This combined Section 7 consultation would result in the preparation of a comprehensive BA and BO covering all three river systems.

Also, the existing consultation covered only one species, the Interior least tern. Due to the presence of two other species, the bald eagle (*Haliaeetus leucocephalus*) and American burying beetle (*Nicrophorus americanus*), which were not addressed in the original BA, both agencies mutually agreed to include these species in the comprehensive consultation as well.

The USACE is also conducting two additional studies along the McClellan-Kerr Arkansas River Navigation System (MCKARNS) that could have potential impacts on Federally listed species. The first is the Arkansas River Navigation Feasibility Study, which consists of two phases. Phase I will address system operations of the MCKARNS, and Phase II will address proposed channel modifications. The second study involves revising the Dredge Material Disposal Management Plan for the Oklahoma portion of the MCKARNS. Since cumulative effects must be addressed as a component of the BA, it was deemed prudent to include these proposed actions in the comprehensive BA as well.

Recently, Tulsa District initiated a reallocation study on Lake Texoma. This study will address reallocating 300,000 acre-feet of existing hydropower storage into water supply storage. The potential impacts of the proposed reallocation will also be considered in this BA and addressed as cumulative impacts.

By letter dated July 30, 2003, to the USFWS, the USACE requested an official list of Federally listed species for all the designated action areas. The USFWS replied by letter dated August 28, 2003, which updated the list of species furnished to the USACE in a planning assistance report for the Arkansas River Navigation Study dated April 2, 2001. The total number of species to be addressed in this BA is 16 and includes the American alligator, gray bat, Indiana bat, Ozark big-eared bat, American burying beetle, whooping crane, bald eagle, pink mucket pearly mussel, scaleshell mussel, piping plover, Arkansas River shiner, pallid sturgeon, Interior least tern, *Geocarpon minimum*, western prairie fringed orchid, and Harperella.

Since issuance of the 1998 BO, additional information has become available that supports preparation of this BA and the USFWS request for reinitiation of consultation. Additional surveys have been conducted on the three river systems, and the results of these surveys need to be addressed in the BA and considered in the BO. Also, the USACE formed a multi-agency Least Tern Committee in 2002 to develop and provide comprehensive guidelines for management and protection of Interior least terns nesting below USACE water resource projects on the Arkansas, Canadian, and Red rivers. These management guidelines and strategies have been implemented by the USACE and need to be considered and addressed in the BO.

This BA will address the 16 noted species with respect to the following areas, USACE studies, and operational and management activities on projects within these areas:

- The main stem of the Arkansas River from below Kaw Lake to Muskogee, Oklahoma, and the MCKARNS, and the impacts of 11 operational Oklahoma lakes associated with releases into the MCKARNS downstream to the mouth of the White River in Arkansas and then to the Mississippi River. These lakes include Keystone Lake, Oologah Lake, Grand Lake, Lake Hudson, Fort Gibson Lake, Tenkiller Ferry Lake, Eufaula Lake, Kaw Lake, Hulah Lake, Copan Lake, and Wister Lake.

- A total of 27 miles of the Canadian River from below Eufaula Dam to the confluence of the MCKARNS.

- Lake Texoma and approximately 240 miles of the Red River from below Denison Dam to Index, Arkansas.

CHRONOLOGY

A chronology of previous Section 7 consultation activities with respect to the Interior least tern on the Arkansas River system in Oklahoma can be found in the USFWS BO dated March 16, 1998. This information provides a history of all activities and correspondence from the start of informal consultation in 1986 to issuance of the BO in 1998 and is included in Appendix 1. Following is an update of all events and issues with respect to monitoring nesting Interior least terns and "take" since issuance of the 1998 BO for the Arkansas River:

August 11, 1998. USFWS letter to USACE requesting USACE initiate consultation efforts to minimize adverse effects on the Interior least tern at USACE projects on the Canadian River and Red River.

November 6, 1998. USACE letter to USFWS agreeing that USACE would survey Red and Canadian rivers in 1999 and use the information to prepare a BA.

March 13, 2001. USACE study plan for nesting island habitat evaluation furnished to USFWS. This study plan would initiate implementation of Reasonable and Prudent Measure No. 5 of the 1998 BO.

March 15, 2001. USACE letter to USFWS informing them that the Tulsa District has and will assume responsibility for any future consultation on the operation of Kaw and Keystone per Memorandum of Understanding (MOU) dated July 23, 1980, signed by the Administrator, Southwestern Power Administration (SWPA) and the USACE Division Engineer, Southwestern Division. The MOU states, " The administrator recognizes the Corps responsibility to operate the projects to serve all authorized functions including power."

April 20, 2001. Interagency meeting between USFWS, USACE, SWPA, and Department of Interior (DOI), Office of the Field Solicitor. The meeting was conducted to resolve agency differences with respect to Section 7 consultation agency requirements and to improve communications among agencies.

May 31, 2001. USFWS letter notifying USACE and SWPA that they should avoid and minimize "take" related to operation of projects on the Canadian and Red rivers.

July 02, 2001. USACE submitted a "may affect" BA to USFWS on the effects of operating Denison Dam on the Red River and requested initiation of formal Section 7 consultation.

August 14, 2001. USFWS letter stating they had reviewed the BA for the operation of Denison Dam on the Red River and concurred in the findings. The USFWS requested additional information on the Corps proposed actions to allow an accurate assessment of potential take and to develop recommendations to avoid or minimize take.

December 18, 2001. USACE submittal of BA to USFWS concerning the effect of operating Eufaula Dam for its Federally authorized purposes on the Interior least tern and request for initiation of formal Section 7 consultation.

USACE, Little Rock Chronology

After a meeting with the U.S. Department of the Interior, Fish and Wildlife Service in 1985, the Little Rock District entered into a formal review as per Section 7 of the Endangered Species Act for the portion of the McClellan-Kerr Arkansas River Navigation System. Mr. Fred Bagley of the Jackson, Mississippi, Area Office of Region IV was the USFWS point of contact on this review. Mr. Clyde Gates represented the U.S. Army Corps of Engineers, Little Rock District. The review was entered into because the Arkansas River had been a historic nesting area for an unknown population of the Interior least tern *(Sterna antillarum athalasso)* prior to construction of the navigation system. The navigation system consisted of a series of locks and dams, two lakes, and various revetments to better maintain a navigational channel. As a result of a jeopardy opinion from the USFWS, Mr. Gates developed a management plan that would protect and enhance nesting populations of the least tern on the navigation system in Arkansas. The management plan was coordinated with the Arkansas Department of Natural Heritage, the Arkansas Game and Fish Commission, and the Jackson Area office. The management plan has been in effect since 1986.

SPECIES TO BE ADDRESSED IN BIOLOGICAL ASSESSMENT

In a Planning Assistant report dated April 2, 2001, the USFWS furnished a list of 12 Federally listed threatened and or endangered species that could possibly be occurring in association with all the Arkansas River Navigation projects. By letter dated July 30, 2003, the USACE requested an official list of species from the USFWS for all the proposed action areas. The USFWS responded by letter dated August 28, 2003, and added an additional four species. A total of 16 species will be addressed in this BA and are shown in Table 1 along with their status and range.

TABLE 1. FEDERALLY LISTED SPECIES OCCURRING IN PROPOSED ACTION AREAS

Species Listings	Status	Range	
		OK	**AR**
Alligator, American (*Alligator mississippiensis*)	T (S/A)	X	X
Bat, Gray (*Myotis grisescens*)	E	X	X
Bat, Indiana (*Myotis sodalis*)	E	X	X
Bat, Ozark big-eared (*Corynorhinus townsendii ingénues*)	E	X	X
Beetle, American burying (*Nicrophorus americanus*)	E	X	X
Crane, whooping (*Grus americana*)	E	X	X
Eagle, bald (*Haliaeetus leucocephalus*)	T	X	X
Mucket, pink (*Lampsilis abrupta*)	E	-	X
Mussel, scaleshell (*Leptodea leptodon*)	E	X	X
Plover, piping (*Charadrius melodius*)	T	X	-
Shiner, Arkansas River (*Notropis girardi*)	T	X	X
Sturgeon, pallid (*Scaphirhynchus albus*)	E	-	X
Tern, least (*Sterna antillarum athalasso*)	E	X	X
Geocarpon minimum *(no common name)*	T	-	X
Orchid, western prairie fringed (*Platanthera praeclara*)	T	X	-
Harperella (*Ptilimnium nodosum*)	E	-	X

A copy of the correspondence with the USFWS relative to these species is included in Appendix 2.

SECTION I. DESCRIPTION OF PROPOSED ACTION

The proposed action (PA) is to prepare a comprehensive BA addressing all Federally listed species for those portions of the Arkansas River, Red River, and Canadian River impacted by operation and maintenance of USACE projects while taking into consideration other Congressionally authorized uses of the river and cumulative impacts. The proposed action will evaluate the impacts on Federally listed species of operating the following projects:

- Arkansas River System Operations
- Arkansas River Navigation Study, Phases I and II
- MCKARNS Dredge Material Disposal Management Plan
- Canadian River Operations
- Red River System Operations

SECTION II. DESCRIPTION OF ACTION AREAS

A. Action Area I, Arkansas River (Kaw Lake to Muskogee, Oklahoma)

Kaw Lake is a main stem impoundment on the Arkansas River located at river mile 653.7. It was constructed by the USACE for flood control, water supply, water quality, recreation, and fish and wildlife and became operational in May 1976. Keystone Lake is also a main stem impoundment bisecting the Arkansas River at river mile 538.8, about 15 miles west of Tulsa, Oklahoma. It was constructed by the USACE for flood control, water supply, hydroelectric power, navigation, and fish and wildlife and became operational on May 21, 1968. Water releases from Kaw and Keystone dams in the form of regulated flood flows, water quality, and hydropower releases contributes to main stem flows on the Arkansas River and will be the basis for assessing impacts to Federally listed species in this BA. Action Area I is shown on Figure 1. Reaches within Action Area I to be considered and evaluated in this BA are defined as follows:

- The 114.9-mile stretch of the Arkansas River from below Kaw Lake to Keystone Dam.
- The 58-mile stretch of the main stem of the Arkansas River from below Keystone Dam to its confluence with the Verdigris River and the MCKARNS at navigation mile 395.

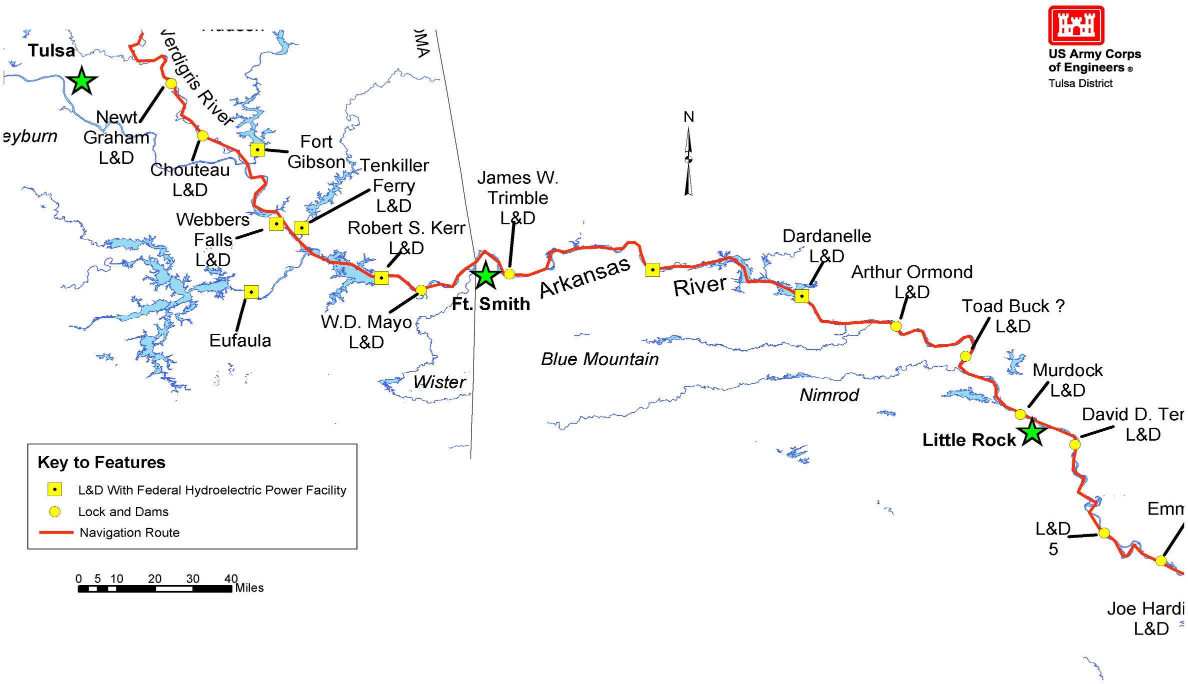


Figure 1 - Arkansas River Basin Action Areas

B. Action Area II. Arkansas River Navigation Study (Verdigris and Arkansas Rivers, Oklahoma-Arkansas, Phases I and II)

The USACE, Tulsa District and Little Rock District are conducting a combined study effort for the Arkansas River Navigation Feasibility Study consisting of two phases. Phase I was to develop and evaluate alternatives for implementing solutions to problems resulting from sustained high flows on the MCKARNS. Phase I examined a variety of project alternatives, including operational changes to the existing reservoirs as well as construction of additional lakes or levees along the Arkansas River for navigational flow management. Alternative 4, the Operations Only Plan, is the recommended plan and would increase the number of days in which longer tows of barges could navigate the system. The Operations Only Alternative is defined as the existing operating plan with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3% lower system storage except during June 15 through October 1. Modeling analysis estimates there would be an approximately 14-day reduction in flows above 60,000 cfs at Van Buren, and a 2-day increase in flows above 100,000 cfs at Van Buren compared to the existing operation plan. It also showed essentially no change at 137,000 cfs (channel capacity). Under Alternative 4, flood control and recreation impacts would not change from current operation plans.

Phase II is examining the feasibility of increasing the channel depth along the entire MCKARNS and widening the Verdigris River portion of the system to allow tows to pass at almost any location on the Verdigris River. Ongoing activities of Phase II include a detail survey of the navigation channel from the juncture of the system with the Mississippi River to the Port of Catoosa at the head of the navigation channel. Proponents of the navigation system are interested in the feasibility of increasing the depth of the navigation system in Arkansas and Oklahoma from 9 feet to 12 feet.

Currently, the USACE is authorized to maintain the MCKARNS at a 9-foot channel depth. Due to ongoing maintenance dredging of the existing navigation channel and natural stream scour, approximately 80-90% of the system is already 12-feet deep over a portion of the channel width. Changing the authorized channel depth 10 to 12-feet would allow tow drafts on the MCKARNS to match those of the lower Mississippi River system. A number of private and public ports on the system can currently only accommodate tow and barges capable of operating in a 9-foot channel. These ports will have to modify their facilities to accommodate barges with drafts deeper than those allowed by a 9-foot channel.

Current MCKARNS channel widths are 300 feet on the White River Entrance Channel, Arkansas Post Canal, and Lake Langhofer; 250 feet on the Arkansas River; 150 feet on the Verdigris River; and 225 feet on Sans Bois Creek. For most of the MCKARNS, channel width is sufficient to allow tows to pass each other at any location, but passing on the Verdigris River is restricted to only certain wider locations. Increasing the width of the Verdigris River to 300 feet would ease congestion by allowing tows to pass at almost any location on that portion of the system.

Currently, the USACE, Tulsa District and Little Rock District cooperatively control flows in the Arkansas River system in Kansas, Oklahoma, and Arkansas. The action area for the Arkansas River Navigation study includes the MCKARNS from the Port of Catoosa near Tulsa, Oklahoma, downstream to the confluence of the Mississippi River in southeastern Arkansas as well as 11 reservoirs in Oklahoma that influence river flow within the MCKARNS. The MCKARNS action area (Figure 1) is approximately 445 miles in length and consists of a series of 18 locks and dams (17 existing and 1 presently under construction). Action Area II reaches to be considered and evaluated in this BA are defined as follows:

- A 50-mile reach of the Verdigris River from the Port of Catoosa to Muskogee (navigation miles 445-394),
- Lower Arkansas River, which comprises 375 miles of the MCKARNS (navigation miles 394 to 19),
- The Arkansas Post canal, a 9-mile canal connecting the Arkansas River to the lower portion of the White River (navigation miles 19 to 10),
- The lower 10 miles of the White River (navigation miles 10 to 0)
- The lower Arkansas River downstream of Dam 2 (not formally part of the MCKARNS). This portion of the Arkansas River is included in the Arkansas River Navigation Study project area because MCKARNS river flows may also influence this segment of the river.

- Eleven reservoirs in Oklahoma that may influence flows on the upper Arkansas River when operated for flood control, water supply, hydroelectric power, fish and wildlife, recreation, and other benefits. These include Keystone Lake, Oologah Lake, Pensacola (Grand) Lake, Lake Hudson, Fort Gibson Lake, Tenkiller Ferry Lake, Eufaula Lake, Kaw Lake, Hulah Lake, Copan Lake, and Wister Lake.

C. Action Area III, MCKARNS Dredge Material Disposal Management Plan (Verdigris and Arkansas Rivers, Oklahoma)

The Oklahoma portion of the MCKARNS includes approximately 140 navigation miles of channel. Channel widths vary throughout, including 250 feet along the Arkansas River, 150 feet along the Verdigris and Poteau rivers, and 225 feet along the Sans Bois Creek. Depths of the navigation channel run approximately 9 feet throughout the MCKARNS. There are five locks and dams within the Oklahoma portion of MCKARNS, including W. D. Mayo (Lock & Dam 14), Robert S. Kerr (Lock & Dam 15), Webbers Falls (Lock & Dam 16), Chouteau (Lock & Dam 17), and Newt Graham (Lock & Dam 18).

The operation and maintenance program for the Oklahoma portion of the MCKARNS is addressed in a Final Environmental Statement dated September 1974. This EIS included the locations of dredge disposal areas. Operation of the MCKARNS and disposal of dredged materials has occurred at the locations addressed in the final EIS. As part of the ongoing operations and management program, the USACE, Tulsa District is evaluating a future 20-year plan for dredging operations for the Oklahoma portion of the MCKARNS. Preliminary findings indicate that additional disposal areas may be required to meet the projected 20-year dredging requirements for the Oklahoma portion of the MCKARNS. Consequently, the Dredge Material Disposal Management Plan and any new recommended sites will be evaluated for impacts associated with Federally listed species and included in this BA. The limits of the MCKARNS Dredge Material Disposal Management Plan are shown in Figure 1. The reaches of Action Area III to be considered and evaluated in this BA are defined as follows:

- Along either side of the MCKARNS from the head of navigation on the Verdigris River at Catoosa, Oklahoma, navigation mile 445.2, to the lower limits of the Oklahoma portion of the MCKARNS at navigation mile 308.5.

D. Action Area IV, Canadian River, Oklahoma

The Canadian River originates in Colfax County, New Mexico, and flows southeasterly through New Mexico and easterly through the Texas Panhandle. It enters Oklahoma and forms the boundary between Ellis and Roger Mills counties. The river then travels eastward some 410 miles across the state of Oklahoma and joins the Deep Fork River and North Canadian River to form Eufaula Lake. Eufaula Lake was constructed by the USACE on the Canadian River at mile 27.0, and became operational in September 1964. It was constructed for flood control, water supply, hydroelectric power, and navigation (sediment control). The Canadian River exits

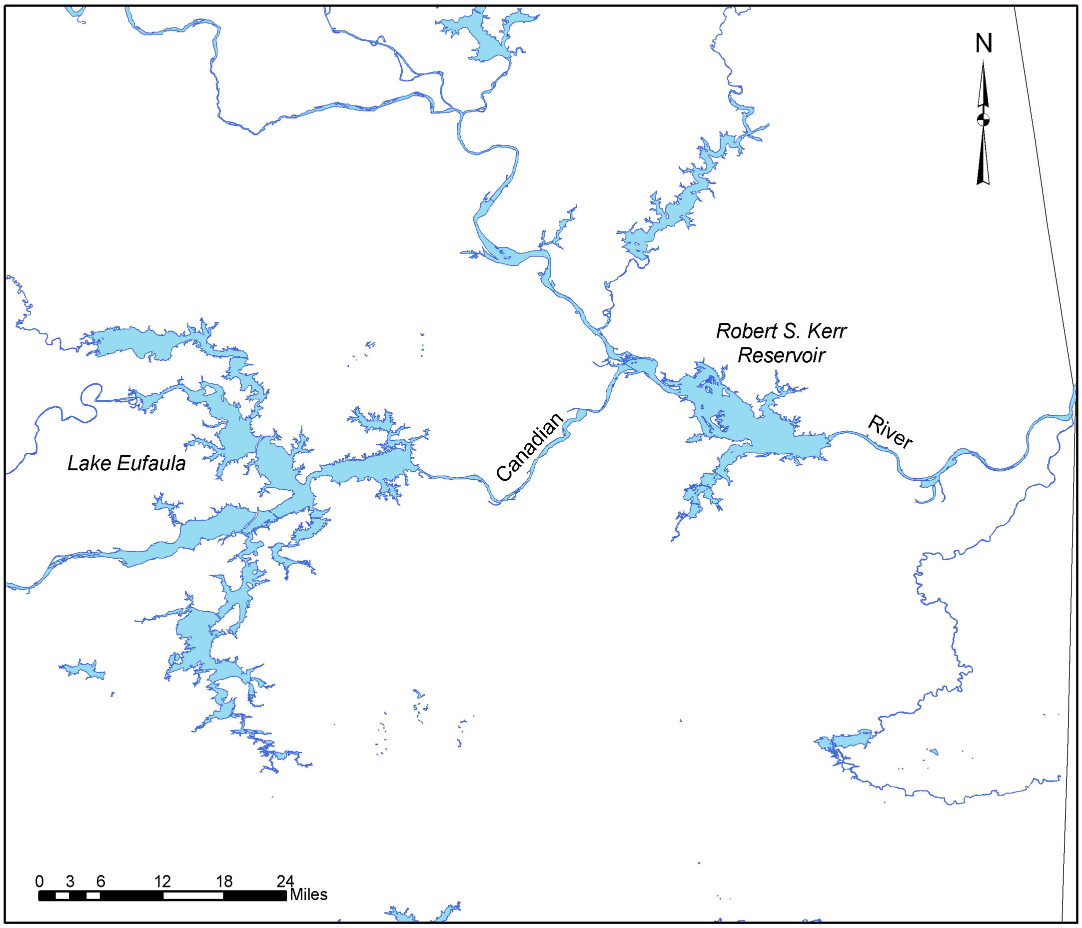
Eufaula Dam and flows eastward to its confluence with the MCKARNS near navigation mile 357 and the Haskell County and Muskogee County line.

In December 2001, the USACE submitted a “may affect” BA to the USFWS with respect to operations of Eufaula Dam on the lower Canadian River for the Interior least tern, but a BO on the assessment has not been issued by the USFWS. It is the intent of this BA to update the findings of the 2001 BA and expand it to include all Federally listed threatened and endangered (T&E) species. A map depicting Action Area IV is shown in Figure 2. For assessment purposes, this component of the BA is defined as follows:

- The 27-mile stretch of the main stem of the Canadian River downstream of Eufaula Dam to its confluence with the MCKARNS at navigation mile 359.3.

E. Action Area V, Red River Below Denison Dam to Index Arkansas; Texas; and Oklahoma

The Red River is one of the two major river systems in Oklahoma. It originates from small streams in eastern New Mexico and gradually runs eastward approximately 517 miles to the Oklahoma-Arkansas State line in southwestern Arkansas. In its extreme western reaches it is composed of the Prairie Dog Town Fork of the Red River, which flows southeasterly to loosely form the southern border of Oklahoma. At the confluence of the Prairie Dog Town Fork of the Red River with the Salt and North Forks of the Red River, it continues as the State’s southern border but is referred to as simply the Red River. In Oklahoma, there are 22,791 square miles of contributing drainage area to the Red River.



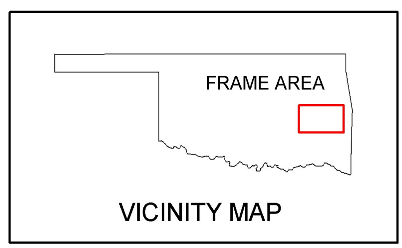
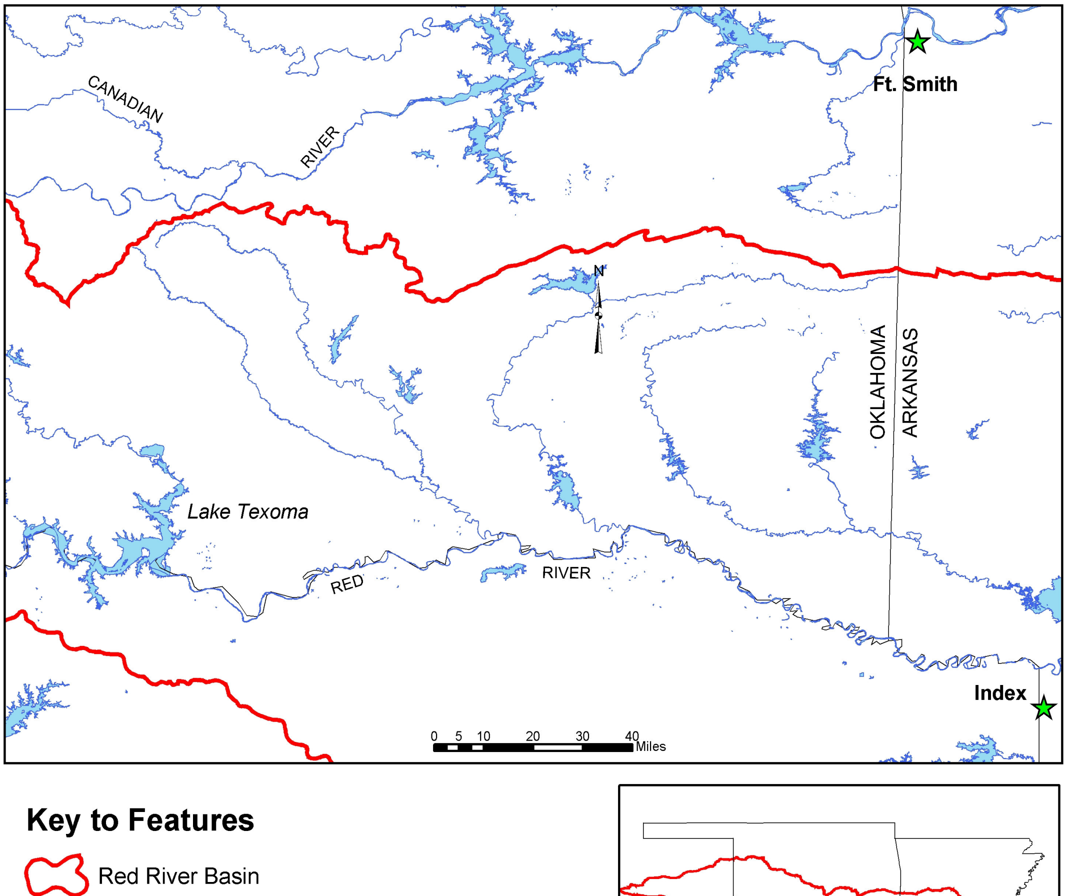


Figure 2 - Canadian River Action Area

At river mile 725.9, the main stem of the Red River is bisected by Denison Dam (Lake Texoma), which was constructed by the USACE for flood control, water supply, hydroelectric power, regulating flows, and improving navigation. Upon exiting Denison Dam, the river flows approximately 240 miles to Index, Arkansas, which is the eastern limit of the USACE, Tulsa District. In July 2002, the USACE submitted a "may affect" BA to the USFWS on operations of Denison Dam on the lower Red River to Index, Arkansas, with respect to the Interior least tern, but a BO has not been issued by the USFWS. This BA will update the findings of the 2002 BA and will be expanded to include all Federally listed T&E species. The scope of the BA will also be expanded into a single comprehensive BA for all the noted action areas. For assessment purposes, this BA will assess the impacts of operating Lake Texoma on all Federally listed species on the Red River to the eastern limits of the Tulsa District. The limits of Action Area V are shown in Figure 3 and defined as follows:

- Lake Texoma
- The 240-mile reach of the Red River below Denison Dam to Index, Arkansas



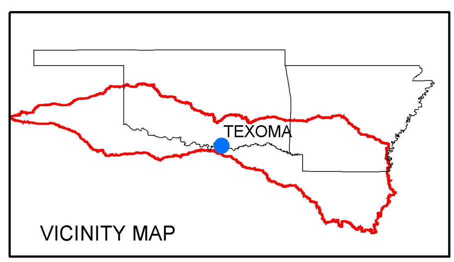


Figure 3 - Red River Basin Action Areas

SECTION III. DESCRIPTION OF EXISTING CONDITIONS/CURRENT OPERATIONS

A. Arkansas River Basin

1. Arkansas River. The Arkansas River is one of the two major river basins in Oklahoma. The river is the fourth longest river in the United States and the sixteenth longest in the world. Many major tributaries flow into the Arkansas River, including the Cimarron, Canadian, Neosho, Grand (formed by the confluence of the Neosho and Spring rivers) Verdigris, and White rivers. Minor tributaries include the Currant and Big Sandy rivers in Colorado; the Pawnee, Walnut, Rattlesnake, and Little Arkansas Rivers in Kansas; the Salt Fork, Illinois, and Poteau rivers in Oklahoma.

From its source in the Rocky Mountains near Leadville, Colorado, it flows in a southeasterly direction through the State of Kansas and enters Kay County, Oklahoma, just south of Arkansas City, Kansas, at the upper limits of Kaw Lake. It then runs in a southerly direction through Kaw Lake where it forms the county line between Osage, Noble and Pawnee counties. Kaw Dam bisects the Arkansas at river mile 653.7. After leaving Kaw Dam, it continues in a southeasterly direction where Keystone Dam bisects it approximately 15 miles west of Tulsa, Oklahoma. It continues in a southeasterly direction through Tulsa County and forms the boundary between Wagoner and Muskogee counties. In Muskogee County, it converges with the Verdigris and Grand rivers at the upper limits of Webbers Falls Lock and Dam. At this point near Muskogee, Oklahoma, it becomes part of the MCKARNS. It continues southeasterly through Webbers Falls and Robert S. Kerr lakes and forms the county line between Sequoyah and LeFlore counties. It leaves the state of Oklahoma at navigation mile 361 below W.D. Mayo Lock and Dam where it flows into the State of Arkansas. From this point, it flows southeasterly through the State of Arkansas and a series of 13 locks and dams and reservoirs to its confluence with the White River near navigation mile 10. From its confluence with the White River, it continues its southeasterly flow to its confluence with the Mississippi River in Desha County, Arkansas, at navigation mile 0.

a. Topography. The difference in elevation from the beginning of the MCKARNS at the Port of Catoosa to the confluence with the Mississippi River is 420 feet. Because the elevation of the Arkansas River through Tulsa is 100 feet higher than the Verdigris at Catoosa, the USACE channeled up the Verdigris River from Muskogee to Catoosa rather than the Arkansas River. The MCKARNS study area traverses many physiographic regions in Arkansas and Oklahoma. The major physiographic provinces include the Ouachita Province, the Ozark Plateau Province and the Mississippi Alluvial Plain.

The Ouachita Province is divided into the Ouachita Mountains Section in the southern portion of the province and the Arkansas Valley Section in the northern portion. The Ouachita Mountains Section is distinguished by ridge and valley topography rising in some areas to more than 2,000 feet above sea level. The Arkansas Valley Section includes lower elevation plains (300-600 feet above sea level) with smaller east-west ridges generally no more than 1,000 feet above sea level. Normal MCKARNS navigation pool elevation in the Arkansas Valley

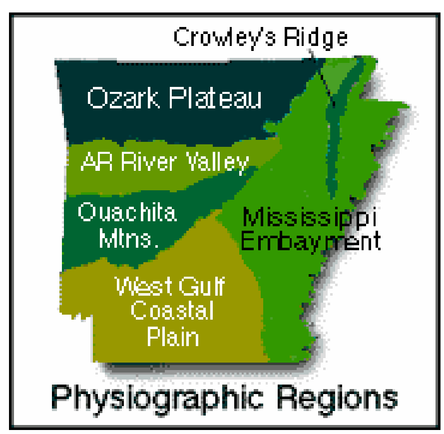
Section varies from over 500 feet above sea level in eastern Oklahoma to approximately 250 feet above sea level near Little Rock, Arkansas.

The Ozark Plateau Province is north of the Ouachita Province and is separated into the Boston Mountains Section to the south of the Province and the Salem and Springfield Plateaus to the north. The Boston Mountains Section occurs along the northern portion of the Arkansas River Valley in northwestern Arkansas and northeastern Oklahoma. This 35-mile-wide section is a deeply dissected plateau region characterized by flat-crested ridges that generally range from 1,900 to 2,500 feet above sea level. The valleys are generally v-shaped and are cut 300 to 1,000 feet below the ridges.

Downstream of Little Rock, Arkansas, the topography transitions to the Mississippi Alluvial Plain that generally consists of low floodplains, and floodplain terraces. Crowley's Ridge in Arkansas is the most prominent topographic feature of the Mississippi Alluvial Plain. It is thought that this ridge is in part a north-south outlier of older, underlying Coastal Plain rocks.

b. <u>Geology</u>. The rocks that underlie the Ouachita and Ozark Provinces are Paleozoic (Cambrian to Pennsylvanian) in age. The Ouachita Province bedrock is fractured, faulted, and folded shale, sandstone, limestone and cherty-novaculite rocks, whereas the Ozark Province consists of well-consolidated, flat lying to south dipping, fractured carbonate and clastic rocks. The Mississippi Alluvial Plain consists of alluvial deposition with underlying material similar to the Coastal Plain - Mesozoic to Cenozoic (Jurassic to Quaternary) in age.

The Ouachita Province rock is mostly a thick sequence of shale and sandstone deposited during the Cambrian to early Pennsylvanian time within an elongating subsiding Ouachita trough. Rifting along a late Precambrian-early Paleozoic continental margin formed the trough. The Ouachita trough contains depositional deep-water sediments. The trough was closed during the late Pennsylvanian time by compressional tectonic forces. These forces created an intensely folded structure with north and south directed thrust faults. The thrust faults occur in folded structures and result in the rocks above the fracture depositing over the rocks below. Normal faults are common in the areas north of the Arkansas River, and thrust faults are present south of the river in the Ouachita Mountains.



The Ozark Plateau Province consists of rocks of Ordovician to Pennsylvanian age that are underlain by dolomite and sandstone beds of Cambrian Age that formed at the basal part of the Paleozoic sequence. The Ozark uplift, centered in southern Missouri, affects the structural attitude of Paleozoic rocks in northern Arkansas. In general, outcrop rocks in northern Arkansas result from annular bands around the Ozark uplift. Rocks of Ordovician to Mississippian age in the Ozark Plateau Province that dip gently southward from northern Arkansas are dominated by shallow-water carbonate-shale sequences with some deltaic sandstones. These were deposited on a cretonic shelf in the Precambrian. The Boston Mountains Section of this province consists mostly of Pennsylvanian sedimentary rocks of sandstone and shale deposited in deltaic, open marine, coastal, and swamp environments.

The Mississippi Alluvial Plain contains alluvial deposition over the Coastal Plain sedimentary rock, which is of Cretaceous to early Tertiary in age, except where covered by Holocene deposition from the ancestral Mississippi River. About 12,000 years ago, a braided ancestral Mississippi River resulted from glacial melt waters carrying large volumes of course-grained sand and gravel detritus. As the sediment load lessened, the Mississippi River became a meandering river system, depositing sand, silt, and clay.

c. <u>Soils</u>. Within the MCKARNS, deposition and down cutting by major rivers and streams were extensive from the end of the Tertiary period to the Quaternary Period. This ongoing pattern of erosion and deposition left a series of alluvial depositions as the streams progressively lowered their beds. The more recent alluvial terraces may only be a few feet above the current floodplain. The alluvium is the most recent depositional material within the confines of the current floodplain.

In Oklahoma, the alluvium and alluvial terraces of the main stem of the Arkansas River average more than 5 miles in width and 45 feet in depth between the confluences with the Cimarron River and where the Arkansas passes Tulsa. The deposits are predominantly sand and gravel, and the water table is generally less than 20 feet below the soils.

In the northwestern portion of Arkansas where the Arkansas River enters the state through Sebastian County, the Arkansas River valley is characterized by rolling flat-topped hills, long narrow ridges, and broad valleys. The hilltops and ridges are mostly underlain by shale. The USDA (1975) as reported by USACE (2003) has indicated the following soil associations for the area:

- The mountaintops and hilltops are generally *Mountainburg-Linker* soils, which are well drained, gently sloping to steep, deep, loamy soils.
- *Enders-Mountainburg* soils are well drained, gently sloping to steep, deep and shallow, loamy soils on narrow ridges.
- The fertile bottomlands of the valleys are generally *Leadvale-Taft*, which are moderately well drained to somewhat poorly drained, level to sloping, deep, loamy soils with a fragipan. The *Wrightsville* association is similar but predominantly level on old stream terraces.

- The Arkansas River floodplain soils include the *Crevasse* association, which is excessively drained, level and nearly level, deep soils that are sandy throughout, and the *Severn-Iberia-Norwood* association, which is well drained to poorly drained, dominantly level, deep, loamy and clayey soils. These two associations frequently run parallel and adjoining each other, with the Crevasse association typically found to the north of the other.

The southeastern portion of the study area within the State of Arkansas is represented by Desha County (USDA, 1972a as reported by USACE, 2003), and limited southern portions of Arkansas County (USDA, 1972b as reported by USACE, 2003), which includes the area of the confluence of both the Arkansas and White rivers with the Mississippi River. Soils types range from loamy soils along bayou ridge tops to predominantly clay in lower elevations. The primary soil associations of the study area through this portion of the state include:

- The *Herbert-Rilla-McGee* association is level and nearly level, somewhat poorly drained to well-drained, loamy soils found along ridge tops of the bayous.
- The *Sharkey-Commerce-Coushatta* and the *Perry-Rilla-Portland* associations are generally level bottomlands along the Arkansas River, which are poorly drained to well-drained, clayey and loamy soils.
- The *Sharkey-Desha* association is level and gently undulating, poorly drained to somewhat poorly drained, predominantly clayey soils on lower broad floodplain terraces.

The transition from the mountainous physiographic of northwestern Arkansas to the deltaic characteristics of the southeastern portion of the MCKARNS occurs gradually along its southeasterly progress through the State of Arkansas, but it is most pronounced through the Little Rock area.

B. McClellan-Kerr Arkansas River Navigation System

Congress, in the River and Harbor Act of July 24, 1946, authorized the MCKARNS project. Construction of the 9-foot-deep channel occurred during the 1960's, with the system being declared open to commercial traffic on December 2, 1970. Public Law 91-649, passed by Congress in 1971, designated it as the McClellan–Kerr Arkansas River Navigation System.

The beginning of the MCKARNS is located at the confluence of the White River and the Mississippi River. The Arkansas River comprises most of the MCKARNS and is entered via the White River to the Arkansas Post Canal, then up the Arkansas River to Muskogee to the Port of Catoosa via the Verdigris near Tulsa. The total length of the MCKARNS is 445 miles, of which 375 miles is the lower Arkansas River (navigation miles 394 to19). Other MCKARNS components include approximately 50 miles of the Verdigris River (navigation miles 445 to 394); the Arkansas Post Canal, a 9-mile canal connecting the Arkansas River to the lower portion of the White River (navigation miles 19 to 10); and the lower 10 miles of the White River (navigation miles 10 to 0).

Navigation on the lower Arkansas and the other components of the MCKARNS is controlled by a series of 18 locks and dams. The USACE maintains a minimum 9-foot channel depth on the system. Passage through MCKARNS lock chambers was configured for 8 barges, but can accommodate 15 barge tows using double lockage. Each lock chamber is 100 feet wide and 600 feet long. There are currently 17 completed locks and 1 under construction. Five of the lock and dams are located in Oklahoma beginning on the Verdigris River. The remaining locks and dams are located on the Arkansas portion of the MCKARNS.

The lock and dam structures are constructed along the waterway in a stair step pattern that gradually follows the natural elevation changes of the topography while still maintaining a navigation pool. Table 2 includes the length, surface area, capacity, location, and elevation for each navigation pool.

TABLE 2. NAVIGATION POOLS OF THE MCKARNS

Navigation Pool (NP)	Length (miles)	Surface Area[1]	Capacity[2]	Navigation Mile[3]	Elevation[4]
Oklahoma Pools					
Newt Graham NP*	23.2	1,490	2,500	421.6	532 to 511
Chouteau NP*	20.2	2,270	23,340	401.4	511 to 490
Webbers Falls Lake	32.5	11,640	170,100	368.9	490 to 460
Robert S. Kerr Lake	32.7	32,800	525,700	336.2	460 to 412
W.D. Mayo NP	16.6	1,595	15,800	319.6	412 to 392
Arkansas Pools					
Hammerschmidt Lake (J.W. Trimble)	26.8	NA	NA	292.8	392 to 372
Ozark Lake (Ozark-Jeta Taylor)	36.0	NA	NA	256.8	372 to 338
Dardanelle Lake	51.3	NA	NA	205.5	338 to 284
Rockefeller Lake (Arthur V. Ormond)	28.6	NA	NA	176.9	284 to 265
Toad Suck Ferry NP	21.0	NA	NA	155.9	265 to 249
Murray NP	30.5	NA	NA	125.4	249 to 231
David D. Terry NP	17.3	NA	NA	108.1	231 to 213
Lock & Dam No. 5 NP	21.8	NA	NA	86.3	213 to 196
Emmett Sanders NP	20.3	NA	NA	66.0	196 to 182
Joe Hardin NP	15.8	NA	NA	50.2	182 to 162
Lock No. 2 (Canal)**	36.9	NA	NA	13.3	162 to 142
Norrell (Canal)**	3.1	NA	NA	10.2	142 to WR

[1] Surface area measured in acres at top of the upper pool.
[2] Capacity is measured at the top of the upper pool in acre-feet.
[3] Navigation miles upstream from the mouth of the White River (WR).
[4] Elevation in feet above mean sea level (msl) from upper pool to lower pool.
* Verdigris River; ** Arkansas Post Canal; NA=Not available
Source: USACE, 2003.

1. **Locks and Dams**. Development of the waterways of the MCKARNS involved many in-stream modifications that produce stability and consistency to a naturally erratic system. Dams were created along the length of the system in order to maintain a navigation pool, typically along the old river channel, that provided a constant minimum navigation depth to the channel. This series of navigation pools from dam to dam creates a stair step profile to the waterway from pool to pool (Figure 4). This allows the system traffic to "climb" or "ascend" the system's 420-foot elevation change with a consistent navigable channel.

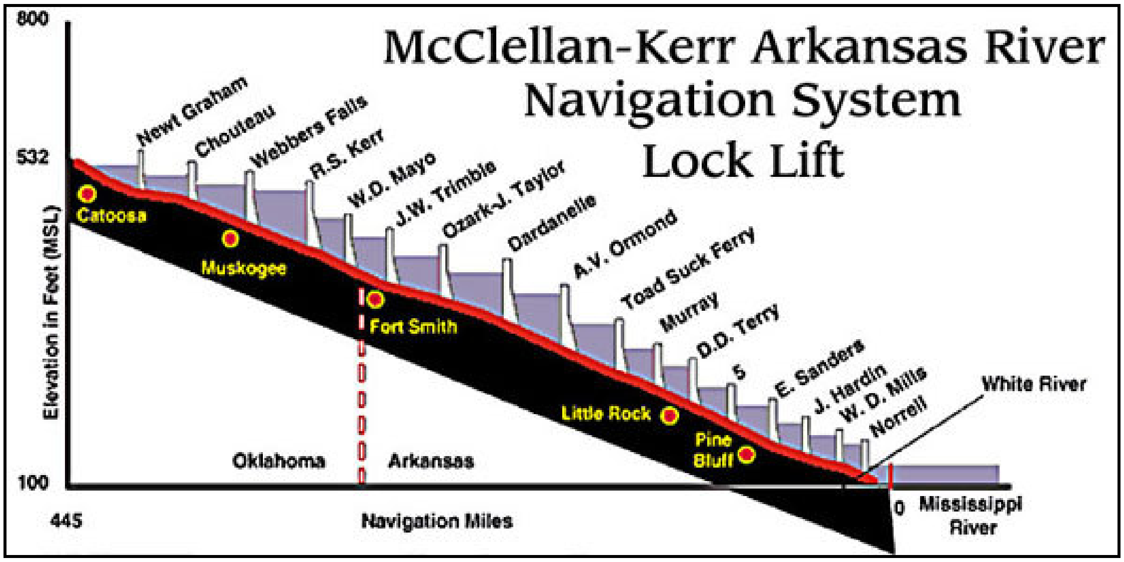


Figure 4. McClellan-Kerr Arkansas River Navigation System Lock Lift.

Passage through a dam is achieved through a "lock" chamber system that lowers downstream traffic by reducing the water level in the chamber to that of the downstream navigation pool and raising the chamber elevation for upstream traffic.

The lock and dam structures along the MCKARNS vary in design and include 13 “low-head” and 4 “high-head” locks and dams. A 14^{th} low-head lock and dam at the mouth of the White River (Montgomery Point Lock & Dam) is currently under construction.

Additionally, the four high-head USACE-operated locks and dams are used for hydroelectric power production as well as navigation control. Hydroelectric power production occurs at additional locks and dams along the MCKARNS; however, these are not USACE-operated facilities.

Table 3 lists each of the USACE lock and dam structures located on the MCKARNS. Dams with hydroelectric power capabilities are also identified in Table 3 and discussed in more detail in the next section.

TABLE 3. LOCK AND DAM STRUCTURES OF THE MCKARNS

Lock and Dam (L & D)	Construction Dates	Navigation Mile[1]	Elevation[2]
Oklahoma Lock & Dams			
Newt Graham L & D (No. 18)*	1966 to 1970	421.6	532 to 511
Chouteau L & D (No. 17)*	1966 to 1970	401.4	511 to 490
Webbers Falls L & D (No. 16)ϟ	1965 to 1970	368.9	490 to 460
Robert S. Kerr L & D (No. 15)ϟ	1964 to 1970	336.2	460 to 412
W. D. Mayo L & D (No. 14)	1966 to 1970	319.6	412 to 392
Arkansas Lock & Dams			
J. W. Trimble L & D No. 13ϟ	1966 to 1969	292.8	392 to 372
Ozark-Jeta Taylor L & D (No. 12)ϟ	1964 to 1969	256.8	372 to 338
Dardanelle L & D (No. 10)ϟ	1957 to 1969	205.5	338 to 284
Arthur V. Ormond L & D (No. 9)ϟ	1966 to 1969	176.9	284 to 265
Toad Suck Ferry L & D (No. 8)	1965 to 1969	155.9	265 to 249
Murray L & D (No. 7)ϟ	1965 to 1969	125.4	249 to 231
David D. Terry L & D (No. 6)	1965 to 1968	108.1	231 to 213
L & D No. 5	1965 to 1968	86.3	213 to 196
Emmett Sanders L & D No. 4	1964 to 1968	66.0	196 to 182
Joe Hardin L & D (No. 3)	1964 to 1967	50.2	182 to 162
Wilbur D. Mills Dam (No. 2)ϟ	1963 to 1968	40.5[3]	162 to AR
Lock No. 2**	1963 to 1967	13.3	162 to 142
Norrell L & D (No. 1)**	1963 to 1967	10.2	142 to ~115
Montgomery Point L & D	1998 (not complete)	0.6[4]	~115

[1] Navigation miles upstream from the mouth of the White River (WR).
[2] Elevation in feet above mean sea level (msl) from upper pool to lower pool.
[3] Miles upstream from the mouth of the Arkansas River (AR) at the Mississippi River (MR).
[4] Navigation miles 0.6 of the White River Entrance Channel.
ϟ Hydroelectric power
* Verdigris River
** Arkansas Post Canal.
Source: USACE and MCKARNS, 2003.

Following are descriptions of each lock and dam structure along the MCKARNS. This does not include a description of reservoir project dams, which are included in a subsequent section.

Newt Graham Lock and Dam (No. 18). Located on the Verdigris River at navigation mile 421.6, approximately 8 miles southwest of Inola in Wagoner County, Oklahoma, the Newt Graham Lock and Dam Project was authorized by the River and Harbor Act of 1946. Construction began in 1966 and was completed and operational for navigation in 1970.

Newt Graham Dam is a 1,630-foot embankment of rolled earth fill and concrete. The spillway is a gated, concrete ogee weir with a crest elevation of approximately 506 feet above mean sea level (msl). The elevation at the top of the spillway gates is approximately 532 feet above msl. The total width of the spillway is 220 feet with a net flow width of 180 feet. The lock is a 110- x 600-foot single lift chamber with miter gates and has a normal lift of 21 feet.

Chouteau Lock and Dam (No. 17). The River and Harbor Act of 1946 authorized the creation of Chouteau Lock and Dam as part of the MCKARNS. The lock is located on the Verdigris River at navigation mile 401.4, about 4 miles northwest of Okay in Wagoner County, Oklahoma. Construction of the dam began in 1966 and was completed in 1970. The first boats traveled through the lock only a few weeks later.

The 11,690-foot dam is a combined earth fill and concrete, gravity dam. The spillway is a gated, concrete, ogee weir with a crest elevation of 485 feet above msl. The tops of the spillway gates are at 512 feet above msl. There are left and right uncontrolled overflow sections. The total width of the spillway is 386 feet, with a net flow width of 346 feet. Chouteau Lock has a 110- x 600-foot single-lift chamber with miter gates. It has a normal lift of 21 feet and a maximum lift of 24 feet.

Webbers Falls Lock and Dam (No. 16). Located at navigation mile 368.9, approximately 5 miles northwest of Webbers Falls, Oklahoma, the lock and dam were constructed for both navigation and hydroelectric power. Authorization to build the lock and dam came from the River and Harbor Act of 1946. Construction began in 1965 and the lock and dam became operational for navigation in 1970.

The Webbers Falls Lock and Dam Project is 4,370 feet long, including the spillway, powerhouse intake, and navigation lock. The dam is constructed of rolled-earth material and stands 84 feet above the streambed. The elevations from the upper and lower pools are 490 and 460 feet above msl, respectively. The spillway is a gated, concrete, ogee weir. The lock, an Ohio River-type with a normal lift of 30 feet, has a culvert and port filling system and side outlet discharge. The chamber is 110 feet wide by 600 feet long.

Robert S. Kerr Lock and Dam (No. 15). The River and Harbor Act of 1946 authorized the Robert S. Kerr Lock and Dam Project as part of the MCKARNS. The project was originally named the Short Mountain Lock and Dam. The name was changed by Public Law 88-62 (approved July 8, 1963). The lock and dam are located at navigation mile 336.2, about 8 miles south of Sallisaw in Le Flore County, Arkansas. Construction was started in 1964 with the objectives of navigation, hydroelectric power, and recreation. Closure of the dam and navigable operation occurred in 1970.

The total length of the project is 7,230 feet, including the spillway, powerhouse intake, and navigation lock. The dam, constructed of rolled earth fill material, is 75 feet above the streambed. The gated, concrete, ogee weir-type spillway extends partly across the existing river channel and a portion of the right bank between the power improvements and the navigation lock. It is 900 feet long. The single-lift, Ohio River-type lock is located to the left of the spillway and has a culvert and port filling system. The chamber is 110 feet wide by 600 feet long and provides a normal lift of 48 feet.\

W.D. Mayo Lock and Dam (No. 14). - Located at navigation mile 319.6, approximately 9 miles southwest of Fort Smith, Arkansas, the W.D. Mayo Lock and Dam were authorized under the River and Harbor Act of 1946. Construction began in 1966 and was completed and operational in 1970.

The dam is 7,400 feet long and consists of a low concrete apron and sill. It is surmounted by twelve 60- x 21-foot tainter gates, each separated by 10-foot concrete piers. The piers hold the machinery that operates the gates. W.D. Mayo Lock has a 110- x 600-foot, single-lift chamber with miter gates. The normal and maximum lifts are 20 and 22 feet, respectively.

J.W. Trimble Lock and Dam No. 13. The J.W. Trimble Lock and Dam are located at navigation mile 292.8 about 3 miles east of Fort Smith, Arkansas. Also authorized by the River and Harbor Act of 1946, it is the first lock and dam as the Arkansas River enters the state of Arkansas. Construction began in 1966 and was completed and opened for navigation in 1969.

The spillway is composed of a low concrete apron about 1,050 feet long, surmounted by fifteen 60- x 30-foot tainter gates. The lock has a maximum lift of 22 feet.

Ozark-Jeta Taylor Lock and Dam (No. 12). Situated at navigation mile 256.8 within Franklin County, Arkansas, the Ozark-Jeta Taylor Lock and Dam are 1 mile southeast of Ozark, Arkansas. Construction activities occurred from 1964 to 1969.

The dam has a spillway elevation of 327 feet above msl. The tops of the gates are at 373.0 feet above msl. The top of the lock wall and embankment reach 382 feet above msl. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

Dardanelle Lock and Dam (No. 10). Dardanelle Lock and Dam are located at navigation mile 205.5 along the border of Pope and Yell counties in Arkansas. Authorization to build the lock and dam came from the River and Harbor Act of 1946. Construction was initiated in 1957 and completed in 1969.

The spillway crest and top of the dam elevations are 300 355 feet above msl, respectively. The dam is 2,683 feet long and the spillway is 1,210 feet long. The dam has 20 gates, each of which is 50- x 39-feet is size and is located at 339 feet above msl. Dardanelle Lock has a 110 x 600 foot chamber with a maximum lift of 54 feet. The top of the lock wall is 348 feet above msl.

Arthur V. Ormond Lock and Dam (No. 9). This lock and dam project is located at navigation mile 176.9 in Conway County, Arkansas. Construction began in 1966 and was completed for navigation in 1969. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

Arthur V. Ormond Dam is 1,800 feet long. The spillway is 980 feet long and consists of fourteen 60- x 35-foot gates. The elevations of the spillway crest and fully open gate lip are 253 and 313.5 feet above msl, respectively. The chamber of the Arthur V. Ormond Lock measures 110 x 600 feet. It has a 19 and 22-foot normal and maximum lift, respectively. The top of the lock wall is 297 feet above msl. The chamber floor stands at 247 feet above msl.

Toad Suck Ferry Lock and Dam (No. 8). - Toad Suck Ferry Lock and Dam are located at navigation mile 155.9 west of Conway, Arkansas. Construction began in 1965 and was completed for navigation in 1969. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The spillway is 1,120 feet long and consists of sixteen 60- x 24-foot gates. The elevations of the spillway crest and fully open gate lip are 242 and 294 feet above msl, respectively. The chamber of the Toad Suck Ferry Lock measures 110 x 600 feet and has a 16-foot normal lift. The top of the lock, guard, and guide walls stands ranges in elevation from 247 to 279 feet above msl. The lock's chamber floor ranges from 218 to 231 feet above msl.

Murray Lock and Dam (No. 7). - Murray Lock and Dam are located at navigation mile 125.4 in Pulaski County, Arkansas. Construction was authorized by the River and Harbor Act of 1946, and began in 1965. It was completed for navigation in 1969.

The spillway is 980 feet long and consists of fourteen 60- x 33-foot gates. The elevations of the spillway crest and fully open gate lip are 218 and 268 feet above msl, respectively. The chamber of Murry Lock measures 110 x 600 feet and has an 18-foot normal lift. The top of the lock, guard, and guide walls stands at 259 feet above msl. The lock's chamber floor ranges in elevation from 192 to 197 feet above msl.

David D. Terry Lock and Dam (No. 6). The David D. Terry Lock and Dam construction began in 1965 at navigation mile 108.1. The project was completed for navigation several years later in 1968. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam spillway section consists of seventeen gates, each 60- x 27-feet in size. The spillway itself is 1,190 feet long. The spillway crest is 206 feet above msl. The gate lip, when fully open, reaches 252 feet above msl. The David D. Terry Lock ranges in elevation from 196 feet above msl (chamber floor) to 243 feet above msl (top of lock wall). It has a single-lift chamber measuring 110 x 600 feet. The normal lift is 18 feet.

Lock and Dam No. 5. Lock and Dam No. 5 are situated at navigation mile 86.3. Construction of the lock and dam began in 1965 and was complete and operable for navigation in 1968. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam has fifteen 60- x 31-feet gates and a 1,050-foot spillway. The spillway crest and fully open gate lip elevations are 183 and 242 feet above msl, respectively. The lock chamber measures 110 x 600 feet in size and has a normal lift of 17 feet. The top of the lock wall is at 225 feet above msl, while the chamber floor is at 179 feet above msl.

Emmett Sanders Lock and Dam No. 4. The Emmett Sanders Lock and Dam construction began in 1964 at navigation mile 66.0. The project was completed and operable for navigation 4 years later in 1968. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam spillway section consists of 17 gates. Eight gates are 60- x 23-feet in size and nine gates are 60- x 28-feet in size. The spillway itself is 1,190 feet long. The spillway crests are 169 and 174 feet above msl. The gate lip, when fully open, reaches 217 feet above msl. The Emmett Sanders Lock ranges in elevation from 165 feet above msl (chamber floor) to 206 feet above msl (top of lock wall). It has a single-lift chamber measuring 110 x 600 feet in size. The normal lift is 14 feet.

Joe Hardin Lock and Dam (No. 3). Joe Hardin Lock and Dam are situated at navigation mile 50.2. Construction of the lock and dam began in 1964 and was completed by 1968. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam has eighteen 60- x 25-feet gates and a 1,260-foot spillway. The spillway crest and fully open gate lip elevations are 158 and 207 feet above msl, respectively. The lock chamber measures 110 x 600 feet in size and has a normal lift of 20 feet. The top of the lock wall is at 194 feet above msl, while the chamber floor is at 147 feet above msl.

Wilbur D. Mills Dam (No. 2). The Wilbur D. Mills Dam construction at river mile 40.5 (upstream from the mouth of the Arkansas River at the Mississippi River) began in 1963 and was completed for navigation several years later in 1967. Authorization to build the dam came from the River and Harbor Act of 1946.

The dam spillway section consists of sixteen gates, each 60- x 30-feet in size. The spillway itself is 1,120 feet long. The spillway crest is 134 feet above msl. The gate lip, when fully open, reaches 180 feet above msl.

Lock No. 2. Lock No. 2 is situated at navigation mile 13.3 on the Arkansas Post Canal. Construction of the lock began in 1963 and was completed in 1967. Authorization to build the lock came from the River and Harbor Act of 1946.

The lock chamber measures 110 x 600 feet in size and has a normal lift of 20 feet. The top of the lock wall is at 174 feet above msl, while the chamber floor is at 127 feet above msl.

Norrell Lock and Dam (No. 1). Norrell Lock and Dam are situated at navigation mile 10.2 on the Arkansas Post Canal. Construction of the lock and dam began in 1963 and was completed in 1967. Authorization to build the lock and dam came from the River and Harbor Act of 1946.

The dam has an ungated weir and a 227-foot spillway. The spillway crest elevation is 142 feet above msl. The lock chamber measures 110 x 600 feet in size and has a normal lift of 30 feet. The top of the lock wall is at 156 feet above msl, while the chamber floor is at 95 feet above msl.

Montgomery Point Lock and Dam. Construction of the Montgomery Point Lock and Dam, authorized by the River and Harbor Act of 1946, is currently underway. The decision to build the structure resulted from the chronic low water levels and subsequent dredging near the mouth of the White River. It is being constructed near navigation mile 0.6 of the White River Entrance Channel.

Montgomery Point will have bottom-hinged, torque-tube gates. Adjacent to a 300-foot-wide gate and weir structure will be the lock chamber, which will be approximately 670 feet long. The entire dam (except the control tower) will be submerged during high water conditions. The lock will be employed when Mississippi River elevations fall below 115 feet above msl. When river levels exceed 115 msl, the gates will be kept in a lowered position, allowing vessels to pass over them without locking procedures.

2. Other In-River Structures. Other river structures created for stream stability included wing dikes and revetments. Wing dikes force the water flow away from the bank from which they are built. Typically then, revetments, which strengthen and hold unstable banks from erosional forces, must …..

3. Reservoirs. The reservoir system of the MCKARNS is part of a larger navigation and flood control plan for the Arkansas River in Oklahoma and Arkansas. Authorization for construction of the reservoirs on the MCKARNS came principally from the passing of the various Flood Control Acts (1936, 1938, 1944, and 1962) and subsequent amendments to the original legislation. Legislation was also passed through the River and Harbor Act to incorporate upstream reservoirs in Oklahoma that have the capacity to control flows on the MCKARNS into the multipurpose plan for the system.

River flow and water storage of the MCKARNS are primarily influenced and controlled by these 11 reservoirs in Oklahoma as well as the Arkansas River upstream of its confluence with the Verdigris River (river mile 394). The 11 Oklahoma reservoirs include:

Keystone Lake	Lake Hudson	Kaw Lake
Oologah Lake	Fort Gibson Lake	Hulah Lake
Grand (Pensacola) Lake	Tenkiller Ferry Lake	Copan Lake
	Eufaula Lake	Wister Lake

The 11 reservoirs include 9 USACE (Tulsa District) reservoirs as well as 2 electric utility (Grand River Dam Authority [GRDA]) reservoirs. The reservoirs provide flood control, water supply, power generation, recreation, and water quality maintenance (through sediment trapping). Information concerning various elements of the surface water features for each reservoir is detailed below. Information regarding the water supply, hydroelectric power, and recreation resources for each reservoir are presented in subsequent sections.

The reservoirs also aid the MCKARNS by assisting in the control of water releases through spillways and power generating units. The rate of release water from each reservoir depends on many factors including available water storage, power requirements, navigation water requirements, inflow rates, river flow rates downstream, and weather conditions.

A summary of the characteristics of each reservoir is presented in Table 4, including watershed drainage area, elevation, surface area, storage capacity, and shoreline mileage. Within the reservoirs, three zones of water storage are present to assist these functions - the flood control pool, the conservation pool, and the inactive pool. The flood control pool zone is reserved for retaining floodwaters and is only utilized during flood control periods. The conservation or power pool is the middle zone that provides water for power generation, MCKARNS flow regulation, and water supply. The bottom zone or inactive pool provides water pressure for water releases and power generation as well as sediment trapping. Water storage is measured in acre-feet, which is the amount of water available to cover one acre to a depth of one foot.

TABLE 4. CHARACTERISTICS OF FLOOD CONTROL RESERVOIRS IN THE UPPER MCKARNS

Reservoir	Operated By	Drainage (Sq mi)	Elevation (Feet above msl)			Surface area (Acres)			Storage Capacity (Acre-feet)			Shoreline*
			1	2	3	1	2	3	1	2	3	
Keystone Lake	USACE	74,506	754	723	706	54,678	22,420	12,430	1,672,613 (lake total)			330
									1,167,232	278,122	227,259	
Oologah Lake	USACE	4,339	661	638	592	67,120	31,040	880	1,559,279 (lake total)			209
									1,007,060	545,284	6,935	
Pensacola (Grand) Lake	GRDA, USACE	10,298	755	745	730	46,500	NG	NG	2,197,000 (lake total)			1,300
									525,000	585,500	1,086,500	
Lake Hudson	GRDA, USACE	11,553	636	619	599	12,000	NG	NG	444,510 (lake total)			200
									244,210	151,670	48,630	
Fort Gibson Lake	USACE	12,494	582	554	551	51,000	19,900	16,950	1,284,400 (lake total)			225
									919,200	53,900	311,300	
Tenkiller Ferry Lake	USACE	1,610	667	632	594.5	20,800	12,900	NG	1,230,800 (lake total)			130
									576,700	371,000	283,100	
Eufaula Lake	USACE	47,522	597	585	565	143,700	105,500	46,100	3,826,000 (lake total)			600
									1,511,000	1,463,000	852,000	
Kaw Lake	USACE	7,250	1,044.5	1,010	978	38, 000	17,000	5,600	1,348,000 (lake total)			168
									919,400	343,500	85,100	
Hulah Lake	USACE	732	765	733	710	13, 000	5,160	3,570	289,088 (lake total)			62
									257,932	31,156	0	
Copan Lake	USACE	505	732	710	687.5	17,850	13,380	4,850	227,734 (lake total)			30
									184,318	42,820	596	
Wister Lake	USACE	993	502.5	478	450	23,366	6,700	NG	427,485 (lake total)			NG
									366,056	61,037	392	

(1) Flood control pool, (2) Conservation or power pool, (3) Inactive pool
NG=Not given
* Shoreline measured in miles.
USACE - U.S. Army Corps of Engineers
GRDA - Grand River Dam Authority
Source: USACE, 2003

a. **Keystone Lake**. Keystone Lake has two major arms including the Cimarron River arm, which is characterized by gently rolling hills, and the Arkansas River arm, which is characterized by steep, broken hills to low rolling hills and many small valleys in its upper reaches. The damming of the Arkansas River at river mile 538.8, approximately 15 miles east of Tulsa, in Tulsa County, Oklahoma, formed the lake. The terrain of the lake includes sandy beaches as well as wooded shorelines and high bluffs. Project lands surrounding the lake vary from rugged rocky terrain and forests near the dam, to gently rolling hills and grasslands in the upper reaches.

The reservoir drains a 74,506-square-mile area above the dam. The surface area for the lake is 54,678; 22,420; with 12,430 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 330 miles of shoreline. Approximately 251 miles of the shoreline is classified as protected lakeshore and 55 miles is designated for public recreation. The remaining shoreline includes 21 miles allocated for limited development and 3 miles allocated as prohibited access.

b. **Oologah Lake**. Oologah Lake lies in the Cuesta Plains subdivision of the Interior Lowlands physiographic province at the western slope of the Ozark uplift and is characterized by gently rolling hills, isolated buttes, and low east facing escarpments separated by broad valleys. The damming of the Verdigris River at river mile 90.2, approximately 2 miles southeast of Oologah, in Rodgers County, Oklahoma, formed the lake. The reservoir extends northward 35 miles into Nowata County, Oklahoma. The topography of the lake reflects the edge of the Ozark uplift and is characterized by westward dipping rocks throughout both counties and results in a long irregular shoreline that varies from moderate slopes to steep banks. The topography is characterized in the lower portion of the lake by forested hills and limestone bluffs that transition into rolling grass covered plains in the upper reaches.

The reservoir drains a 4,339-square-mile area above the dam. The surface area for the lake is 67,120; 31,040; with 880 acres for the top of the flood control, conservation, and inactive pools, respectively. Although the lake is relatively clear under normal conditions, the main river channel (the Verdigris) contributes higher turbidity during high flow periods. The lake has approximately 209 miles of shoreline with very little public development.

c. **Grand (Pensacola) Lake**. Grand Lake forms the upper portion of the boundary line between the western slope of the Ozark uplift and the Cherokee Plains, which is the flat divide between the Verdigris River and the Grand River. The area is characterized by rolling valleys on the west and ravines, bluffs, and hillsides on the east. The lake was formed by the damming of the Grand (Neosho) River at the city of Langley in Mayes County, Oklahoma. The reservoir begins at the Pensacola Dam on the Grand (Neosho) River and extends northeast upriver into Delaware and Ottawa counties, ending at the confluence of the Neosho and Spring rivers.

The reservoir drains a 10,298-square-mile area above the dam (including upstream projects). The surface area for the lake is approximately 146,500 acres and has approximately 1,300 miles of shoreline. The shoreline is available for private development.

d. **Lake Hudson**. Lake Hudson, which is also known as the Markham Ferry project, forms the middle of the boundary line between the western slope of the Ozark uplift and the Cherokee Plains, which is the flat divide between the Verdigris River and the Grand River. The area is characterized by rolling valleys on the west and ravines, bluffs, and hillsides on the east. The lake was formed by the damming of the Grand (Neosho) River at the city of Locust Grove in Mayes County, Oklahoma. The reservoir begins upstream of Fort Gibson Lake on the Grand (Neosho) River and extends northeast upriver to the Pensacola Dam (Grand Lake).

The reservoir drains an 11,553-square-mile area above the dam (including upstream projects). The surface area for the lake is approximately 12,000 acres and has approximately 200 miles of shoreline. The shoreline is available for private development.

e. **Fort Gibson Lake**. Fort Gibson Lake forms the lower 26 miles of the boundary line between the western slope of the Ozark uplift and the Cherokee Plains, which is the flat divide between the Verdigris River and the Grand River. The area is characterized by rolling valleys on the west and ravines and hillsides on the east. The lake was formed by the damming of the Grand (Neosho) River at river mile 7.7, approximately 5 miles north of Fort Gibson and 12 miles northeast of Muskogee in Mayes, Wagoner and Cherokee counties, Oklahoma. The reservoir begins 7.7 miles above the confluence of the Grand (Neosho) and Arkansas Rivers, and extends northeast upriver to the Markham Ferry (Lake Hudson).

The reservoir drains a 12,494-square-mile area above the dam (including upstream projects). The surface area for the lake is 51,000; 19,900; and 16,950 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 225 miles of shoreline. Approximately 142 miles of the shoreline is classified as protected lakeshore and 57 miles is designated for public recreation. The remaining shoreline includes 23 miles allocated for limited development and 3 miles allocated as prohibited access.

f. **Tenkiller Ferry Lake**. Tenkiller Ferry Lake is nestled in the Cookson Hills of eastern Oklahoma. The reservoir was formed by the damming of the Illinois River, which originates from the Ozark geological uplift region of northwest Arkansas. The Illinois River flows 145 miles through the low mountains of northeastern Oklahoma to its confluence with the Arkansas River; the dam is located on river mile 12.8. The reservoir is located in Cherokee and Sequoyah counties, about 7 miles northeast of Gore and about 22 miles southeast of Muskogee, Oklahoma.

The reservoir drains a 1,610-square-mile area above the dam and has a capacity of 1,230,800 acre-feet at the top of the flood control pool. The reservoir drains a 1,610-square-mile area above the dam. The surface area for the lake is 20,800 and 12,900 for the top of the flood control and power pools, respectively. The lake has approximately 130 miles of predominantly rocky, rugged shoreline. The lake is a clear rocky-bottomed reservoir with a depth of over 165 feet.

g. **Eufaula Lake**. Eufaula Lake is located in a narrow valley and was formed by the damming of the Canadian River. The project is located at river mile 27, approximately 12 miles east of Eufaula, in McIntosh County, Oklahoma. The northern shoreline exhibits rugged, steep rocky hillsides and sharp bluffs that rise from the water on either side. The terrain of the southern portion of the lake graduates into more moderate to gently sloping shorelines with sandy beaches. The central portion of Eufaula Lake is the convergence of the Deep Fork, North Canadian, and South Canadian Rivers. The Deep Fork converges with the North Canadian approximately 7 miles north of Eufaula. The Southern Canadian, which forms the main channel for the Canadian River, enters the lake just north of Eufaula. These rivers carry heavy silt loads that form deltas at their confluence and cause decreased clarity in the lake.

The reservoir drains a 47,522-square-mile area above the dam. The surface area for the lake is 143,700; 105,500; and 46,100 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 600 miles of shoreline. Approximately 56% of the shoreline is classified as protected lakeshore and 21% is designated for public recreation. The remaining shoreline includes 22% allocated for limited development and 1% allocated as prohibited access. Over 250 housing developments are in proximity to the shoreline. Mowing and boat dock permits allow property owners to maintain shoreline areas in front of their properties.

h. **Kaw Lake**. Kaw Lake lies in a wide, flat valley and was formed by the damming of the Arkansas River. The project is located at river mile 653.7, approximately 8 miles east of Ponca City, in Kay County, Oklahoma. The northern portion of the flood control pool extends as far north as Arkansas City in Cowley County, Kansas. The Kaw Lake project lies in the Northern Limestone Cuesta Plains subdivision of the Interior Lowlands physiographic province.

The reservoir drains a 7,250-square-mile area above the dam. The surface area for the lake is 38,000; 17,000; and 5,600 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 168 miles of shoreline.

i. **Hulah Lake**. Hulah Lake lies in a relatively flat, broad valley and was formed by the damming of the Caney River, a tributary of the Verdigris River. The project is located at river mile 96.2, approximately 15 miles northwest of Bartlesville, in Osage County, Oklahoma. The upper end of the flood control pool to the north lies in Chautauqua County, Kansas. The Hulah Lake project lies in the upper reaches of the high rounded Osage Hills, which result from a gently dipping anticline fold with numerous folds superimposed upon it. This fold possesses oil deposits that include active wells around the project lands. The region surrounding Hulah Lake is typified by long, rolling, partially wooded ridges separated by broad, flat valleys.

The reservoir drains a 732-square-mile area above the dam. The surface area for the lake is 13,000; 5,600; and 3,570 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 62 miles of shoreline. Approximately 49 acres are classified as protected lakeshore and 10 miles for public recreation. The remaining shoreline includes 2 miles for limited development and 1 mile allocated as prohibited access.

j. **Copan Lake**. Copan Lake was formed by the damming of the Little Caney River, a tributary of the Caney River in the Verdigris watershed. The project is located at river mile 7.4, approximately 9 miles of Bartlesville, in Washington County, Oklahoma. The project area shoreline is generally flat and gently sloping in the northern portion of the reservoir to rolling and steep in the areas above the dam. The reservoir extends from the town of Copan Oklahoma, northward to the town of Caney in Kansas.

The reservoir drains a 505-square-mile area above the dam. The surface area for the lake is 17,850; 13,380; and 4,850 acres for the top of the flood control, conservation, and inactive pools, respectively. The lake has approximately 30 miles of shoreline.

k. **Wister Lake**. Wister Lake was formed by the damming of the Poteau River in a mountainous region with steep and rocky valley slopes in an east west trend of long parallel ridges formed by severely faulted hard sandstones of the Ouachita Mountains. The project is located at river mile 60.9 of the Poteau River, approximately 2 miles south of Wister, Oklahoma, in LeFlore County.

The reservoir drains a 993-square-mile area above the dam. The surface area for the lake is 23,366 and 6,700 acres for the top of the flood control and conservation pools, respectively.

4. **Floodplains.** The Arkansas River was once a meandering and unpredictable river, which left a wide floodplain in many areas. The accumulation of alluvial deposits in the floodplain and floodplain terraces has created fertile soils for cultivation. The study area, which includes the navigation pools created above lock and dam structures along the MCKARNS as well as the upstream reservoirs, covers much of the historic floodplain of the Arkansas River and its tributaries. Lands once cultivated by both Native Americans and settlers have now been inundated by pool and reservoir waters.

The MCKARNS has also been channelized and stabilized with dikes and revetments to improve navigation on the system. This channelization has also reduced the historic breadth of the floodplain in these areas. The placement of levees along the system to retain floodwaters and control normal flood events has also impacted the systems' historic floodplain.

5. **Land Use/Land Cover.** Along the course of the Arkansas River that comprises the MCKARNS, the land looks much as it did in pre-settlement days with rich floodplain soils well suited to cultivation. The wide bottomlands with fertile soil support many crops as well as pine and hardwood forests. Land use cover varies throughout the project area and includes the following cover types:

Urban (Residential, Commercial, and Industrial)	Water Bodies
Agricultural	Wetlands
Rangeland	Barren Land
	Forest

The land coverage of the majority of the study area consists of water bodies including the MCKARNS and its 11 associated reservoirs. Adjoining land coverage varies depending on the land use. Land cover for recreational lands that adjoin USACE projects include forests, wetlands, rangelands, and agricultural lands, depending on the location of each individual project.

Land coverage in the western portion of the MCKARNS study area includes smaller reservoirs in northern Oklahoma plains that include rangelands and agricultural areas. The study lands in northeastern Oklahoma and northwestern Arkansas, which are located in mountainous areas, include higher percentages of forested land cover. The lower MCKARNS through central Arkansas contains primarily agricultural lands. However, lowland forests associated with the White River National Wildlife Refuge and surrounding areas dominate the land coverage in the extreme lower portion of the MCKARNS. Adjoining lands to non-USACE reservoirs include more residential and commercial development.

6. Vegetation. The Arkansas River valley from Kaw Lake to the mouth of the Mississippi River encompasses a diversity of ecosystems. The entire basin lies within the 2000 Humid Temperate Domain, as described by (Bailey, 1980). The Arkansas River Basin from Kaw Lake to the State line falls within the 2500 Prairie Division. As it flows through Arkansas it passes through Bailey's 2215 Hot Continental and the 2300 Subtropical Divisions. Near Kaw Lake the river is within the 2530 Tall Grass Prairie province and shortly thereafter enters the 2512 Oak Hickory Bluestem Parkland Province and Oak–Bluestem Parkland Provinces which ends at approximately the Oklahoma–Arkansas State line. At this point, the river transitions into the 2215 Oak-Hickory Forest Province. At the center of the state, the river transitions into the 2320 Southeastern Mixed Forest Province and finally enters the 2312 Southern Floodplain Forest as it nears the White and Mississippi rivers.

In the Prairie Parkland Provinces, the topography is gently rolling plains, with steep bluffs bordering the valleys. Average annual precipitation ranges from 23 to 40 inches. Grasses are the dominant plants on the prairies. Woody vegetation is rare except along the floodplains, which are dominated by cottonwoods. Dominant plants include big and little bluestem, Indian grass, switch grass, side-oats gramma, western wheatgrass, plains muhly, panic grass, and sedges. Various species of oaks and hickories including post oak, blackjack oak, red oak, and white oak dominate upland forests. Along the floodplains and moist hillsides, there is a richer forest of deciduous trees that include elm, sycamore, bur oak, eastern cottonwood, hackberry, redbud, and buckeye.

As the river enters the State of Arkansas, the shift in vegetation occurs to a winter deciduous forest. Tall, broadleaved trees that provide a dense canopy in summer and are bare in winter dominate this forest. These temperate deciduous forests are composed of various species of oaks, beech, birch, hickory, walnut, maple, basswood, elm, ash, chestnut, and hornbean. The poorly drained areas may include forest containing alder, willow, ash, elm, and hydrophytic shrubs.

The lower section of the river travels through the 2320 Southeast Mixed Forest and 2312 Oak-Hickory–Pine Forest provinces. The average annual temperature increases to 60-70º F, and the rainfall increases from 40-60 inches per year. The climax vegetation within the Southeastern Mixed Forest Province consists of broadleaf deciduous and needle leaf evergreen trees, which may contain stands of loblolly pine, short leaf pine, or southern yellow pines. Other species present include oak, hickory, sweetgum, blackgum, red maple, and winged elm.

C. Other USACE Studies and Proposals Relevant to the Project Area(s)

1. MCKARNS Dredge Material Disposal Management Plan. The U.S. Army Corps of Engineers' navigation mission is to provide safe, reliable, efficient, and environmentally sustainable waterborne transportation systems (channels, harbors, and waterways) for the movement of commerce, national security needs, and recreation.

The removal or excavation, transport, and placement of dredged sediments are the primary components of the "dredging process". After the sediment has been excavated, it is transported from the dredging site to the designated disposal area. This transport operation is accomplished by the dredge itself or by using additional equipment such as barges or pipelines with booster pumps. The collected and transported dredged material is placed in either open-water, islands or upland locations. The choice of disposal alternatives involves a variety of factors related to the dredging process including environmental acceptability, technical feasibility, and economic feasibility of the chosen alternative.

The USACE, Tulsa District has developed a 20-Year Dredge Material Disposal Management Plan for the 150-mile portion of the MCKARNS it operates and maintains. A copy of this plan and maps of the disposal areas are included as Appendix 3. The purpose of this plan is to evaluate future 20-year needs relevant to dredging operations for the McClellan-Kerr Arkansas River Navigation System within the State of Oklahoma. Historical data, current and past dredging operations, site availability and access, governing regulations, and environmental considerations were evaluated to determine the most feasible locations for disposal areas. Dredge disposal sites were located as close as possible to areas along the navigation channel currently identified and/or expected dredging locations within the 20-year time frame. Detailed designs and dredging operations are not included in this document.

Twenty-three dredge disposal sites are being evaluated in the BA and are summarized in Table 5. Seven sites (18A, 18B, 17A, 17B, 16A and A1, 16B, and 16C) have been constructed. There are four new sites (16E, 16F, 15B and B1, and 13A), which are highlighted in yellow, that have not been addressed in the Operation and Maintenance Program EIS for the MCKARNS. These will require additional National Environmental Policy Act Documentation prior to their use. Open water disposal, which is highlighted in purple, and confined island disposal are proposed for site 15B and B1. The remaining sites were discussed in the existing EIS for the MCKARNS and were in compliance with the ESA at the time the EIS was prepared in1974. Most are already constructed and being used at the present time. Since 1974, no subsequent studies on T&E species or compliance activities with respect to the ESA have occurred to date on the MCKARNS. For this BA, all 23 sites will be evaluated for potential impacts on Federally listed species. Following is a summary of each site:

- Site 18A. This site is located in Pool 18 on the left descending bank to the navigation channel between miles 444.6 and 445 down stream of Port of Catoosa (Drawing 2). This is an existing approved EIS disposal site with a constructed confined disposal dike with a minimum anticipated capacity of 300,000 cubic yards (C.Y.) for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form through a pipeline to the confined site. The quantity of estimated dredged material from the problem area (Bird Creek area mile 444.4 to 445) to 2023 is anticipated to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated no elevated contaminants in the sediment. These findings were utilized to conclude that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. No real estate acquisition is needed.

- Site 18B. This site is located in Pool 18 on the right descending bank to the navigation channel between miles 444 and 445 down stream of Port of Catoosa (Drawing 2). This is an existing approved EIS disposal site with a constructed confined disposal dike with a minimum anticipated capacity of 300,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form through a pipeline to the confined site. The quantity of estimated dredged material from the problem area (Bird Creek area mile 444.4 to 445) to 2023 is anticipated to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated no elevated contaminants in the sediment. These findings were utilized to conclude that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. No real estate acquisition is needed.

- Site 18C. This site is located in Pool 18 on the left descending bank to the navigation channel between miles 421.6 and 422.2 above Lock 18 (Drawing 3). This site is an existing unconfined approved EIS disposal site. It is projected that this site will be used for future disposal activities and that mechanical dredging such as hydraulic/ clamshell or dragline dredging will be utilized to remove debris and sediment and dispose of it into a unconfined disposal site adjacent to the channel. The estimated quantity of dredged material from the problem area (Wharf area at Lock 18) through 2023 is anticipated to be approximately 100,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. No real estate acquisition is needed.

- Site 17A. This site is located in Pool 17 on the left descending bank to the navigation channel between miles 420.8 and 421.6 below Lock 18 (Drawing 3). This site is an EIS approved disposal site and consists of a confined disposal dike with two outlets and a minimum anticipated capacity 600,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 420.7 to 421.4) through 2023 is anticipated to be approximately 500,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. No real estate acquisition is needed.

- Site 17B. This site is located in Pool 17 on the right descending bank to the navigation channel between miles 401.6 and 402.6 above Lock 17 (Drawing 4). This is an existing approved EIS disposal site with a confined disposal dike with one single outlet and has an anticipated minimum capacity of 300,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 401.6 to 403.5) through 2023 is anticipated to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. No real estate acquisition is needed.

- Site 16A & 16A-1. This site is located in Pool 16 on the left descending bank to the navigation channel between miles 400.5 and 401 below Lock 17 (Drawing 4). This is an existing approved EIS disposal site with two confined disposal dikes, each with a single outlet and a combined anticipated minimum capacity of 600,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal sites. The estimated dredged material quantity from the problem area (mile 400 to Lock 17) through 2023 is anticipated to be approximately 400,000 C.Y. Analysis of this site was performed using the procedures found in

Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. No real estate acquisition is needed.

- Site 16B. This site is located in Pool 16 on the right descending bank to the navigation channel between miles 395 and 395.5 in the Three Forks area (Drawing 5). This is an existing approved EIS site with a confined disposal dike with a single outlet and an anticipated minimum capacity of 400,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal sites. The estimated dredged quantity of material from the problem area (mile 395 to 395.5) through 2023 is anticipated to be approximately 600,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated no elevated contaminants in the sediment. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the site. No real estate acquisition is needed.

- Site 16C. This site is located in Pool 16 on the right descending bank of the Arkansas River at mile 395 in the Three Forks area (Drawing 5). This is an existing approved EIS disposal site. This is an unconfined disposal site with an anticipated minimum capacity of 100,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the unconfined disposal site. The estimated quantity of dredged material from the problem area (mile 394 to 395) through 2023 is anticipated to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated contaminants in the sample were elevated above acceptable levels. Therefore, Tier II Analysis will be required for disposal at this site. No real estate acquisition is needed.

- Site 16D. This site is located in Pool 16 on the right descending bank to the navigation channel between miles 394 to 394.7 in the Three Forks area (Drawing 5). This is an existing approved EIS disposal site. This is an unconfined disposal site with an anticipated minimum capacity of 100,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the unconfined disposal site. The estimated quantity of dredged material from the problem area (mile 394 to 394.7) through 2023 is anticipated to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in

Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated contaminants in the sample were elevated above acceptable levels. Therefore, Tier II Analysis will be required for disposal at this site. No real estate acquisition is needed.

- Site 16E. This site is located in Pool 16 on the left descending bank to the navigation channel between miles 393 and 394 in the Three Forks area (Drawing 5). This is a new site not constructed and is not an approved EIS site. This site will be constructed as a confined dike disposal site and will handle a capacity of 1,500,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 393 to 394) through 2023 is anticipated to be approximately 500,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated contaminants in the sample were elevated above acceptable levels. Therefore, Tier II Analysis will be required for disposal at this site. No real estate acquisition is needed.

- Site 16F. This site is located in Pool 16 on the right descending bank to the navigation channel between miles 392.8 and 393.3 at the Highway 62 Bridge (Drawing 5). This new, yet to be constructed site, is not an approved EIS site. This site will be constructed as a confined dike disposal site and will handle a capacity of 600,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 392.8 to 393.3) through 2023 is anticipated to be approximately 500,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated contaminants in the sample were elevated above acceptable levels. Therefore, Tier II Analysis will be required for disposal at this site. This site is jointly owned by the Port of Muskogee and the USACE. The total area is approximately 20 acres, and real estate action may be required to design this site. The design of the confined disposal site and EIS approval will be required. The Port of Muskogee foresees beneficial use of the dredged material for future expansion of the port.

- Site 16G. This site is located in Pool 16 on the left descending bank to the navigation channel between miles 393 and 394 in the Three Forks area (Drawing 5). This is an existing approved EIS disposal site. This site is a confined rock dike disposal site with an anticipated minimum capacity of 600,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 393 to 394) to 2023 is anticipated to be approximately 500,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. Data from analysis of sediment sampling at this site indicated contaminants in the sample were elevated above acceptable levels. Therefore, Tier II Analysis will be required for disposal at this site. No real estate acquisition is needed.

- Sites 15A & 15A-1. These sites are located in Pool 15 between miles 353 and 356 at the Canadian River Confluence and Stoney Point (Drawing 6). The two existing islands are EIS approved sites. It is projected that these sites will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing islands. Each island is to be an oval or teardrop shape, approximately 4 acres in area with the length greater than the width, and about 6 feet above the normal high water mark. Each island will contain approximately 50,000 C.Y. of dredging materials and be used for Least Tern Habitats. The estimated quantity of dredged material from the problem area (mile 353 to 356) through 2023 is anticipated to be approximately 100,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Also, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for testing of the sites. No real estate acquisition is needed. Design of confined islands with silt fences for Least Tern Habitats may be required and hydrographic surveys may be needed.

- Site 15B & 15B-1. This site is to be investigated as a designated Open Water Dredge Disposal Site (OWDDS). This site is located in Pool 15 between miles 348 and 349.5 at Sandtown Bottom area (Drawing 7). This site is not an approved EIS site. It is projected that this site will be used for future disposal activities and that hydraulic dredging using direct pipeline discharge will be utilized to place dredged material in the designated open water site. The estimated quantity of dredged material from the problem area (mile 348 to 349.5) through 2023 is anticipated to be approximately 100,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for testing of the sites. No real estate acquisition is needed.

- Sites 15C & 15C-1. These sites are located in Pool 15 between miles 6.8SBC and 7.4SBC at Sans Bois Creek Channel (Drawing 8). The two existing islands are EIS approved sites. It is projected that these sites will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing islands. The estimated quantity of dredged material from the problem area (mile 6.9SBC to 7.4SBC) through 2023 is anticipated to be approximately 200,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Also, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. No real estate acquisition is needed.

- Sites 15D, 15E, &15F. These sites are located in Pool 15 between miles 8SBC and 11SBC upstream of Highway 9 to the Turning Basin on Sans Bois Creek Channel (Drawing 9). The three existing islands are EIS approved sites. It is projected that these sites will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing adjacent islands. The estimated quantity of dredged material from the problem area (mile 8BC to 11SBC) to 2023 is anticipated to be approximately 300,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Also, the fact the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. No real estate acquisition is needed.

- Site 13A. This site is located in Pool 13 on the right bank adjacent to the navigation channel between miles 318.3 and 319.1 below Lock 14 (Drawing 10). This new, yet to be constructed site, is not an approved EIS site. This site will be constructed as a confined disposal site to handle a minimum capacity of 500,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The existing sites are full and the estimated quantity of dredged material from the problem area (mile 317.2 to 319.6) to 2023 is anticipated to be approximately 200,000 C.Y. Analysis of the site was performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand

and gravel and is most likely to be free of contaminants. Also, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. No real estate acquisition is needed. Design of the confined dike and EIS approval will be required.

- Site 13B. This site is located in Pool 13 on the right descending bank to the navigation channel between miles 315 and 317.2 at Peno Point below Lock 14 (Drawing 11). This is an existing approved EIS unconfined disposal site. The dredged materials in this area are heavy sand and gravel and can be disposed of over the bank without use of dikes. The existing contours provide adequate containment. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing unconfined disposal site. The estimated dredged material quantity from the problem area (mile 315 to 317.2) to 2023 is anticipated to be approximately 500,000 C.Y. Analysis of the site was performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Also, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. No real estate acquisition is needed.

- Site 13C. This site is located in Pool 13 on the right descending bank to the navigation channel between miles 311.5 and 313.9 in the Camp Creek area (Drawing 11). This is an existing approved EIS unconfined disposal site. The dredged materials in this area are heavy sand and gravel and can be disposed of over the bank without use of dikes. The existing contours provide adequate containment. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the existing site over the banks into the existing unconfined disposal site. The estimated quantity of dredged material from the problem area (mile 311.8 to 313.5) to 2023 is anticipated to be approximately 500,000 C.Y. Analyses of these sites were performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material, anticipated to be approximately 500,000 C.Y, to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Also, the fact that the proposed dredging site is not near any known sources of contamination led to the conclusion that there is no reason to believe that contaminants are present. Therefore, there is no need for further testing of the sites. No real estate acquisition is needed.

- Site 13D. This site is located in Pool 13 on the right descending bank to the navigational channel at mile 308.8 to 310 at the confluence of the Poteau River (Drawing 12). This is an existing approved EIS site. This site will handle a minimum capacity of 300,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the adjacent existing disposal site. The estimated quantity of dredged material from the problem area (from the confluence of the Poteau River to the Turning Basin, PR mile 0.0 to 2.0) through 2023 is anticipated to be approximately 300,000 C.Y. Analysis of this site was performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Therefore, there is no need for further testing of the site. No real estate acquisition is needed. Real estate easement may be needed for the use of dredge discharge pipelines across private land.

- Site 13E. This site is located in Pool 13 on the left descending bank to Poteau River Turning Basin PR mile 1.7 to 2.0 (Drawing 12). This new, yet to be constructed site, is not an approved EIS site. This site will be constructed as a confined disposal site to handle a minimum capacity of 300,000 C.Y. for the 20-year plan. It is projected that this site will be used for future disposal activities and that hydraulic dredging with discharge pipes ranging from 18 to 24 inches in diameter will be utilized to remove and transport sediment in liquid slurry form by pipeline to the confined disposal site. The estimated quantity of dredged material from the problem area (mile 1.7 to 2.0) through 2023 is anticipated to be approximately 200,000 C.Y. Analysis of the site was performed using the procedures found in Tier I of the Inland Testing Manual. The Tier I Analysis would indicate no reason to believe that testing is required based on the type of material to be dredged at these sites. Dredge material at this site is composed primarily of sand and gravel and is most likely to be free of contaminants. Therefore, there is no need for further testing of the sites. No real estate acquisition is needed. Design of the confined dike and EIS approval will be required.

TABLE 5. 20-YEAR DREDGE DISPOSAL PLAN SUMMARY

Site #	Navigation Mile	Dredging Method	Disposal Options	Design Capacity (CY x 1000)	Real Estate Acquisition	EIS Approved Site	Site Design Complete	Construction Completed	Estimated Cost ($ x 1000)
18A	444.6 L	Hydraulic/Clamshell	CD	300	Not Req.	Yes	Yes	Yes	300
18B	444.6 R	Hydraulic/Clamshell	CD	300	Not Req.	Yes	Yes	Yes	300
18C	422 L	Hydraulic/Clamshell	UOB	300	Not Req.	Yes	N/A	N/A	0
17A	421 L	Hydraulic/Clamshell	CD	600	Not Req.	Yes	Yes	Yes	600
17B	402 R	Hydraulic/Clamshell	CD	300	Not Req.	Yes	Yes	Yes	300
16A & A-1	400.8 L & 400.2 L	Hydraulic/Clamshell	CD	300 & 300	Not Req.	Yes	Yes	Yes	600
16B	395 R	Hydraulic/Clamshell	CD	400	Not Req.	Yes	Yes	Yes	400
16C	395 R	Hydraulic/Clamshell	UOB	300	Not Req.	Yes	N/A	N/A	0
16D	394.3 R	Hydraulic/Clamshell	UOB	300	Not Req.	Yes	N/A	N/A	0
16E	393.6 L	Hydraulic/Clamshell	CD	1,500	Not Req.	No	No	No	1,500
16F	393 R	Hydraulic/Clamshell	CD	500	Not Req.	No	No	No	500
16G	393.5 L	Hydraulic/Clamshell	CD, OW	600	Not Req.	Yes	Yes	Yes	0
15A & A-1	355 & 353.7	Hydraulic/Clamshell	CI	500 & 300	Not Req.	Yes	No	No	200
15B & B-1	349 & 350	Hydraulic/Clamshell	OW, CI	300 & 300	Not Req.	No	N/A, No	N/A, No	100
15C & C-1	6.8 & 7.2 SBC	Hydraulic/Clamshell	OW, CI	150 & 150	Not Req.	Yes	N/A, No	N/A, No	50
15D	9 SBC	Hydraulic/Clamshell	OW, CI	150	Not Req.	Yes	N/A, No	N/A, No	25
15E	9.9 SBC	Hydraulic/Clamshell	OW, CI	150	Not Req.	Yes	N/A, No	N/A, No	25
15F	10.5 SBC	Hydraulic/Clamshell	OW, CI	300	Not Req.	Yes	N/A, No	N/A, No	50
13A	319 R	Hydraulic/Clamshell	CD	500	Not Req.	No	No	No	500
13B	316 R	Hydraulic/Clamshell	UOB	1,000	Not Req.	Yes	N/A	N/A	0
13C	312.5 R	Hydraulic/Clamshell	UOB	1,000	Not Req.	Yes	N/A	N/A	0
13D	309 R	Hydraulic/Clamshell	UOB	1,000	Not Req.	Yes	N/A	N/A	0
13E	2 L, Poteau River	Hydraulic/Clamshell	CD	300	Req.	Yes	No	No	300

L/R Left / Right CD Confined Dike UI Unconfined Island EIS Env. Imp Stmt UOB Unconfined Overbank OW Open Water CI Confined Island SBC San Bois Creek

2. Arkansas River McClellan-Kerr Navigation Feasibility Study. The ongoing Arkansas River Navigation Study is developing and evaluating alternatives for implementing solutions to problems on the MCKARNS. Phase I of the study developed and evaluated alternatives for implementing solutions to problems resulting from sustained high flows that are adverse to navigation. Phase I studies have identified a recommended plan (Alternative 4). Phase II studies have just been initiated and will address the feasibility of increasing the channel depth along the entire MCKARNS and widening the Verdigris River portion of the system to allow tows to pass at almost any location on the Verdigris River

a. Phase I. During the Phase I studies, 23 alternatives were considered initially. This number was eventually reduced down to four that were considered in detail. Alternative 4, identified as the "Operations Only Alternative," was selected as the recommended plan. It is defined as the existing plan of operation with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3% lower system storage except during June 15 through October 1.

For the recommended plan, SUPER Model analysis estimates a 14-day reduction in flows above 60,000 cfs at Van Buren. The analysis estimated a 2-day increase in flows above 100,000 cfs at Van Buren compared to the existing operation plan. It also showed essentially no change at 137,000 cfs (channel capacity). Based on the SUPER Model results, this alternative, compared to the existing regulation plan, would result in a 0.5% decrease in overall damages to crops and structures. The modeling results also indicated little change in navigation damages, pool damages, recreation losses, or power production when compared to the existing plan.

The analysis indicated less than 1% reduction in overall damages to crops and structures and navigation damages as well as a less than 1% increase in hydropower and pool damages compared to existing conditions.

Lowering the 60,000 cfs bench by 3% (except from June-October), with all other parameters remaining equal, eliminates most of the current operating plans impact on the duration of floodwater under the existing 75,000 cfs bench.

There were two primary differences between the existing conditions plan and the operations only plan (based upon the SUPER Model analysis). These differences addressed the proposed action in a positive manner: 1) the reduction of 14 days per year above 60,000 cfs (a key level for farming interest in Arkansas), and 2) an increase in days between 40,000 cfs and 60,000 cfs (key to scouring flows in the navigation system).

Because the Van Buren gauging station was used as the control point for river stages, the river flow stage at that station was used as the basis of the analysis. For the study, certain critical flow rates were defined in order to provide a frame of reference for analysis. Flow rates were designated as "optimum", "moderate", "high", and "very high" based on the flow rate's effect on commercial navigation and farming.

- Optimum Flows. Optimum river flows are defined as less than 61,000 cfs. This definition correlates to optimum conditions for commercial navigation on the MCKARNS.

- Moderate Flows. Moderate river flows are defined as those between 61,000 cfs and 100,000 cfs. Flooding of some fields along the main stem of the Arkansas River in western Arkansas begins at flows greater than 61,000 cfs.

- High Flows. High river flows are defined as those between 100,000 cfs and 175,000 cfs. The 100,000 cfs level is considered critical because any flow above 100,000 cfs renders the navigation system non-navigable for commercial barge traffic. A flow of 137,000 cfs represents bank full at Van Buren.

- Very High Flows. Very high river flows are defined as those greater than 175,000 cfs. A flow of 175,000 cfs is notable because that is the point in the modeled condition data above which no appreciable difference is shown from the baseline or between alternatives.

Modeling results were used to compare river stages and reservoir elevations at the critical river flow rates of 61,000 cfs and 100,000 cfs at Van Buren. The following paragraphs summarize the potential effects resulting from implementation of the action alternatives.

- Greater than 61,000 cfs, Effect on Agriculture. Agricultural damages have historically occurred in the Van Buren area when river flows exceed 61,000 cfs. Under all three-action alternatives, the number of days when the river is anticipated to be at or above 61,000 cfs is decreased.

- Greater than 70,000 cfs Flows, Effect on Recreational Navigation. Small craft warnings are issued when flows reach 70,000 cfs or greater.

- Greater than 100,000 cfs Flows, Effect on Commercial Navigation. Commercial navigation on the MCKARNS is not possible when flows are above 100,000 cfs and commercial barge traffic is suspended until flows decrease.

Tables 6 and 7 summarize the differences in the number of days the Arkansas River is expected to be at or above certain river flows at Van Buren for the recommended plan compared to the existing, baseline condition (represented by the No Action Alternative). In general, the expected differences in anticipated river flows for the study alternatives compared to existing conditions include the following:

- No Action Alternative (Alternative 1). No change from existing conditions.

- Operations Only Plan Alternative (Alternative 4). This alternative provides approximately 14 fewer days per year at or above 61,000 cfs. This alternative results in slightly less than two additional days per year at or above 100,000 cfs.

TABLE 6. ANNUAL CHANGES IN NUMBER OF DAYS AT OR ABOVE A GIVEN FLOW AT VAN BUREN, ARKANSAS, COMPARED WITH THE NO ACTION ALTERNATIVE (ALTERNATIVE 1)

Flow in cfs	No Action Alternative (Alternative 1)	Operations Only Plan Alternative (Alternative 4)
20,000	Baseline (0)	0.6
40,000	Baseline (0)	2.5
61,000*	Baseline (0)	-13.6
75,000	Baseline (0)	-1.8
90,000	Baseline (0)	2.1
100,000	Baseline (0)	1.7
137,000	Baseline (0)	0.0
150,000	Baseline (0)	0.0
175,000	Baseline (0)	0.0
200,000	Baseline (0)	0.0
250,000	Baseline (0)	0.0
300,000	Baseline (0)	0.0

Positive numbers represent more days; negative numbers represent fewer days than No Action Alternative (Alternative 1), i.e., the existing plan.
* Since flows greater than 61,000 cfs begin to have effects on commercial navigation and agriculture, a flow of 61,000 cfs was used for the purposes of modeling.
Source: USACE, Tulsa District and Parsons, 2003.

TABLE 7. SEASONAL CHANGES IN NUMBER OF DAYS AT OR ABOVE A GIVEN FLOW (VAN BUREN, ARKANSAS) COMPARED WITH NO ACTION ALTERNATIVE (ALTERNATIVE 1)

Flow in cfs	Operations Only Plan Alternative (Alternative 4)					
	Jan/Feb	**Mar/Apr**	**May/June**	**Jul/Aug**	**Sep/Oct**	**Nov/Dec**
20,000	0.0	0.0	0.2	0.2	0.1	0.1
40,000	0.6	0.0	-0.2	1.1	0.4	0.6
61,000	-2.4	-2.0	-1.9	-2.6	-1.4	-3.1
75,000	-0.3	0.7	-0.4	-0.9	-0.2	-0.8
90,000	0.4	0.4	0.3	0.2	0.3	0.5
100,000	0.3	0.2	0.2	0.3	0.3	0.5
137,000	0.1	0.1	-0.1	0.1	0.0	-0.1
150,000	0.1	0.1	0.0	0.0	0.0	-0.2
175,000	0.0	0.0	0.0	0.0	0.0	0.0
200,000	0.0	0.0	0.0	0.0	0.0	0.0
250,000	0.0	0.0	0.0	0.0	0.0	0.0
300,000	0.0	0.0	0.0	0.0	0.0	0.0

Positive numbers represent more days and negative numbers represent fewer days than No Action Alternative (Alternative 1), i.e., the existing plan.
*Since flows greater than 61,000 cfs begin to have effects on commercial navigation and agriculture, a flow of 61,000 cfs was used for the purposes of modeling.
Source: USACE, Tulsa District and Parsons, 2003.

Study alternatives are based upon changes in the operational flows of the river. Changes in river flows would be associated with changes in the storage of water in the reservoirs linked with the MCKARNS, since flows on the MCKARNS are influenced by the storage and release of water in the upstream reservoirs.

- Tables 8 and 9 summarize the differences in the number of days the major reservoirs that influence flows on the Arkansas River are expected to be above conservation pool for each alternative compared to existing conditions (No Action Alternative) within the reservoirs. In general, the expected differences in anticipated reservoir levels under each study alternative compared to existing conditions are the following:

- Alternative 4 (Operations Only Plan). This alternative would have reservoir levels very similar to existing conditions. However, under this plan it is generally anticipated that reservoir levels would be between 0 and 8 feet above conservation pool slightly more frequently than under existing conditions, and reservoir levels would be greater than 8 feet above conservation pool slightly less frequently than under existing conditions.

TABLE 8. ANNUAL CHANGES IN THE NUMBER OF DAYS RESERVOIRS ARE EXPECTED TO BE ABOVE CONSERVATION POOL COMPARED TO EXISTING CONDITIONS (NO ACTION ALTERNATIVE)

Operations Only Plan Alternative (Alternative 4)							
Storage	**0 feet**	**2 feet**	**4 feet**	**6 feet**	**8 feet**	**10 feet**	**12 feet**
Copan	0	0	0	0	0	0	0
Eufaula	1	0	0	0	0	0	0
Gibson	0	0	1	1	1	-2	-2
Grand	1	1	0	0	-1	0	0
Hudson	0	1	0	0	0	0	0
Hulah	0	0	0	0	0	0	0
Kaw	0	0	0	0	0	0	0
Keystone	1	2	3	2	2	0	0
Oologah	2	1	3	2	0	0	0
Tenkiller	2	4	2	1	1	0	0
Wister	1	1	0	0	0	0	0
Columns represent feet above reservoir conservation pool. Source: SUPER Model Report 2002, USACE, Tulsa District, and Parsons, 2003.							

TABLE 9. CHANGE IN THE NUMBER OF DAYS RESERVOIRS ARE EXPECTED TO BE LESS THAN 8 FEET ABOVE CONSERVATION POOL AND GREATER THAN 8 FEET ABOVE CONSERVATION POOL COMPARED TO EXISTING CONDITIONS (NO ACTION ALTERNATIVE)

Operations Only Alternative (Alternative 4)	**Jan-Feb**		**Mar-Apr**		**May-Jun**		**Jul-Aug**		**Sep-Oct**		**Nov-Dec**	
	< 8 feet	**8 feet +**	**< 8 feet**	**8 feet +**	**< 8 feet**	**8 feet +**	**< 8 feet**	**8 feet +**	**< 8 feet**	**8 feet +**	**< 8 feet**	**8 feet +**
Keystone	0.4	-0.1	-0.1	0.1	-0.7	0.6	-1.3	1.7	0.0	0.1	0.2	0.1
Oologah	5.0	0.0	-12.8	0.0	0.2	0.1	-1.2	1.2	0.5	-0.1	0.1	0.1
Grand	0.2	0.0	0.4	0.0	-0.3	0.0	0.1	0.0	0.1	0.0	0.3	-0.1
Hudson	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fort Gibson	0.0	0.0	-0.1	0.1	-0.3	0.2	-0.2	0.4	0.2	0.0	-0.1	0.1
Tenkiller Ferry	0.3	-0.1	0.5	0.0	0.2	0.2	-0.2	0.7	0.1	0.1	0.4	-0.3
Eufaula	0.1	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.0
Kaw	-0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0
Hulah	-0.1	0.2	0.0	0.0	0.1	0.0	0.0	0.1	-1.5	0.0	0.0	0.1
Copan	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	-0.1	0.1	-0.1	0.1
Wister	0.3	-0.2	-0.3	0.2	0.0	0.0	0.9	0.0	0.3	0.0	0.0	0.0
Source: USACE, Tulsa District and Parsons, 2003.												

b. **Phase II.** Currently, the USACE is authorized to maintain the MCKARNS at a 9-foot channel depth. Due to ongoing maintenance dredging of the existing navigation channel and natural stream scour, approximately 80-90% of the system is already 12 feet deep over a portion of the channel width. It is being performed under the following planning constraints:

- Maintain all existing project purposes
- Allow all existing locks to remain in operation
- Allow no in-stream disposal in Oklahoma
- Minimize/mitigate impacts to the entire aquatic ecosystem, i.e., fisheries, wetlands, etc.
- Minimize/mitigate flood damages
- Minimize stream bank erosion
- Upstream reservoir releases will follow Phase I recommendations

Deepening would be accomplished through dredging only. No dredging would be required from the mouth of the Mississippi River to Lock and Dam No.1. To accommodate deeper draft barges, this analysis assumes a 12-foot channel (11.5-foot draft, plus 6 inches for operational fluctuations), with 3-foot advance maintenance. The total amount to be excavated in this analysis is 15 feet for the channel (from the Norrell Lock and Dam to the Port of Catoosa). The 15 feet serves as the basis of an estimate of worst-case scenario in terms of the cost of providing a channel that can consistently accommodate 11.5-foot draft traffic on the MCKARNS. A cross-section of the 12-foot channel is shown in Figure 5.

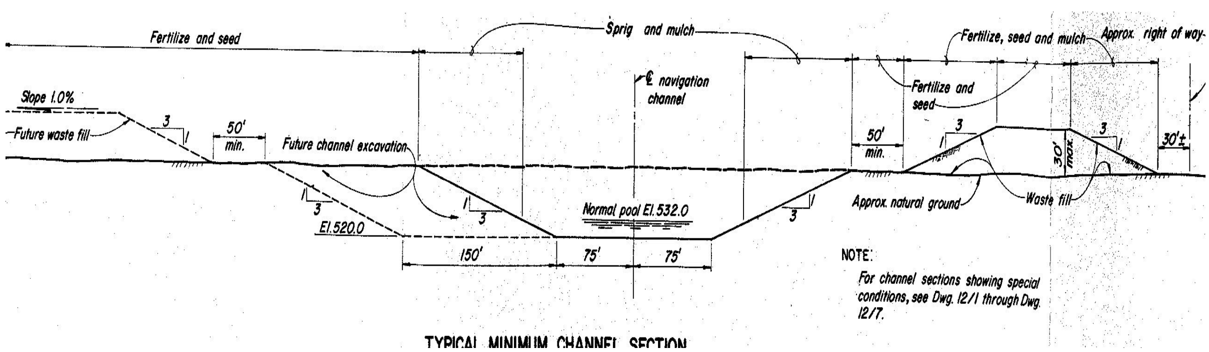


Figure 5. Typical Minimum Channel Section.

The study assumes that no modification of existing locks and dams would be required. The existing locks on the system are designed for barges that can operate on a 9-foot channel depth (the shallowest lock sills are at a depth of 14 feet) and for towboats to power through during locking procedures. The preliminary analysis will use the assumption that tows and barges using a 12-foot channel can safely navigate through the existing locks without requiring structural modification to the locks through implementation of strict towboat operating procedures. If this assumption proves to be unreliable as the Phase II study continues, the cost to increase the channel depth to 12 feet will significantly increase.

The study also assumes that river maintenance structures, such as dikes and bank stabilization revetments, are required to reduce the maintenance dredging requirements for the navigation channel. These structures help direct the flow so that bottom scouring will occur in problem areas and reduce the need to dredge in those areas. The Phase II study will include detailed sedimentation studies, which will establish the exact number, type, and location of these structures for the efficient operation of up to a 12-foot channel.

Currently, dredged material disposal areas on the Oklahoma portion of the waterway are scarce. The Tulsa District is currently reviewing and updating a long-term dredged material disposal plan for the existing 9-foot channel (See Table 5.). Initial assessments show existing disposal areas are insufficient to accommodate maintaining a 9-foot channel in the future. As part of the review, the Corps is asking the Oklahoma Department of Environmental Quality (OKDEQ) for a consensus on in-stream disposal of dredged material on portions of the system. As stated earlier, the OKDEQ considers portions of the waterway as impaired because of sediment load and because in-stream disposal would further impair water quality. As a result, the OKDEQ representative indicated that the agency would not concur with such disposal methods. Consequently, analyses for this preliminary report assumed that all Oklahoma disposal areas would be upland. Some of the upland areas, particularly on the Verdigris River, have high spoils mounds adjacent to the waterway left from materials deposited during initial construction of the waterway. Any additional cost of transporting or pumping the dredged material over the mounded areas requires more scrutiny. Dredging to accommodate a 12-foot depth will require acquisition of substantial amount of lands and related access in Oklahoma. For this preliminary analysis, only two additional disposal areas are anticipated to be required on the Arkansas portion of the system, both along the Arkansas Post Canal. Phase II studies will address acquiring private lands, environmentally sensitive areas, cultural resources, and other issues for all disposal areas.

The MCKARNS has historically had some shoaling problem areas. Shoaling may be an issue in a number of areas with the deeper channel scenario. For this analysis, 3 feet of advance maintenance dredging is assumed over the entire length of the system (see Table 10).

TABLE 10. PERTINENT DATA FOR DEEPENING THE CHANNEL TO 12 FEET AND WIDENING THE VERDIGRIS RIVER

Dredging & Rock Removal		**Cubic Yards**
L&D1 to L&D 5	Dredging	1,883,710
	Rock	0
L&D 5 to Murray	Dredging	233,380
	Rock	0
Murray to Ozark	Dredging	2,100,420
	Rock	0
Ozark to Mayo	Dredging	2,078,239
	Rock	47,000
Mayo to Chouteau	Dredging	5,036208
	Rock	0
Chouteau to Catoosa	Dredging	1,118,703
	Rock	10,000

Since specific information with respect to alignments, locations for dredge material, and widening have not been developed, the assessment of potential affects of the proposed action on the Federally listed species will be rather broad and generalized.

D. Canadian River Basin.

The Canadian River originates in Colfax County, New Mexico, and flows southeasterly through New Mexico and easterly through the Texas Panhandle. It enters Oklahoma and forms the boundary between Ellis and Roger Mills counties. It travels eastward some 410 miles across the State of Oklahoma and joins the Deep Fork River and the North Canadian River to form Eufaula Lake. Eufaula Lake was constructed by the USACE on the Canadian River at mile 27.0, and became operational in September 1964. It was constructed for flood control, water supply, hydroelectric power, and navigation (sediment control). The Canadian exits Eufaula Dam and flows eastward to its confluence with the MCKARNS near navigation mile 357 and the Haskell County and Muskogee County line.

At the top of conservation pool, the lake covers 102,500 acres. It extends up the Canadian, North Canadian, and Deep Fork rivers; Gaines Creek; and numerous minor tributaries. The lake principally lies in McIntosh, Haskell, Pittsburg and Okmulgee counties, but also extends into small areas of Muskogee and Latimer counties.

Approximately 1,470,000 acre-feet of storage in the lake are allocated for flood control, 1,481,000 acre-feet for hydropower and water supply, and 897,000 acre-feet in dead storage for power head and sediment.

The lake provides flood protection on the Canadian River downstream from the dam and contributes to downstream flood control on the Arkansas River below the confluence of the Canadian River. The maximum discharge that can occur through the outlet works without downstream flooding is 100,000 cfs.

The project lies in the Prairie Plains Homocline, which consists of a gently eastward-sloping plain with gently northwestward dipping Pennsylvanian and Permian rocks. The plain slopes from a maximum elevation of about 1, 350 feet in Oklahoma County to about 500 feet at Eufaula Lake, a slope averaging about 6.4 feet per mile. Many steep eastward-facing escarpments are capped by resistant sandstones and limestones whereas the intervening valleys have been excavated in less resistant shales. The overlying mantle consists mainly of Pleistocene terraces and Holocene or Recent alluvium. The Pleistocene deposits are mainly gravel, sand, and silty clay while an occurrence of volcanic ash is present in the alluvium.

Spring and autumn months are mild with warm days and cool pleasant nights. Summers are usually long and hot, while winters are comparatively mild and short. The average length of the growing season is 215 days.

Ecologically, the area is included in within the Oak-Hickory-Bluestem Section of the Prairie Parkland Province as described by (Bailey, 1980). The vegetation of the uplands is characterized by species such as post oak, blackjack oak, northern red oak, black hickory, shellbark hickory, shagbark hickory and winged elm. Wetter areas along the tributaries are characterized by bottomland species consisting of water oak, over cup oak, sweet gum, sycamore, cottonwood, black willow, black walnut, pecan, river birch, winged elm, hackberry, red maple, and green ash. Native grasses found in the area include little bluestem, switch grass, Indian grass, and Johnson grass.

Sport fish species found in the lake include black and white crappie; white bass, largemouth, and spotted bass; channel, blue, and flathead catfish; walleye; and striped bass/white bass hybrids. The lake is noted for its crappie and catfish fishery. Eufaula Lake also has an excellent tail water fishery for striped bass and catfish.

Big game and upland game habitat in the project areas were significantly reduced as the result of construction and operation of Eufaula Lake. Approximately 102,500 acres of habitat were inundated with the project and another 40,500 acres are periodically inundated during flood control operations. Fourteen thousand acres of habitat in the downstream floodplain have received flood protection, which has resulted in land use changes and loss of wildlife habitat. Waterfowl habitat has been increased with the project.

Important game animals in the project area include whitetail deer, bobwhite quail, fox squirrels, cottontails, swamp rabbits, raccoon, and mourning doves.

In addition to operating the lake for its authorized project purposes and routine operation and maintenance activities, the lake has a rather large real estate outgrant program. This program oversees the management of leases, easements, and other outgrants. Through this program, project lands are leased or licensed for activities such as marinas, utility easements, grazing, wildlife management, and agricultural purposes.

The powerhouse at Eufaula Lake has three 30,000-kilowatt generators with a capacity range from 60,000 to 90,000 kilowatts, depending on lake levels. The Southwestern Power Administration (SWPA) markets the total power output of the Eufaula project. The hydropower facilities are designed for generation during peak power requirement periods because of limited inflows to the lake. The base load is supplied by thermal generation. Hydroelectric power is ideal for “peaking” in that it readily available to meet sudden changes in load, and it does not contribute to air and thermal pollution.

The hydroelectric power produced at Eufaula and at seven other USACE Tulsa District projects is marketed by the SWPA. This marketing is done in accordance with contractual agreements that the SWPA has developed with various power companies or Co-Ops. The availability of water for hydroelectric power production is determined by the USACE. Power production has to be coordinated with the other project purposes. Available channel capacities, navigation flow requirements, water in storage, threatened and endangered species, and equipment condition can affect power production schedules. The SWPA has responsibility for scheduling power within the limits of the projects and system constraints as determined by the USACE.

E. Red River Basin.

The Red River is one of the two major river systems in Oklahoma. It originates from small streams in eastern New Mexico and gradually runs eastward approximately 517 miles to the Oklahoma-Arkansas State line in southwestern Arkansas. In its extreme western reaches, it is composed of the Prairie Dog Town Fork of the Red River, which flows southeasterly to loosely form the southern border of Oklahoma. At the confluence of the Prairie Dog Town Fork of the Red River with the Salt and North Forks of the Red River, it continues as the state's southern border but is referred to as simply the Red River. In Oklahoma, there are 22,791 square miles of contributing drainage area to the Red River.

The Red River is an interstate stream which starts in the arid plains of Curry County, New Mexico, and runs east where, at latitude 34 33' 35" and longitude 100 00' 00", the south bank of the river becomes the 440-mile boundary between Texas and Oklahoma. The river turns south through Arkansas, then southeast into Louisiana where it discharges into the Mississippi and Atchafalaya rivers. The main stem of the Red River has a total length of 1,217 river miles. The Red River Basin has a total drainage area of 94,450 square miles, of which 73,671 square miles actually contribute to flows and 24,463 square miles lie within Texas. There are 29 stream segments totaling 1,616 stream miles with 32 significant reservoirs.

Geologically, the area is shale, limestone, sandstone, and sand. The river lies along the Northern Shelf, the Gulf Coastal Plain, and the Red Bed Plain geologic provinces (Hill, 1992). Lake Texoma is located in the Osage Plains section of the Central Lowland physiographic province. The bedrock strata are sedimentary rocks, mostly limestone and sandstone of Upper Paleozoic age (USACE, 1993). In the project area, the basin is underlain by limestone, clay, chalk, and sand of Cretaceous age (Red River Authority, 2000).

Summers are hot with occasional severe rainstorms. Within the project area, rainfall is 30-40 inches a year (Red River Authority, 1998). May, June, September, and October are typically the wettest months.

The project is within the Oak Woodlands/Prairie plant community of the Oak Woods and Prairie natural region as defined by TPW (Diamond et al., 1987). A mixed community of prairie grasses and woodland species characterizes this region. Perhaps more accurately referred to as a transitional zone; typical species include post oak, blackjack oak, water hickory, pecan, white ash, little bluestem, Indian grass, and swithchgrass. Pine hard wood forest comprised of short leaf pine, post oak, and southern red oak is the dominant vegetation type listed by TPW (1997) as occurring along Bowie, Red River, and Lamar counties in the project area. This same vegetation may be assumed on the Oklahoma side in Bryan, Choctaw, and McCurtain counties.

Along the river, dominant species include eastern red cedar, bois d'arc, cottonwood, sweetgum, white oak, southern red oak, common hackberry, black locust, American elm, cane), greenbrier, lance-leaved ground cherry, wild grape *(Vitis* spp.), johnsongrass, and horse nettle (TNRCC, 2000).

The project area is located within a narrow strip of the Austroriparian province, along the eastern edge of the Texan biotic province (Blair). Blair describes the Texan biotic province as an ecotone between the eastern woodlands and the western grasslands. This diversity in biotic communities in the vicinity of the proposed project has encouraged a large variety of faunal species. According to Fields et al., most vertebrate species found in this ecotone come from either the Austroriparian province to the east or from grasslands to the west. Today, the fauna is dominated by avian species; however, prior to the introduction of agricultural practices, native mammalian species may have been more abundant and/or diverse as well. Mammalian and avian species include deer, rabbits, burrowing animals, prairie chickens, grouse, and quail.

Within the boundaries of the project area, the majority of the land has been cultivated. Although the depth of cultivation is variable, the average depth of the recent plow zone is approximately 11.8 inches below present ground surface. Currently, the project area is a mosaic of cultivated fields and pasture, interrupted by narrow bands of woodlands. Typical crops in the project area include cotton, soybeans, field corn, and a mixture of native and introduced grasses for hay. Ranching and oil and gas production are also primary land uses (Hill, 1992).

1. Lake Texoma. At river mile 725.9, the main stem of the Red River is bisected by Denison Dam (Lake Texoma), which was constructed by the USACE for flood control, water supply, hydroelectric power, regulating Red River flows, and improvement of navigation. Upon exiting Denison Dam, the river flows approximately 240 miles to Index, Arkansas, which is the eastern limits of the USACE, Tulsa District. Construction on the dam began in August 1939 and was completed in February 1944. The project was first available to operate for full flood control without any restrictions in January 1944. The first hydroelectric turbine was placed on line in March 1945 and the second in September 1949. The structure is a rolled earth-filled embankment with a rock-protected upstream slope. The main embankment is 15,200 feet long. The maximum height of the structures is 165 feet above the streambed. A rolled earth-filled dike 5,870 feet long and 15 feet high is located in the vicinity of Platter, Oklahoma. The outlet works consist of three 20-foot-diameter, concrete conduits through the embankment equipped with six 9-by 19-foot vertical lift gates. Capacity of the outlet works is 67,500 cfs at the top of the flood control pool and 60,120 cfs at the top of the power pool.

Flood control storage capacity is 2,580,386 acre-feet, and conservation storage is 1,570,216 acre-feet, which includes 150,000 acre-feet for water supply. The maximum release from Lake Texoma was 144,000 cfs in May 1990 during heavy flood conditions. The downstream channel capacity is 45,000 cfs to 60,000 cfs. The maximum rate of pool draw down is 1 foot per week or 3 feet per 4-week period.

Lake Texoma is regulated in conjunction with existing lakes on the Red River and tributaries for the control of floods on the Red River from Denison Dam through the project area. The stream gauges at Arthur City, Dekalb, and Index are utilized as control points for regulation of flood flows. The Red River Control/Forecasting Section of the USACE, Tulsa District makes hydrologic forecasts. These involve information on lake levels, weather, stream flow, etc.

Estimated hydrographs for control points downstream of Denison Dam combine with trial releases from the dam to achieve the desired results (USACE, 1993). Hugo Lake has a more immediate effect on the lower portion of the Red River, so it is operated to fine-tune regulated flows of the lower reaches. The low-flow seasons are primarily November through February and July through August; however, low flows can occur at any time of year. Primary flood periods are from March through June and September through October, but floods are possible any time of year (USACE, 1993).

Although the primary purpose of dam operations is flood control, Congress authorized formation of a Lake Texoma Advisory Committee (Public Law 100-71) to allow lake users, concessionaires, State and Federal agencies, and people with downstream agricultural and navigation interests to make recommendations to the Corps regarding the regulation and management of Lake Texoma.

In 1991, the Advisory Committee devised a seasonal pool plan calling for a draw down of the lake level to an elevation of 615 feet in the late winter and early spring, a rise to 619 feet during May and through the summer, a draw down to 616 feet in the late summer and early fall, and a rise to 618 feet in the late fall and early winter. The resulting regulation of flows is guided by a schedule put forth in the 1993 USACE Water Control Manual. An overview is presented in Figure 6.

Generation of power is another authorized function of the Denison Dam. The powerhouse contains two 35,000-kilowatt generators with provisions for three additional 43,000-kilowatt units. Peak flow from both hydropower units running at full power is 10,500 cfs and from one power unit is 5,300 cfs. One 20-foot-diameter, steel-lined conduit provides water for each power unit. Each of the five power conduits is equipped with two 9- by 19-foot vertical lift gates located in the intake structure. The storage in Lake Texoma between elevations 590 feet and 617 feet has been allocated for hydropower generation and water supply. Thus, when the lake level is between the bottom of the conservation pool (elevation 590 feet) and the top of the transitional pool (about 617 feet), releases are governed by power generation requirements. The storage contained in the conservation pool also contains 15,000 acre-feet for water supply as well as hydropower storage. The required flow for firm energy varies between 1,500 and 2,300 day/second/feet depending on the demands of the season. Typically demand is high from May through September. System flood control operation thus allows Lake Texoma to release flows of approximately 2,000 cfs required to generate the primary energy (429 Mwh/day) of the Texoma project in accordance with the power system demands. However, when conditions warrant, releases at Lake Texoma may be reduced below the daily average for firm power or shut off completely. The required flow for firm energy is 1,800 cfs average daily flow.

Graphic representations of existing flows versus natural flows for the months that Interior least terns are present downstream of Lake Texoma to Index, Arkansas, are shown in Appendix 4. As depicted in the graphics, construction and operation of the lake for its authorized purposes have modified the hydrology of the Red River downstream of the lake. For the period of record (1940-2000) under natural conditions at the four gauging stations, there would have been 44 events with flows exceeding 50,000 cfs. Under existing conditions for the same period of record, there have only been 26 events of flows exceeding 50,000 cfs at the four gage stations. The magnitude of flood events on the Red River downstream of the lake is greatly diminished with operation of the lake. Under natural conditions, the larger flood events would occur and peak over a short period of time. With the project, the peaks of the larger flood events have been reduced and flows downstream are released at a lesser damaging rate over a protracted period of time. The magnitude of flood events on the Red River has been diminished with operation of the project for flood control, which is an authorized project purpose. Conversely, during July and August, monthly flows from Lake Texoma are considerably higher than what occurs under natural conditions. These conditions are probably attributable to operation of the lake for hydropower purposes.

Lake Texoma is not regulated for water supply because the withdrawal points are within the lake and well below the top of the conservation pool. The only current water supply user not withdrawing from the lake directly is the Texas Power and Light facility located 19 miles downstream of Denison Dam. They have not requested flow modifications because they have a large storage pool to cover low flow periods.

Although recreation is an authorized purpose of the Denison Dam, no storage is provided for that specific purpose and no special regulations are made for recreational activity. The lake has normally been regulated to the top of the conservation pool elevation of 617 feet. Most of the recreational users prefer elevations between 615 and 617 feet. When the lake level drops below 612 feet, most of the boat docks and marinas have to shut down. Major problems with most lake activities occur below 610 feet. Conversely, above 621 feet, many marinas, docks, and walkways have to close due to flooding, and at 630 feet, most are closed. The seasonal pool plan recommended by the Lake Texoma Advisory Committee enhances recreation by raising the normal pool elevation during the summer months of June through August.

Fish and wildlife are not identified as an authorized project purpose; therefore, no specific storage is provided. The project does, however, provide secondary benefits to fish and wildlife. The seasonal pool plan designed by the Advisory Committee in conjunction with the Oklahoma Department of Wildlife Conservation and Texas Parks and Wildlife is designed to enhance fish and wildlife management in the lake.

In 2002, the USACE, Tulsa District implemented management guidelines and strategies for operation of three USACE lakes (including Lake Texoma) to protect nesting least terns downstream of the dams. A copy of this plan is shown in Figure 6. Beginning June 1 of each year, the USACE will begin computing 2-week average inflows for Lake Texoma. These flows can be compared with median inflows to predict a trend. This process is then repeated every 2 weeks through the end of the nesting period. The data are used to forecast pool draw downs due to minimum flow requirement for the terns as well as hydropower generation. This process identifies the maximum release rates, which will not exceed the draw down limits identified for Lake Texoma.

In 2003, the management plan was used to establish special operations of hydropower releases for least terns below Denison Dam. It was necessary to schedule generation at times that would protect birds around Highway 78 from ATV's during daylight hours beginning on the fourth of July holiday and weekend days through July 13th.

2. **<u>Red River Downstream of Denison Dam to Index, Arkansas</u>.** From Denison Dam to Arkansas (Figure 7), the river flows between high banks about 1,000 feet apart. Unlike the Arkansas River, which has been intensely modified for navigation, the low water channel is poorly defined and is subject to continual shifting from fluctuations in stream flow. The banks

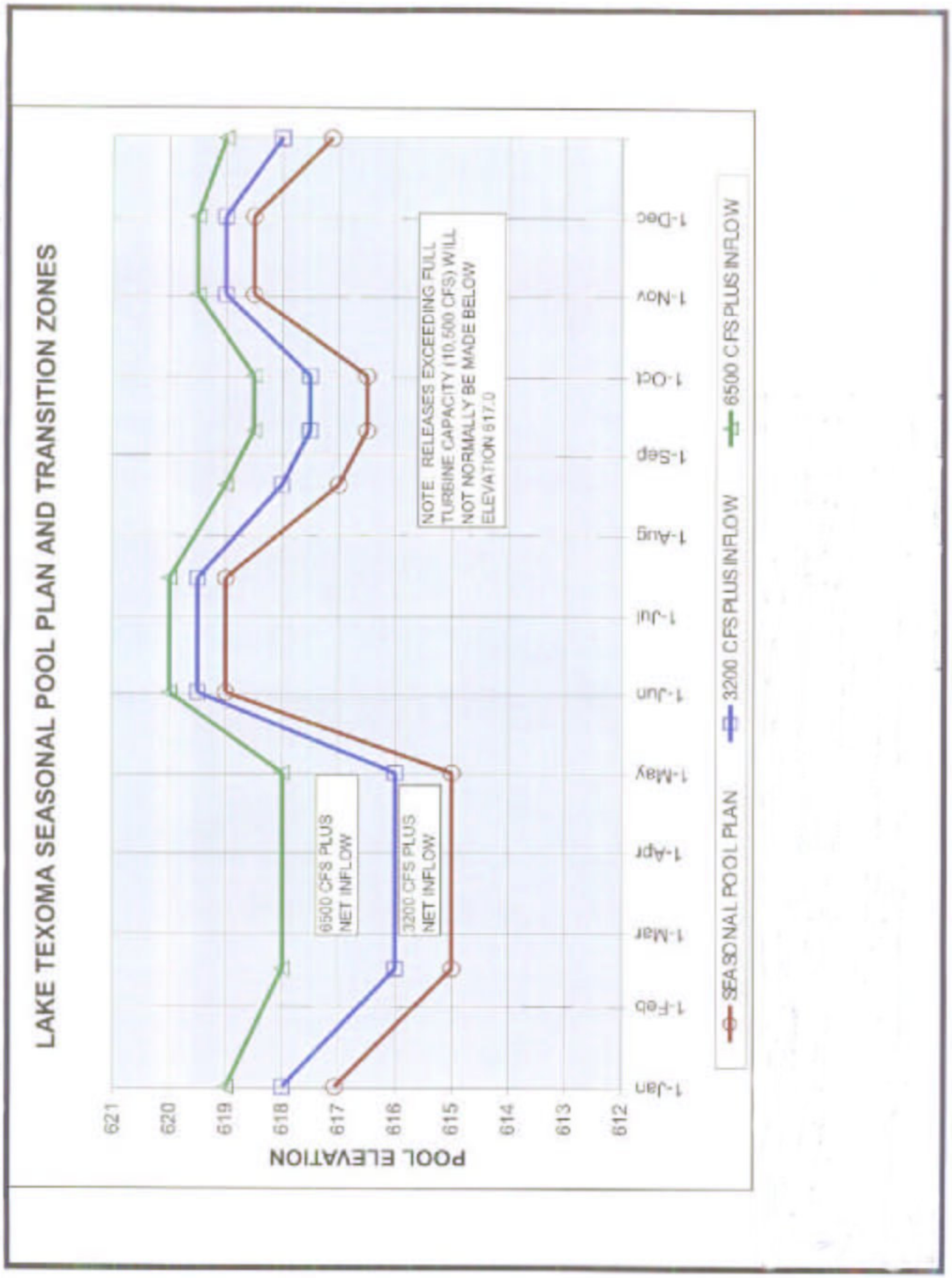


Figure 6. Recommended Regulation of Flows From Denison Dam.

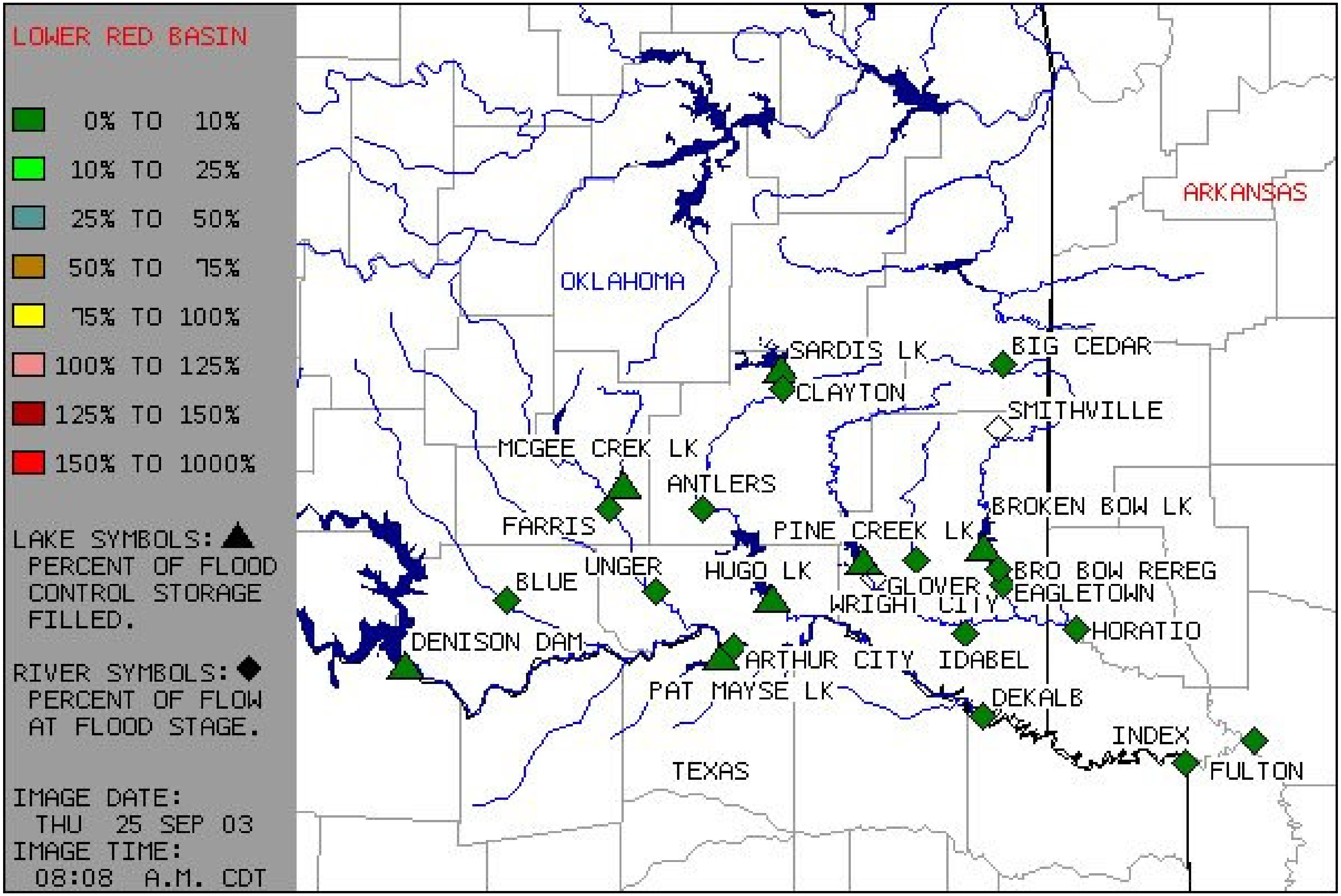


Figure 7. The Red River Basin From Denison Dam to Index, Arkansas, and Its Major Tributaries.

rise from 15 to 25 feet above the low water flow line. In the action area, the most important tributaries entering the Red River are Boggy Creek, Kiamichi River, and Little River. The channel capacity downstream of Denison Dam is in the range of 45,000 to 50,000 cfs.

Three gauges within the project area contribute to calculating necessary releases. The Arthur City gauge 07335500 is located at river mile 633.1 near the U.S. Highway 271 Bridge. The National Weather Service (NWS) flood stage at the Arthur City gauge is designated as 26 feet or 132,000 cfs. The Corps regulating flood stage is 20 feet or 73,000 cfs (1993 channel rating). The Dekalb station 07336820 is located at river mile 556.9 near the U.S. Highway 259 Bridge. The National Weather Service flood stage is designated as 24 feet or 60,800 cfs. The Corps regulating flood stage is 23.7 feet or 58,600 cfs (1993 channel rating). The Index, Arkansas, gauge 07337000 is at river mile 485.3 near the U.S. Highway 71 Bridge across the Texas-Arkansas border. The National Weather Service flood stage is designated as 25 feet or 150,600 cfs. The Corps regulating flood stage is 19.8 feet or 89,800 cfs (1993 channel rating) (USACE, 1993).

3. Other Reservoirs. The USACE, Tulsa District has completed a number of water resources control, flood control, and impoundment projects on tributaries to the main stem of the Red River and downstream of the Denison Dam to the Arkansas border. Operations of these structures have changed the water flow, quality, and/or sediment load within the main stem, and may potentially have influenced the habitat and ecology of breeding Interior least terns. Due to this extensive regulation, streams in the Red River Basin (Figure 7) constitute interdependent components of a complex system. Water flow along the project area is affected not just by operations of the Denison Dam, but, in various degrees, by all these entities and by diversions, irrigation return, agricultural withdrawals from groundwater, etc.

a. McGee Creek. McGee Creek Reservoir is located on Muddy Boggy Creek (a major Red River tributary) and was approved as a joint project with the Bureau of Reclamation in 1976. Diversion was made in 1984, and impoundment began in 1987. The total length of the dam, dike, and spillway is 7,200 feet. The spillway and the municipal outlet works consist of an intake tower with three gates spaced to allow withdrawal of the best quality of water from the reservoir. The record flood occurred in June 1945 when a peak discharge of 22,600 cfs was recorded at the McGee Creek Dam site gauge. The volume of runoff was 79,700 acre-feet, which is equivalent to 8.89 inches of runoff from the drainage area. Flood control storage is 85,340 acre-feet, and water supply storage is 107,980 acre-feet. The drainage area is 171 square miles.

b. Pat Mayse Lake. Pat Mayse Lake is located on Sanders Creek, a tributary of the Red River, approximately 1.5 miles southwest of Arthur City and 12 miles north of Paris in Lamar County, Texas. It was authorized in 1965 with the diversion completed in 1967. Flood control storage is 64,830 acre-feet and conservation storage is 114,700 acre-feet, including 109,600 acre-feet for water supply. The drainage area is 175 square miles. The record flood occurred in December 1971 with an estimated peak discharge of 30,600 cfs and a volume of 75,500 acre-feet.

c. **Sardis Lake**. Sardis Lake is located on Jackfork Creek, a tributary of the Kiamichi River (a major tributary of the Red River). Construction began in 1975 and impoundment started in 1983. Flood control storage is over 122,570 acre-feet and conservation storage is over 274,210 acre-feet. Storm studies show the record flood at the dam site occurred in May 1943 with an estimated discharge of 60,000 cfs and a volume of 80,000 acre-feet. The total volume of inflow in the April through May 1990 flood was approximately 270,000 acre-feet with a peak daily inflow of 33,600 cfs. During the 1990 flood, the peak release was 5,675 cfs. Drainage area is 635 square miles.

d. **Hugo Lake**. Hugo Lake is located on the Kiamichi River (a main tributary to the Red River) at river mile 17.6, about 7 miles east of Hugo in Choctaw County, Oklahoma. Construction began in 1968 with impoundment beginning in 1974. The dam is a rolled earth embankment, including the gate-controlled, concrete spillway, and is 10,200 feet long. Discharge at maximum pool elevation (445.2 feet) is 365,000 cfs. Flood control storage is 808,300 acre-feet and conservation storage is 121,500 acre-feet, which includes 47,600 acre-feet for water supply or 58 million gallons per day (58 mad yield) and 73,900 acre-feet for water quality control. The maximum peak inflow of 120,000 cfs occurred in May 1990. During the 1990 flood, the lake crested at elevation 439.96 with a peak release of 35,000 cfs. In December 1971, a peak inflow of 87,060 cfs occurred. The maximum volume of flow past the dam site of 1,549,500 acre-feet occurred from April through June 1957. Drainage area is 1,434 square miles. Releases from Lake Hugo are a major complement to Lake Texoma releases since they have a more direct influence on the lower reaches of the project area.

SECTION IV. DESCRIPTION OF SPECIES AND STATUS WITHIN THE PROPOSED ACTION AREAS WITH RESPECT TO CORPS OF ENGINEERS OPERATIONS

A American Alligator.

1. **Description of Species**. The American alligator (*Alligator mississippiensis*) is a large reptile inhabiting wetland areas of the southeastern United States. They have broadly rounded snouts without conspicuous upward-protruding teeth, and may attain lengths up to 15 feet. They are dark in appearance with paler cross-banding markings on the back and vertical markings on the sides. They differ from the American crocodile in having a broader snout and in not having the lower jaw tooth protruding at the end of the snout.

2. **Distribution of Species.** Alligators are found primarily in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. To a lesser extent they are found in Texas, Oklahoma, and South Carolina as populations in these states are on the periphery of its range. Historically, their distribution in Oklahoma was considered to be the Red and Little River drainages in southeastern Oklahoma. Presently, they only sporadically occur along the Red River in McCurtain County, Oklahoma. In Arkansas, they are reported to occur naturally in the Little River system in Hempstead County located in southwestern Arkansas.

3. **Habitat**. They are inhabitants of rivers, swamps, estuaries, lakes, and marshes. They dig dens in riverbanks or the shorelines of lakes where they spend the winter or use during times of drought. They are generally inactive during winter months. They are opportunistic feeders and eat a variety of animals including fish, turtles, mammals, and snakes. Juveniles feed on crayfish, mollusks, small fishes, amphibians, and small mammals. Adults eat vertebrates including reptiles, mammals up to the size of deer, and fish.

4. **Cause of Decline**. The decline of this species was attributed to over harvest and destruction of habitat.

5. **Status of Species**. The alligator was originally classified by the USFWS as endangered (32 FR 4001; March 11, 1967, but was reclassified to threatened due to similarity of appearance (T S/A) in Oklahoma and Arkansas on June 4, 1987 (50 FR 21059). No critical habitat was determined for this species. The American alligator is designated as Delisted Taxon, Recovered, and Being Monitored First Five Years in the Entire Range. It was originally classified as endangered throughout its range in 1967 due to concerns over harvesting. Since its protection, it has recovered to the point where it is neither in danger of extinction nor likely to become so in the foreseeable future.

B. Gray Bat.

1. **Description of Species.** The gray bat (*myotis grisescens*) is a medium-sized bat with a wingspan of 10 to 11 inches. It has grayish-brown fur and is the only bat in its range with unicolored dorsal hairs. The fur is usually gray in color, but may be chestnut brown or russet. Other bats within its range have bi-colored or tri-colored dorsal hairs. The wing membrane of the gray bat connects at the ankle instead of the base of the first toe as in other members of the genus. Total lengths for this species range from 80-105mm, forearm lengths range from 40-46mm, ear lengths range from 14-16mm, and wingspread is 275-300mm.

2. Distribution of Species. The distribution of this species is limited to areas of the Southeastern United States containing limestone caves. Major populations are located in Alabama, Arkansas, Kentucky, Missouri, and Tennessee. In Oklahoma, this species occurs in four counties in northeastern Oklahoma and include Adair, Cherokee, Delaware, and Ottawa. In Arkansas, it occurs in at least 16 counties, but only Pope County is within the proposed action area. In Oklahoma, Cherokee County is the only county within the proposed action area. Portions of Tenkiller Ferry Lake, Fort Gibson Lake, Grand Lake, and Markham Ferry Lake are located within the range of this species and probably contain suitable habitat for this species. However, Grand Lake and Markham Ferry Lake were constructed and operated by the Grand River Dam Authority and are outside the purview of this BA.

USACE personnel responsible for inspection of the dams and associated structures were surveyed about the occurrence of bats for all the projects associated with the proposed action areas. In Oklahoma, bats were reported to occur at only Keystone and Tenkiller lakes. The replies from the projects surveyed in Arkansas along the MCKARNS were negative with one exception. A single pipistrelle sp. was found at the Dardanelle Powerhouse.

3. Habitat. This species roosts almost exclusively in caves year-round and has very specific requirements. However, there are some reports of colonies using storm sewers and mines as roosts. Winter caves must be cold, deep, and with vertical walls. This species is very temperature sensitive, and winter roosts must range in temperature between 42 ºF and 52 ºF. Summer caves must be warm (57 ºF-77 ºF) or contain tightly restricted rooms that can trap the body heat of roosting bats. Summer caves are usually located close to rivers and lake shorelines near feeding areas. Bats are known to range up to 12 miles from their colonies to feed.

The only habitat containing suitable limestone caves for this species within the action areas for Oklahoma, and within the range of this species, include the shoreline areas around Grand Lake, Markham Ferry Lake, Tenkiller Ferry Lake, and Fort Gibson Lake. In Arkansas, the only county where this species has been reported is for Pope County. The occurrence of the gray bat in Pope County is probably more in association with the Ozark National Forest in the northern part of the county rather than the southern part of the county and the MCKARNS.

Very little, if any, suitable habitat containing caves is present for this species within the proposed action areas. Due to the feeding range and foraging habits of this species it could use the shorelines of the MCKARNS and associated lakes for feeding areas.

4. Cause of Decline. In the early 1960's, the population for this species was thought to be over 3 million, but by the 1980's it declined in abundance to approximately 1.5 million. The primary reasons for decline of this species are considered to be human disturbances of hibernacula and maternity caves, poisoning from pesticides, loss of habitat due to construction of impoundments, and commercialization of caves.

5. **Status of Species.** The gray bat was listed as Endangered by the USFWS on April 28, 1976 (41 FR 17740). No critical habitat was listed for this species. Since 1991, the range-wide population appears stable due to protection efforts.

C. Indiana Bat.

1. **Description of Species.** The Indiana bat (*Myotis sodalis*) is a medium-sized bat with a dull gray to chestnut colored fur dorsally, and pinkish white underparts. The basal portion of the hairs of the back is a dull gray color. The total length of the species ranges from 75-102mm, tail length 27-44mm, and a wingspread of 240-267mm. Approximately 500,000 individuals of this species still exist.

2. **Distribution of Species.** The Indiana bat is found primarily in the midwestern and eastern United States and has been reported from 23 states. The largest populations are in Arkansas, Indiana, Kentucky, Missouri, and Tennessee. Eastern Oklahoma represents the western limit of its range. Its present range in Oklahoma includes Adair, Delaware, LeFlore, and Pushmataha counties. In Arkansas it is listed to occur in nine counties, but none are within the proposed action areas. In Oklahoma, LeFlore County is the only county within a designated action area. Portions of Grand Lake and Markham Ferry Lake are located within the range of this species and probably contain suitable habitat for this species. However, these reservoirs were constructed and operated by the Grand River Dam Authority and are outside the purview of this BA.

USACE personnel responsible for inspection of the dams and associated structures were surveyed about the occurrence of bats for all the projects associated with the proposed action areas. In Oklahoma, bats were reported to occur at only Keystone, Eufaula, and Tenkiller lakes. The replies from the projects surveyed in Arkansas along the MCKARNS were negative with one exception. A single pipistrelle sp. was found at the Dardanelle Powerhouse.

This species is migratory with approximately 87% of the entire known population hibernating in just seven caves. If the Indiana bat utilizes any of the proposed action area, it would probably be as a summer resident. After the winter hibernation period, the colonies would disperse to summer areas, which are usually located along streams where the bats forage for flying insects.

3. **Habitat.** Habitat requirements are similar to the gray bat in that they need limestone caves for hibernation, and caves with pools are preferred. They require stable temperatures from 39 ºF to 46 º F and 66 to 95% humidity. Because of these requirements, this species is highly selective of hibernacula. Low cave temperatures allow the bats to maintain a low metabolic rate throughout hibernation. Consequently, only a small percentage of caves meet the specific conditions required by Indiana bats. Maternity sites are in trees. During the summer months, they can be found under bridges, in old buildings, under tree bark, or in hollow trees generally associated with streams.

4. **Cause of Decline.** The primary reasons for decline of this species are considered to be commercialization of roosting caves, disturbances of hibernacula caves from spelunkers or vandals, poisoning from pesticides, and loss of habitat due to channelization of streams.

5. **Status of Species.** The Indiana bat was listed as Endangered by the USFWS on March 11, 1967 (32 FR 4001). Critical habitat was designated for this species and consists of a few caves located in Tennessee and Kentucky.

D. Ozark Big-eared Bat.

1. **Description of Species.** The Ozark big-eared bat (*Corynorhinus townsendii*) is a medium-sized bat with forearms measuring 39-48mm long and weighing 7 to 12 grams. It has very large ears (over 1 inch) that connect at the base across the forehead. The snout has prominent lumps with fur that ranges in color from light to dark brown.

2. **Distribution of Species.** Historically this species was known from Oklahoma, Arkansas, and Missouri. It is believed to have been extirpated from Missouri. In Arkansas it is known primarily from Marion and Washington counties, but records exist for Franklin and Crawford counties, which are within the proposed action areas. The recovery plan for the species lists it as possibly occurring in Pope and Johnson counties as well. In Arkansas, only four caves are presently known to be regularly used by this species. None are within the proposed action area, although one possible use cave was listed for Crawford County. The Arkansas population is estimated to be 600 individuals while the Oklahoma population is estimated to range between 1,000-1,600 individuals, which are located in Adair County. In Oklahoma, Cherokee County is the only county where this species has been recorded that is within the proposed action area. Historically, it was found in Sequoyah, but it does not occur there presently. All the known caves currently used by this species in Oklahoma are located in either Adair or Delaware counties, which are not in the proposed action areas. Portions of Grand Lake and Markham Ferry Lake are located within the range of this species and probably contain suitable habitat for this species. However, these reservoirs were constructed and operated by the Grand River Dam Authority and are outside the purview of this BA.

USACE personnel responsible for inspection of the dams and associated structures were surveyed about the occurrence of bats for all the projects associated with the proposed action areas. In Oklahoma, bats were reported to occur at only Keystone, Eufaula, and Tenkiller lakes. The replies from the projects surveyed in Arkansas along the MCKARNS were negative with one exception. A single pipistrelle sp. was found at the Dardenelle Powerhouse.

3. **Habitat.** The Ozark big-eared bat is found in caves, cliffs, and rock ledges associated with oak-hickory forests of the Ozarks. They forage along the edges of upland forests for insects (primarily moths). Edge habitat between forested and open areas is the preferred foraging area. The temperature of hibernacula ranges from 40 ºF to 50 ºF, and maternity caves range from 50 ºF to 59 ºF. This species does not migrate and probably has a range of less than 20 miles. They have an affinity to return year after year to the same maternity sites and hibernacula.

4. **Cause of Decline.** The primary reasons for decline of this species are considered to be disturbance and vandalism of caves and roost sites and possibly predation at cave entrances. It was listed as endangered because of its small population size, reduced distribution, and vulnerability to human disturbance.

5. **Status of Species**. The Ozark big-eared bat was listed as endangered under the Endangered Species Act of 1973, as amended on November 30, 1979 (Federal Register, Vol.44, No. 232). No critical habitat was designated for this species.

E. American Burying Beetle.

1. **Description of Species**. The American burying beetle *(Nicrophorus americanus)* is the largest species of its genus in North America measuring 25-35 millimeters (mm) in length (Peck and Anderson, 1985). It has a shiny black body with smooth and shiny black elytra with bright orange-red markings. The antennae are large, abruptly clubbed, and orange at the tip. It is a member of the Family Silphidae, which are know as the carrion or burying beetles, due to their behavior of burying vertebrate carcasses which are used for brood chambers for their young.

2. **Distribution of Species.** This species was formerly known from much of eastern North America with its historical range described as being most of temperate eastern North America. Historically, its range included 35 states in the eastern and central United States and the southern edges of Canada. The easternmost record for the species is from Nova Scotia in Canada and the westernmost record is from central Montana. The northernmost record is from the upper peninsula of Michigan and the southernmost record is from Kingsville, Texas. More recently (since 1970), it has been documented from Arkansas, Kansas, Kentucky, Missouri, Nebraska, Oklahoma, and Rhode Island. Presently, the current distribution encompasses seven states including Nebraska, Kansas, Arkansas, Rhode Island, Massachusetts, South Dakota, and Oklahoma.

In Oklahoma, this species was originally thought to occur in only Latimer, Cherokee, Muskogee, and Sequoyah counties. More recently, it has been discovered in 17 counties in Oklahoma (Figure 8) including Bryan, Choctaw, Atoka, Coal, Johnston, Pontotoc, Cherokee, Haskell, Latimer, LeFlore, McCurtain, Muskogee, Okfuskee, Pittsburg, Pushmataha, Sequoyah, and Tulsa (USFWS, 2003).

Existing populations in Arkansas are limited to five counties in the western part of the state. Most of these occurrences are from Federal lands, such as Fort Chaffee and the Ouachita National Forest. Within the proposed action area they occur in Sebastian, Logan, and Franklin counties (Arkansas National Historic Commission, 2003).

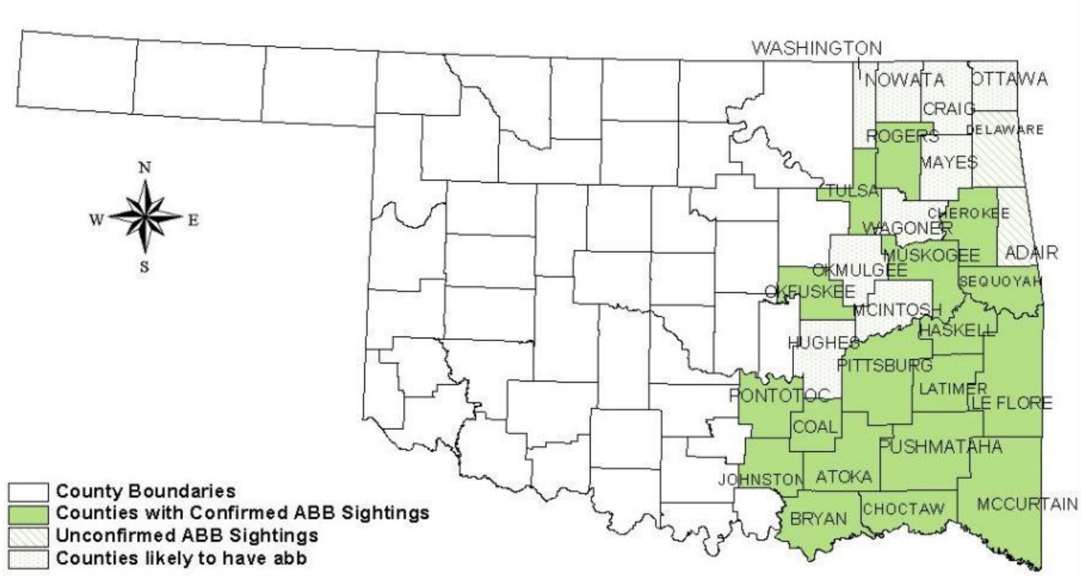


Figure 8. Distribution of American Burying Beetle in Oklahoma.
Source: Nature Serve, 2003, http://www.natureserve.org/explorer

The most stable populations occur in Arkansas, Oklahoma, and Rhode Island. In Latimer County, Oklahoma, the populations are found on private holdings. The Muskogee and Cherokee counties population occurs primarily on Federal lands licensed to the Oklahoma Army National Guard and the Oklahoma Department of Wildlife Conservation. The Arkansas populations occur on Federal lands including the Fort Chaffee Military Reservation, the Ozark National Forest, and the Ouachita National Forest. Given the mobility of this species, it is likely these represent a single population of this species.

The USACE has conducted surveys for *N. Americanus* on several projects with negative results. Surveys have been conducted at selected areas at Keystone Lake, along Mingo and Fry creeks, Hugo Lake, Wister Lake, Fall River Lake, and Robert S. Kerr Lake. However, these surveys were completed for small areas where minor construction activities were proposed and did not include a survey of the entire project.

3. **Habitat**. Very little information on the historical collection habitat of *N. americanus* exists. Walker (1957) provides the earliest published description of *N. americanus* as follows:

> " A park-like stand of large deciduous trees with little shrub layer and few small trees. Six species were prominent in the canopy--*Quercus falcate, Quercus alba, Liquidambar styraciflua, Carya ovata, Nyssa sylvatica,* and *Liriodendron tulipifera.* Hornbeam (*Carpinus caroliniana*) formed a relatively continuous tree understory, even predominating over canopy species in basal area (about 20%) and in number of stems (about 45%). There was no evidence of lumbering. Grasses and sedges were markedly dominant in the sparse ground cover."

In Oklahoma, the habitat types where populations have been documented to occur vary from deciduous and coniferous forests to open pasture. The topography includes slopes, ridge tops and flat grasslands. In Arkansas where they are found, it is primarily open grasslands and is very similar to habitat in Oklahoma. The population in Rhode Island is found in habitat consisting of maritime shrub thickets, coastal marine grassland, and agricultural pastures (Kozol et al., 1989). In Nebraska, they have been collected from predominantly riparian deciduous forests or scrub forests along water courses (Ratcliffe et.al., 1992).

The Oklahoma Natural Heritage Inventory performed surveys in a large area of western Cherokee and eastern Muskogee counties, Oklahoma. Three different habitat types were surveyed, oak-hickory forest (second and third growth), grassland, and bottomland hardwood forest. Slightly more individuals were collected in grasslands than in oak-hickory forests and fewer still were captured in the bottomland forest. Analysis of habitat distribution data from two locations - one in Arkansas and the other in Oklahoma - indicated that the species is a "habitat generalist, " meaning that it is found in all types of habitats with only a very slight preference (Lomolino, 1993).

With the wide distributional pattern of the species with respect to habitat types, it does not appear likely that vegetation and soil type are limiting factors. It has been collected from mature virgin forests, open pastureland, and grasslands. While certain types of soil conditions are not suitable for carcass burial (such as very xeric, saturated, or loose sandy soils), the availability of appropriate carrion appears to be more of a limiting factor (Raithel, 1991).

4. Cause of Decline. Once widely distributed throughout eastern North America, this species has disappeared from most of its former range. At the time of listing, it was reported to occur in only three geographic areas: (1) on a small island off the New England Coast; (2) at two locations in Nebraska; and (3) at several locations in western Arkansas and eastern Oklahoma. The reasons for this decline are not known. Several theories exist concerning possible reasons for decline of this species. Some of the more widely accepted reasons include: (1) direct habitat destruction, (2) DDT and other organochlorine pesticides, (3) predation or species-specific disease, (4) interspecific *Nicrophorus* competition, (5) outdoor lighting, (6) habitat fragmentation, and (7) and changes in vertebrate species composition and density.

5. Status of Species. The American burying beetle, *Nicrophorus americanus,* was Federally listed as endangered on July 13, 1989, 50 CFR (Federal Register 54, No 29652-133.5). No critical habitat was designated for this species.

F. Whooping Crane.

1. Description of Species. The whooping crane, *Grus americana,* is a tall snowy white bird with a long neck and legs. It has red facial skin, a black wedge shaped patch on the neck, and black primaries, which are visible during flight. It is the tallest bird in North America. It can reach a height of 45 inches and has a wingspan of up to 90 inches.

2. Distribution of Species. The historical range of this species extended from the Arctic coast to central Mexico, and from Utah east to New Jersey, South Carolina, Georgia, and Florida (USFWS, 1992). Presently, only three wild populations of this species remain. The only self-sustaining population nests in Alberta, Canada, primarily in the Woods Buffalo National

Park and winters along the Gulf of Mexico on the Arkansas National Wildlife Refuge (NWR). This population migrates through Oklahoma during the spring and fall. Two smaller populations have been reintroduced to the wild, and are located in Florida and southeastern Idaho. These are referred to as the Florida and the Rocky Mountain populations.

Within the proposed action areas, the whooping crane would be considered a possible migrant. Most sightings in Oklahoma have been from the north-central to southwestern part of the state, well west of the project areas. Most sightings are associated with the Great Salt Plains National Wildlife Refuge in Alfalfa and Grant counties, Oklahoma, and the upper Red River in southwestern Oklahoma and Texas. However, there are some observations from Muskogee, Wagoner and Rogers counties, Oklahoma. The historical populations occurring in Arkansas are assumed to have been extirpated (USFWS, 2003).

3. **Habitat.** The nesting grounds for whooping cranes are located in poorly drained prairie areas interspersed with numerous potholes and wetlands of the Northwest Territories in Canada. The nest sites are located in emergent vegetation along the edges of marshes, potholes, or lakes. During migration, whooping cranes use a variety of habitats including croplands for feeding and isolated riverine wetlands for roosting. The wintering grounds include areas of salt flats, tidal marshes and flats, and shallow bays along the Texas Gulf Coast and the Arkansas NWR.

During the summer months, the whooping cranes feed on insects, crustaceans, and berries. Their winter diet consists of grains, insects, crustaceans, mollusks, fishes, reptiles, and marine worms (USFWS, 1980).

4. **Cause of Decline**. The listed causes for decline of this species include loss of habitat due to agricultural, human disturbance of nesting areas, and uncontrolled hunting. Collision with power lines became the major cause of death after hunting was curtailed (USFWS, 2003). Delayed sexual maturity, small clutch size, and low recruitment impact recovery of this species.

5. **Status of Species**. The whooping crane was determined to be endangered by the USFWS in accordance with the Endangered Species Act of 1973, as amended on March 11, 1967 (32 FR 4001). Critical Habitat was designated for this species on May 15, 1978 (43 FR 20938). The only critical habitat listed for this species close to the proposed action area is an area of land, water, and air space in Alfalfa County, Oklahoma. Additional critical habitat was proposed for this species, but was withdrawn on March 16, 1979 (FR Vol. 44, No. 45, 4310).

On June 2, 1970 (FR 8495), the whooping crane was designated as Experimental Population, Non-Essential in the USA (AL, AR, GA, IL, IN, IA, KY, LA, MI, MN, MS, MO, NC, OH, SC, TN, VA, WI, WV). On January 22, 1993, it was designated as Experimental Population, Non-Essential in the U.S.A. for Colorado, Idaho, Florida, New Mexico, Utah, and the western half of Wyoming).

The total population of whooping cranes is small and has not increased dramatically since listing. In 1989, the total population was reported to be 138 individuals. This number increased to 200 individuals being reported in 1990. By 1996, the total population was reported to number 260, composed of 96 captives and 163 in the wild (USFWS, 2003).

Within the proposed action areas, this species would be considered a rare migrant along the western edge of the MCKARNS that occurs within Muskogee, Tulsa, and Rogers counties, Oklahoma. It would not be expected to occur in Arkansas.

G. Bald Eagle.

1. <u>Description of Species</u>. The bald eagle (*Haliaeetus leucocephalus*) is the only species of sea eagle native to North America. Adults are black with a snow-white head and tail. Sub adults are mottled brown and black and lack the distinctive white head and tail. Wingspan is 6 to 7 feet with females weighing between 10-14 lbs and males weighing between 8-10 lbs.

2. <u>Distribution of Species</u>. Bald eagles winter throughout the United States but are most abundant in the West and Midwest. Within the project area (Oklahoma and Arkansas), they winter around reservoirs and along major river systems. In winter, it is common for bald eagles to congregate in communal roosting sites that are generally close to water and afford protection from inclement weather and human disturbance. At Keystone Lake, Oklahoma, eagles have used a communal roost during the winter and spring (November-March) in a protected cover area for the last 20 years and are commonly seen fishing along the Arkansas River downstream of Keystone Dam during daylight hours. Annual mid-winter eagle surveys for Oklahoma are shown in Figure 9.

Bald eagles are long-lived birds and are believed to mate for life. The oldest known specimen was reported to be 28 years old (Schempf, 1997). At Eufaula Lake, Oklahoma, one pair of eagles have nested several consecutive years in a tree located within a public use area on the lake, but typically nesting within the project area is usually associated with the more remote sections of large rivers above and below impoundments. Nesting is known to occur on the Arkansas River below Kaw Dam and Keystone Dam and along the Canadian River below

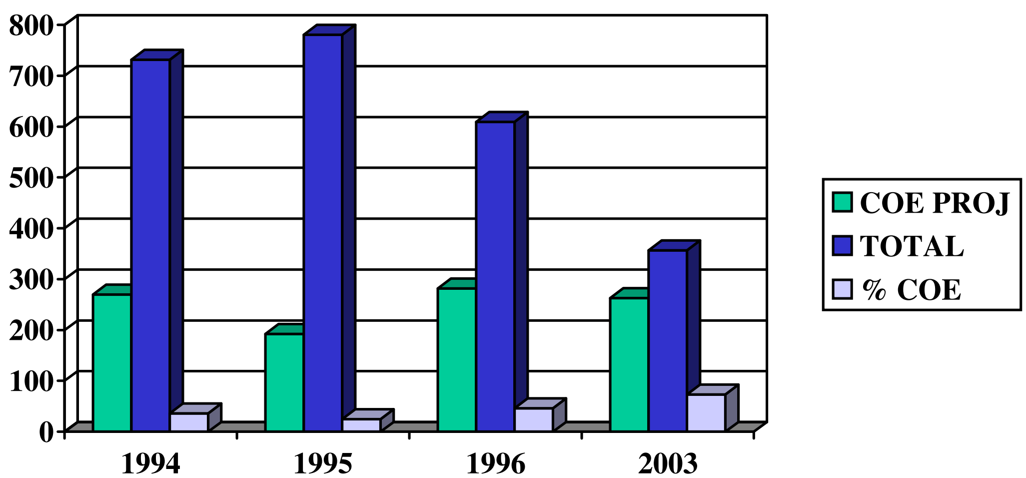
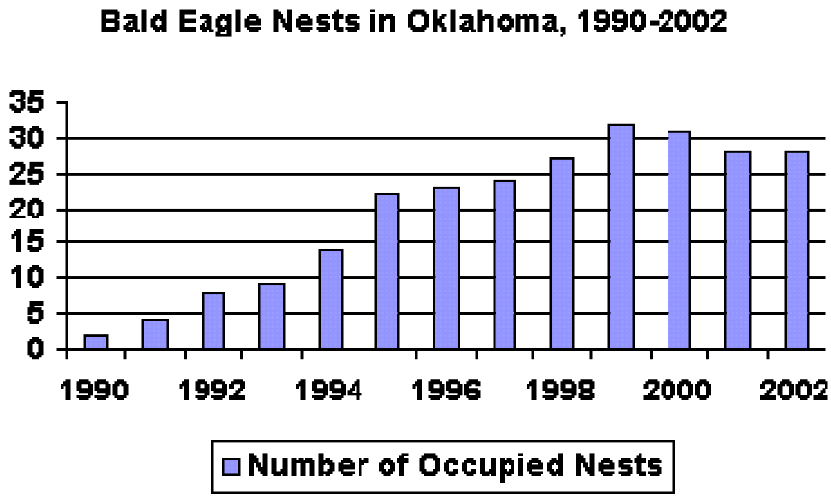


Figure 9. Midwinter Bald Eagle Surveys for Oklahoma.

Eufaula Lake. USACE and USFWS personnel conducting surveys for nesting Interior least terns have reported numerous sightings of eagle nests, immature eagles, and adults along these rivers between June and August.



Source: Sutton Avian Research Center, 2003

3. **Habitat**. The bald eagle is found throughout North America and winters near large rivers and reservoirs across this region. Their diet is mainly fish, but bald eagles are opportunistic and may feed on carrion, waterfowl, or other prey species. They typically nest in trees near water. Eagles utilize mature trees, especially cottonwoods, along rivers and lakes for nesting, roosting, and perching.

4. **Cause of Decline.** During the early part of the 19th century, bald eagle numbers were greatly reduced. These declines are attributed to loss of habitat, poisoning, trapping, and shooting. Mortality from poisoning, trapping, and shooting has been substantially reduced through protection efforts and legislation. However, loss of habitat from land development activities and encroachment on river floodplains still continues.

An as great or greater threat to the bald eagle was the use of the pesticide Dichloro diphenyl trichloroethane (DDT), which came into widespread use after World War II. This pesticide was used extensively along coastal and other wetland areas to control mosquitoes (Carson, 1962) and quickly entered the food chain. Eagles would catch and ingest fish or other prey species associated with the aquatic environment containing DDT and fail to reproduce successful. Ingestion of DDT resulted in eggshell thinning and/or embryonic mortality and the population plummeted. The use of DDT was subsequently banned in 1972, and by 1976 other pesticides such as dieldrin, heptachlor, and chlordane, were also restricted. Consequently, eagle numbers have increased significantly.

5. **Status of Species.** The bald eagle was Federally listed as endangered under the Endangered Species Act of 1966 on March 11, 1967, 50 CFR (Federal Register 32, 4001). No critical habitat was designated for this species. On February 14, 1978, 50 CFR (43 Federal

Register 6233), the species was listed as endangered in 43 states except Washington, Oregon, Minnesota, Wisconsin, and Michigan, where it was listed as threatened. On July 12, 1995, 50 CFR (60 Federal Register 36000), the eagle was reclassified as threatened in all 48 conterminous states. The USFWS has proposed to remove this species from the List of Endangered and Threatened Wildlife in the lower 48 states of the United States, 50 CFR (64 Federal Register 36454, July 6, 1999, Proposed Rules). However, until the delisting process has been completed, the protection afforded under the Endangered Species Act and requirements for consultation are still required. Bald eagles declined in numbers due to pesticide-induced reproductive failure, loss of riparian habitat, and human disturbances such as shooting, poisoning, and trapping. More recently, its numbers have recovered due to habitat protection and management actions initiated under the EAS and a reduction in levels of persistent organ chlorine pesticides such as DDT.

In 1963, there were an estimated 487 nesting pairs of bald eagles. This number has substantially increased with the 1992 nationwide midwinter survey for bald eagles reporting approximately 16,000 bald eagles. The 1993 midwinter survey reported even greater numbers with approximately 12,000 birds. By 1998, due to recovery efforts of the USFWS, eagle numbers had increased to approximately 6,000 nesting pairs that produced approximately 7,000 young.

As proposed by the USFWS, bald eagle populations have recovered to the point that they are being delisted from the threatened and endangered species list. The midwinter bald eagle surveys conducted in Oklahoma for 1994-1996 and 2003 show bald eagles counts have varied from 357 to 732 sightings (Figure 9). For the same years, counts occurring in concert with USACE operating projects have varied from 25% to 73%, which indicates wintering populations of bald eagles are closely associated with USACE projects. Other sightings during the survey found eagles at non-USACE projects and on major rivers. Large numbers of eagles were found on two reaches of the Arkansas River. The midwinter counts for Arkansas River Reach 1 vary from a low of 96 in 1989 to a high of 297 in 1986. For 1990, 1991, and 1993, the counts were 236, 242, and 244, respectively. For Arkansas River Reach 2, the counts are somewhat lower and ranged from a low of 32 in 1993 to a high of 138 in 1994.

Bald eagles also extensively use the lower part of the MCKARNS as shown in Figure 10. Midwinter bald eagle counts found birds at Pools 1-6, Toad Suck Ferry, Pools 7 and 8, Lake Dardanelle, and Pool 9. The heaviest use appears to be associated with Lake Dardanelle where numbers have ranged from a low of 51 to a high of 246. Significant numbers also occur in association with the White River National Wildlife Refuge.

Between 1984 and 1992, the Sutton Avian Research Center (SARC) raised and released 275 bald eagles in the southeastern U.S. Aerial and ground surveys in the vicinity of Oklahoma release sites show that the number of bald eagle nests in Oklahoma has increased annually. Those increases are as follows: 1990 (2), 1991 (4), 1992 (8), 1993 (9), 1994 (14), 1995 (22), 1986 (23), 1997 (24), 1998 (27), 1999 (32), and 2000 (31) (Sutton Avian Research Center, 2003). The exact location of these nests was not available for dissemination, but the reported nesting sites tripled the recovery plan goal for Oklahoma (10 nests).

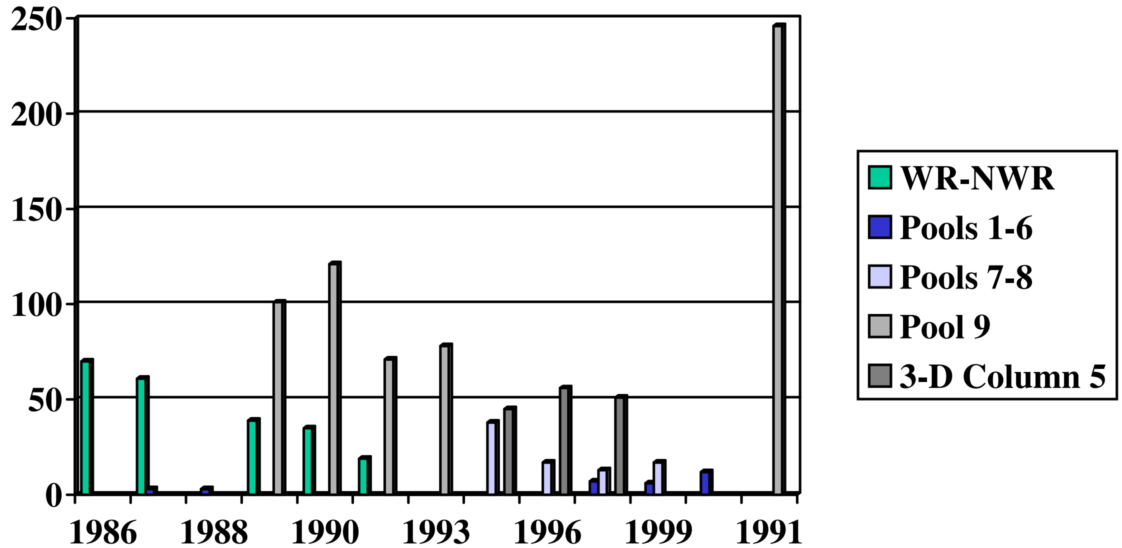


Figure 10. Midwinter Bald Eagle Counts for the Lower MCKARNS.

Representatives from the USACE and the USFWS have made numerous sightings of adult bald eagles, immature bald eagles, and nests along the Arkansas River below Kaw Dam to Keystone Lake; along the Arkansas River from Keystone Dam to Muskogee; and along the Canadian River from below Eufaula Dam to the MCKARNS. USACE personnel have not conducted eagle surveys on the Red River below Denison Dam, but it is highly probable they exist along the Red River as well. From the information obtained from the SARC, it is not known if nesting eagles have been recorded along the Red River. However, data from the midwinter bald eagle surveys indicate that eagles winter around Lake Texoma. Numbers have varied from a low of 19 in 1994 to a high of 52 reported in 1995. For this assessment, bald eagles will be considered to occur on all USACE projects associated with all the proposed actions, and nesting bald eagles will be considered to occur on all the proposed action areas for the Arkansas and Canadian River system within the action area described for the Red River below Lake Texoma to Index, Arkansas.

Trend data for the midwinter bald eagle counts from 1986-2000 show a positive trend for numbers of eagles for both Oklahoma and Arkansas. Based upon data for 12 routes and 86 surveys from 1986-2000, the trend is +0.3% for Arkansas and +0.9% for Oklahoma based on 30 routes and 277 surveys (http://ocid.nacse.org/qml/nbii/eagles/sumtrend.html).

H. Pink Mucket Pearly Mussel.

1. <u>Description of Species</u>. The pink mucket pearly mussel, *Lampsilis abrupta*, as described by Cummings (1992) has a shell that is rounded to elliptical, solid, and inflated. The anterior end is rounded and the posterior end is bluntly pointed in males. The shell is smooth and yellow to yellowish green in color with faint green rays. It can attain a length up to 4inches.

2. **Distribution of Species**. Its distribution includes the lower Mississippi and Ohio rivers and their larger tributaries. Historically, this species was found in 13 states and from 25 rivers and tributaries of the eastern United States and ranged from Missouri and Arkansas eastward to Pennsylvania and Virginia. It was scattered throughout the Mississippi, Tennessee, Ohio, and Cumberland River systems.

This species does not occur in Oklahoma, but is listed to occur in Arkansas County from the lower White River. The USFWS Recovery Plan for this species lists it as occurring in only the upper reaches of the Black River and Spring River of northeast Arkansas (USFWS, 1985). However, Harris (2003) reported that it had been collected as far downstream as Clarendon, Arkansas, on the White River. Harris et al. (1997) shows that it has been collected from 21 locations on the White River, most are from the middle and upper reaches of the White River and none are close to its confluence with the MCKARNS.

3. **Habitat.** The pink mucket is associated with riffle areas of large river systems within sand or gravel substrates and strong currents. It has been reported to survive and reproduce in river-lake conditions, but never in standing pools of water (USFWS, 1985).

4. **Cause of Decline**. The causes for decline of the species include modification of habitat (construction of dams and dredging), degradation of water quality, and over harvest by the commercial mussel industry.

5. **Status of Species**. The USFWS determined the pink pearly mucket mussel to be endangered in accordance with the Endangered Species Act of 1973, as amended on June 14, 1976 (Federal Register 41 (115) 24062-24067). Critical habitat was not determined for this species. This species has never been collected in large numbers from any one site or drainage (USFWS, 1985). Historically, it was found in 25 rivers and tributaries, but by 1990 its range had been restricted to only 16 rivers and tributaries (Matthews and Moseley, 1990). It is unlikely that this species occurs in the lower White River within the proposed action area.

I. Scaleshell Mussel.

1. **Description of Species**. The scaleshell mussel, *Leptodea leptodon*, is a thin delicately shelled species with an oblong rhomboidal shaped shell and can attain a length up to 4 inches. The dorsal margin is slightly rounded and the ventral margin is broadly rounded. Both the anterior and posterior ends are sharply rounded. Growth-rest lines sometimes produce heavily pigmented lines, usually seen as very fine concentric ridges and grooves. The epidermis is olive-colored with fine wavy rays.

2. **Distribution of Species.** The scaleshell is considered to be rare wherever it is found (Oesch, 1984). Historically, it was found in 55 streams in 13 states throughout the eastern United States. Presently, it is found in 13 streams in Arkansas Missouri, Oklahoma, Minnesota, Nebraska, and South Dakota.

In Oklahoma, this species is associated primarily with the Red River Basin in southeastern Oklahoma. It has been reported to occur in the Kiamichi, Mountain Fork, and

Lower Little Rivers; and from the Poteau River, a tributary to the Arkansas River (USFWS, 2003b). The final rule listing this species (USFWS, 2001) reported it as occurring in the Poteau River based upon a single specimen, but states that the existence of the scaleshell in the Poteau River is doubtful.

Within the State of Arkansas, this species is reported to occur in seven counties including Crawford, Fulton, Jackson, Lawrence, Perry, Sevier, and Francis (USFWS, 2003b). The USFWS final rule listing this species reports this species as having been collected from Frog Bayou, the South Fourche LaFave, and the Mulberry rivers in Arkansas. Perry and Crawford counties are within the proposed action areas. The record (s) for Perry County are associated with the Fourche LaFave River, which is a tributary to the MCKARNS at navigation mile 146.5, and Frog Bayou which is a tributary to the MCKARNS at navigation mile 277. Potential habitat for this species in Frog Bayou is restricted to the area between the town of Rudy and the MCKARNS (USFWS, 2001). Live mussels have not been found at the confluence of the Arkansas River likely due to dredging activities (Gordon, 1980).

The only scaleshell mussel record from the South Fourche LaFave River is based on a single live specimen taken in 1991 (USFWS, 2001). The occurrence of the scaleshell mussel in the Mulberry River is based upon a single specimen (USFWS, 2001), and the USFWS believes its existence in the Mulberry River is unlikely. There are no records of this species occurring in the Arkansas River (Arkansas Natural Historical Commission, 2003).

3. **Habitat**. This species inhabits larger creeks and small to medium size rivers. Oesch (1984) has described its habitat as occurring in riffles with moderate to high gradients in creeks to large rivers. It is been reported to occur in riffle areas having relatively strong currents and a substrate consisting of gravel, cobble, boulders, and occasionally mud or sand. It is restricted to rivers with good water quality (Oesch, 1995).

4. **Cause of Decline**. The primary reasons for decline of this species are listed as present or threatened destruction, modification, or curtailment of its habitat or range; over utilization for commercial, recreational, scientific, or educational purposes; disease; and predation.

5. **Status of Species.** The USFWS determined this species to be endangered over its entire range in accordance with the Endangered Species Act of 1973, as amended on October 9, 2001 (Federal Register Volume 66, No. 195). No critical habitat was determined for this species. This is a rare mussel species wherever it is found. The (USFWS, 1999) reports that in mussel surveys conducted since 1980, it has never comprised more than 0.4% of the mussels collected. Of the 13 remaining populations of scaleshell mussels, three are thought to be stable, two are declining, four are thought to be in decline, and the status of the fourth is not known (USFWS, 1999). It is unlikely this species occurs in the MCKARNS.

J. Piping Plover.

1. **Description of Species**. The piping plover, *Charadrius melodus,* is a small shorebird approximately 7 inches in length with a wingspan of approximately 15 inches and weights from 1.5 to 2 ounces. It is sand-colored on the back with white undersides. It is distinguished from similar species by its bright orange legs. During the breeding season, the plover has a single black band across its breast and forehead, which are absent during the winter.

2. **Distribution of Species.** The historical breeding range of the piping plover in North America included the Atlantic coastal beaches from Newfoundland to South Carolina; beaches of the Great Lakes; and the northern Great Plains region from Alberta to Ontario and south to Nebraska (USFWS, 1988). These populations were generally reported to winter along the Gulf of Mexico, the Atlantic coast from North Carolina to Florida, eastern Mexico, and in the Caribbean Islands (Haig and Oring, 1985). This species is not reported to occur in Arkansas.

The population potentially occurring within the proposed action areas is the northern Great Plains population. It is primarily a transient migrant throughout the project area utilizing larger rivers, reservoir beaches, and mudflats. It has been recorded to nest on the Salt Plains National Wildlife Refuge in western Oklahoma. It has also been reported to use mudflats in the upper reaches of Oologah Lake during migration periods.

3. **Habitat.** Piping plover breeding habitat is comprised of open, sparsely vegetated areas with alkali or unconsolidated substrate (USFWS, 2000). They have been reported to nest on rangeland consisting of mid- or short-grass prairies. On rivers they nest in association with beaches, sand flats, dredge islands, and drained river floodplains where vegetative cover is usually less than 20% (Haig, 1986; Schwalbach, 1988). During migration periods, they use beaches and alkali flats. They feed mainly on freshwater, marine, and terrestrial invertebrates.

4. **Cause of Decline**. The primary causes for decline of this species are listed as habitat loss and degradation and human disturbance. Loss of breeding habitat has resulted from recreation and commercial development of sandy beaches on the Great Lakes, Atlantic Coast, and Gulf of Mexico. Where breeding does occur on coastal beaches, inland lakes, and river sites, reproductive success has been reduced by disturbance from humans and pets. Additional habitat has been lost due to construction and operation of reservoirs and river channelization.

5. **Status of Species.** The USFWS determined the piping plover to be endangered and threatened in accordance with the Endangered Species Act of 1973, as amended, on December 11, 1985 (Federal Register Volume 50, No. 238). Endangered status was determined for the plover in the watershed of the Great Lakes (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, and Ontario). It was determined to be threatened in the remainder of its range: northern Great Plains (Iowa, northwestern Minnesota, Montana, Nebraska, North Dakota, South Dakota, Alberta, Manitoba, and Saskatchewan); Atlantic coast (Quebec, Newfoundland, Maritime Provinces, and states from Maine to Florida); Gulf coast (Florida to Mexico); Bahamas; and West Indies. Critical habitat was not designated for this species.

Population trend data for this species is sparse. In the early 1900's, it was generally considered to be common. Early 20th century accounts report that hunting caused the first known major decline of the piping plover along the Atlantic coast (Brent, 1929; Hall, 1960). With passage of the Migratory Bird Treaty Act in 1918, plover populations recovered only to decline again in the recent times.

Surveys of breeding plovers in the early 1980's reported the Northern Great Plains population to be between 2,137 - 2,684 adult plovers (Haig and Oring, 1985). The 1991 breeding ground surveys estimated 3,467 adults in this population, and 1996 surveys estimated 3,284 adults for the Northern Great Plains Population (Plissner and Haig, 1997).

K. Arkansas River Shiner.

1. __Description of Species__. The Arkansas River shiner (*Notropis girardi)* is a small minnow less than 2 inches in length. It is sandy colored dorsally and silver colored laterally with dorsal scales lightly outlined with dark pigment. A small black chevron is usually present at the base of the tail.

2. **__Distribution of Species__**. Historically its range included western Arkansas, Kansas, Oklahoma, New Mexico, and Texas. It was once widespread throughout the western portion of the Arkansas River Basin in Kansas, New Mexico, Oklahoma, and Texas, but was probably never widespread in Arkansas. A small population may exist in the Cimarron River in Kansas.

A multi-year survey (2000-2002) funded by the USACE and conducted by Texas Tech University for this species on the North Canadian River above Canton Lake to Optima Dam failed to find this species. It is now primarily found in the South Canadian River above Eufaula Lake in Oklahoma to New Mexico. It has become widely established in the Pecos River system in New Mexico through introductions. This species is considered to be extirpated from the State of Arkansas and is no longer present in any of the proposed action areas along the Arkansas River and the MCKARNS.

3. __Habitat__. The preferred habitat is the main channels of large sandy-bottomed rivers and streams. It utilizes the downstream side of sand ridges in the channels where they feed on detritus and invertebrates exposed by the shifting substrate and current. Spawning occurs in July and is thought to be associated with flood events. However, there is some evidence that spawning may occur throughout May, June, and July. The eggs are buoyant and float until hatching. After hatching, the larvae move to backwater side channel areas to mature.

4. __Cause of Decline__. The causes for decline of this species include changes in natural stream flow patterns due to diversion of surface water and excessive groundwater pumping, habitat loss due to construction of impoundments, water quality degradation, competition from introduced species, and incidental capture during commercial harvest of bait fish (USFWS, 1998).

5. __Status of Species__. The USFWS determined the Arkansas River Basin population of the Arkansas River shiner to be a threatened species under the Endangered Species Act of 1973, as amended on November 23, 1998, final rule (Federal Register Volume 63, No. 225). Critical habitat was not originally listed for this species, but on June 30, 2000, the USFWS

(FR 64772) proposed critical habitat for this species. Critical habitat proposed for this species included approximately 1,160 miles of river and 300 feet of their adjacent riparian zones for portions of the Arkansas River in Kansas; the Cimarron River in Kansas and Oklahoma; the Beaver/North Canadian River in Oklahoma; and the Canadian/South Canadian River in New Mexico, Texas, and Oklahoma. None of the critical habitat is within the proposed action areas.

The Arkansas River shiner has disappeared from over 80% of its historical range within the last 35 years, and is restricted to about 500 miles of the Canadian River in Oklahoma, Texas, and New Mexico (USFWS, 1998). A small population may still exist on the Cimarron River in Kansas and Oklahoma. Historically, this species would have occurred throughout the proposed action areas. However, habitat alteration following construction of Kaw and Keystone lakes on the Arkansas River in Oklahoma and construction of the MCKARNS in 1970, the shiner is no longer believed to occur in the Arkansas River in Arkansas, Kansas, and Oklahoma (USFWS, 1998).

L. Pallid Sturgeon.

1. <u>Description of Species</u>. The pallid sturgeon, *Scaphirhynchus albus*, is also known as the white sturgeon. Pallid sturgeon can exceed 6 feet in length and weigh in excess of 80 lbs. They have a flattened, shovel-shaped snout, and a long and completely armored caudal peduncle lacking a spiracle (Smith, 1979). The mouth is positioned on the underside of the snout and is toothless and protractible. It has five rows of scutes that run the entire length of the body. It is similar in appearance and closely related to the shovelnose sturgeon, *Scaphirhynchus platorynchus*, and oftentimes hybridizes with this species.

The pallid sturgeon is a prehistoric fish evolved from an ancient group of bony fishes of the subclass Paleopterygii during the Paleozoic Era. Most species of this subclass became extinct sometime during the Mesozic Era. The living descendants of this group of fish in North America include paddlefish (Polyodontidae) and eight species of sturgeon (Acipenseridae) (USFWS, 1993).

2. <u>Distribution of Species</u>. The pallid sturgeon inhabits large turbid rivers and is endemic to the middle and lower Mississippi River; the Missouri River; and the lower reaches of the Platte, Kansas, and Yellowstone Rivers (Bailey and Cross, 1954). The pallid sturgeon was not described as a species until 1905; consequently, little is known of its historic range and abundance (Pflieger, 1975). Carlson and Pflieger (1981) state that pallid sturgeon are rare, but widely distributed in the Missouri River and in the Mississippi River downstream from the mouth of the Missouri. Since 1980, they have most frequently been reported from the Missouri River. Keenlyne (1989) reports records for the Mississippi River from its mouth upstream to its confluence with the Missouri River, the lower Yazoo/Big Sunflower and St. Francis Rivers, the lower Kansas River, the lower Plate River, and the lower Yellowstone River.

States within or bordering the range of this species includes Montana, North Dakota, South Dakota, Nebraska, Iowa, Kansas, Missouri, Illinois, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana. Within the proposed action areas, only the lower White River and possibly the lower Arkansas River would be included in the range of this species. Only two records are known for Arkansas. One is from the Mississippi River and one is from the St. Francis River in northeastern Arkansas (Robison, 1988). There are no documented collection records of this species from either the White or Arkansas rivers.

The U.S. Army Corps of Engineers Waterways Experiment Station (ERDC) conducted limited sampling (33 samples) of the Arkansas-White River cutoff region for pallid sturgeon in June 2003, but this species was not collected. ERDC collection records on the Mississippi River (1997-2001) show pallid sturgeon have been collected from the Mississippi River between river miles 585-615, which is near the confluences of the Arkansas and White rivers (Personal Communication, Jack Kilgore, 2003).

3. Habitat. The pallid sturgeon is a fish adapted to living on the bottom of large swift, free flowing, and turbid rivers. This species evolved in the diverse constantly changing ecosystem of large river systems and their floodplains such as the Mississippi and Missouri. This system has been greatly altered by construction and operation of reservoirs for flood control, water supply, hydroelectric power, recreation, and locks and dams for navigation. These activities have resulted in the loss of riverine habitat, modification of the natural flow regimes, loss of spawning habitat, reduction in floodplains and associated nutrient input, and loss of shallow water habitat needed for nursery and feeding areas for this species.

4. Cause of Decline. The reasons for decline of this include habitat modification (construction of large dams, and channelization), commercial exploitation, pollution, and hybridization with shovelnose sturgeon (USFWS, 2003a).

5. Status of Species. The USFWS determined the pallid sturgeon to be endangered in accordance with the Endangered Species of 1973, as amended, on September 6, 1990 (55 FR 3661). This species has been reported as rare throughout its range, but numbers have declined dramatically within the last two decades. Reproduction within the Missouri River is very low and this population is being supplemented with hatchery-propagated fish. While this species has not been recorded from the proposed action area, its possible occurrence (at least at times) in the lower White or Arkansas rivers cannot be discounted.

M. Interior Least Tern.

1. Description of Species. A detailed description and discussion of this species and life history requirements can be found in the previous biological assessment for the lower Red River dated May 2001 and provided in Appendix 1. Least terns are the smallest members of the tern family and are about the size of a cardinal. They have a grayish back and wings and snowy white undersides. They can be distinguished from all other terns by their combination of a black crown, white forehead, and a black tipped bill.

Currently, there are three U.S. subspecies of *Sterna antillarum.* The Interior least tern, *Sterna antillarum athalassos,* breeds along the major tributaries of the Mississippi River Drainage and the Rio Grande. The California subspecies *(S. a. browni)* breeds from San Francisco Bay to Southern Baja, California. The eastern least tern *(S.a. antillarum)* breeds along the Atlantic-Gulf Coast from the southern tip of Texas to southern Maine. However, the three subspecies are identical in appearance, morphology, habitat use characteristics, vocalizations, and behavior. Electrophoretic analysis of coastal versus interior subspecies revealed no genetic differences in Texas populations. Only their breeding ranges distinguish them. Because of the taxonomic uncertainty, the USFWS chose to list those populations of least terns currently occurring in the interior of the U.S. (Sidle and Harrison, 1990). The breeding range of Interior least terns is from Montana to Texas and from eastern New Mexico and Colorado to Indiana and Louisiana, mainly on interior rivers.

2. <u>Distribution of Species</u>. Interior least terns are migratory birds with an inland distribution along major river systems in the interior U.S. Historically, Interior least terns were distributed over the entire Great Plains between the Mississippi River and the Rocky Mountains (Figure 11). The range extended northward to Montana, south to Texas, west to New Mexico and eastern Colorado, and east to Indiana (Sidle and Harrison, 1990).

In recent years, the breeding range of Interior least tern has decreased dramatically (Figure 12). They are no longer breeding in Louisiana and most of Missouri and Iowa. Within the states where they still breed, their range is reduced, fragmented, and generally restricted to the less altered river segments. In Oklahoma, the birds occur along sandy stretches of the Canadian, Arkansas, Cimarron, and Red rivers and at the Salt Plains National Wildlife Refuge (NWR). Texas shares least terns with Oklahoma along the state boundary on the Red River (Campbell, 1995). Interior least terns also occur in Texas along the Rio Grande near Falcon, Amistad, and Lake Casa Blanca reservoirs; in the northern panhandle along the Canadian River; and in the eastern panhandle along the Prairie Dog Town Fork of the Red River. Within the Red River system, they are known to currently nest from Arkansas to as far as Highway 207 south of Claude, Texas (USACE, 2003a).

Interior least terns are seasonal migrants to Central and South America and the Caribbean. The interior populations seem to follow major river basins southward to the confluence with the Mississippi River, feeding and resting along the way. Below the Gulf of Mexico, their route is unknown (Thompson et al., 1997). In Oklahoma, migration usually begins in mid- to late August with adults and young staging at prime fishing sites along the major rivers. At this time, the juveniles' fishing skills are still inadequate and adults help with supplementing their diet. The southward fall migration of adults with young may be protracted due to differences in reproductive timing imposed by environmental conditions; migration northward into the U.S. is quite rapid (Thompson et al., 1997). The historic range of the Interior least tern is shown in Figure 11.

3. <u>Habitat</u>. The Interior least tern migrates through and nests within the proposed action area. It passes through the area in the spring and fall, and nests on sparsely vegetated islands or sandbars along the larger rivers and salt flats. They are piscivorous, feeding on small fish in the shallows of lakes, rivers, and ponds. Moseley (1976) believes them to be opportunistic feeders feeding on any fish within a certain size range.

4. <u>Cause of Decline</u>. Historical records of the interior populations of least terns date back to the journals of Lewis and Clark which described the birds in 1804 as "common and constant" in present-day Nebraska on the Platte River. Other early descriptions indicate that it

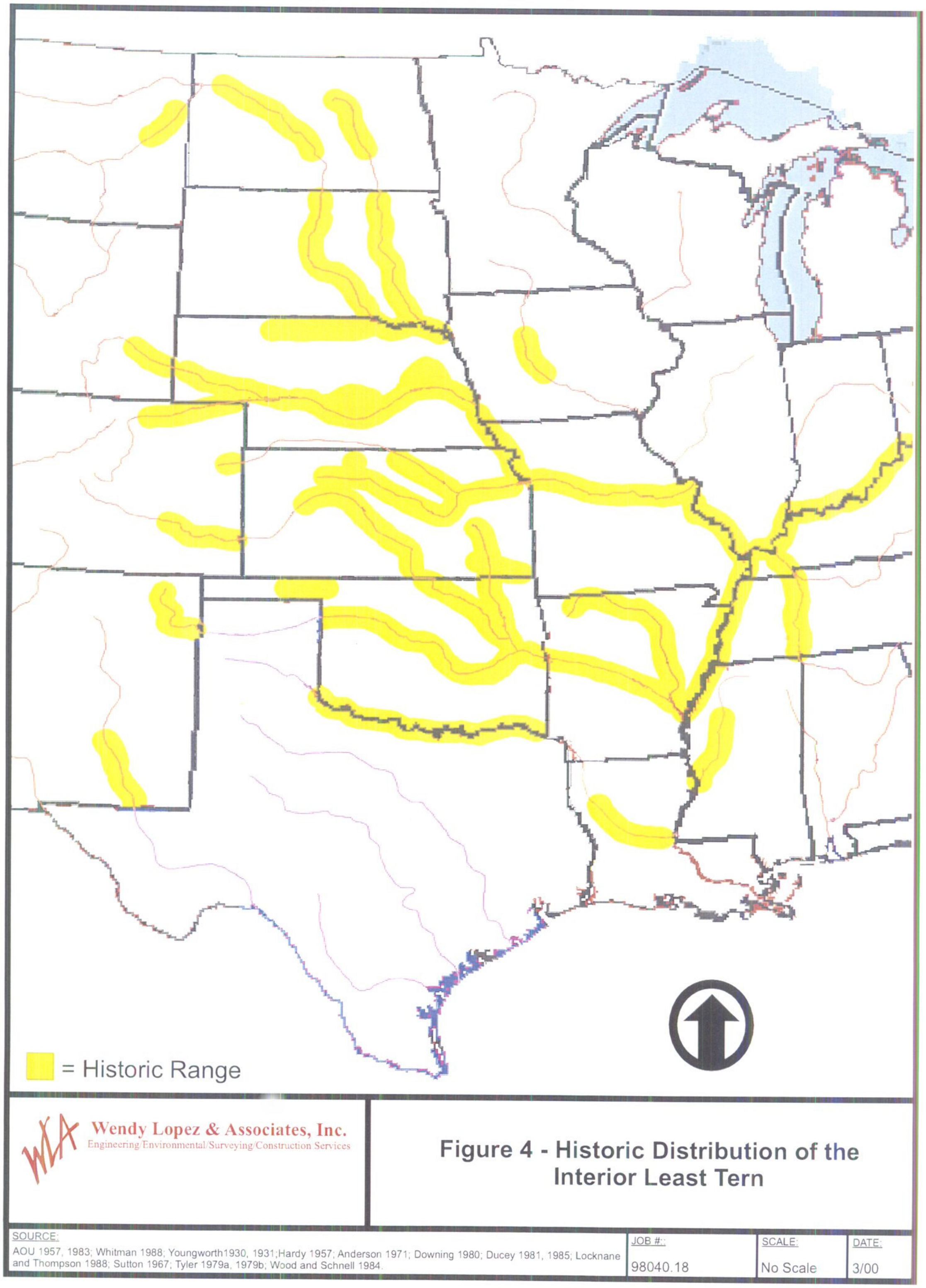


Figure 11. Historic Distribution of the Interior Least Tern.

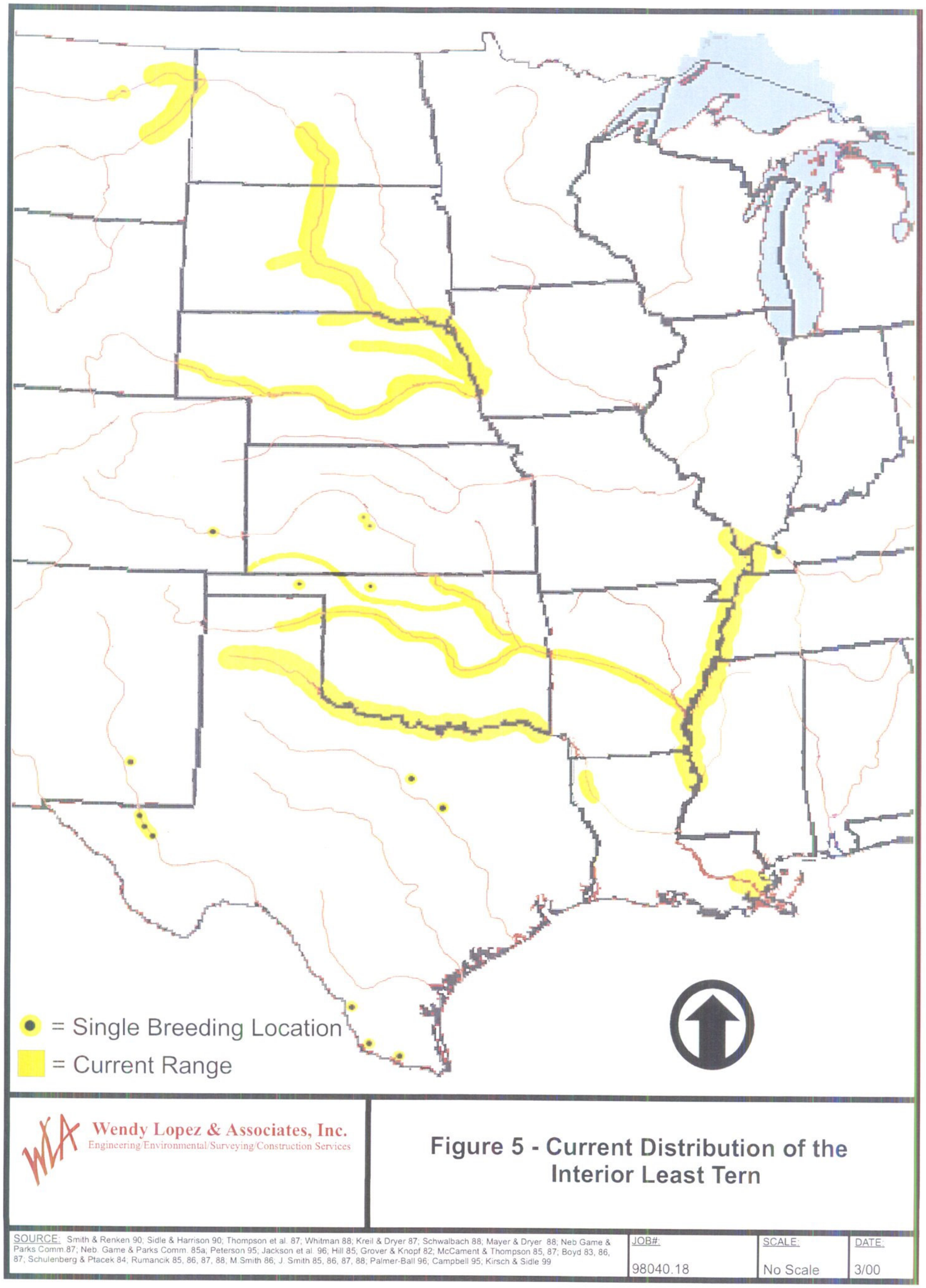


Figure 12. Current Distribution of the Interior Least Tern.

was much more common range-wide than today breeding over a larger area with a greater density of colonies.

Populations were formerly severely depleted by extensive plume hunting. The hat trade in the late nineteenth century led to serious declines of this bird with as many as 100,000 killed per year. After passage of the Migratory Bird Treaty Act in 1918, populations increased through the 1940's when dams, increased water recreation, and irrigation and housing developments began another rapid population decline (USFWS, 1990).

More recently, the major cause of decline has been attributed to the loss of nesting habitat due to reservoir construction and channelization projects, water discharge regimes associated with operation of main stem impoundments, uncontrolled vegetative growth on nesting islands, and recreational use of sandbars by humans.

5. Status of Species. The Interior least tern, *Sterna antillarum,* was Federally listed as endangered on June 27, 1985, 50 CFR (Federal Register 21, 784-21, 792). Within the area covered by this listing, this species was know to occur in Arkansas, Colorado, Iowa, Illinois, Indiana, Kansas, Kentucky, Louisiana, Missouri, Mississippi, Montana, North Dakota, Nebraska, New Mexico, Oklahoma, South Dakota, Tennessee, and Texas. No critical habitat was designated for this species.

Census data indicate that in 1990 there were a total of only 5,000 birds. It breeds over a broad area of the United States along coastal beaches and on sandbar islands within the major rivers of the Mississippi River system. Once widespread and common, the terns survived the commercial hat-making trade and rebounded with the passage of bird protection laws. More recently, their populations declined as a result of channelization projects and construction of reservoir projects (USFWS, 1985). Additional impacts may result from competition with humans for recreation areas.

The recovery plan for the Interior least tern population indicates 7,000 terns as the total interior population size that must be maintained for 10 years before this species can be down listed. This number is broken down into sub-populations required in each area of the terns' interior range. The plan outlines strategies to manage and protect essential habitat and achieve this recovery goal of 7,000 birds.

Population increases were noted in 1990, 1994, and in 1995. A compilation of survey data in 1999 estimated that the total interior population had increased and exceeded 7,000 birds. However, 12 of the regional areas designated in the recovery plan had not reached corresponding objectives (Kirsch and Sidle, 1999). The increase between listing in 1985 and the 1995 census was primarily due to a tripling of numbers along a 560-mile stretch of the Lower Mississippi River (Rumancik, 1985, 1986, 1987, 1988, 1989); numbers for most breeding areas had not reached recovery levels. Kirsch and Sidle (1999) believe that the best explanation for the local increases in the interior populations is immigration surges from the coastal portion of the population, which is large and stable or increasing (Thompson, 1902; Jackson and Jackson, 1985; Thompson et al., 1997), especially since reproduction in many interior areas was not sufficient even for population maintenance. Productivity data Kirsch and Sidle analyzed from across the range did not show highs in the years preceding the population increases noted in 1990 or 1994.

Within regional areas, there have been dramatic fluctuations in distribution and numbers (Thompson et al., 1997a; Kirsch and Sidle, 1999) perhaps reflecting changes in habitat and/or differences in immigration/emigration patterns, as well as differences in survey techniques.

a. <u>Oklahoma</u>. In Oklahoma, there are over 142 miles of river and over 7,000 ha of salt flats, which may contain habitat (Hill, 1993). Based upon data collected since 1993, this figure is probably low. Monitoring of Interior least tern colonies for fledging success in Oklahoma has been done sporadically on the Arkansas, Canadian, and Red rivers; at Optima Lake; at the Salt Plains NWR; and at the Little and Big Salt Plains. The USACE, Tulsa District has intensively monitored for least terns on the Arkansas River since 1990, and on the Canadian and Red rivers since 2000.

1. <u>Arkansas River</u>. The USACE, Tulsa District has been consulting with the USFWS with respect to the Interior least tern on the Arkansas River since 1987. The Arkansas River population has been intensively surveyed since 1990, as shown in Figure 13. Over this period of time, the adult population has varied from approximately190 to 470 birds. The Fledgling to Breeding Pair ratio (F/BR) has ranged from a high of approximately 1.9 in 1991 to a low of 0.43 in 1998. The high numbers of nesting terns and production in 1991 are believed to be in response to large flood events in 1990, which scoured islands and created additional nesting islands. The low F/BR in 1998 was not due to flood control operations, but rather lack of continuous low flow, which created extensive periods of land bridging on nesting islands. For this period of record, the USFWS requirement for a FB/R 0.05 was met except for 1998.

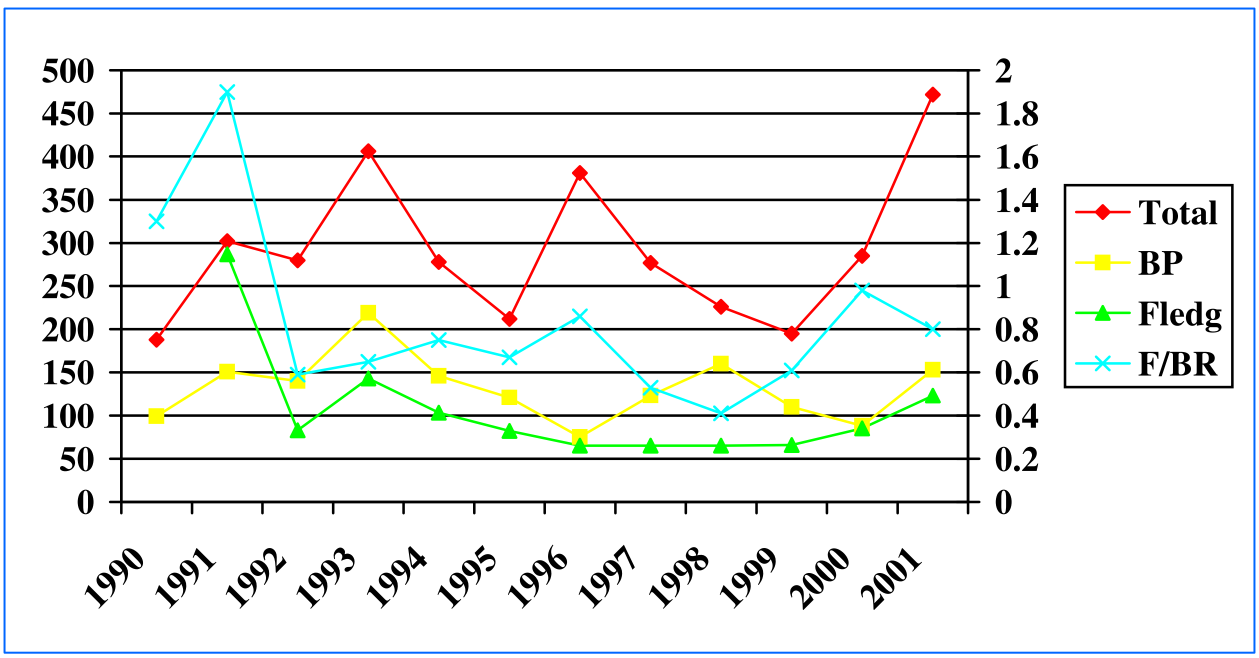


Figure 13. Arkansas River Interior Least Tern Survey Results.

The majority of least tern production occurs on the Arkansas River from Tulsa to Muskogee. However, least tern production has been increasing on the stretch from Kaw Lake to the upper end of Keystone Lake. In 2002, there were nesting colonies located approximately 2 miles below Kaw Dam and three or four colonies located further downstream near the town of Ralston, Oklahoma. Approximately 100 adult birds and 34 flying young were observed in these locations.

Very few terns nest between Keystone Dam and the I-244 Bridge in Tulsa, Oklahoma. Most of the reproduction comes from two locations in Tulsa and downstream to the Highway 69 bridge north of Muskogee, Oklahoma. In the late 1980's and early 1990's, Zink Island (manmade), located just below the I-244 Bridge, was the largest nesting site and producer for least terns on the Arkansas River. However, production at this site has steadily declined since 1998. The reason for this decline is not documented, but is thought to be the result of less desirable nesting conditions. Since the occurrence of major flood events in the late 1980's and early 1990's, the island has gradually become vegetated and lost much of its sand. A large number of Canada geese have also begun nesting on the island. USACE and USFWS personnel have worked to remove or poison the vegetation, but have had limited success. The USACE has also tried flooding the island, but the quantity and duration of flooding has not achieved the desired results. In 2002, Zink Island had only 29 nesting pairs of birds and produced only 6 fledglings.

2. Canadian River. The USACE, Tulsa District surveyed the Canadian River below Eufaula Lake to its confluence with the MCKARNS from 1999-2003. The results of USACE surveys (1990-2002) for the Interior least tern on the Canadian River are shown in Figure 14. On one of the trips in 1999, observers identified 106 adults but no nests or chicks were found. During the 2000 survey, observers found 80 adults, 36 nests as 71 adults, and 31 nests. During the 2001 survey, as many as 65 adults, 7 flying young, 7 chicks, and 5 nests were reported. Successful nesting in this stretch of the Canadian River has not been good due to flooding, predation, and localized thunderstorms.

In 2002, the USACE, Tulsa District and the USFWS jointly surveyed the upper Canadian River from Norman, Oklahoma, to the upper limits of Eufaula Lake. On this survey, they reported 232 adults, 7 flying young, 4 chicks, and 17 nests.

The USFWS Recovery Plan Goal for the Canadian River is 300 adults. From the limited survey information, this goal is close to being met on the upper reaches of the Canadian River. The lower reach below Eufaula Lake has been very productive to contributing to this goal.

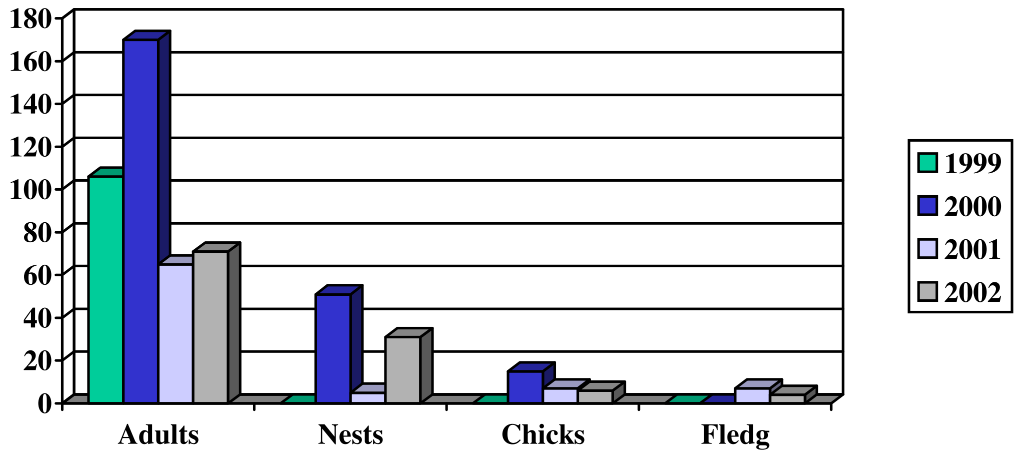


Figure 14. USACE Canadian River Least Tern Surveys.

3. Red River. Terns were once common in the Red River Basin; between 1910 and 1960, they were reported from most of the counties along the Texas-Oklahoma border. They were also known to occur on the Prairie Dog Town Fork of the Red River in the Texas panhandle as well as in salt flat areas. Downing (1980) surveyed 300 miles of the Red River in 1975, but found only one colony near Spanish Fort, Montague County, Texas.

Between 1984-1986, Locknane and Thompson (1988) surveyed a 448-mile stretch of the Red River upstream of the Denison Dam, mostly in the Texas Panhandle, and found only a few scattered colonies containing 35 birds. These were along the Prairie Dog Town Fork of the Red River and the Red River east to Burkburnett, Texas.

The USACE, Tulsa District and the USFWS conducted an aerial survey in July 1991 on segments of the Red River above and below Denison Dam. They counted two colonies with ten or more terns and two with four to nine terns and reported eight "potential or probable colonies" in the BLM portion of the river upstream of Lake Texoma. Below the dam, they reported six to seven colonies of ten or more birds and 12-14 sites with four to nine birds. Adults seen totaled 139-152 upstream and 323-339 downstream. The main concentration of downstream individuals and colonies was between U.S. Highway 78 and U.S. Highway 71 below Denison Dam.

The USFWS and BLM personnel surveyed the Red River upstream of Lake Texoma from the North Fork of the Red River to 79 miles downstream in July 1994. They reported over 200 adults with little evidence of nesting or chicks. The lack of nests and chicks along with the low number of immature birds seen (three) led USFWS personnel to conclude that flood flows apparently severely reduced nesting success during the 1994 season.

The USACE, Tulsa District has been conducting intensive tern nesting surveys on the lower 240-mile stretch of the Red River below Lake Texoma since 1999. A summary of these surveys is shown in Figure 15. Bird numbers for the lower Red River are consistently higher than those earlier reported by the USFWS, with the numbers of adult birds being over 600 for the years surveyed. However, reproduction in this reach has not been as great as anticipated despite efforts to manage flows in this reach for the benefit of nesting terns. An FBR of 0.5 has only been achieved in 2001, yet tern numbers appear fairly stable to increasing. The large influx of individuals in 2001 cannot be explained, but could reflect an influx of terns moving to the Red River from some other geographic region. Based on the numbers of adult birds returning since 1991, it would appear this population is growing. Presently, the numbers for the Red River system are exceeding the Recovery Plan Goal for this species.

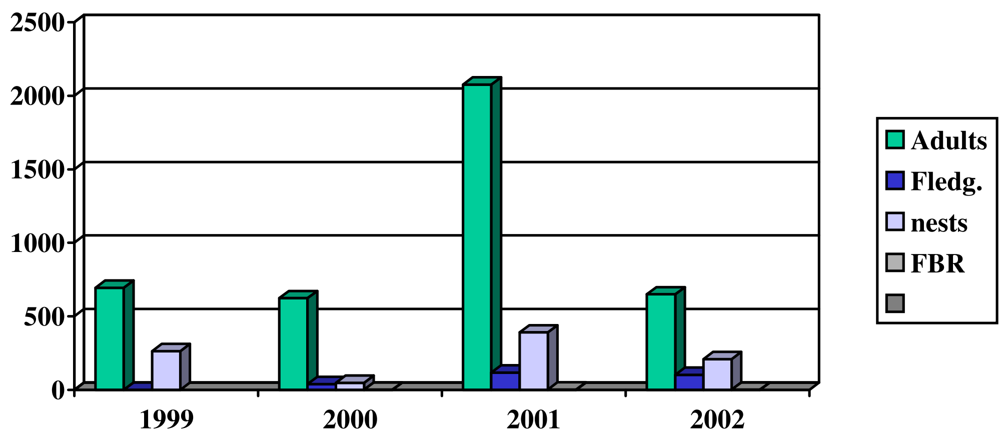


Figure 15. USACE Lower Red River Interior Least Tern Surveys.

b. **Arkansas.** The USACE, Little Rock District has monitored for least terns on that portion of the MCKARNS along the Arkansas River within the State of Arkansas in 1991, 1993, 1994, 2001, and 2003. Additional surveys were conducted by Urbanic (2003) who monitored this population and provided population estimates and estimates of nesting success for 2001 and 2002. Urbanic reported the breeding population to be 180 adults in 2001 and 264 adults in 2002. The USACE surveys for the MCKARNS are shown in Figure 16. The USFWS Recovery Plan Goal for the Arkansas River within the State of Arkansas is 150 adults. This goal has been met or exceeded for most years.

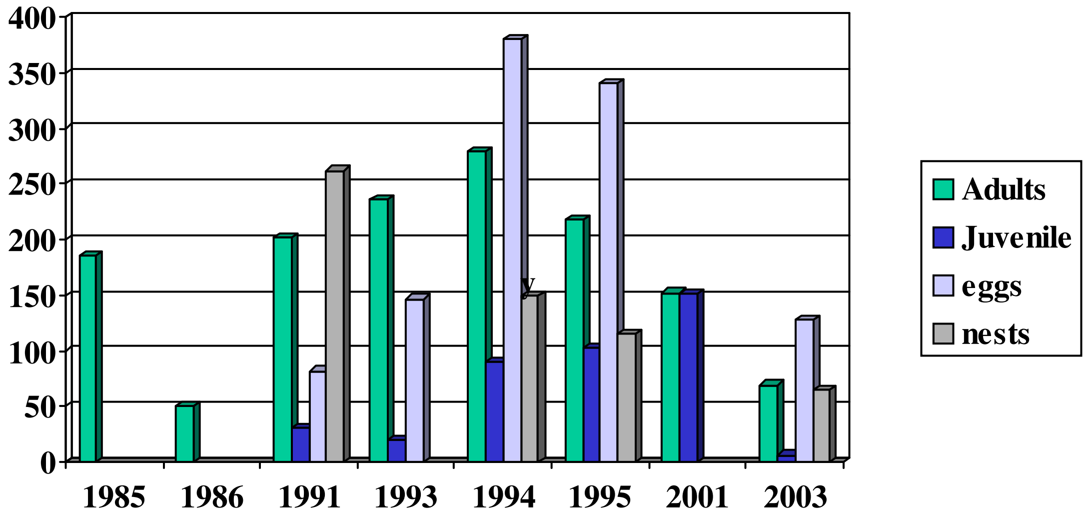


Figure 16. USACE Lower Arkansas River Interior Least Tern Surveys.

c. **Texas**. In 2003, the USACE, Tulsa District also surveyed 368 miles of the Red River above Lake Texoma from the Texas State Highway 207 bridge south of Claude, Texas, downstream along the Red River to the Interstate Highway 35 bridge at the upper limits of Lake Texoma. A total of 597 adult least terns were counted. Five hundred twenty one adult terns were associated with 48 colonies, and 76 terns were documented but could not be associated with a specific colony. A total of 220 nests were associated with the 48 colonies. Six fledglings were counted and no chicks found. Heavy thunderstorm caused flooding along most of the survey area shortly before this survey was conducted. This most likely contributed to the lack of young birds on this survey. A copy of this survey is included in Appendix 5. The USFWS Recovery Plan Goal for the Red River system is 300 birds. Presently, tern numbers for the Red River system are exceeding the Recovery Plan Goal for this species.

d. **Other Areas In Region**. The Lower Mississippi River (Gape Girardeau, Missouri, to Vicksburg, Mississippi) today hosts the largest population of nesting Interior least terns. This population has exceeded 5,000 individuals for 7 out of the last 7 years. It has exceeded the recovery goal established for the Lower Mississippi River of 2,200-2,500 birds, every year since 1990 (Rumancik, 1985, 2000). Some believe that the best explanation for the local increases in the Interior least tern population is immigration surges from coastal portions of the population, which is large and stable or increasing. However, this seems unlikely since numbers are stable or increasing each year.

N. *Geocarpon minimum.*

1. **Description of Species.** Geocarpon is a small, succulent annual that ranges from 1-4 cm in height. The flowers have no petals and are inconspicuous in the axils of the leaves, which are oppositely arranged on the stems. Young plants are a dull gray color and turn reddish-purple at maturity. The plant has a short life cycle of approximately 3 weeks beginning in early spring.

2. **Distribution of Species**. Geocarpon is only known from 4 sites in Arkansas, 13 sites in southwestern Missouri, and recently from 2 new sites in Louisiana. In Arkansas, it is extant in four counties including Bradley, Cleveland, Drew, and Franklin. Only Franklin County is within any of the proposed action areas. In Arkansas, a large population exists at Warren Prairie Natural Area in Bradley and Drew counties, two small populations exist at Kingsley Prairie in Cleveland County, and one small population exists on private lands in Franklin County. Surveys for this species were conducted at Fort Chaffee in Franklin and Sebastian counties, Arkansas, but this species was not found (Personal Communication, Jerry Sturdy, 2003).

3. **Habitat.** In Arkansas, this species is found on sites characterized as "saline soil prairies" where it grows on bare mineral soils high in sodium and magnesium. These bare areas, sometimes called "slicks" or "slick spots" are high in salinity and low in species diversity. They are sometimes colonized by prominent blue-green alga colonies.

4. **Cause of Decline.** This species is threatened by its limited distribution and by habitat destruction or modifications of saline soil prairies to pastureland, off-road vehicle use, forestry practices, and natural succession.

5. **Status of Species.** The USFWS determined this species to be threatened over the entire range in accordance with the Endangered Species Act of 1973, as amended on June 16, 1987 (Federal Register, Volume 52, No.115). No critical habitat was listed for this species. Geocarpon is unlikely to be found along the MCKARNS due to its limited distribution and specific habitat preferences (i.e., sandy clay prairies with bare mineral soils). It is unlikely that this species occurs on lands associated with any of the designated action areas.

O. Harperella.

1. **Description of Species.** Harperella (*Ptilimnium nodosom*) is an annual herb with slender, erect stems, and grows to height of 6 to 36 inches. It has hollow, quill like leaves and bears small white flowers. The flowers occur in heads or umbels and have five regular parts and are bisexual and unisexual.

2. **Distribution of Species.** It is currently known from 13 existing populations in 7 states including Alabama, Arkansas, Georgia, Maryland, North Carolina, South Carolina, and West Virginia. In Arkansas, the USFWS reports that Harperella occurs in Scott and Yell counties, while the Arkansas Natural Heritage Commission lists the species as occurring in Perry and Yell counties, which are both within the proposed action area. However, there are no records of this species on Federal lands. In Yell County, this species is listed as occurring on Irons Fork and is private ownership. This population contains several hundred plants distributed over 5-7 miles of river.

3. **Habitat.** This species occurs in two types of habitats: rocky or gravel shoals and margins of clear, swift-flowing streams, and along the edges of intermittent pineland ponds in the coastal plain. It is always found on saturated substrates and readily tolerates periodic, moderate flooding. Available evidence indicates this species tolerates and may require a very specific and unusual water regime that includes moderately intensive spring flooding, which is thought to eliminate competing vegetation. Due to its very specific habitat requirements it is easily eliminated from its habitat by minor alterations or disturbances.

4. **<u>Cause of Decline</u>.** At the time of listing, it was estimated that over 50% of known populations of *Ptilimnium nodosum* had been lost. The primary causes for decline of this species are attributed to loss of habitat due to human activities such as increased siltation, eutrophication, and impoundments. Other factors that may have an impact on this species include disease, predation from livestock grazing, and lack of protection.

5. **<u>Status of Species</u>.** Harperella was listed as endangered in the entire range by the USFWS in accordance with Threatened and Endangered Species Act of 1973, as amended on September 28, 1988 (Federal Register Volume 53, No. 188). No critical habitat was listed for this species. Due to its limited distribution and specific habitat requirements it is unlikely this species occurs on lands associated with any of the designated action areas.

P. Western Prairie Fringed Orchid.

1. **<u>Description of Species</u>.** The Western Prairie Fringed Orchid (*Platanthera praeclara)* is a perennial herb of the orchid family that can grow up to 1.2 m tall. It has large white flowers in an inflorescence that may reach as high as 47 inches with up to 40 flowers. The plant has numerous coarse, fleshy roots arising from a fleshy tuber. It regenerates from tuber rootstock that lie dormant in the winter. Dormant season burning and high moisture levels appear to promote flowering.

2. **<u>Distribution of Species</u>.** The historical range of this species is Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Manitoba. Extant populations now occur in 41 counties in 6 states including Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and Manitoba, Canada. This species is not reported from Arkansas, but has only been reported to occur in Craig and Rogers counties, Oklahoma.

It was originally widespread in eastern Nebraska, but is known presently from only four counties. One large scattered population occurs in North Dakota. In Kansas, it was historically found in 14 counties, but is now found in only 8. It has been extirpated from South Dakota. In Oklahoma, two populations, both located on privately owned hay meadows, were reported as late as 1975, but have not been observed since. The recovery plan for this species reports it is absent from Oklahoma and South Dakota. The only portion of proposed action areas that may have contained this species are project lands surrounding Oologah Lake and lands along the Verdigris River portion of the MCKARNS.

3. **<u>Habitat</u>.** This species is found in the tall grass prairie areas west of the Mississippi River. It is most commonly associated with unplowed prairies and wet meadows. It has also been documented to occur in disturbed areas such as borrow pits and road ditches.

4. **<u>Cause of Decline</u>.** The species is thought to have declined due to the massive conversion of tall grass prairie to cropland, overgrazing, and haying practices. It is also believed that depletion or contamination of the water table may also be a factor in the decline of this species.

5. **<u>Status of Species</u>.** The USFWS determined *Planthera praeclara* to be a threatened species in accordance with the Endangered Species Act of 1973, as amended on September 28, 1989 (Federal Register Volume 54, No. 187). No critical habitat was designated for this species. This species is not extant in Arkansas and has not been seen in Oklahoma since 1975. It is doubtful this species is present in the proposed action areas.

SECTION V. OPERATIONAL ACTIVITIES POTENTIALLY AFFECTING FEDERALLY LISTED SPECIES WITHIN THE ACTION AREA

A. Action Area I, Arkansas River (Kaw Lake to Muskogee, Oklahoma)

1. Existing Operations/Impacts. Action Area I is not within the documented range of the American alligator, scaleshell mussel, pink mucket pearly mussel, pallid sturgeon, *Geocarpon*, Western prairie fringed orchid, or Harperella. Continued operation of the Keystone and Kaw Lake projects would have no affect on these species.

In September 2003, USACE personnel at the projects within the proposed action area were surveyed concerning the presence or absence of bats noted during periodic inspections of dams and associated structures. A positive response noting the presence of bats was received from Keystone, Eufaula, and Tenkiller lakes, but no bats have been found at Kaw Dam or any of the other dams or locks and dams associated with the proposed action areas for the Arkansas River. No Gray, Indiana, or Ozark big-eared bats have been noted within Action Area I. Continued operation of the Keystone and Kaw Lake projects would have no affect on these species. Bats were found to be present at Keystone Lake in expansion joints under the roadway across the top of the dam in August 2003, but were determined to be big brown bats (*Eptesicus fuscus*). Additional studies are being conducted on this bat colony by Oklahoma State University.

Keystone Lake lies within parts of Osage, Creek, Tulsa, and Pawnee counties, Oklahoma, and Kaw Lake lies within Kay and Osage counties. The American burying beetle has been reported only from Tulsa County. USACE personnel conducted one survey for the American burying beetle at Keystone Lake in Pawnee County, but did not find this species. However, this species is highly mobile and could potentially be found at any given time in appropriate habitats at either project. The biggest threats to this species are probably the use of pesticides and the loss of habitat. The use of pesticides at USACE lakes has been severely curtailed and as long as activities involving loss of habitat are not allowed, existing operations of the reservoirs should not impact this species. However, any major ground disturbing activities proposed by the USACE at operating projects in counties where the beetle has been collected may affect this species, if it occurs in the area.

The whooping crane would be considered a rare migrant through this area, and is more commonly seen at the Great Salt Plains NWR. There should be no affect on this species with continued operation of Kaw and Keystone lakes.

Numerous bald eagles utilize Kaw and Keystone lakes and the Arkansas River below both lakes. Eagles are commonly seen below both dams fishing during the winter when hydropower releases keep the river free of ice. There is also a communal roost on the Arkansas River arm of Lake Keystone that has been used for over 20 years by eagles during the winter months. It is protected by the USACE and placed off limits to any recreational activities from November to March of each year.

The midwinter bald eagle counts for Kaw Lake have varied from 11 in 1987 to as high as 190 in 1986. The midwinter count for the Arkansas River that includes Keystone Lake has varied from 32 in 1993 to a high of 138 in 1994. Nesting has also been verified on the Arkansas River below Kaw Lake and the reach of the Arkansas River from Keystone Lake to Muskogee, Oklahoma. From the numbers of eagles using these areas and evidence of nesting on the Arkansas River, it would seem that current operations of these projects have a positive affect on this species. No critical habitat has been designated for this species; therefore, none will be affected.

The piping plover would be considered a migrant through the proposed action area and is known to utilize mudflats near the Winganon Bridge at Oologah Lake during migration periods. This species could use the Arkansas River above and below Keystone Lake and mudflats within Kaw and Keystone lakes, although it has not been documented there. Since it is present within the action area for such a short period of time during migration, continued operation of the Keystone and Kaw Lake projects should have no affect on this species.

The Arkansas River shiner was formerly found throughout Action Area I. However, following loss of habitat from construction and operation of Kaw and Keystone lakes and the MCKARNS on the Arkansas River, the shiner has been extirpated from this portion of its range. Continued operation of Kaw and Keystone lakes would have no affect on this species, since it no longer occurs in the Arkansas River.

Historical flows on the Arkansas River were significantly modified with the construction of Kaw and Keystone lakes. No longer does the river exhibit the large annual flood events lasting for several days followed by longer periods of median flows. Releases during storm events are now made at lesser non-damaging rates over a protracted period of time. Modified releases during the least tern-nesting season have not been beneficial to least tern reproduction. Also, operation of these lakes for hydropower has created wide fluctuation in daily flows and created many periods of little or no flow.

Long term affects on the nesting habitat for this species have also occurred as a result of constructing Kaw and Keystone lakes, but have not been quantified. Much of the sediment load transported by these rivers has become trapped behind the dams. This reduction in stream sediment transport combined with a reduction in large flow events and duration has impacted the quantity and quality of suitable nesting islands for this species. While it has been difficult to measure and quantify this loss, it nonetheless has occurred and will continue to occur with operation of the reservoirs.

Under existing operations, Kaw and Keystone lakes would continue to be operated for their authorized project purposes. Potential affects on least terns would be similar to those documented to have occurred in the past, which include flooding of nests as a result of flood control operations, land-bridging of nesting islands as a result of hydropower operations, and long term habitat loss. Survey data and information from previous years of operation confirm that these operations have resulted in “take” of least terns. However, with one exception (1998) on the Arkansas River, the levels of take associated with the Arkansas have been within the limits established for take under the existing 1998 BO.

With implementation of the measures and procedures outlined in the 2002 Management Guidelines and Strategies for Interior least terns, some "take" will continue to occur, but the continued existence of the species should not be jeopardized. Continued operation of these reservoirs with the existing management guidelines and implementation of the long-range strategies identified in the plan should be consistent with recovery of the species. No critical habitat has been designated for this species; therefore, none would be affected.

B. Action Area II, Arkansas River Navigation Study (Verdigris and Arkansas Rivers, Oklahoma)

1. <u>Phase I, Total System Operations</u>. The Phase I study developed and evaluated alternatives for implementing solutions to problems resulting from sustained high flows that are adverse to navigation. The results of the study identified a plan (Alternative 4, Operation Only Plan) that is very similar to existing operations, but would provide some benefits to navigation.

As shown in Table 6, this alternative provides approximately 14 fewer days per year at or above 61,000 cfs. At Van Buren, Arkansas, flows of 20,000 cfs would be increased by 0.6 days per year. Flows of 40,000 cfs would increase approximately 2.5 days per year. Flows of 75,000 cfs would decrease 1.8 days per year. Flows of 90,000 cfs would increase 2.1 days per year, and flows of 100,000 would increase 1.7 days per year. The recommended plan would provide a total reduction of 5 days of flow above 61,000 cfs, and would result in an average annual increase of 2 days per year in flow above 100,000 cfs. There would be no expected change in flow above 175,000 cfs along the MCKARNS compared with existing operations.

The annual changes in the number of days reservoirs are expected to be above and below the conservation pool compared to existing conditions are shown in Tables 6 and 8. The number of days affected reservoirs are expected to be above the existing conservation pool is very similar to existing conditions. Generally, reservoir levels would be between 0 and 8 feet above the conservation pool slightly more frequently than under existing conditions, and reservoir levels would be greater than 8 feet above the conservation pool slightly less frequently than under existing conditions. The magnitude of the projected changes in reservoir pool levels is even less than changes presently occurring at some lakes as a result of special operations implemented for nesting interior least terns. For most lakes, there is zero or minimal change (1-2 days) in the number of days above or below the conservation pool. The worse case scenario would be at Oologah and Keystone lakes, which would have 3 more days of pool elevation above 4 feet, and Tenkiller Lake, which would have 4 additional days of pool elevation above 2 feet. All potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the alternatives would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data

Table 11 shows the land cover classifications affected by a change in target flow under each alternative. This table was produced from land cover data provided by the USGS and map coverage of 150,000 cfs (baseline), 175,000 cfs, and 200,000 cfs flows at Van Buren provided by the USACE, Little Rock and Tulsa districts.

TABLE 11. LAND USE/LAND COVER POTENTIALLY IMPACTED BY THE MAXIMUM TARGET FLOW AT VAN BUREN, ARKANSAS, UNDER EACH ALTERNATIVE (ACRES AFFECTED)

Land Use Category	No Action Alternative (Alternative 1)	Operations Only Alternative (Alternative 4)
Barren land	610.2	610.2
Wetlands	1030.5	1030.5
Water	12103.8	12103.8
Forest	4541.0	4541.0
Rangeland	52.7	52.7
Agriculture	9160.2	9160.2
Urban	360.2	360.2

Source: USGS 1994 and USACE 2002.

With the recommended plan, there would be no change in land use/land cover as a result of modifying existing operations. No direct or indirect impacts to terrestrial or aquatic resources are expected with implementation of the recommended plan. River and associated reservoir levels would fluctuate similarly to current flow and reservoir draw down rates.

Implementation of the recommended plan would reduce the number of days per year with flows above 61,000 cfs by 14. A decrease in flow days above 61,000 cfs would reduce the duration of floodplain inundation, which potentially improves farming operations along the MCKARNS. While there would be no increases in agricultural/structural or recreational damages within the system, less frequent flooding of farm fields may stimulate agricultural production. Although impacts would vary over time and by location, these changes may encourage the cropping of additional land, thus potentially displacing native vegetation within the floodplain.

On the other hand, if increases in reservoir storage were short-term, shoreline vegetation would provide additional habitat for larval fish. According to hydrologic modeling data, increases in pool elevation at all lakes are spread throughout the year, with no more than 2 additional days over 8 feet above conservation pool occurring in any 2-month period. Other minor impacts of this water level fluctuation may include altering the littoral or shoreline zone of the reservoirs that provide important aquatic habitat. The USACE's modifications of flow rates would continue to remain compatible with the authorized operational plan of each reservoir.

Action Area II is on the periphery of the range of American alligator, but it would be considered a possible visitor to the lower portion of the MCKARNS. This species was originally classified as endangered throughout its range in 1967 due to concerns over harvesting. Since its protection, it has recovered to the point where it is neither in danger of extinction nor likely to become so in the foreseeable future. Implementation of the "Operations Only Plan" would have no affect on this species.

In September 2003, USACE personnel at the projects within the proposed action areas were surveyed concerning the presence or absence of bats noted during periodic inspections of dams and associated structures. A single specimen of pipistrelle sp. was found at the Lake Dardanelle Powerhouse. A positive response noting the presence of bats was received from Keystone, Eufaula, and Tenkiller lakes, but no bats have been found at Kaw Dam or any of the other dams or locks and dams associated with the proposed action areas for the Arkansas River.

Bats were found to be present at Keystone Lake in expansion joints under the roadway across the top of the dam in August 2003, but were determined to be big brown bats (*Eptesicus fuscus*). Additional studies are being conducted on this bat colony. Previous investigations by USACE personnel in 1998 found large colonies of little brown bats *(Myotis lucifugus*) under the spillway bridges at both Eufaula and Tenkiller lakes. No Gray, Indiana, or Ozark big-eared bats have been documented to occur on Federal properties associated with Action Area II. Implementation of the proposed "Operations Only Plan" should have no affect on these species.

As discussed in Section IV, the American burying beetle has been recorded to occur within counties adjacent to the MCKARNS in Oklahoma and western Arkansas. USACE personnel conducted limited surveys for the American burying beetle at Keystone Lake, Wister, Robert S. Kerr, and at other locations in Tulsa County but did not find this species. Large populations of this species are found immediately to the MCKARNS at Camp Gruber located in Muskogee and Cherokee counties in Oklahoma and at Fort Chaffee in Sebastian and Franklin counties in Arkansas. In 1992, the American burying beetle was collected on Federal lands at the Sequoyah National Wildlife Refuge, along the MCKARNS.

It has usually been collected from upland sites in association open grasslands or forests. Most of the habitat along the MCKARNS was former floodplain of the Arkansas and Verdigris rivers and is probably not optimal habitat for this species. However, this species is highly mobile and could potentially be found at any given time in appropriate habitats along the MCKARNS, although it has not been documented to occur on these lands.

The biggest threats to this species are probably the use of pesticides and loss of habitat. The use of pesticides at USACE lakes has been severely curtailed and as long as activities involving loss of habitat are not allowed, existing operations of the reservoirs should not impact this species. However, any major ground disturbing activities proposed by the USACE at operational projects in counties where the beetle has been collected may have an affect on this species, if it occurs in the area.

The whooping crane would be considered a rare migrant through Action Area II and is more commonly seen at the Great Salt Plains NWR. The minor changes associated with implementation of the "Operations Only Plan" should have no affect on this species

As shown in Section IV, the bald eagle is found throughout the limits of Action Area II and utilizes the MCKARNS and 11 supporting reservoirs as well. Its numbers have increased under existing operation of the MCKARNS and the 11 supporting reservoirs. The minor changes associated with implementation of the "Operations Only Plan" would have negligible, if any, impacts on this species. Consequently, implementation of Alternative IV should have no affect on this species.

In Oklahoma, the scaleshell mussel is associated primarily with the Red River Basin in southeastern Oklahoma. It has been reported to occur in the Kiamichi, Mountain Fork, and Lower Little Rivers, and from the Poteau River, a tributary to the Arkansas River (USFWS, 2003b). The final rule listing this species (USFWS, 2001) reported it as occurring in the Poteau River based upon a single specimen, but states that existence of the scaleshell in the Poteau River is doubtful.

Within the State of Arkansas, the scaleshell mussel is reported to occur in seven counties including Crawford, Fulton, Jackson, Lawrence, Perry, Sevier, and Francis (USFWS, 2003b). The USFWS final rule listing this species reports this species as having been collected from Frog Bayou and the South Fourche LaFave and Mulberry rivers in Arkansas. Perry and Crawford counties are within the proposed action areas. The record (s) for Perry County are associated with the Fourche LaFave River, which is a tributary to the MCKARNS at navigation mile 146.5, and Frog Bayou, which is a tributary to the MCKARNS at navigation mile 277. Potential habitat for this species in Frog Bayou is restricted to the area between the town of Rudy and the MCKARNS (USFWS, 2001). Live mussels have not been found at the confluence of the Arkansas River, likely due to dredging activities (Gordon, 1980).

The only scaleshell mussel record from the South Fourche LaFave River is based on a single live specimen taken in 1991 (USFWS, 2001). The occurrence of the scaleshell mussel in the Mulberry River is based upon a single specimen (USFWS, 2001), and the USFWS believes its existence in the Mulberry River is unlikely. While this species occurs in the general area associated with Action Area II, it does not appear to be found within the MCKARNS. Consequently, implementation of the "Operations Only Plan" would have no affect on this species.

The pink mucket pearly mussel occurs throughout the Mississippi, Tennessee, Ohio, and Cumberland River systems. This species does not occur in Oklahoma, but is reported to occur in Arkansas County from the lower White River and Lower White-Bayou Des Arc (NatureServe Explorer 2003), which are near Action Area II. It is possible this species may have historically occurred within the lower reaches of the White River. However, the present range and status of this species within Action Area II show it is only recorded from the White river well above the confluence of the White River and the MCKARNS (Harris, 1997). Implementation of the "Operations Only Plan" would have negligible impacts on flows in the lower reaches of Action Area II. Consequently, implementation of this alternative should have no affect on this species.

The piping plover would be considered a migrant throughout the proposed action area and is known to utilize mudflats near the Winganon Bridge at Oologah Lake during migration periods. With implementation of the "Operations Only Plan," the pool level of Oologah Lake would be between 4-8 feet above conservation pool for approximately 2 more days above the existing plan during the piping plover migration period (February-April and July-September) of each year. The proposed pool level changes associated with implementation of the Operations Only Plan within Action Area II should be negligible and have no affect on this species.

The Arkansas River shiner was formerly found in the western reaches of Action Area II. However, following loss of habitat from construction and operation of Kaw and Keystone lakes and the MCKARNS on the Arkansas River, the shiner has been extirpated from its former range in the Arkansas River. Implementation of the "Operations Only Plan "would have no affect on this species, since it no longer occurs in the designated action areas.

The pallid sturgeon inhabits large turbid river systems and is endemic to the middle and lower Mississippi River and Missouri River and larger tributaries. The lower White River and possibly the lower Arkansas River would be included in the range of this species. It has been recorded from the Mississippi River and the St. Francis River in Arkansas. However, there are no documented collection records of this species from either the White or Arkansas rivers. It has, however, been collected in the Mississippi River between river miles 585-615, which is near the confluences of the Arkansas and White rivers. While this species has not been recorded from within Action Area II, its possible occurrence, at least at times, cannot be discounted. Implementation of the "Operations Only Plan" should have no affect on this species, if it occurs in the action area.

The Interior least tern occurs throughout Action Area II. In Oklahoma, it primarily uses the Arkansas River from below Kaw Lake to Muskogee and the Canadian River from below Eufaula Lake to the Canadian Rivers confluence with the MCKARNS. Use of the remainder of the Oklahoma portion of the MCKARNS by the Interior least tern is very low. Terns for nesting utilize the portion of the MCKARNS within Arkansas, and evidence suggests that at times this population may have been flooded from current operations of the MCKARNS or reservoirs associated with the MCKARNS.

The USACE's modifications of flow rates are compatible with the authorized operational plan of each reservoir along the MCKARNS. The USACE would continue to cooperate with State and Federal fish and wildlife agencies to develop plans for some lakes and to provide regular seasonal pool fluctuations. Appropriate seasonal pool variations help to improve fish spawn by maintaining or increasing water levels during spring months, improve water recreation by maintaining levels sufficient for recreation during summer months, and improve waterfowl food and hunting by fluctuating water levels to maximize waterfowl habitat and hunting opportunities during fall months.

Implementation of the Operations Only Plan would result in very minor modifications to existing operation of the MCKARNS navigation system and the 11 upstream lakes providing flow to the MCKARNS. Consequently, implementation of this plan would have no affect on the Interior least tern.

Geocarpon is only known from four sites in Arkansas and has been recorded from only one location (Franklin County) within Action Area II. This population is located on private lands. *Geocarpon* is unlikely to be found along the MCKARNS due to its limited distribution and specific habitat preferences. Implementation of the "Operations Only Plan" should have no affect on this species.

The Western prairie fringed orchid historically occurred in association with tall grass prairies west of the Mississippi River from Texas to Canada. This species is not reported from Arkansas, but has only been reported to occur in Craig and Rogers counties. In Oklahoma, two populations, both located on privately owned hay meadows, were reported as late as 1975, but have not been observed since. The recovery plan for this species reports it is absent from Oklahoma and South Dakota. The only portion of proposed action areas that may have contained this species are project lands surrounding Oologah Lake and possibly lands along the Verdigris River portion of the MCKARNS. This species would not be expected to occur on project lands in Action Area II. Consequently, implementation of the "Operations Only Plan" would have no affect on this species.

Harperella is currently known from 13 existing populations in 7 states including Alabama, Arkansas, Georgia, Maryland, North Carolina, South Carolina, and West Virginia. In Arkansas, the USFWS reports that Harperella occurs in Scott and Yell counties, while the Arkansas Natural Heritage Commission lists the species as occurring in Perry and Yell counties, which are both within the proposed action area. However, there are no records of this species on Federal lands. In Yell County, this species is listed as occurring on Irons Fork and is in private ownership. This population contains several hundred plants distributed over 5-7 miles of river. Due to its limited distribution and specific habitat requirements, it is unlikely this species occurs on lands associated with the MCKARNS in Action Area II. Implementation of the "Operations Only Plan" should have no affect on this species.

2. <u>Phase II, Proposed Channel Modifications</u>. Phase II of the MCKARNS feasibility will evaluate deepening the navigation channel to 12 feet over the entire system from the Mississippi River to the Port of Catoosa, Oklahoma, and widening the channel from 150 feet to 300 feet on the Verdigris River portion of the system (to a depth of 12 feet). Phase II is a feasibility study. Detailed information will be developed, but is not available at this time for assessment purposes. The following assumptions were used to assess the affects of the proposed study on Federally listed species:

- All deepening would be through dredging only.
- There would be no modification of existing locks and dams.
- River maintenance structures, such as dikes and revetments, would be required.
- Additional dredge disposal areas would be required.
- Advance maintenance dredging would be required in problem areas.

Action Area II is on the periphery of the range of American alligator, but it would be considered a possible visitor to the lower portion of the MCKARNS. This species was originally classified as endangered throughout its range in 1967 due to concerns over harvesting. Since its protection, it has recovered to the point where it is neither in danger of extinction nor likely to become so in the foreseeable future. Implementation of Phase II of the feasibility study, Proposed Channel Modifications should have no affect on this species.

In September 2003, USACE personnel at the projects within the proposed action area were surveyed concerning the presence or absence of bats noted during periodic inspections of dams and associated structures. A single specimen of pipistrelle sp. was found at the Lake Dardanelle Powerhouse. A positive response noting the presence of bats was received from Keystone, Eufaula, and Tenkiller lakes, but no bats have been found at Kaw Dam or any of the other dams or locks and dams associated with the proposed action areas for the Arkansas River**.**

Bats were found to be present at Keystone Lake in expansion joints under the roadway across the top of the dam in August 2003, but were determined to be big brown bats (*Eptesicus fuscus*). Additional studies are being conducted on this bat colony. Previous investigations by USACE personnel in 1998 found large colonies of little brown bats *(Myotis lucifugus*) under the spillway bridges at both Eufaula and Tenkiller lakes. No Gray, Indiana, or Ozark big-eared bats have been documented to occur on Federal properties associated with Action Area II. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, should have no affect on these species.

As discussed in Section IV, the American burying beetle has been recorded to occur within counties adjacent to the MCKARNS in Oklahoma and western Arkansas. USACE personnel conducted one survey for the American burying beetle at Keystone Lake, Wister Lake, Robert S. Kerr Lock and Dam, and at other locations in Tulsa County but did not find this species. Large populations of this species have been found immediately adjacent to the MCKARNS at Camp Gruber located in Muskogee and Cherokee counties in Oklahoma and at Fort Chaffee in Sebastian and Franklin counties in Arkansas. This species is also known to occur on the Sequoyah National Wildlife Refuge located on the MCKARNS.

These species are usually collected from upland sites in association with open grasslands or forests. Most of the habitat along the MCKARNS was in former floodplains of the Arkansas and Verdigris rivers and is probably not optimal habitat for this species. However, this species is highly mobile and could potentially be found at any given time in appropriate habitats along the MCKARNS.

The biggest threats to this species are probably the use of pesticides and loss of habitat. The use of pesticides at USACE lakes has been severely curtailed and as long as activities involving loss of habitat are not allowed, existing operations of the reservoirs should not impact this species. Any major ground disturbing activities proposed by the USACE at operational projects in counties where the beetle has been collected may affect this species. No critical habitat has been designated for this species; therefore, none will be affected. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, may affect this species if upland dredge disposal sites are used to dispose of dredge materials and the species occurs there.

The whooping crane would be considered a rare migrant through the western portion of Action Area II and is found more in association with the Great Salt Plains NWR. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, should have no affect on this species.

The bald eagle utilizes Federally owned lands along the MCKARNS and the 11 reservoirs associated with operation of the MCKARNS. Activities associated with deepening the MCKARNS up to the Verdigris River (navigation mile 445.2) should have no affect on the habitat for this species. However, placement of dredge disposal material into disposal areas has the potential to adversely impact habitat utilized by eagles for roosting, nesting, or perching. This impact cannot be quantified until the locations of the proposed disposal areas have been delineated.

Deepening and widening the Verdigris River portion of the MCKARNS could have the potential to adversely impact the riparian corridor along the Verdigris River and adversely impact eagle habitat. In addition, any deepening activities by dredging have the potential to introduce contaminants tied up in the sediments into the aquatic environment. This could make contaminants available for assimilation into the food chain and the fish community, which is a major food source for eagles using the MCKARNS. Evidence suggests that some areas of the MCKARNS contain elevated levels of contaminants. Additional sampling of sediments within the proposed dredge areas would be required to better define the potential for risks to this species. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, may have an affect on this species.

In Oklahoma, the scaleshell mussel is associated primarily with the Red River Basin in southeastern Oklahoma. It has been reported to occur in the Kiamichi, Mountain Fork, and Lower Little Rivers, and from the Poteau River, a tributary to the Arkansas River (USFWS, 2003b). The final rule listing this species (USFWS, 2001) reported it as occurring in the Poteau River based upon a single specimen, but states that existence of the scaleshell in the Poteau River is doubtful.

Within the State of Arkansas, this species is reported to occur in seven counties including Crawford, Fulton, Jackson, Lawrence, Perry, Sevier, and Francis (USFWS, 2003b). The USFWS final rule listing this species reports this species as having been collected from Frog Bayou and the South Fourche LaFave and Mulberry rivers in Arkansas. Perry and Crawford counties are within the proposed action areas. The record(s) for Perry County are associated with the Fourche LaFave River, which is a tributary to the MCKARNS at navigation mile 146.5, and Frog Bayou, which is a tributary to the MCKARNS at navigation mile 277. Potential habitat for this species in Frog Bayou is restricted to the area between the town of Rudy and the MCKARNS (USFWS, 2001). Live mussels have not been found at the confluence of the Arkansas River, likely due to dredging activities (Gordon, 1980).

The only scaleshell mussel record from the South Fourche LaFave River is based on a single live specimen taken in 1991 (USFWS, 2001). The occurrence of the scaleshell mussel in the Mulberry River is based upon a single specimen (USFWS, 2001), and the USFWS believes its existence in the Mulberry River is unlikely. While this species occurs in general areas associated with Action Area II, it does not appear to be found within the MCKARNS. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, should have no affect on this species.

The pink mucket pearly mussel occurs throughout the Mississippi, Tennessee, Ohio, and Cumberland River systems. This species does not occur in Oklahoma, but is reported to occur in Arkansas from the White River (Nature Serve Explorer 2003), which is within Action Area II. It is possible this species may have historically occurred within the lower reaches of the White River associated with the MCKARNS, but records do not support this. If it did, it is unlikely this species has survived the modifications associated with construction and operation of the MCKARNS. Harris (1997) reported this species from the middle and upper reaches of the White River well above its confluence with the MCKARNS. Harris (personal communication, 2003) reported this species to have been collected near Clarendon, Arkansas, on the White River, which is well above the influence of the MCKARNS. No records exist for this species on the White River below Clarendon at river mile 99. It is unlikely this species occurs within the MCKARNS. Consequently, implementation of Phase II of the feasibility study, Proposed Channel Modifications, should not affect this species since it is unlikely to occur there.

The piping plover would be considered a migrant within the western portion of the proposed action area and is known to utilize mudflats near the Winganon Bridge at Oologah Lake during migration periods. If it were to utilize any of the MCKARNS, it would be only briefly during its migration periods in the fall and spring. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, should have no affect on this species.

The Arkansas River shiner was formerly found in the western reaches of Action Area II. However, following loss of habitat from construction and operation of Kaw and Keystone lakes and the MCKARNS on the Arkansas River, the shiner has been extirpated from its former range in the Arkansas River. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, should have no affect on this species since it is no longer present in the area.

The pallid sturgeon inhabits large turbid river systems and is endemic to the middle and lower Mississippi River and Missouri River and larger tributaries. The lower White River and possibly the lower Arkansas River would be included in the range of this species. It has been recorded from the Mississippi River and the St. Francis River in Arkansas. However, there are no documented collection records of this species from either the White or Arkansas rivers. It has, however, been collected in the Mississippi River between river miles 585-615, which is near the confluences of the Arkansas and White rivers.

The loss of aquatic habitat and riverine dynamics due to navigation is well documented and has affected the pallid sturgeon on the Missouri River and tributaries. Types of activities associated with the loss of habitat include construction of impoundments, channelization, channel degradation, reduced sediment transport and turbidity, and lake operation. Similar operations presently occur on the MCKARNS. The activities on the Missouri River have impacted the pallid sturgeon by reducing larval and juvenile rearing habitat, reducing availability of seasonal refugia, reducing the forage base of pallid sturgeon by reducing nutrient cycling and habitat diversity, reducing pallid sturgeon staging and spawning cues, and increasing hybridization with the shovelnose sturgeon.

While this species has not been recorded from within Action Area II, its possible occurrence, at least at times, cannot be discounted. Implementation of Phase II of the feasibility study, Proposed Channel Modifications may have an affect on this species, if it occurs in the lower White or Arkansas Rivers

The Interior least tern occurs throughout Action Area II. In Oklahoma, it primarily uses the Arkansas River from below Kaw Lake to Muskogee and the Canadian River from below Eufaula Lake to the Canadian Rivers confluence with the MCKARNS. Use of the remainder of the Oklahoma portion of the MCKARNS by the Interior least tern is very low. Terns utilize the portion of the MCKARNS within Arkansas for nesting, and evidence suggests that at times this population may have been flooded from operations of the MCKARNS or reservoirs associated with the MCKARNS. Deepening the MCKARNS to an overall depth of 12 feet would have little impact on this species since most of the system is already at this depth. Widening the Verdigris River to a width of 300 feet for navigation would probably not impact this species since terns do not nest on the Verdigris River below Oologah Lake.

However, deepening of the MCKARNS by dredging has the potential to introduce contaminants tied up in the sediments into the aquatic environment. This could make contaminants available for assimilation into the food chain and the fish community, which is a major food source for nesting least terns using the MCKARNS at the mouth of the Canadian River and in Arkansas. Evidence suggests that some areas of the MCKARNS contain elevated levels of contaminants. Additional sampling of sediments within the areas proposed to be dredged would be required to better define the potential for risks to this species.

The disposal of dredge material could be used for construction of islands and with proper design and annual maintenance could create additional nesting habitat for this species. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, may have an affect on this species.

The piping plover would be considered a migrant within the western portion of the proposed action area and is know to utilize mudflats near the Winganon Bridge at Oologah Lake during migration periods. If it were to utilize any of the MCKARNS, it would be only briefly during its migration periods in the fall and spring. Implementation of the Dredge Material Disposal Management Plan should have no affect on this species.

Geocarpon is only known from four sites in Arkansas but has been recorded from only one location (Franklin County) within Action Area II. This population is located on private lands. *Geocarpon* is unlikely to be found along the MCKARNS due to its limited distribution and specific habitat preferences**.** Implementation of Phase II of the feasibility study, Proposed Channel Modifications, should have no affect on this species.

The Western prairie fringed orchid historically occurred in association with tall grass prairies west of the Mississippi River from Texas to Canada. This species is not reported from Arkansas, but has only been reported to occur in Craig and Rogers counties. In Oklahoma, two populations, both located on privately owned hay meadows, were reported as late as 1975, but have not been observed since. The recovery plan for this species reports it is absent from Oklahoma and South Dakota. The only portion of proposed action areas that may have contained this species are project lands surrounding Oologah Lake and lands along the Verdigris River portion of the MCKARNS. This species would not be expected to occur on project lands in Action Area II. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, should have no affect on this species.

Harperella is currently known from 13 existing populations in 7 states including Alabama, Arkansas, Georgia, Maryland, North Carolina, South Carolina, and West Virginia. In Arkansas, the USFWS reports that Harperella occurs in Scott and Yell counties, while the Arkansas Natural Heritage Commission lists the species as occurring in Perry and Yell counties, which are both within the proposed action area. However, there are no records of this species on Federal lands. In Yell County, this species is listed as occurring on Irons Fork and is in private ownership. This population contains several hundred plants distributed over 5-7 miles of river. Due to its limited distribution and specific habitat requirements, it is unlikely this species occurs on lands associated with the MCKARNS in Action Area II. Implementation of Phase II of the feasibility study, Proposed Channel Modifications, should have no affect on this species.

C. Action Area III, MCKARNS Dredge Material Disposal Management Plan (Verdigris and Arkansas River, Oklahoma

Flows moving down the Arkansas River are regulated in accordance with the Water Control Master Manual for the Arkansas River Basin, Tulsa and Little Rock Districts, approved July 11, 1980. The primary objective of the system water control plan is to provide a system operation that achieves a reasonable balance of purposes for which the projects are operated. Major emphasis of the plan is for flood operations and navigation requirements following a flood event. The system water control plan provides for a slow decrease or taper in the Arkansas River flow so that the sand shoals developed in the navigation channel during high flows can be located and removed before low flow conditions are reached again. Tapered flow also provides sufficient depth for normal navigation traffic to continue over the shoals while they are being located and removed. In order to accomplish the navigation objective, infringement on the flood control storage is required. The degree of infringement varies depending on basin hydrologic conditions and the distribution of flood control storage among projects.

The Southwestern Division, Tulsa and Little Rock districts developed a system regulation plan in a joint effort. The plan consists of flow regulation guides that take into consideration all beneficial uses of the projects. Individual project operational guide curves, system balancing of flood control storage, equivalent percent of basin storage utilized, and a seasonal guide curve for the Van Buren gage were developed for use in the system flow regulation.

Circumstances or events may arise under which the District Engineer will determine a deviation from the system regulation criteria is warranted. Typical deviations from the system criteria may involve increasing or decreasing flood regulating flows and/or durations of navigation tapers, revisions to lake balancing criteria, or increasing lake releases for low flow navigation needs. Deviations from the system regulation plan may affect operations in both districts and require extensive coordination and approvals.

The operation and maintenance activities associated with the MCKARNS consist of operation of the locks for barge and boat traffic; maintenance of project structures, dikes, revetments, equipment, buildings; maintenance of minimum channel depth and width; maintenance of hydroelectric power generation, erosion control on channel banks and project lands; tree and grass planting for enhancement of aesthetic quality; cooperative wildlife management; administration and management of agriculture and grazing leases; inspection of general leases and outgrants; pollution control; recreation management which includes disposal of solid waste and sewage; control of undesirable vegetation; maintenance of recreation areas; and insect control.

The general instructions and policies with respect to operating and maintaining each of the individual projects of the MCKARNS are contained in the Operation and Maintenance Manuals developed specifically for each project.

During construction of the MCKARNS, dredge material from the Verdigris and Arkansas rivers were placed on the bank adjacent to the river. Many of these areas were also determined to be used for dredge materials disposal sites for maintaining and operating the project after construction. Maps showing these areas are shown in Appendix 3.

As a result of construction and operation of the MCKARNS and system operation of other USACE projects, the lower Verdigris and Arkansas rivers and associated terrestrial and aquatic habitat have been substantially modified from pre-project conditions.

Action Area III is not within the documented range of the American alligator, scaleshell mussel, pink mucket pearly mussel, pallid sturgeon, Geocarpon, or Harperella. Continued operation of the Oklahoma portion of MCKARNS would have no affect on these species.

In September 2003, USACE personnel surveyed project personnel within the proposed action area concerning the presence or absence of bats noted during periodic inspections of dams and associated structures. A positive response noting the presence of bats was received from Keystone, Eufaula, and Tenkiller lakes, but no bats have been found at Kaw Dam or any of the dams or locks and dams associated with operation of the MCKARNS or the Verdigris and Arkansas rivers. No Gray, Indiana, or Ozark big-eared bats have been noted within Action Area III. Continued operation of the Keystone and Kaw Lake projects would have no affect on these species. Bats were found to be present at Keystone Lake in expansion joints under the roadway across the top of the dam in August 2003, but were determined to be big brown bats (*Eptesicus fuscus*). Additional studies are being conducted on this bat colony by Oklahoma State University.

The American burying beetle has been recorded from several counties within the boundaries of the MCKARNS. One of the largest populations in Oklahoma is found on Camp

Gruber, which is located immediately adjacent to the MCKARNS in Muskogee County. USACE surveys for this species have been limited. There is one known occurrence of this species from USACE properties in the action area. The beetle was collected in 1992 from Federal lands at the Sequoyah National Wildlife Refuge. USACE personnel surveyed for this species on Fry Creeks along the Arkansas River in 1998, and from the Sallisaw Creek Recreation Area at Robert S. Kerr but did not find this species. Survey records from sampling conducted at Camp Gruber (Schnell, 1992) indicate this species is not usually found in bottomland habitats. Also, none were reported on Camp Gruber lands near the MCKARNS, although they are immediately adjacent to it. This species is more commonly found in uplands.

The MCKARNS and associated operational activities are located primarily in or along the floodplains of the Arkansas and Verdigris rivers. The habitats associated with this area are primarily bottomland hardwoods, agricultural areas, and wetlands. Very little, if any, of the preferred habitat for this species is found on USACE property associated with the MCKARNS. However, given the mobility of this species, it is highly probable that it does at times occur on periphery areas of the MCKARNS if suitable habitat and carrion are present. Activities associated with implementation of the Dredge Material Disposal Management Plan may affect this species.

Bald eagles are found throughout that portion of the MCKARNS operated by the U.S. Army Corps of Engineers, Tulsa District. Evidence suggests eagles use the area during the winter and also for nesting. Both adult and immature bald eagles have been sighted along the lower reaches of the Arkansas River near its confluence with the Verdigris River by USACE and USFWS personnel, while conducting Interior least tern surveys. Midwinter bald eagle counts show eagles are also present at Webbers Falls and Robert S. Kerr Lakes. Bald eagles are also known to nest in the Robert S. Kerr pool and along the Canadian River below Eufaula Lake.

Maintenance dredging and disposal activities associated with operation of the MCKARNS have been ongoing since project completion in 1969. As shown in Table 5, seven of the 23 sites have already been constructed as part of the ongoing maintenance program. Since construction of the MCKARNS, numerous areas on project lands have developed mature stands of bottomland hardwoods that could be utilized by bald eagles. At some disposal areas, mature trees have been removed during construction, which may have impacted eagle roosting and perching habitat. However, these activities may also have created shallow water habitat or wetlands, which could benefit this species. Overtime, these areas reestablish themselves and mature into habitat that can potentially be used by eagles. While construction and operation of the dredge disposal areas has probably impacted bald eagle habitat, there is no indication that eagle use of the MCKARNS has been impacted as a result of these ongoing activities since the project was constructed.

To date, most of the dredge material on the Oklahoma portion of he MCKARNS has been placed in confined disposal areas. The proposed Dredge Material Disposal Management Plan proposes the use of open-water disposal at one location on Robert S. Kerr Lake. This site (Site 15B) is located in Pool 15 between miles 348 and 349.5 in the Sandtown Bottom area. The recovery of the bald eagle is strongly linked to the ban of DDT and other organochlorine compounds. Consequently, there would be concerns associated with any dredge and disposal operations that would disturb contaminated sediments and/or release contaminants into the water column. This concern would certainly be warranted with any proposed open water disposal.

Limited sampling of sediments has occurred at Site 15 B. However, the U.S. Army Corps of Engineers, Tulsa District has sampled sediments from Pool 16 (USACE, 1995) and found levels of arsenic, cyanide, and mercury to be above the classification guidelines. If open water disposal is found to be feasible and approved, additional sediment sampling would be required to determine if pollutants occur in the sediments at this location and the potential for risk to this species.

Implementation of the Dredge Material Disposal Management Plan may adversely affect the bald eagle and its habitat by the potential removal of habitat and the potential for release of contaminants into the water column from dredging. Implementation of the plan could also create additional shallow water habitat, which could be beneficial to the species.

The piping plover would be considered a migrant within the western portion of the proposed action area and is known to utilize mudflats near the Winganon Bridge at Oologah Lake during migration periods. If it were to utilize any of the MCKARNS, it would be only briefly during its migration periods in the fall and spring. Implementation of the Dredge Material Disposal Management Plan should have no affect on this species.

The Arkansas River shiner was formerly found within all of Action Area III. However, following loss of habitat from construction and operation Kaw, Oologah, and Keystone lakes and the MCKARNS on the Arkansas River, the shiner has been extirpated from its former range in the Arkansas River. Implementation of the Dredge Material Disposal Management Plan should have no affect on this species since it is no longer present in this area.

The range of the Interior least tern includes the areas associated with the proposed Dredge Material Disposal Management Plan. This species is present primarily as a migrant through the area during spring and fall migrations. There is at least one record of this species nesting at the confluence of the Canadian River on an island within the Sequoyah National Wildlife Refuge, but this island has become heavily vegetated and is no longer used by terns for nesting. It does nest in proximity to the MCKARNS near its confluence with the Arkansas and Canadian rivers and possibly forages in the MCKARNS at these locations. It is doubtful least terns utilize the Verdigris River portion of the MCKARNS due to lack of suitable sandbar and island habitats.

Implementation of the proposed Dredge Material Disposal Management Plan should not adversely impact existing least tern habitat or nesting habitat. However, implementation of the plan could create new nesting habitat for this species, especially if islands were created (and regularly maintained) from dredged material. Similar concerns exist for least terns with respect to the occurrence of pollutants in the sediments, as previously discussed for bald eagles. Additional testing of sediments would be required to assess the risk, if any, to this species prior to island creation. No critical habitat has been designated for this species; therefore, none will be affected. Implementation of the proposed Dredge Material Disposal Management Plan may have both a positive and negative affect this species.

The Western prairie fringed orchid historically occurred in association with tall grass prairies west of the Mississippi River from Texas to Canada. This species has only been reported to occur in Craig and Rogers counties. The two populations in Oklahoma are both located on privately owned hay meadows. These populations have not been observed since 1975 and are presumed extinct. The recovery plan for this species reports it is absent from Oklahoma and South Dakota. The only portion of proposed action areas that may have contained this species are project lands surrounding Oologah Lake and lands along the Verdigris River portion of the MCKARNS. This species would not be expected to occur on project lands in Action Area III. Implementation of the Dredge Material Disposal Management Plan would not be expected to affect this species since it no longer occurs in the area.

D. Action Area IV, Canadian River, Oklahoma

Action Area IV is not within the documented range of the American alligator, scaleshell mussel, pink mucket pearly mussel, pallid sturgeon, Geocarpon, Western prairie fringed orchid, or Harperella. Continued operation of the Oklahoma portion of MCKARNS would have no affect on these species.

In September 2003, USACE personnel surveyed project personnel within the proposed action area concerning the presence or absence of bats noted during periodic inspections of dams and associated structures. A positive response noting the presence of bats was received from Eufaula Lake. Apparently a large colony of little brown bats are located under the spillway bridge at Eufaula. This population was investigated by Operations personnel in 1998 and did not contain any Federally listed species of bats. No Gray, Indiana, or Ozark big-eared bats have been noted within Action Area III. Continued operation of the Eufaula Lake projects should have no affect on these species.

The American burying beetle has been recorded from several counties within the boundaries of the MCKARNS. One of the largest populations in Oklahoma is found on Camp Gruber, which is located immediately adjacent to the MCKARNS in Muskogee County. USACE surveys for this species have been limited; however, there are no known occurrences of this species from USACE properties in the action area. USACE personnel surveyed for this species on Fry Creeks along the Arkansas River in 1998, and from the Sallisaw Creek Recreation Area at Robert S. Kerr but did not find this species. Survey records from sampling conducted at Camp Gruber (Schnell, 1992) indicate this species is not usually found in bottomland habitats. Also, none were reported on Camp Gruber lands near the MCKARNS, although they are immediately adjacent to it. This species is more commonly found in uplands.

Lake Eufaula lies within Pittsburg and McIntosh counties, Oklahoma. The American burying beetle has been not been reported from McIntosh County, but has been recorded from Pittsburg County and several adjacent counties. USACE personnel conducted one survey for the American burying beetle on Longtown Creek (Pittsburg County) at Eufaula Lake in 2001, but did not find this species. This species has been collected on uplands adjacent to the Canadian River downstream of the dam in Haskell County. It is also reported to occur on Federal property at the Sequoyah National Wildlife Refuge at the confluence of the Canadian River and the

MCKARNS. Since this species is highly mobile and could potentially be found at any given time in suitable habitat on Eufaula, the probabilities are high that it occurs on project lands. The greatest threats to this species are probably the use of pesticides and loss of habitat. The use of pesticides at USACE projects has been severely curtailed and as long as activities involving loss of habitat are not allowed, existing operations of the reservoirs should not affect this species. Continued operation of Eufaula Lake for its authorized purposes should not affect this species if it occurs along the Canadian River downstream of Eufaula Dam. However, any future major ground disturbing activities or land use changes proposed by the USACE through its operation and management program at Eufaula Lake may affect this species.

Numerous bald eagles winter around Eufaula Lake and on the Sequoyah National Wildlife Refuge near the confluence of the Canadian with the MCKARNS. Eagles are commonly seen below both the dam fishing during the winter when hydropower releases keep the river free of ice. There have also been some nesting attempts along the Canadian River immediately below the dam and at the Belle Star Public Use Area on the lake. Both sites are protected by the USACE and placed off limits to any recreational activities during the nesting season, and the area below the dam is protected from November-March of each year.

The midwinter bald eagle counts for Eufaula Lake have varied from 2 in 1995 to as high as 32 in 1991. The bald eagle recovery is strongly linked to the ban of DDT and other organochlorine compounds. Since the ban of DDT and protection from shooting and poisoning, the eagle has recovered. Today, most bald eagle fatalities are associated with power line collisions. From the numbers of eagles using the Eufaula Lake area and nesting activities around the lake, the USACE believes current operations of the project have a positive affect on this species. No critical habitat has been designated for this species; therefore, none will be affected.

The piping plover would be considered a migrant within the western portion of the proposed action area and is known to utilize mudflats near the Winganon Bridge at Oologah Lake during migration periods. Eufaula Lake is within the migratory corridor for this species. If it were to utilize any of the Eufaula Lake project lands, it would be only briefly during its migration periods in the fall and spring. Continued operation of Eufaula Lake for its authorized project purpose should have no affect on this species.

The Arkansas River shiner was formerly abundant throughout the Canadian River system. However, following loss of habitat from construction and operation of Eufaula Lake and the MCKARNS on the Arkansas River, the shiner has been extirpated from that portion of its range on the Canadian River below Eufaula Lake. The USFWS (Federal Register Vol. 66, No. 65, April 4, 2001) reports that it still exists in a 30-mile section of the South Canadian River from the Indian Nation Turnpike Bridge downstream to the upper limits of Eufaula Lake. They report, …"the distributional limit of these populations frequently fluctuates. Management of water surface elevations in Eufaula Reservoir for flood control and the resultant backwater effects routinely alter stream morphology at the downstream extent of the population. Under elevated surface water conditions, the lower reaches of this segment are degraded or may be entirely unsuitable for the Arkansas River shiner". Continued operation of Eufaula Lake for its authorized project purposes should have no affect on this species over that which has already occurred.

Historical flows on the Canadian River have been significantly modified with construction and operation of Eufaula Lake. No longer does the river exhibit the large annual flood events lasting for several days followed by longer periods of median flows. Releases during storm events are now made at a non-damaging rate over a protracted period of time. The lack of large recurring floods does not maintain abundant tern nesting habitat.

Historically, flood events measured at the Whitefield gage below Eufaula Lake with flows of at least 50,000 cfs occurred 42 times between 1939 and 1960, flows of at least 75,000 cfs occurred 24 times, and flows of 100,000 cfs occurred 16 times for the same period of record. Since closure of Eufaula Dam in 1962, flood events of at least 50,000 cfs have occurred only 5 times, flows of at least 75,000 cfs have occurred only 1 time, and flows of at least 100,000 cfs have occurred only 1 time.

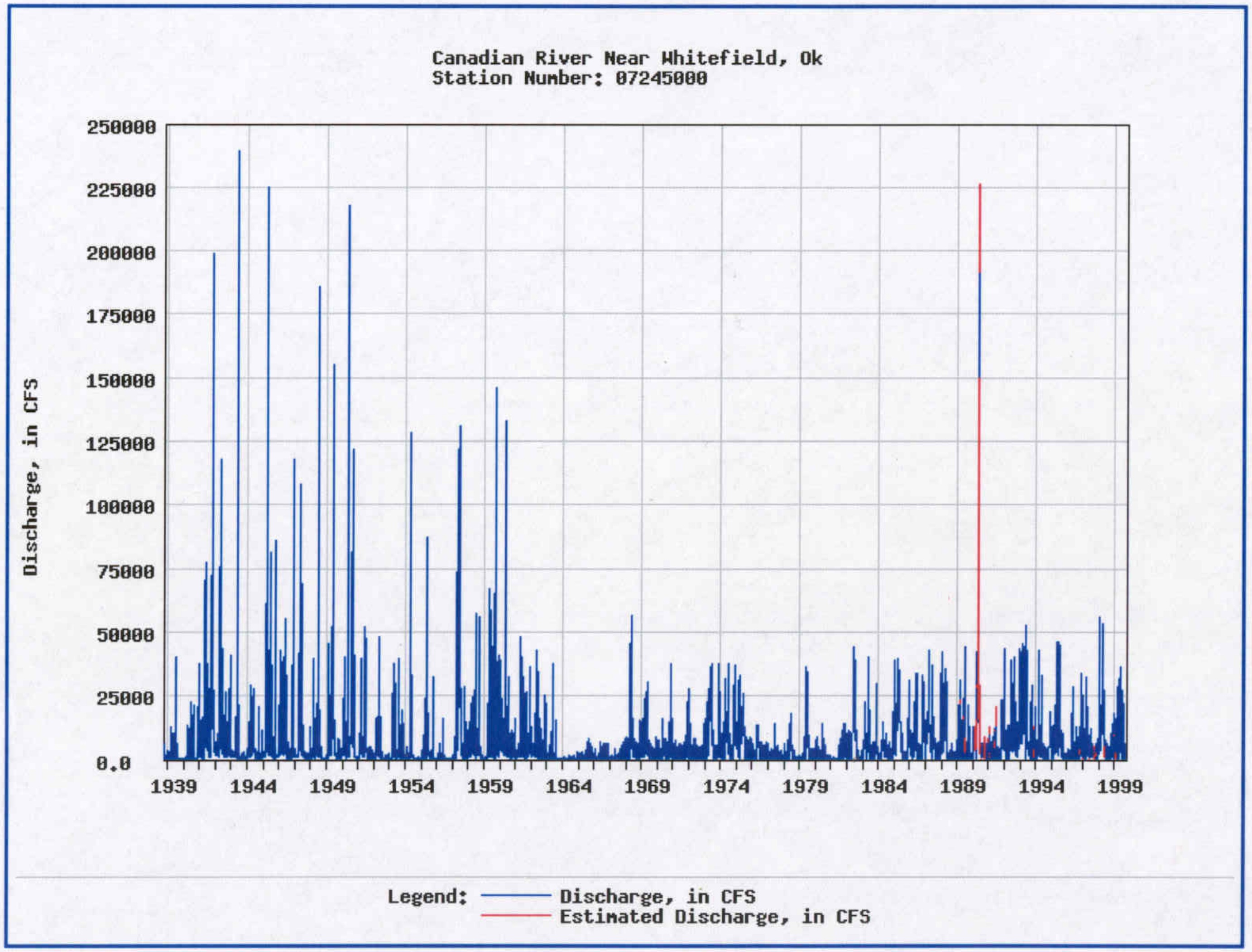
Also, operation of the lake for hydropower has created wide fluctuation in daily flows of the river downstream of the dam, and created many periods of little or no flow during the least tern nesting season. The daily fluctuations at the Whitefield gage attributable only to hydropower releases on a daily cycle basis can vary between over 12,000 cfs running three generating units to less than 2,000 cfs. During periods when less than three units are operating or when the units are shut down for more than a 24-hour period, low flows would be much less than 2,000 cfs unless flood or low flow releases are made.

Off-road vehicle use is a major activity pursued on the sandbars in the area. Four-wheeler activity is evident year-round with groups of vehicles being operated on many of the sandbars on weekends. Four-wheeler activity increases to almost a daily occurrence during the summer when school is out. Fishermen also use four-wheelers to access the river and fish the deeper holes in the river for striped bass during the summer. These high-use activities coincide with much of the tern-nesting season. A major parking and access area is at the Highway 2 bridge at Whitefield. From this access point during low or no flows, recreational four-wheelers utilize the sandbars along the river channel for several miles.

Long term affects on the nesting habitat for this species have also occurred as a result of Eufaula Lake, but have not been quantified. Much of the sediment transported by the Canadian River has become trapped behind the dam. This reduction in stream sediment transport combined with a reduction in large flow events has impacted the quantity and quality of suitable nesting islands for this species. While it has been difficult to measure this loss, it nonetheless has occurred and will continue to occur. Evidence of this is can be seen from immediately below the dam to just above the Whitefield Bridge where the river has degraded to rock with few if any islands remaining in this reach that are suitable for nesting sites. Presently, the only available nesting habitat on the Canadian River is from the Whitefield Bridge downstream to the upper limits of the MCKARNS navigation pool.

From Figure 14, it can be seen that least terns are present along the lower Canadian River and attempt to nest. However, survey data indicate reproductive success has been severely limited. In 1999, no reproduction was noted, though 106 adults were found on the first survey. It appeared that all nests had been flooded. In 2000, some reproduction occurred, but was

Historical Streamflow Daily Values Graph for Canadian River Near Whitefield, Ok (07245000)



impacted by predation caused by periods of low flow due to hydropower operations. The 2001 surveys found 65 adults and 7 flying young. Reproduction during 2001 was minimally successful. In 2002, there were 52 adult birds and 31 nests. Six chicks were counted, but only 4 fledglings were produced. Evidence suggests that production was thought to be severely impacted by a severe summer thunderstorm producing large hail, heavy rain, and winds in the small nesting area in late July.

Under existing operations, Eufaula Lake would continue to be operated for its authorized project purposes. Potential affects on lest terns would be similar to those documented to have occurred in the past, which include flooding of nests as a result of flood releases and land bridging as a result of hydropower operations. With implementation of the measures and procedures outlined in the 2002 Management Guidelines and Strategies for Interior least terns, some "take" will probably continue to occur. To date, implementation of these measures has not achieved the desired levels of results as they have for the Arkansas River below Kaw and Keystone lakes. It is doubtful that this species will ever be too successful in the Canadian River below Eufaula for the following reasons

- Limited availability of suitable nesting islands
- Limited length of river suitable for nesting
- Uncontrolled recreational use of the river from adjacent private property
- Occurrence of severe summer thunderstorms

With continued implementation of the measures and procedures outlined in the 2002 Management Guidelines and Strategies for Interior least terns, "take" will continue to occur, but it is highly unlikely that recovery of this species to the recommended recovery plan goal of 300 adults can be achieved on the Canadian River below Lake Eufaula. USACE will continue operation of Eufaula Lake under the agreed upon Management Guidelines and Strategies for least terns. Implementation of the long-range strategies identified in the plan would be consistent with recovery of the species, but their effectiveness is questionable. It might be more prudent to consider implementing these measures in other areas where the chance for success is more practical and certain.

E. Action Area V, Red River Below Denison Dam to Index, Arkansas; Texas; and Oklahoma

Action Area V is not within the expected range of Gray bat, Indiana bat, Ozark big-eared bat, pink mucket pearly mussel, Arkansas River shiner, pallid shiner, *Geocarpon,* Western prairie fringed orchid, or Harperella. Consequently, continued operation of Lake Texoma and the Red River system of lakes for their authorized project purposes would have no affect on these species.

Action Area V is on the periphery of the range of American alligator, but it would be considered a possible visitor to the lower portion of the Red River. This species was originally classified as endangered throughout its range in 1967 due to concerns over harvesting. Since its protection, it has recovered to the point where it is neither in danger of extinction nor likely to become so in the foreseeable future. Continued operation of the Red River system should have no affect on this species.

The American burying beetle is known to occur in Bryan, Choctaw, and McCurtain counties along the Red River. USACE personnel have conducted limited surveys for the American burying beetle on the Washita Arm of Lake Texoma and at Hugo Lake, but did not collect this species. One specimen has been observed and was filmed on a gopher carcass near Hugo Lake (personal communication David Stewart). Since this species is highly mobile and could potentially be found at any given time in suitable habitat on Lake Texoma and other USACE lakes on tributary streams downstream of Lake Texoma, the probabilities are high that it occurs on project lands. The greatest threats to this species are probably the use of pesticides and loss of habitat. The use of pesticides at USACE projects has been severely curtailed. However, any major ground disturbing activities or land use changes at Lake Texoma or other dams located on tributaries downstream has the potential to affect this species if it occurs on project lands.

The Whooping Crane would be considered a rare migrant through Action Area V. While it is possible that it could use Lake Texoma and the Red River below Denison Dam during both spring and fall migration periods, records indicate it primarily uses the Red River above Lake Texoma. Historical populations occurring in Arkansas have apparently been extirpated. Continued operation of Lake Texoma and the Red River system for their authorized project purposes should have no affect on this species.

As documented in Section IV, bald eagles utilize both Lake Texoma and the Red River below Lake Texoma. Survey teams conducting Interior least tern surveys on the Red River below Lake Texoma report sighting bald eagles during the summer, which indicates this species probably nests as well as winters along this stretch of the river. Currently, there is a study underway on Lake Texoma to investigate reallocation of 300,000 acre feet of hydropower storage in Lake Texoma to water supply. If study findings are positive and implemented, this could have a minor change on the amount of water being released downstream into the Red River. However, data on these potential changes are not available at the present time so projected impacts on this species cannot be evaluated.

In Oklahoma, the scaleshell mussel has been reported from the Red River Basin in southeastern Oklahoma. It has been reported to occur in the Kiamichi, Mountain Fork, and Lower Little Rivers, and from the Poteau River, a tributary to the Arkansas River (USFWS, 2003b). It is globally ranked as S1 Critically Imperiled for Oklahoma.

Within the State of Arkansas, this species is reported to occur in seven counties including Crawford, Fulton, Jackson, Lawrence, Perry, Sevier, and Francis (USFWS, 2003b). It may occur in the Little River system, which is also a tributary of the Red River in Arkansas. In Oklahoma, recent surveys of the Red River Basin failed to find this species (Federal Register, 2001). It appears the most likely occurrence of this species would be the Kiamichi River above Hugo Lake.

While this species occurs in the general area associated with Action Area V, it does not appear to be found within the Proposed Action Areas associated with the Red River. Continued system operations of the Red River for its authorized project purposes should not impact this species since it is unlikely to be found in the lower Red River.

Lake Texoma and the Red River below the lake are within the migration corridor of the piping plover. It is possible for this species to use mudflats associated with the Red River system of lakes and sandbars along the Red River during fall and summer migration periods (February-April and July-September) of each year. However, there are no records of frequently used areas noted for this species in Action Area V. Due to the limited amount of time this species would be in Action Area V, continued system operations in the Red River for its authorized project purposes should not affect this species.

The Interior least tern was once common in the Red River Basin between 1910 and 1960 and has been reported from most of the counties along the Texas-Oklahoma border. They were also known to occur on the Prairie Dog Town Fork of the Red River in the Texas panhandle. Previous to recent surveys populations of this species in the Red River above and below Lake Texoma found only a few scattered colonies

The USACE, Tulsa District and the USFWS conducted an aerial survey in July 1991 on segments of the Red River above and below Denison Dam. They counted two colonies with ten or more terns and two with four to nine terns and reported eight "potential or probable colonies" in the BLM portion of the river upstream of Lake Texoma. Below the dam, they reported six to seven colonies of ten or more birds and 12-14 sites with four to nine birds. Adults seen totaled 139-152 upstream and 323-339 downstream. The main concentration of downstream individuals and colonies was between U.S. Highway 78 and U.S. Highway 71 below Denison Dam.

The USFWS and BLM personnel surveyed the Red River upstream of Lake Texoma from the North Fork of the Red River to 79 miles downstream in July 1994. They reported over 200 adults with little evidence of nesting or chicks. The lack of nests and chicks along with the low number of immature birds seen (three) led USFWS personnel to conclude that flood flows apparently severely reduced nesting success during the 1994 season.

The USACE, Tulsa District has been conducting intensive tern nesting surveys on the lower 240-mile stretch of the Red River below Lake Texoma since 1999. A summary of these surveys is shown in Figure 17. Bird numbers for the lower Red River are consistently higher than those reported earlier by the USFWS, with the numbers of adult birds being over 600 for the years surveyed. However, reproduction in this reach has not been as great as anticipated despite efforts to manage flows in this reach for the benefit of nesting terns. An FBR of 0.5 has been achieved in only 2001, yet tern numbers appear fairly stable to increasing. The large influx of individuals in 2001 cannot be explained, but could reflect an influx of terns moving to the Red River from some other geographic region. Based on the numbers of adult birds returning since 1991, it would appear this population is growing.

Historical flows on the Arkansas River were significantly modified with the construction Denison Dam and Lake Texoma. No longer does the river exhibit the large annual flood events lasting for several days followed by longer periods of median flows. Releases during storm events are now made at lesser non-damaging rates over a protracted period of time. Also, operation of the lake for hydropower has created wide fluctuation in daily flows and created many periods of little or no flow.

Long term affects on the nesting habitat for this species have also occurred as a result of constructing Lake Texoma, Waurika, Hugo, Pat Mayse, and possibly the chain of lakes on the Little River in Arkansas, but have not been quantified. Much of the sediment load transported by these rivers has become trapped behind the dams. This reduction in stream sediment transport combined with a reduction in large flow events and flood duration have impacted the quality of suitable nesting islands for this species. While it has been difficult to measure this loss, it nonetheless has occurred and will continue to occur with operation of the reservoirs.

Under existing operations, Lake Texoma and the other Red River tributary lakes would continue to be operated for their authorized project purposes. Potential affects on least terns would be similar to those documented to have occurred in the past, which include flooding required by high flood release operations, land-bridging of nesting islands as a result of hydropower operations, and long term habitat loss.

With implementation of the measures and procedures outlined in the 2002 Management Guidelines and Strategies for Interior Least Terns, some "take" will continue to occur, but continued existence of the species should not be jeopardized. Continued operation of these reservoirs with the existing management guidelines and implementation of the long-range strategies identified in the plan should be consistent with recovery of the species. No critical habitat has been designated for this species; therefore, none will be affected.

The operation of Lake Texoma and the other Red River tributary lakes has impacted the population of Interior least terns nesting below Denison Dam, both positively and negatively. Operation of Lake Texoma and the associated impoundments has the potential for causing an adverse affect on this species and its habitat if release guidelines are not followed. However, based on HQUSACE surveys in the Red River Basin since 1999, it appears this population of least terns is increasing despite the amount of take occurring.

SECTION VI. SUMMARY OF DIRECT AND INDIRECT EFFECTS OF THE PROPOSED ACTION(S)

The proposed action(s) were evaluated and the anticipated effects of the proposed actions determined in accordance with the ESA. The potential direct, indirect, and cumulative impacts identified with respect to the listed species and proposed actions are summarized as follows and are shown in Table 12.

A. Interior Least Tern.

- Damage or destruction to nests, eggs, or chicks resulting from operation of reservoirs for flood control during breeding period.
- Damage or destruction to nests, eggs, or chicks resulting from recreational uses of sandbars and islands during the breeding period under low-flow conditions.
- Modification of nesting islands due to vegetation encroachment from lack of scouring flows.
- Gradual diminution of suitable nesting islands and sand bars due to the capture of sediment by main stem dams and sand and gravel operations.
- Exposure of nesting sites to terrestrial predators and increased recreation due land-bridging.
- Loss of nesting habitat behind navigational dikes and revetments due to vegetation encroachment.
- Potential for increase of turbidity during dredging operations, which could limit ability of Interior least terns to capture prey species.
- Potential for increased levels of pollutants and uptake of contaminants at proposed open water dredge disposal sites
- Potential for increasing nesting island habitat from placement of dredge materials.

B. Bald Eagle.

- Potential loss of habitat (mature cottonwood trees) used for perching and roosting associated with creation of dredge material disposal sites.
- Potential for temporary increases in turbidity during dredging operations, which could limit ability of bald eagles to capture prey species.
- Potential long-term increase in shallow water habitat, which could increase prey base and facilitate capture of prey species.

- Potential for increased levels of pollutants and uptake of contaminants at proposed open water dredge disposal sites.

C. American Burying Beetle.

- Potential for slight increase in flooding frequency of flood pool lands in 11 upstream reservoirs contributing flow to the Arkansas River.

- Potential for loss of habitat on USACE projects within the range of this species due to land use changes and out-granting real estate practices.

- Potential for loss of habitat if dredge material is placed on upland sites.

D. Pallid Sturgeon.

- Potential for loss of habitat, juvenile rearing habitat, forage base, and spawning cues from channelization, dredging, and operational activities associated with the MCKARNS, if this species occurs in the lower White and Arkansas rivers.

TABLE 12. SUMMARY OF POTENTIAL IMPACTS ON FEDERALLY LISTED SPECIES OCCURRING IN THE PROPOSED ACTION AREAS

Species Listings	Status	Range		Impacts
		OK	AR	
Alligator, American (*Alligator mississippiensis*)	T (S/A)	X	X	No affect.
Bat, Gray (*Myotis grisescens*)	E	X	X	No affect. Not likely to occur on project lands.
Bat, Indiana (*Myotis sodalis*)	E	X	X	No affect. No likely to occur on project lands.
Bat, Ozark big-eared (*Corynorhinus townsendii ingénues*)	E	X	X	No affect. Not likely to occur on project lands.
Beetle, American burying (*Nicrophorus americanus*)	E	X	X	Potential for may affect if this species occurs on project lands.
Crane, whooping (*Grus americana*)	E	E	X	No affect, species not present over most of action areas.
Eagle, bald (*Haliaeetus leucocephalus*)	T	X	X	May affect due to loss of bottomland hardwoods resulting from widening of the Verdigris River. Positive affect from created wetlands.
Mucket, pink (*Lampsilis abrupta*)	E	-	X	No affect. Species occurs only in the White River well above the influence of the MCKARNS.
Mussel, scaleshell (*Leptodea leptodon*)	E	X	X	No affect. Species not likely to occur on project lands.
Plover, piping (*Charadrius melodius*)	T	X	-	No affect. Species only occurs in action areas during migration.
Shiner, Arkansas River (*Notropis girardi*)	T	X	X	No affect. Species extirpated from project area.
Sturgeon, pallid (*Scaphirhynchus albus*)	E	-	X	May affect due to construction and operation of the MCKARNS if species is found to occur in the lower White or Arkansas rivers.

TABLE 12. (Continued)

Species Listings	Status	Range		Impacts
		OK	AR	
Tern, least (*Sterna antillarum*)	E	X	X	May affect due to operation of projects for authorized project purposes (both positive and negative affects).
Geocarpon minimum *(no common name)*	T		X	No affect. Species not likely to occur in project area.
Orchid, western prairie fringed (*Platanthera praeclara*)	T	X	-	No affect. Species not likely to occur in project area.
Harperella (*Ptilimnium nodosum*)	E	-	X	No affect. Species not likely to occur in project area.

SECTION VII. OTHER NON-USACE ACTIVITIES OCCURRING IN THE PROPOSAL ACTION AREAS THAT MAY POTENTIALLY IMPACT FEDERALLY LISTED SPECIES

The procedures for conducting consultation and conference activities under Section 7 of the ESA require the Federal agency preparing the BA to describe any known, unrelated, future non-Federal activities ("cumulative effects") reasonably certain to occur within the action area that are likely to affect the species. With respect to this BA, the USACE has identified two such actions that have the potential to affect one of the Federally listed species, the Interior least tern.

The first action is a proposed surface water delivery system as an irrigation source for a large area of southwest Little River County, Arkansas. It is being proposed by the USDA Natural Resources Conservation Service and is entitled the "Walnut Bayou Irrigation Project." The proposed plan consists of installation of a surface water delivery system to pump water from the Red River into a series of canals, streams, and pipelines, which will deliver irrigation water to farms. The proposed plan would pump up to 385 cfs from the Red River during May through September, which coincides with the least tern nesting season. Potential impacts to this species include a reduction in stage of low flows on the Red River. This has the potential to increase the occurrence of land bridging of least tern nesting islands, which increases the risk of predation and human disturbance to nesting least terns. If implemented, this action could have additional impacts on nesting least terns over those occurring as a result of operational activities associated with existing USACE projects above Index, Arkansas.

The NRCS is presently consulting with the USFWS with respect to this proposed action. If a Section 404 permit is required for this activity, the Regulatory Branch of the Little Rock District, USACE will become involved with this action through the Section 404 permit process.

As previously noted in the BA, long-term effects on nesting habitat for this species have occurred as a result of construction of main stem impoundments. Much of the sediment load transported by these rivers has become trapped behind dams. This reduction in stream sediment transport combined with a reduction in large flow events and duration has impacted both the quantity and quality of suitable nesting islands for this species. While it is difficult to measure and quantify this loss, it nonetheless has occurred and is noticeable in large stretches of the rivers immediately below Lakes Texoma, Keystone, Kaw, and Eufaula.

The second "cumulative effect" identified by the USACE concerns the long-term loss of nesting habitat in the Arkansas and Red rivers resulting from removal of sand and gravel for commercial purposes. This is especially true for the stretch of the Arkansas River from below Keystone Lake to Muskogee, Oklahoma, where numerous operators remove large amount of material daily. Over time, removal of this material for commercial purposes may contribute to shortages f sand available to the fluvial processes for creation and maintenance of island habitat for this species. Most of the commercial sand operations are suction dredge operations and are deemed non-regulated activities under Section 404 of the Clean Water Act. Consequently, these activities and any impacts on threatened or endangered species are largely uncontrolled.

SECTION VIII. DETERMINATION

Based upon the best available information, the USACE has evaluated the impacts of its continued operation of its existing projects, proposed projects, studies, and cumulative impacts for the noted 16 Federally listed species and concludes there would be no affect on the following Federally listed species; American alligator, Gray bat, Indiana bat, Ozark big-eared bat, Whooping crane, Scaleshell mussel, Piping plover, Arkansas River shiner, *Geocarpon*, Western prairie fringed orchid, and Harperella. This is due to the fact that the range of many of these species is not associated with the projects, the species is no longer found in the area, suitable habitat is not present on project lands, or the impacts were considered to be inconsequential.

The evaluation also concludes that continued operation of its existing projects, proposed projects, studies, and cumulative impacts may have an affect on the following Federally listed species and or their habitats: Interior least tern, Pallid sturgeon, Bald eagle, and American burying beetle.

Documented evidence has shown that operation of USACE reservoirs for their authorized project purposes has had and will continue to have an impact, both positive and negative, on the Interior least tern and its habitat. Operation of these reservoirs for flood control and hydropower have the potential to reduce nest flooding during flood events and conversely have flooded nesting terns and created occurrences of land bridging, which have resulted in documented take of this species. Though unquantifiable, there has been a gradual diminution of suitable nesting islands and sand bars immediately downstream of large reserviors due to the capture of sediment by these impoundments. Sand and gravel operations are also partially responsible for the removal of sand from the rivers.

Implementation of the Dredge Material Disposal Management Plan and Phase II of the Arkansas River Navigation Study could have both a positive and negative impact on least terns. With disturbance of sediments by dredging, there is a potential for increased levels of pollutants and uptake of contaminants at proposed dredge disposal sites. However, with this proposal, an opportunity exists to create additional nesting habitat for this species.

Several issues have arisen under operation of the existing BO, which the USACE, Tulsa District believes should be readdressed under the new BO. One deals with the calculation of "take" based upon an established FBR. From surveys since 1990, we believe that calculation of an FBR does not represent the most acceptable method of attributing "take" to the USACE. There are too many variables associated with calculating fledging ratios to make it a reliable tool for estimating "take". These variables include mobility and hiding ability of chicks, calculation of fledge rates between colonies, movement of fledglings away from colony sites, and sources of mortality attributable to non-USACE related activities such as aerial predation and weather.

The USACE believes that a more acceptable measure of "take" would be to base it upon factors the USACE can control or manage. Consequently, the USACE requests the BO consider this request and propose that in lieu of FBR's, the USACE be required to measure "take" by providing the birds with an appropriate number of nesting days free of flooding and with an acceptable level of low flows.

While no records exist for the occurrence of the pallid sturgeon in either the Arkansas River or the White River, it is reasonable to assume that at times it could be found in the lower White river. Therefore, it is reasonable to assume that implementation of the Arkansas River Navigation Study, Phase II, Channel Modification, could have an affect on this species if it is found to occur in this area. Additional surveys for this species would be required to confirm its occurrence prior to implementation of this project.

The bald eagle occurs throughout all the proposed action areas. Most of the proposed actions would have no affect on this species. However, implementation of the Dredge Material Disposal Management Plan and Phase II of the Arkansas River Navigation Study, Deepening and Widening, would have the potential to negatively affect this species directly by removal and loss of habitat and indirectly by disturbing sediments that may contain contaminants.

The known range of the American burying beetle is found throughout much of the MCKARNS and the 11 supporting reservoirs. Limited sampling has failed to find this species on USACE managed properties, but given the mobility of this species it probably is there if suitable habitat exists. Since complete surveys have not been conducted at any of the operating projects within the proposed action areas, it is reasonable to assume that it may be present. Consequently, continued operation of existing reservoirs, the MCKARNS, and supporting projects may have an affect on this species. Indirectly, operation of the 11 supporting reservoirs may have an indirect adverse impact on this species through implementation of land use changes and the real estate outgrant programs associated with operational activities.

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APPENDIX 1

CORRESPONDENCE

APPENDIX 3

USACE

DRAFT
DREDGE MATERIAL DISPOSAL MANAGEMENT PLAN
AND SITE DRAWINGS

APPENDIX 4

HYDROGRAPHS FOR RED RIVER BELOW LAKE TEXOMA

APPENDIX 5

USACE LEAST TERN SURVEY FOR RED RIVER ABOVE LAKE TEXOMA

C.4
USFWS Biological Opinion

In Reply Refer To:
FWS/R2/OKES/
02-14-04-F-0172

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
222 South Houston, Suite A
Tulsa, Oklahoma 74127
918/581-7458 / (FAX) 918/581-7467

June 28, 2005

District Engineer
Attn: Planning, Environmental, and Regulatory Division
U.S. Army Corps of Engineers
1645 South 101st East Avenue
Tulsa, Oklahoma 74128-4609

Dear Colonel Kurka:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (opinion) pursuant to section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq*.). This joint U.S. Army Corps of Engineers (Corps) and Southwestern Power Administration (SWPA) action involves operating multipurpose projects on the Red River from Lake Texoma to Index, Arkansas, the Canadian River from Eufaula Lake to the Arkansas River confluence, and all of the McClellan Kerr Arkansas River Navigation System (MKARNS) excluding Grand Lake. The Corps is the lead Federal agency for this consultation.

The Service has reviewed the recent information provided by the Corps for the Grand Lake portion of the MKARNS. We agree that, with modifications proposed by the Corps, Phase I and II of the Arkansas River Navigation Study (ARNS) are not likely to significantly affect Corps operations at that reservoir. Although the ARNS may not increase the frequency of flooding within gray bat *Myotis grisescens* maternity caves, the existing Corps flood control operations at Grand Lake occasionally flood these caves and may flood Neosho madtom *Noturus placidus* habitat upstream. It is unlikely that flood control operations could be sufficiently altered to completely avoid adverse effects to federally-listed species, and formal consultation regarding these operations likely will be required to comply with section 7 of the ESA. However, we agree with your request to delay this consultation until appropriate data can be obtained regarding potential impacts to listed species at that reservoir. We continue to recommend that this consultation include the Federal Energy Regulatory Commission, because some of their ongoing and future actions (such as hydropower generation and a potential new rule curve) are interrelated with the Corps flood control operations at Grand Lake. We agree that a separate consultation would allow time for necessary studies to be conducted at Grand Lake and allow the consultation on the remainder of the proposed action to continue on schedule. However, until that consultation is completed, the Corps currently has no exemption from section 9 of the ESA for take related to flood control operations at Grand Lake.

At least seventeen federally-listed species occur in or near the Action Area. The Corps determined in their Biological Assessment (BA) that only four are likely to be affected by the proposed action (when the Grand Lake portion is excluded). The Service concurs with the Corps' determination that the endangered American burying beetle *Nicrophorus americanus* (ABB) and interior population of the least tern *Sterna antillarum* (hereafter referred to as least tern) may be affected by the proposed action. The Corps has agreed to incorporate actions recommended by the Service to minimize adverse effects to these species, but adverse effects to the ABB and least tern are not completely avoided by the proposed action.

Information related to potential project-related impacts for the remaining two of these four species is limited. Potential impacts to the threatened bald eagle *Haliaeetus leucocephalus* related to contaminants in the dredged material cannot be fully assessed until testing of sediments to be dredged is completed and the status of the endangered pallid sturgeon *Scaphirhynchus alba* in the Action Area is unknown. There are no records of the species occurring in the Action Area, but the Service agrees that pallid sturgeon could occur there. The Service agrees that the proposed action may affect both the bald eagle and pallid sturgeon, but based on the existing information, we would support a "not likely to adversely affect" determination for both species. The preliminary contaminants information for sediments does not suggest impacts to bald eagles are likely and the proposed changes in flows are unlikely to affect potential pallid sturgeon habitat. Therefore, the bald eagle and pallid sturgeon will not be addressed in this consultation. While the Service does not anticipate that the proposed project would impact these species, if new information indicates the contrary, then the Corps should reinitiate consultation.

The Ivory-billed woodpecker *Campephilus principalis* was recently discovered in or near portions of the Action Area after the BA was prepared and was not addressed in the BA. The Corps has determined that the proposed action is not likely to adversely affect the Ivory-billed woodpecker and we concur with that determination, but we invite the Corps to assist in recovery actions for this species.

This opinion emphasizes anticipated effects of the proposed action on the least tern and is based on the best available scientific and commercial information, including the Corps BA, Service files, pertinent literature, discussions with recognized species authorities, and other reliable sources. A complete administrative record of this consultation is on file in the Oklahoma Ecological Service's Field Office (OKES) in Tulsa.

CHRONOLOGY OF SECTION 7 EVENTS/CONSULTATION HISTORY

The Corps has been attempting to operate Kaw and Keystone Reservoirs on the Arkansas River in Oklahoma under the provisions of a biological opinion completed on March 16, 1998. Since that time, incidental take has been exceeded in at least two years and some terms and conditions in the biological opinion have not been fully implemented. After several meetings and review of operating conditions for the Arkansas River with respect to terms and conditions established in the 1998 opinion, the Corps decided to reinitiate consultation.

In August 1998, the Service also requested the Corps initiate section 7 consultation for Corps actions on the Canadian River below Eufaula Reservoir and the Red River below Denison Dam. The Corps agreed in their November 6, 1998, letter and two BAs concluding a "may affect" determination were subsequently prepared and provided by the Corps. Additional information was requested by the Service for both BAs. After reviewing the proposed action, the Corps and Service agreed to combine the ongoing consultations on the Red, Arkansas, and Canadian Rivers.

The combined proposed action now includes two additional studies that would impact federally-listed species. The first study is the ARNS, which initially consisted of two phases. Phase I would have addressed system operations of the MCKARNS, and Phase II would address proposed channel modifications. The second study involves revising the Dredge Material Disposal Management Plan for the Oklahoma portion of the MCKARNS. The Corps also formed a multi-agency Least Tern Committee in 2002 to develop and provide comprehensive guidelines for management and protection of least terns nesting below Corps water resource projects on the Arkansas, Canadian, and Red Rivers. These management guidelines and strategies have been implemented by the Corps and are now part of the proposed action.

A chronology of previous section 7 consultation activities prior to 1998 on the Arkansas River system in Oklahoma can be found in the Service's opinion dated March 16, 1998. This opinion provides a history of all activities and correspondence from the start of informal consultation in 1986 to issuance of the opinion in 1998. The following is an update of all events and issues with respect to the consultation since issuance of the 1998 opinion for the Arkansas River:

- August 11, 1998. Service letter to Corps requesting Corps initiate formal consultation and begin efforts to minimize adverse effects on the Interior least tern at Corps projects on the Canadian and Red Rivers.

- November 6, 1998. Corps letter to Service agreeing that Corps would survey Red and Canadian rivers in 1999 and use the information to prepare a BA.

- March 13, 2001. Corps study plan for nesting habitat evaluation furnished to Service. This study plan would initiate implementation of Reasonable and Prudent Measure No. 5 of the 1998 opinion.

- March 15, 2001. Corps letter to Service stating that the Tulsa District has and will assume the lead responsibility for any future consultation on the operation of Kaw and Keystone per Memorandum of Understanding (MOU) dated July 23, 1980, signed by the Administrator, SWPA and the Corps Division Engineer, Southwestern Division. The MOU states, "The administrator recognizes the Corps responsibility to operate the projects to serve all authorized functions including power."

- April 20, 2001. Interagency meeting between Service, Corps, SWPA, and U.S. Department of Interior (DOI), Office of the Field Solicitor. The meeting was conducted to resolve agency differences with respect to compliance with the ESA, section 7 consultation requirements, and ways to improve communication among the agencies.

- May 31, 2001. Service letter notifying Corps and SWPA that they should avoid and minimize “take” related to operation of projects on the Canadian and Red rivers and should reinitiate consultation for the Arkansas River projects.

- July 02, 2001. Corps submitted a “may affect” BA to Service on the effects of operating Denison Dam on the Red River and requested initiation of formal section 7 consultation.

- August 14, 2001. Service letter acknowledging receipt of the BA for the operation of Denison Dam on the Red River and concurring with the findings. The Service requested additional information on the Corps proposed actions to allow development of an accurate assessment of potential take and appropriate recommendations to avoid or minimize take.

- December 18, 2001. Letter from the Corps submitting their BA to Service concerning the effect of operating Eufaula Dam for its federally authorized purposes on the least tern and request for initiation of formal section 7 consultation.

- January 30, 2002. Service letter requesting additional information regarding the proposed action and cumulative effects related to the Eufaula Project.

- February – June 2002. A team was established to develop least tern management guidelines for the Tulsa District. The guidelines were implemented during the 2002-2003 least tern nesting season.

- November 20, 2002. A meeting was held between Corps and Service staff to discuss combining the section 7 consultations for projects on the Red, Canadian, and Arkansas Rivers.

- March 10, 2003. Corps letter notifying the Service of their intent to prepare a revised BA to include all projects on the three river systems.

- April 22, 2003. Service letter supporting the Corps proposal to prepare a BA regarding operation of multi-purpose projects in all three river systems and reminding the Corps and SWPA of obligations to avoid and minimize take until the consultation was completed.

- July 30, 2003. Corps letter to the Service requesting an official list of federally-listed species within the designated action areas.

- August 28, 2003. Service letter updating the list of species previously provided to the Corps in a planning assistance report for the ARNS dated April 2, 2001.

- November 20, 2003. Corps letter transmitting the BA to the Service.

- December 17, 2003. Service letter providing comments on the BA and requesting additional information.
- April 22, 2004. Corps letter to the Service requesting a modification of the proposed action to exclude operations at Grand Lake.
- May 5, 2004. Service letter to the Corps agreeing to modify the proposed action and requesting a description of the modified action and recommending that impacts at Grand Lake be addressed in a separate consultation.
- July 7, 2004. Corps letter to the Service describing the modified action at Grand Lake.
- August 12, 2004. Draft biological opinion provided to the Corps.
- September 30, 2004. Corps letter to the Service providing comments on the draft opinion and describing a change in the proposed action to incorporate standard practices to minimize take of ABBs.
- February 11, 2005. A revised draft biological opinion and transmittal letter provided to the Corps.
- May 17, 2005. Meeting with Colonel Kurka to discuss the Corps' comments on the draft biological opinion. A letter dated May 16, 2005 providing written comments on the revised draft was hand delivered by the Colonel.

Corps, Little Rock Chronology

After meeting with the DOI and the Service in 1985, the Little Rock District entered into consultation pursuant to section 7 of the ESA for operations of the Arkansas portion of the MKARNS. Mr. Fred Bagley of the Jackson, Mississippi Area Office of Region IV was the Service point of contact on this consultation. Mr. Clyde Gates represented the Corps, Little Rock District.

The consultation was initiated because the Arkansas River in Arkansas had been a historic nesting area for the least tern prior to construction of the navigation system. The navigation system at that time consisted of a series of locks and dams, two lakes, and various revetments to better maintain a navigational channel. As a result of the consultation, the Little Rock Corps developed a management plan that would protect and enhance nesting populations of the least tern on the navigation system in Arkansas. The management plan was coordinated with the Arkansas Department of Natural Heritage, the Arkansas Game and Fish Commission, and the Corps' Jackson Area office. The management plan has been in effect since 1986, but has not been fully implemented. The Corps failed to implement appropriate actions to avoid project-related adverse effects to least terns recommended by the Service in a June 3, 1986, letter.

DESCRIPTION OF PROPOSED ACTION

The proposed action is the operation and maintenance of Corps multi-purpose projects for portions of the Arkansas, Red, and Canadian Rivers in Oklahoma, Texas, and Arkansas. The proposed action includes flood control, navigation, water supply, recreation, and hydropower operations (including SWPA operations). The proposed action includes several proposed changes to existing operations, including the ARNS, and reallocation of water supplies in some reservoirs. The least tern management guidelines for the Tulsa District of the Corps (appendix A) are included in the proposed action and the BA references a Least Tern Management Plan (appendix A) has been in effect for the Little Rock District since 1986. A more complete description of the proposed action is provided in the BA (USACE 2003) and is incorporated by reference. The proposed action described in the BA has been subsequently modified by the Corps to:

1. Exclude and modify operations at Grand Lake in Oklahoma and initiate consultation for those operations at a later date.

2. Incorporate standard actions (such as conducting surveys and baiting away) recommended by the Service to minimize take of the ABB.

On September 30, 2004, the Corps submitted a letter of amendment to the BA. This amendment addressed conservation measures that the Corps and SWPA have incorporated into their project implementation methods to minimize adverse impacts to the ABB.

The following description of construction Best Management Practices (BMPs) for minimizing adverse effects to the ABB is included in the proposed action:

1. The Corps will evaluate the likelihood of ABBs in the project area by reviewing the Service's Oklahoma Ecological Services county list of Threatened & Endangered species at: <http://ifw2es.fws.gov/Oklahoma/ctylist.htm>.
2. If the project site is in a county where the ABB *is not* believed to occur, the Corps will proceed without further precautions with regard to the ABB.
3. If the project site is in a county where the ABB is known to occur, the Corps will evaluate the project area for ABB habitat. If the project site is confined to one or more of the following habitats, the Corps will conclude that the habitat is not suitable for the ABB and proceed without further precautions with regard to the ABB.
    - Land that has already been developed and no longer exhibits surficial topsoil or leaf litter.
    - Land that is tilled on at least an annual basis.
    - Soil that is greater than 70 percent sand.
    - Soil that is greater than 70 percent clay.
    - Land where greater than 80 percent of the soil surface is comprised of rock.

- Land where greater than 80 percent of the subsurface soil structure within the top 4 inches is comprised of rock.

- Land that meets the Corps definition of wetland. (However, projects developed in this type of habitat will need to be reviewed by the Corps to ensure compliance with section 404 of the Clean Water Act.)

4. Projects in areas that exhibit suitable habitat for the ABB, *i.e*., do not exhibit the above characteristics, will be evaluated by the Corps for the presence/absence of the ABB in the immediate project area. This will be done by reviewing the Service's database of ABB surveys at: <http://ifw2es.fws.gov/oklahoma/beetle1.htm>.
5. If a nearby ABB survey (within a five-mile radius of the proposed construction site) is found, the Corps will apply the survey results to the project site. If both positive and negative surveys are found to be applicable, positive surveys will always be applied over negative surveys.
6. If applicable survey results are negative for ABB occurrences, the Corps will proceed with the project without further precautions with regard to the ABB.
7. If applicable survey results are positive for the ABB, the Corps will proceed with the project as follows:

    - Whenever possible, the Corps will postpone construction until the active season of the ABB, *i.e*., between May 20 and September 20, when nighttime temperatures average above 60°F. The Corps will begin construction only after implementing the Service's current Baiting Away protocol or current Trapping and Relocating protocol whichever is determined more appropriate.

8. If there are no existing surveys applicable to the proposed construction site and the construction will occur during (or can be postponed until) the active season of the ABB, the Corps will either:

    - Assume ABBs are present and implement the Service's current Baiting Away protocol.

    - Conduct an ABB survey of the project area.

9. If an ABB survey of the project area is negative, the project will proceed without further precautions with regard to the ABB.
10. If an ABB survey of the project area is positive, the Service's current Baiting Away protocol or current Trapping and Relocating protocol will be utilized prior to proceeding with the project.

This opinion addresses effects to federally-listed species related to Corps studies, and operational and management activities on projects located within these areas:

- The main stem of the Arkansas River from Kaw Reservoir to Muskogee, Oklahoma, the MCKARNS, and the impacts of 11 operational Oklahoma reservoirs associated with releases into the MCKARNS downstream to the mouth of the White River in Arkansas and then to the Mississippi River. These operational reservoirs include Keystone Lake, Oologah Lake, Grand Lake, Lake Hudson, Fort Gibson Lake, Tenkiller Ferry Lake, Eufaula Lake, Kaw Lake, Hulah Lake, Copan Lake, and Wister Lake.

- Lake Eufaula and a total of 27 miles of the Canadian River from Eufaula Dam to the confluence of the MCKARNS.

- Lake Texoma and approximately 240 miles of the Red River from below Denison Dam to Index, Arkansas.

The Action Area is shown in Figure 1 below.

SECTION II. DESCRIPTION OF ACTION AREAS

A. Action Area I, Arkansas River (Kaw Lake to Muskogee, Oklahoma)

Kaw Lake is a main stem impoundment on the Arkansas River located at river mile 653.7. This reservoir was constructed by the Corps for flood control, water supply, water quality, recreation, and fish and wildlife and became operational in May 1976. Keystone Lake is also a main stem impoundment bisecting the Arkansas River at river mile 538.8, about 15 miles upstream of Tulsa, Oklahoma. This reservoir was constructed by the Corps for flood control, water supply, hydroelectric power, navigation, and fish and wildlife and became operational on May 21, 1968. Water released from Kaw and Keystone dams in the form of regulated flood flow, water quality, and hydropower releases contributes to main stem flows on the Arkansas River and largely influences flows under most conditions. Reaches within Action Area I to be considered and evaluated in this opinion are defined as follows:

- The 114.9-mile reach of the Arkansas River from Kaw Lake to Keystone Dam.

The 78.6-mile reach of the main stem of the Arkansas River from below Keystone Dam to its confluence with the Verdigris River and the MCKARNS at navigation mile 395 (See Figure 1).

B. Action Area II. Arkansas River Navigation Study (Verdigris and Arkansas Rivers, Oklahoma-Arkansas, Phases I and II)

The Corps, Tulsa District and Little Rock District, are conducting a combined study effort for the Arkansas River Navigation Feasibility Study that initially consisted of two phases. The Corps decided to combine the two phases into a single comprehensive study based on comments received during the National Environmental Policy Act scoping process for Phase I and Phase II (Notice of Intent published in the July 16, 2004, issue of the *Federal Register*). However, the two phases are kept separate in this opinion, because they are separate in the BA.

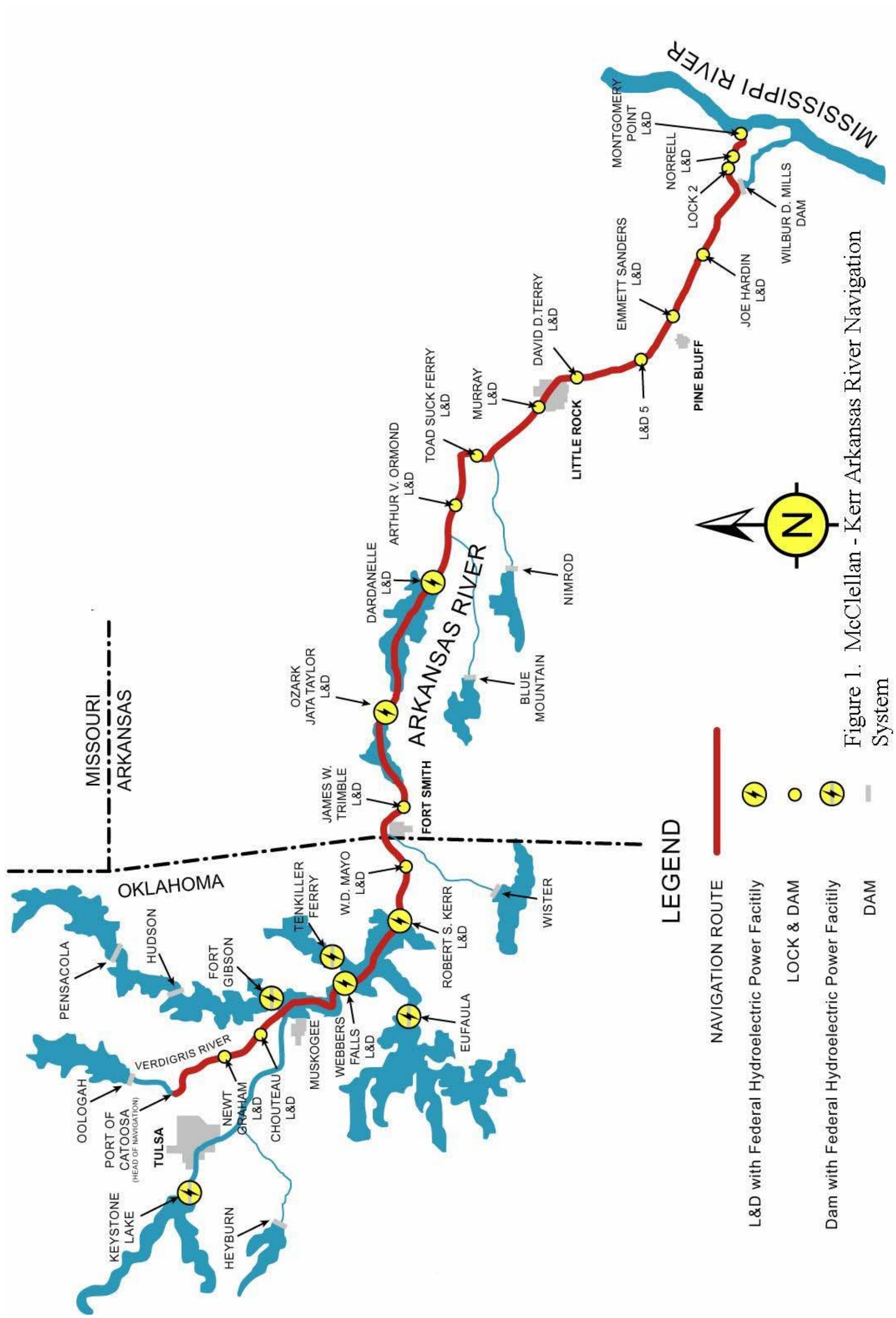

Figure 1. McClellan - Kerr Arkansas River Navigation System

Phase I was intended to develop and evaluate alternatives for implementing solutions to problems resulting from periods of sustained high flows on the MCKARNS. Phase I examined a variety of project alternatives, including operational changes to the existing reservoirs, as well as construction of additional reservoirs or levees along the Arkansas River for navigational flow management. Alternative 4, the Operations Only Plan, is the recommended plan and would increase the number of days in which longer tows of barges could navigate the system. The Operations Only Alternative is defined as the existing operating plan with a modified 60,000 cubic feet per second (cfs) bench (4 days of sustained flow) in place of the 75,000 cfs bench beginning at 3 percent lower system storage except during June 15 through October 1. Phase I, Alternative 4, would call for a 60,000 cfs bench at a system storage level of 8 percent (of the reservoir flood pool) during the spring months and 15 percent during the remainder of the year.

The existing plan calls for a 75,000 cfs bench at a system storage level of 10 percent (of the reservoir flood pool) during the spring months and 18 percent during the remainder of the year. Alternative 4 would accelerate evacuation of flood pools of reservoirs during flood pool rises, but then decrease water releases on the declining side of a flood event. The actual peak flood pool elevations during flood events would not be changed dramatically by the proposed action. Modeling analysis estimates there would be an approximately 14-day reduction in flows above 60,000 cfs as measured at Van Buren, Arkansas and a 2-day increase in flows above 100,000 cfs at Van Buren when compared to the existing operation plan. The analysis revealed essentially no change at flows of 137,000 cfs (channel capacity).

Phase II examines the feasibility of increasing the operational channel depth along the entire MCKARNS by as much as 3 feet (relative to the existing 9 foot minimum channel depth) and potentially widening the Verdigris River portion of the system to allow tows to pass at almost any location on the Verdigris River. Ongoing activities of Phase II include a detailed survey of the navigation channel from the juncture of the system with the Mississippi River to the Port of Catoosa at the head of the navigation channel.

Currently, the Corps is authorized to maintain the MCKARNS at a 9-foot channel depth. Due to ongoing maintenance dredging of the existing navigation channel and natural stream scour, approximately 80-90 percent of the system is already 12-feet deep over at least some portion of the channel width. Changing the authorized channel depth to 12-feet would allow tow drafts on the MCKARNS to match those of the lower Mississippi River system. A number of private and public ports on the system can currently only accommodate tows and barges capable of operating in a 9-foot channel. These ports will have to modify their facilities to accommodate barges with drafts deeper than those allowed by a 9-foot channel.

Current MCKARNS channel widths are 300 feet on the White River Entrance Channel, Arkansas Post Canal, and Lake Langhofer; 250 feet on the Arkansas River; 150 feet on the Verdigris River; and 225 feet on Sans Bois Creek. For most of the MCKARNS, channel width is sufficient to allow tows to pass each other at any location, but passing on the Verdigris River is restricted to only certain wider locations. Increasing the width of the Verdigris River to 300 feet would ease congestion by allowing tows to pass at almost any location on that portion of the system.

Currently, the Corps, Tulsa District and Little Rock District cooperatively control flows in the Arkansas River system in Kansas, Oklahoma, and Arkansas. However, the Little Rock District's operational flexibility in controlling flows is very limited. The action area for the ARNS includes the MCKARNS from the Port of Catoosa near Tulsa, Oklahoma, downstream to the confluence of the Mississippi River in southeastern Arkansas, as well as 11 reservoirs in Oklahoma that influence river flow within the MCKARNS. The MCKARNS action area (Figure 1) is approximately 445 miles in length and consists of a series of 18 locks and dams. Action Area II reaches to be considered and evaluated in this opinion are shown in Figure 1 and defined as follows:

- A 50-mile reach of the Verdigris River from the Port of Catoosa to Muskogee (navigation miles 445 to 394).

- Lower Arkansas River, which comprises 375 miles of the MCKARNS (navigation miles 394 to 19).

- The Arkansas Post Canal, a 9-mile canal connecting the Arkansas River to the lower portion of the White River (navigation miles 19 to 10).

- The lower 10 miles of the White River (navigation miles 10 to 0).

- The lower Arkansas River downstream of Dam 2 (not formally part of the MCKARNS). This portion of the Arkansas River is included in the Arkansas River Navigation Study project area because MCKARNS river flows may also influence this segment of the river.

- Eleven reservoirs in Oklahoma that may influence flows on the upper Arkansas River when operated for flood control, water supply, hydroelectric power, fish and wildlife, recreation, and other benefits. These include Keystone Lake, Oologah Lake, Pensacola (Grand) Lake, Lake Hudson, Fort Gibson Lake, Tenkiller Ferry Lake, Eufaula Lake, Kaw Lake, Hulah Lake, Copan Lake, and Wister Lake.

C. Action Area III, MCKARNS Dredge Material Disposal Management Plan (Verdigris and Arkansas rivers, Oklahoma)

The Oklahoma portion of the MCKARNS includes approximately 140 navigation miles of channel. Channel widths vary throughout, including 250 feet along the Arkansas River, 150 feet along the Verdigris and Poteau rivers, and 225 feet along the Sans Bois Creek. The depth of the navigation channel is approximately 9 feet minimum throughout the MCKARNS. There are five locks and dams within the Oklahoma portion of MCKARNS, including W. D. Mayo (Lock & Dam 14), Robert S. Kerr (Lock & Dam 15), Webbers Falls (Lock & Dam 16), Chouteau (Lock & Dam 17), and Newt Graham (Lock & Dam 18).

The operation and maintenance program for the Oklahoma portion of the MCKARNS is addressed in a Final Environmental Impact Statement (EIS) dated September 1974. This EIS included the locations of dredge material disposal areas. Operation of the MCKARNS and disposal of dredged materials has occurred at the locations addressed in the final EIS. As part of the ongoing operations and management program, the Tulsa District Corps is evaluating a future 20-year plan for dredging operations for the Oklahoma portion of the MCKARNS. Preliminary findings indicate that additional disposal areas likely will be required to meet the projected 20-year dredging requirements for the Oklahoma portion of the MCKARNS. Consequently, the Dredge Material Disposal Management Plan and all new recommended sites will be evaluated for impacts associated with federally-listed species. The boundaries of the MCKARNS Dredge Material Disposal Management Plan are shown in Figure 1. The reaches of Action Area III to be considered and evaluated in this opinion are defined as follows:

- Along either side of the MCKARNS from the head of navigation on the Verdigris River at Catoosa, Oklahoma, navigation mile 445.2, to the lower limits of the Oklahoma portion of the MCKARNS at navigation mile 308.

D. Action Area IV, Canadian River, Oklahoma

The Canadian River originates in Colfax County, New Mexico, and flows southeasterly through New Mexico and easterly through the Texas Panhandle. It enters Oklahoma and forms the boundary between Ellis and Roger Mills counties. The river then travels eastward some 410 miles across the state of Oklahoma and joins the Deep Fork River and North Canadian River to form Eufaula Lake. Eufaula Lake was constructed by the Corps on the Canadian River at mile 27.0, and became operational in September 1964. Project purposes are flood control, water supply, hydroelectric power, and navigation (sediment control). The Canadian River exits Eufaula Dam and flows eastward to its confluence with the MCKARNS near navigation mile 357 and the Haskell County and Muskogee County line.

In December 2001, the Corps submitted a “may affect” BA to the Service with respect to operations of Eufaula Dam on the lower Canadian River for the least tern, but the Service requested additional information and consultation was not completed. One purpose of the current BA is to update the findings of the 2001 BA and expand it to include all federally-listed threatened and endangered (T&E) species. For assessment purposes, this component of the opinion is defined as follows:

- The 27-mile reach of the main stem of the Canadian River downstream of Eufaula Dam to its confluence with the MCKARNS at navigation mile 359.3.

E. Action Area V, Red River, Lake Texoma to Index, Arkansas; Texas; and Oklahoma

The Red River is one of the two major river systems draining Oklahoma. The River originates from small streams in eastern New Mexico and gradually runs eastward approximately 517 miles to the Oklahoma-Arkansas State line in southwestern Arkansas. In its extreme western reaches it is composed of the Prairie Dog Town Fork of the Red River, which flows southeasterly to form the southern border of Oklahoma east of the 100th meridian. At the confluence of the Prairie Dog Town Fork of the Red River with the Salt and North Forks of the Red River, it continues as the State's southern border but is referred to simply as the Red River. In Oklahoma, there are 22,791 square miles of contributing drainage area to the Red River. At river mile 725.9, the main stem of the Red River is bisected by Denison Dam (Lake Texoma), which was constructed by the Corps for flood control, water supply, hydroelectric power, regulating flows, and improving navigation. Upon exiting Denison Dam, the river flows approximately 240 miles to Index, Arkansas, which is the eastern limit of the Corps, Tulsa District.

In July 2002, the Corps submitted a "may affect" BA to the Service on operations of Denison Dam on the lower Red River to Index, Arkansas, with respect to the least tern. The Service requested additional information and the consultation was never completed. The BA for the proposed action updates the findings of the 2002 BA and is expanded into a single comprehensive BA for all the noted action areas. For assessment purposes, this opinion will assess the impacts of operating Lake Texoma on all federally-listed species on the Red River to the eastern limits of the Tulsa District. The limits of Action Area V are defined as follows:

- Lake Texoma.
- The 240-mile reach of the Red River below Denison Dam to Index, Arkansas.

STATUS OF THE SPECIES/CRITICAL HABITAT

SPECIES IN THE ACTION AREA

In a Planning Assistance report dated April 2, 2001, the Service furnished a list of 12 federally-listed threatened and or endangered species that possibly could occur in association with the Arkansas River Navigation projects. By letter dated July 30, 2003, the Corps requested an official list of species from the Service for all the proposed action areas. The Service responded by letter dated August 28, 2003, providing four additional species and the Ivory-billed woodpecker was recently added for a total of 17 species to be addressed in this consultation. These species, along with their status and range in Oklahoma and Arkansas are shown in Table 1.

Table 1. Federally Listed Species Occurring in Proposed Action Areas

Species Listings	Status	Range	
		OK	**AR**
Alligator, American (*Alligator mississippiensis*)	T (S/A)	X	X
Bat, Gray (*Myotis grisescens*)	E	X	X
Bat, Indiana (*Myotis sodalis*)	E	X	X
Bat, Ozark big-eared (*Corynorhinus townsendii ingéns*)	E	X	X
Beetle, American burying (*Nicrophorus americanus*)	E	X	X
Crane, whooping (*Grus americana*)	E	X	X
Eagle, bald (*Haliaeetus leucocephalus*)	T	X	X
Woodpecker, Ivory-billed (*Campephilus principalis*)	E		X
Mucket, pink (*Lampsilis abrupta*)	E	-	X
Mussel, scaleshell (*Leptodea leptodon*)	E	X	X
Plover, piping (*Charadrius melodius*)	T	X	-
Shiner, Arkansas River (*Notropis girardi*)	T	X	X
Sturgeon, pallid (*Scaphirhynchus albus*)	E	-	X
Tern, interior least (*Sterna antillarum*)	E	X	X
Geocarpon minimum *(no common name)*	T	-	X
Orchid, western prairie fringed (*Platanthera praeclara*)	T	X	-
Harperella (*Ptilimnium nodosum*)	E	-	X

STATUS OF AFFECTED SPECIES

At least seventeen federally-listed species historically occurred in or near the Action Area; however, existing information indicates that only the endangered ABB and least tern are likely to be affected by the proposed action. The ABB and least tern are the only species addressed in this consultation.

AMERICAN BURYING BEETLE

The ABB was proposed for federal-listing in October of 1988 (53 FR 39617) and was designated as an endangered species on July 13, 1989 (54 FR 29652) and retains that status. Critical habitat has not been designated for the ABB. The Final Recovery Plan was signed on September 27, 1991.

The ABB is an annual species and typically only reproduces once in their lifetime. They are dependent on carrion for food and reproduction. They often must compete with other invertebrate species, as well as vertebrate species, for carrion. Even though ABBs are considered feeding habitat generalists, they have still disappeared from over 90 percent of their historic range. Habitat loss, alteration, and degradation have been attributed to the decline of the ABB. The U.S. Fish and Wildlife Service (1991) concluded that the most plausible explanation for the decline of ABBs involved habitat fragmentation which creates edge habitat. This habitat change leads to a reduced carrion prey base and an increase in vertebrate scavengers, thus creating more competition and less favorable conditions for the ABB.

Status and Distribution

Historically, the geographic range of the ABB encompassed over 150 counties in 35 states, covering most of temperate eastern North America and part of Canada (USFWS 1991, Peck and Kaulbars 1987). The ABB has disappeared from over 90 percent of its historical range (Ratcliffe 1995). Historic records are known from Texas in the south, north to Montana (single record in 1913) and the southern fringes of Ontario, Quebec, and as far east as Nova Scotia and Florida (USFWS 1991). However, documentation is not uniform throughout this broad historical range. More historic records exist from the Midwest into Canada and in the northeastern United States than from the southern Atlantic and Gulf of Mexico region (USFWS 1991). The last ABB specimens along the mainland of the Atlantic seaboard, from New England to Florida, were collected in the 1940’s (USFWS 1991). At the time of listing, in July 1989, known populations were limited to Block Island, Rhode Island; and eastern Oklahoma.

Currently, the ABB is known from only 8 states: on Block Island off the coast of Rhode Island; Nantucket and Peninskee Islands off the coast of Massachusetts; eastern Oklahoma; western Arkansas; Sand Hills in north-central Nebraska; Chautauqua Hills region of southeastern Kansas (Sikes and Raithel 2002); northeastern Texas (Godwin 2003), and in South Dakota (Ratcliff 1996, Bedick *et al.* 1993). Seeming differences in abundance throughout the ABB’s range, may however largely be a function of survey intensity. Most extant populations are located on private land. Populations known to exist on public land include: Camp Gruber, Oklahoma; Fort

Chaffee, Arkansas; Sequoyah National Wildlife Refuge, Oklahoma; Block Island National Wildlife Refuge, Rhode Island; and Valentine National Wildlife Refuge, Nebraska (USFWS 1991).

There are currently three captive populations of ABBs. One is at the Roger Williams Park Zoo in Providence, Rhode Island. The second captive population is at the Entomology Department at Ohio State University in Columbus, Ohio. The third is at the St. Louis Zoo in St. Louis, Missouri.

Species Description

The ABB is a member of the beetle family Silphidae (208 species worldwide; Ratcliffe 1996) and is in the subfamily Nicrophorinae. Silphids are scavengers of carrion and play an important role in breaking down decaying matter and recycling it back into the ecosystem. The genus *Nicrophorus* presently contains 85 species distributed in Europe, Asia, and North and South America (Ratcliffe 1996), 15 of which occur in the U.S. (USFWS 1991). *Nicrophorus* species are known to bury vertebrate carcasses for reproductive purposes and exhibit parental care of young. Parental care, generally involving both parents, consists of food provisioning, protection, and direct feeding of larvae during the entire larval stage, demonstrating the highest level of sociality in the beetle order Coleoptera (Ratcliffe 1996).

The ABB is the largest species of its genus in North America, measuring 0.98-1.4 inches in length (USFWS 1991). The body of the ABB is shiny black and has hardened protective wings (elytra) that meet in a straight line down the back. The elytra are smooth, shiny black, and each elytron has two scalloped shaped orange-red markings. The pronotum, or shield over the mid-section between the head and wings, is circular in shape with flattened margins and a raised central portion. The most diagnostic feature of the ABB is the large orange-red marking on the raised portion of the pronotum, a feature shared with no other members of the genus in North America (USFWS 1991). The ABB also has orange-red frons (a mustache-like feature) and a single orange-red marking on the top of the head (triangular in females and rectangular in males). Antennae are large, with notable orange clubs at the tips. The aposematic coloration patterns of *Nicrophorus* appear to deter predation by insectivorous birds, although crows are known to eat the ABB and other *Nicrophorus* species (Ratcliff 1996).

General Life History

The ABB is presumed to be an annual species (USFWS 1991), fully nocturnal, and active when nighttime temperatures consistently (*i.e.*, 5 consecutive nights) exceed 60°F. In Oklahoma this typically occurs from May 20 to September 20 (Oklahoma Climatological Survey 1993-2002). For the remainder of its life cycle, late-September to mid-May, the ABB remains in an inactive condition buried in the soil at depths from 6 inches (Anderson 1982) to at least 36 inches (Kozol *et al*. 1988). American burying beetles feed and breed on a wide variety of carrion. They use keen antennal chemoreceptors to detect the presence of carrion.

INTERIOR LEAST TERN

The life history and status of the least tern are well described in the Service's 2000 (USFWS 2000) and 2003 Biological Opinions (BO) (USFWS 2003) for the Corps' Missouri River operations. The 2003 BO for the Missouri River probably provides the best and most recent available information on the status of the interior population of least terns. A portion of that information is summarized below.

Reproductive Biology

Most least terns begin breeding at age 2 or 3 and spend 4 to 5 months of each year at their breeding sites. They arrive at breeding areas from late April to early June (Youngworth 1930, Hardy 1957, Wycoff 1960, Faanes 1983, Wilson 1984, USFWS 1987, as cited in USFWS 2003). Courtship occurs at the nesting site or at some distance from the nest site (Tomkins 1959, as cited in USFWS 2003). It includes the fish flight, an aerial display involving pursuit and maneuvers culminating in a fish transfer on the ground between two displaying birds. Other courtship behaviors include nest scraping, copulation and a variety of postures and vocalizations (Hardy 1957, Wolk 1974, Ducey 1981, as cited in USFWS 2003).

> "The nest is a shallow and inconspicuous depression in an open, sandy area, gravelly patch, or exposed flat. Small stones, twigs, pieces of wood and debris usually lie near the nest. Least terns nest in colonies as small as a single pair to 100+ pairs and nests can be as close as just a few feet apart or widely scattered up to hundreds of feet (Ducey 1988, Anderson 1983, Hardy 1957, Kirsch 1990, Smith and Renken 1990, Stiles 1939, as cited in USFWS 2003). The birds usually lay two to three eggs (Anderson 1983, Faanes 1983, Hardy 1957, Kirsch 1987, 1988, 1989, Sweet 1985, Smith 1985, as cited in USFWS 2003). Both sexes share incubation which generally lasts 20 to 25 days but has ranged from 17 to 28 days (Moser 1940, Hardy 1957, Faanes 1983, Schwalbach 1988, as cited in USFWS 2003). Least tern chicks hatch within one day of one another and stay near the nest bowl for several days. Least tern chicks usually fledge in about three weeks. Departure from colonies by both adults and fledglings varies, but is usually complete by early September (Bent 1921, Stiles 1939, Hardy 1957, as cited in USFWS 2003)."

Survival and Longevity

Least terns are relatively long-lived birds with some adults surviving more than 20 years, but research on adult survival and comparisons between populations is limited. Little is know about survival rates for juveniles (fledgling to breeding adult).

Dugger *et al*. (2000) estimated chick survival from hatching to fledging for least terns nesting at two sites on the Lower Mississippi River in Missouri using mark-recapture methodology. The mean daily survival rate for least tern chicks at river kilometer (Rkm) 1431 was 0.951 and 0.972 at Rkm 1481. Estimated survival of least tern chicks throughout the entire 17-day fledging interval was 0.43 at Rkm 1431 and 0.62 at Rkm 1481. More detailed information on survival and longevity of the interior least tern is provided in the Service's 2000 opinion for the Missouri River (USFWS 2000).

Movements/Dispersal Patterns

Least terns are thought to be highly philopatric, but limited data indicate that the degree and spatial scale of breeding site fidelity vary among breeding populations in different geographic areas (Thompson 1997, as cited in USFWS 2003). Massey (1992, as cited in USFWS 2003) found that 95 percent of banded least tern chicks returned to nest within 75 km of their Pacific Coastal natal colony at Huntington Beach, California. Renken and Smith (1995, as cited in USFWS 2003) reported that 97 percent of 78 banded terns returned to within 1.5 to 80 km of the colony where they were banded. On the central Platte River in Nebraska, 28 percent of 109 adults returned to their natal colony (Lingle 1993, as cited in USFWS 2003).

Band returns on least terns, although limited, also show movement within the least tern interior range. Chicks banded in Nebraska nested in Kansas (Boyd 1993, Lingle 1993, as cited in USFWS 2003), and a chick banded on the Missouri River in South Dakota nested on the Lower Platte River in Nebraska (Thompson 1997, as cited in USFWS 2003).

Relatively new genetic information suggests dispersal among Interior, Eastern, and California least tern populations. Whittier (2001) proposed that the three subspecies of least terns do not differ genetically, although the rate of genetic exchange appears to be lower between Interior and California least terns than between Eastern and Interior, and Eastern and California subspecies:

Results of mtDNA and nuclear DNA analysis were somewhat contradictory because nuclear DNA tests revealed less gene flow than did mtDNA; Whittier (2001) suggested this may be an artifact of small sample size rather than a reflection of actual gene flow. The limitations (such as small sample sizes) of Whittier's genetic results suggests the need for additional research and caution in interpreting existing genetic information. Additional genetic research is currently being conducted by the U.S. Geological Survey (USGS) and Oregon State University that may provide more information on gene flow and movement between least tern populations. The USGS genetic research involves much larger sample sizes and genetic markers that may be more appropriate for detecting genetic variability.

Distribution and Status

Least terns are found over a wide range of the central United States. Good descriptions of the historical and current range are provided in the 2000 and 2003 BOs for the Corps' Missouri River operations. They nest on a variety of habitats, but prefer sandbars and islands in major rivers. The number of adult least terns has increased in most areas since the species was listed in 1985. In 2003, over 8,000 least terns were counted on the Lower Mississippi River and these terns represent 67 percent of the total surveyed population of 12,035 adults.

The least tern is a difficult species to census accurately. The least tern frequently shifts nesting sites and timing of nesting varies locally because of weather, habitat availability (*e.g.*, seasonal duration and timing of flooding of sandbar habitats), and latitude (Thompson, *et al.* 1997). Consistent timing and coverage of surveys is logistically difficult to achieve. The nesting colonies of least terns are ephemeral and occur over a large geographic area that contains remote riverine habitats.

No comprehensive, annual, or regularly scheduled rangewide census for the least tern exists, but the Interior Least Tern Working Group assisting in organizing surveys for 2005 that will cover nearly all of the interior range for nesting least terns. However, several river segments are being surveyed on an annual basis. Many of these surveys are being conducted by the Corps or its contractors. Rivers regularly surveyed by the Corps are the Missouri River, the Arkansas River in Oklahoma, the Red River from Denison Dam to Index, Arkansas, and the Lower Mississippi River. The annual census of the Missouri River is the most comprehensive survey conducted by the Corps. Least Tern surveys also are conducted regularly on the Kansas River, Platte River, North Platte River, Canadian River below Eufaula Dam, and on three National Wildlife Refuges (Salt Plains, Quivera, and Bitter Lake). Efforts are underway by the Service, the Corps, states, and others to develop standard, comprehensive census procedures for least terns. An Interior Least Tern Working Group has been formed to develop recommended monitoring protocols for least terns and their habitat. This is the basic objective of the population assessment measure addressed in the 2000 BO for the Missouri River and the BA.

Table 2 provides a summary of the approximate rangewide number of adult interior least terns. This information represents all available information provided to the Service as of December 2003 and updates the rangewide information provided in the 2000 BO. It is important to note that this table does not represent a complete census; some segments of some rivers are surveyed in one year but not another. Furthermore, no recent surveys have been conducted on the Canadian River above Norman, Oklahoma and the Cimarron River in Oklahoma and Kansas, whereas previous surveys on these two rivers documented important least tern nesting colonies. The Rio Grande River in Texas, another important river segment for least terns, has been sporadically surveyed in recent years. Because it is clear that not all areas have been surveyed recently, we believe that the total abundance estimate in Table 2 is likely a minimum estimate. Better estimates of the rangewide least tern numbers will be available after the 2005 surveys are completed. Most known least tern nesting areas will be surveyed in the summer of 2005.

The estimated number of adult least terns has increased since rangewide summaries were published by Kirsch and Sidle (1999) and in the 2000 BO. Rangewide numbers have increased in the last three years. The number of adult least terns recorded for the Lower Mississippi River in 2003 continues to represent the highest proportion of the interior population (8,082; 67 percent of the total number surveyed).

The number of adult terns surveyed on the Arkansas River, Red River, and Missouri River has increased during the past three years. Although a portion of the increase in tern abundance since

Table 2. Approximate Numbers of Adult Interior Least Terns Throughout the Range

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Yellowstone River, MT to L. Sakakawea	16	14	19	40	21	19	21						
Missouri River, MT Ft. Peck Reservoir	10	0	7	9	2	0	2	4	0	4[1]	0[1]	0[1]	2[1]
Missouri River, MT Ft. Peck Dam to L. Sakakawea	66	110	31	58	95	128	162	25	40	33[1]	39[1]	34[1]	38[1]
Missouri River, ND L. Sakakawea	8	29	14	35	7	27	2	23	9	10[1]	34[1]	21[1]	25[1]
Missouri River, ND/SD Garrison to Oahe Dams	338	322	258	377	368	179	142	231	162	190[1]	219[1]	232[1]	214[1]
Missouri River, SD Ft. Randall to Gavins Pt.*	87	42	114	87	26	30	60	154	200	116[1]	117[1]	126[1]	96[1]
Missouri River, SD/NE Gavins Pt. to Ponca	193	186	272	211	93	82	115	144	161	206[1]	232[1]	314[1]	366[1]
Missouri River, IA Sioux City	0	12			12	13	16						
Missouri River, IA Council Bluffs	20	9	0	0	4	8	5			6[3]			
Kansas River, KS					12[2]	14[2]	10[2]	36[2]	14[2]	22[2]	12[2]	34[2]	38[2]
Subtotal	738	724	715	817	640	500	535	617	586	587	653	761	779
Cheyenne River, SD					32	32	30						
Niobrara River, NE	291					321	103				150[3]		
Niobrara River, NE (Natl. Scenic R. Norden – HWY 137)												15[3]	12[3]
Loup River, NE	117	188	46		150	139					81[3]		
North Loup River, NE						17					16[3]		
South Platte River, NE	0	0	5	0	0	2				8[3]	4[3]		2[3]
North Platte River and Lake McConaughty, NE	16	24	10	12	8	10	10	14[3]	6[3]	4[3]	24[3]	24[3]	28[3]
Platte River, NE North Platte - Lexington (upper)	197[3]	32[3]	32[3]	62[3]	30[3]	24[3]	44[3]	34[3]	18[3]	18[3]	15[3]	12[3]	8[3]
Platte River, NE Lexington - Chapman (central)	19[3]	191[3]	178[3]	169[3]	119[3]	157[3]	120[3]	76[3]	34[3]	42[3]	101[3]	110[3]	94[3]
Platte River, NE Chapman - Missouri Riv. (lower)	487[3]	427[3]	451[3]	426[3]	180[3]	290[3]	377[3]	208[3]	134[3]	460[3]	310[3]		394[3]
Elkhorn River, NE	30	35	38	24	35	86	62				64[3]		
Lower Arkansas River Valley Lakes, CO	46	42	30	22		64							

Table 2 Continued	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Arkansas River (J.M. Res.) and adjacent col, CO													
Quivira NWR, KS	54		48	46	50	66	56					31[3]	28[3]
Jeffery Energy Center, Pottawatomie Co, KS	0	0	0	16	20	20	15				28[4]		10[4]
Cimarron River, KS/OK	67	452	16	22	16	14	14						
Optima Reservoir, OK	15	16											
Salt Plains NWR, OK	82	136	168	90	200	200	200						130[5]
Prairie Dog Town Fork of Red River, TX													597[8]
Red River, OK/TX Denison Dam - Index AR	187								700	631[6]	893[6]	782[6]	993[6]
Red River, AR													250[7]
Arkansas River, OK Kaw Dam to Muskogee	195	393	406	471	322	381	277	312[9]	181	384[9]	628[9]	614[9]	569[9]
Arkansas River, AR		68									198	264	
Canadian River, OK Newcastle to Purcell	38		80	78	122	86	110						
Canadian River, Norman to Eufaula Lake, OK												286	
Canadian River, OK Eufaula Dam – Sequoyah NWR					54	77	41		106[11]	107[11]	65[11]	71[11]	59[11]
Mississippi River, Cape Girardeau to Vicksburg	4297	3653	4589	6776	6971	3067	3428	5538	6159	5920[12]	6361[12]	5802[12]	8082[12]
Ohio River, KY/TN	0			44		138	91						
Gibson Lake, IN	12	9	34	30	24	68				70[3]	80[3]		
Bitter Lake NWR, NM	10	12	14	11	14	14	12			20[3]	22[3]		
Rio Grande River, Falcon Reservoir, TX			655							214[3]			
Rio Grande River, Lake Casa Blanca, TX													
Rio Grande, Armistad Reservoir, TX													
Dallas County, TX, Waste Water Treatment Plant		15	24	20	20	27	25			21[3]			
Annual Total	7153	6339	7580	9136	9024	5800	5550	6799	7743	8486	9693	8772	12035

Update Sources:

1. Missouri River - U.S. Army Corps of Engineers, Omaha District. 2003. Mainstream Missouri River Least Tern Productivity Monitoring 1986-2003. Unpublished report submitted USFWS

2. Kansas River - Boyd 2003

3. Niobrara, Loup, South Platte, North Platte, Platte Rivers, Elkhorn River, Quivera NWR, Rio Grande River, Dallas County, TX, Gibson Lake, and Bitter Lake - Erika Wilson, pers. comm.

4. Jeffrey Energy Center, KS – Boyd 2003 and Boyd 2001

5. Salt Plains NWR – Joanna Whittier, Refuge staff, and Kevin Stubbs, pers. Comm..

6. Red River, OK/TX - Gulf South Research Corportation. 2000, 2001, 2002, and 2003; Kevin Stubbs, pers. comm.

7. Red River, AR - Meduna and Nupp, 2003

8. Prairie Dog Town Fork of Red River – Aqua-Terr, LLC., 2003

9. Arkansas River, OK - U.S. Army Corps of Engineers, Tulsa District 2003; Kevin Stubbs, pers. comm.

10. Arkansas River, AR - Urbanic, 2003

11. Canadian River, OK - U.S. Army Corps of Engineers, Tulsa District 2003; Kevin Stubbs, pers. comm.

12. Mississippi River - URS Corporation, 2003

listing can be attributed to increased survey efforts, in 2003 sufficient habitat existed to support a rangewide population of at least 12,035 terns.

The Interior Least Tern Recovery Plan established a goal of 7,000 terns rangewide maintained for 10 consecutive years. While the current estimate of over 12,000 terns greatly exceeds this goal, the recovery plan also set goals for drainages. The goals for least terns in all drainage basins have not been reached and most areas have not been monitored for 10 years. The recovery plan has not been revised since it was written in 1990 and recovery goals may need to be updated.

In some areas habitat may not be a limiting factor, but on many rivers current suitable least tern nesting habitat is declining in quantity and suitability as woody vegetation encroaches on sandbar habitat. This is largely due to a lack of scouring flows that keep woody vegetation from becoming established and create new nesting habitat. Foraging habitat quality and quantity also may have declined from historical levels. Declining populations of native or suitable small fish species and increasing numbers of introduced and unsuitable forage species could reduce the terns' ability to acquire small fish. Fish that tend to benefit from creation of reservoirs, such as shad and sunfish, have deep, laterally compressed body shapes that are difficult for terns to swallow and these species rapidly grow to sizes that exceed the maximum prey size for least terns (especially chicks).

In the Missouri and Arkansas Rivers, fish community composition changes have occurred. The spatial and temporal availability of small fishes, a component of tern foraging habitat, may affect the species rangewide. Changes in the basin and floodplain physiography and channel morphology due to regulation of the river have greatly changed the native fish community composition and ecology (Welker 2000); commercial fish harvests decreased by over 80 percent and many other native fish have declined on the Missouri River (Hesse et al. 1989, as cited in USFWS 2003). Historically, the annual flow regime determined timing of forage fish availability because many newly spawned fish migrated from the floodplain to the river when the river stage dropped. This connectivity between the river and the floodplain, and resultant recruitment of small fishes provided forage for predators, including least terns (Tibbs and Galat 1998).

On the Lower Mississippi River, 80 percent of small fishes sampled in aquatic habitats adjacent to least tern nesting colonies consisted of taxa known to spawn in floodplain habitats (Tibbs and Galat 1998). Both the timing of the forage fish production and the initiation of least tern nesting are related to the spring rise in river stage; alteration of the historic flow regime may impact tern reproductive success by decoupling the timing of peak forage availability from timing of peak reproductive efforts. Where the connections between the river and the floodplain have been reduced or eliminated completely by construction of levees, forage fish production may have been significantly altered. Such a linkage between forage availability and reproductive success has been demonstrated for some gull and tern species (Safina and Burger 1985, Safina *et al.* 1988, Sydeman *et al*. 1991, as reported by Tibbs and Galat 1998). In addition, Dugger (1997) demonstrated a link between aspects of least tern reproduction and variation in food availability.

Reproduction

Several modeling efforts have suggested that the level of reproduction (measured by fledglings/breeding pair) necessary to ensure population stability or growth level is likely between 0.5 and 1.0 fledglings/breeding pair (USFWS 2003). In evaluating status and trend of least terns, several authors have evaluated what level of reproduction (as measured by number of fledglings produced per breeding pair) is necessary to result in a stable or increasing population given estimates of juvenile and adult survival. However, all estimates of the level of reproduction necessary to ensure population stability or growth should be considered preliminary due to limited information on survival rates and movement between populations (see Table 3). Relatively small changes in survival rates can have significant effects in population models.

Least Tern Table 3. Observed Ratios of Fledglings per Breeding Pair for Least Terns on Selected Rivers 1995-2003.

	Fledge Ratio								
River	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Missouri River[1]	0.67	0.21	0.52	1.74	1.42	1.24	1.06	1.28	0.87
Kansas River[2]	0	0.57	0	0.67	0	1.36	0.05	0.41	0.26
Arkansas River, OK[3]	0.70	1.16	0.68	0.41	0.61	0.49	0.46	0.65	0.64
Red River, OK/TX (Denison Dam – Index, AR)[4]						0.09	0.53	0.33	0.33
Red River, AR[5]								0.7	
Lower Mississippi[6]	1.27	0.28	0.5						
Lower Mississippi[7]	0.85								

1 Corps. 2003d. Mainstem Missouri River Least Tern Productivity Monitoring 1986-2003. Unpublished data

2 Boyd R.L. 2003. Least Tern and Piping Plover Surveys on the Kansas River 2003 Breeding Season. Rpt. To Kansas City District, US Army Corps of Engineers. 29p

3 Corps, Tulsa District. 2002. Table 2 in Annual Report to U.S. Fish and Wildlife Service. Unpublished Report. 2 p. with corrections provided by the U.S. Fish and Wildlife Service.

4 Gulf South Research Corp. 2000. Red River Interior Least Tern Surveys Denison Dam, Oklahoma to Index, Arkansas. Annual Report for Fish and Wildlife Permit submitted to U.S. Fish and Wildlife Service. 6p (excerpts)

Gulf South Research Corp. 2001. Final Report - Survey Report Lower Red River Population of the Interior Least Tern from Denison Dam to Index, Arkansas. US Army Corps of Engineers, Tulsa District. 5 p. (excerpts)

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Gulf South Research Corp. 2003. Draft Report - 2003 Survey Report Lower Red River Population of the Interior Least Tern from Denison Dam to Index, Arkansas. US Army Corps of Engineers, Tulsa District. 4 p. (excerpts)

5 Meduna, L. and T. Nupp. 2003. Annual Report - Status of Reproductive Ecology of the Interior Least Tern (Sterna antillarum) on the Red River in Southwest Arkansas. Unpublished Report.

6 Szell, C.C. and M.S. Woodrey. 2003. Reproductive Ecology of the Least Tern along the Lower Mississippi River. Waterbirds 26(1): 35-43.

7 Dugger, K.M., M.R. Ryan, and R.B. Renken. 2000. Least Tern Chick Survival on the Lower Mississippi River. J. Field Ornithol., 71(2): 330-338.

Thompson (1982) hypothesized that 0.5 fledglings per adult or 1.0 fledglings per pair would result in a stable population. Dugger (1997, page 12) used a deterministic population model, assumed a survival rate of 0.85 for adults and a survival rate of 0.30 for juveniles (fledglings to age 2; generated by Thompson 1982), and concluded that 1.0 fledglings per pair were necessary to support a stable population (see Table 3 for a review).

Kirsch (1996) also used a deterministic population model with a range of adult and juvenile survival rates, together with the average 0.5 fledglings per pair she had observed on the Platte River in Nebraska, and found that a stable or increasing population was achieved only when survival rates were fairly high. For example, at 0.5 fledglings per pair an adult survival rate of 0.85 only achieved a stable population when the juvenile survival rate was at 0.80, and an adult survival rate of 0.90 achieved a stable or increasing population when juvenile survival was at 0.65. She concluded that 0.5 fledglings per pair was a conservative estimate of the minimum level needed to achieve population stability or growth, because most estimates of adult tern survival do not exceed 0.85 and while few estimates of juvenile survival are available, it is unlikely that juvenile survival is as high as adult survival.

On the Platte River, postfledging survival must be very high for the observed level of productivity (0.5) to sustain the population (Kirsch 1996); alternately, the population may be supported by immigration from other areas.

Kirsch and Sidle (1999) in summarizing the status of the interior population of least terns, found that of six geographic areas with significant population trends, four of these areas had observed fledge ratios that would not support the observed population trend. In addition, observed fledge ratios in many local areas were below the 0.5 fledglings per pair conservatively thought necessary to achieve population stability. The observed fledge ratios on the Lower Mississippi River were not sufficient to support the observed population trend in that drainage basin. The overall population trend for the entire interior population was positive, but this was primarily due to the increases observed on the Lower Mississippi River. Kirsch and Sidle (1999) stated that the most plausible explanation for the increase in the population of least terns was surges of immigration from the least tern population along the Gulf Coast. However, relatively little of the Gulf Coast habitat is surveyed for least terns and the tern’s status there is uncertain. Only one published record of a least tern moving between the Gulf Coast and interior breeding areas has been reported (Boyd and Thompson 1985, as cited in USFWS 2003), so this hypothesis is difficult to test. Recent data on rate of genetic exchange between Eastern least terns and Interior least terns indicates that greater than 3 migrants per generation are being exchanged (Whittier 2001), but additional genetic research is ongoing and information with larger sample sizes should be available within a year.

An alternate hypothesis stating that adult longevity, coupled with occasionally high recruitment, may offset generally low levels of production was assessed using data from least terns at Salt Plains National Wildlife Refuge in Oklahoma, Quivira National Wildlife Refuge in Kansas, and along the Missouri River in South Dakota (Whittier 2001). Longevity and periodic high recruitment counteracted lower productivity estimates in the model for terns at Salt Plains and Quivira National Wildlife Refuges, and indicated that the breeding population would persist despite low productivity, but the same was not true for the Missouri River. Whittier (2001) hypothesized that longevity could not counteract low productivity in the Missouri River due to lower overall productivity and no peaks in productivity compared to the other sites. Kruse's (1993) Missouri River data analyzed by Whittier (2001) covers 1986-1992. His estimates of fledglings/pair ranged from 0.20 to 0.64. Since that time observed data indicate a greater range of productivity estimates for this and other reaches of the Missouri River, particularly in the years since the 1997 flood. Since 1998, the average ratio for terns nesting on the Missouri River has exceeded 1.0 fledglings/breeding pair. Whittier's analysis of the Missouri River terns with a longer time series of data might yield a different result for this population. All known least tern nesting areas that have been monitored for 10 or more years have averaged less than 1.0 fledglings/breeding pair, but Whittier's model predicts that periodic peaks of high reproductive success would maintain a stable or increasing population.

ENVIRONMENTAL BASELINE

The environmental baseline is predicated upon an analysis of the accumulated effects of past and recent or ongoing human-induced and natural factors that have lead to the current status of the affected listed species and their habitat. The environmental baseline incorporates: 1) past and present impacts of all federal, state, or private actions or other human activities affecting the species; 2) anticipated impacts to the affected species from all proposed federal projects that have already undergone formal or early section 7 consultations; and 3) impacts of non-federal actions contemporaneous with the consultation in process.

SPECIES STATUS WITHIN ACTION AREA

Status of the ABB within the Action Area

Presently, eastern Oklahoma contains two large concentrations of ABB, one at Camp Gruber in Muskogee County and one in McCurtain County, Oklahoma on a large, privately owned holding (Weyerhaeuser). The numbers of ABBs captured at these areas provides insight into the numbers of ABBs in surrounding areas.

Table 4 provides the number of all surveys (represented by the number of trap nights) conducted throughout Oklahoma by county. The number of trapnights varies among counties and years, ranging from 24 trap nights in Tulsa County to 17,388 in Muskogee County. Camp Gruber is located in Muskogee and Cherokee counties. Surveys for the ABB have been conducted at Camp Gruber annually since 1992, accounting for the high number of trap nights. Likewise, Weyerhaeuser lands are located in McCurtain County and surveys have been conducted since 1997. Although survey intensity differs among counties, this information does provide at least a rough estimate of abundance based on ABBs captured per trap night. This information provides a means to monitor ABB trends and distribution.

Long-term survey data from throughout eastern Oklahoma is lacking. Long-term, mark and recapture data is available for Camp Gruber in northeastern Oklahoma and from a pine plantation on Weyerhaeuser lands in southeastern Oklahoma. Long-term mark and recapture information also is available for Fort Chaffee in Arkansas. However, these mark and recapture surveys are considered unreliable at best.

Most standard techniques used to estimate population size assume that marked and unmarked individuals are equally likely to be captured and that a substantial number of the animals remain in the available population from one trapping period to the next. Creighton and Schnell (1998) discuss mark and recapture efforts for the ABB in eastern Oklahoma and western Arkansas. Absence of recaptures beyond 6 nights post capture was believed to be indicative of the rapid turnover in the trappable ABB population (Creighton and Schnell 1998). They suspected that factors such as mortality, dispersal, and burrowing activity influenced their ability to recapture beetles. As stated by Creighton and Schnell (1998), most standard methods of estimating

Table 4. Abundance of American Burying Beetles in Oklahoma as of 2003.

County	# ABB Captured Per County	Total Trap Nights Per County	ABBs / Trap Night	County	# ABB Captured Per County	Total Trap Nights Per County	ABBs / Trap Night
Atoka	5	681	0.0073	McCurtain	399	12130	0.0329
Bryan	1	248	0.0040	Muskogee	1132	17388	0.0651
Cherokee	450	6240	0.0721	Okfuskee	1	400	0.0025
Choctaw	4	210	0.0190	Osage	2	24	0.0833
Coal	1	68	0.0147	Pittsburg	25	1042	0.0240
Haskell	76	1386	0.0548	Pushmataha	27	334	0.0808
Hughes	1	40	0.0250	Rogers	2	24	0.0833
Johnston	1	68	0.0147	Sequoyah	4	196	0.0204
Latimer	56	6686	0.0084	Tulsa	2	24	0.0833
LeFlore	72	6535	0.0110	Wagoner	2	432	0.0046

population size from mark and recapture data assume that marked and unmarked individuals are equally likely to be captured and that most, if not all, of the organisms remain in the trappable population. They felt this assumption was not valid for ABB populations considering the high turnover rate they observed for the ABB (Creighton and Schnell 1998). Accordingly, conventional methods of estimating population size may not be applicable for the ABB and accurate measures of absolute densities are problematic (Creighton and Schnell 1998).

Kozol (1990) conducted a population estimate for Block Island, Rhode Island, and indicated that the population was relatively stable at a level of approximately 375 animals with a confidence interval ranging from 316 to 450 from 1986-1990. Kozol's mark and recapture population estimate was based on trapping efforts spanning several weeks. Even with an intensive survey effort on a relatively confined population, Kozol cautioned using such figures as more than a guide because, as stated above, ABBs violate the two basic assumptions of population estimate methods.

Factors Potentially Affecting ABBs within the Action Area

The action area defined in this consultation covers the most of the known range of the ABB in Oklahoma and Arkansas. Adequate evaluation of the proposed action covered in this opinion must not only consider the impacts from the proposed activities, but also must consider other, separate effects currently ongoing and likely to occur in the foreseeable future that also could have adverse impacts to the ABB. In accomplishing this evaluation, the Service considers other incidental take statements issued, incidental take permits issued, recovery permits issued, other section 7 consultations conducted, and cumulative impacts within the action area.

From October 1, 2002 to September 30, 2003, the OKES consulted on approximately 1,562 proposed actions of which 858 (55 percent) were proposed to be implemented in the 33 counties in which the ABB likely occurs. Project types evaluated included pipelines, roads, communication towers, residential housing developments, bridges, mining, petroleum production, commercial developments, recreational developments, transmission lines, and water and waste water treatment facilities. Of the 858 projects the Service reviewed, approximately 35 percent involved fuel and petroleum production and distribution, and other industry distribution pipelines.

From October 1, 2003, to June 9, 2004, this same office reviewed about 1,020 projects. Of this total, 438 projects (about 43 percent) were proposed within the 33 counties in Oklahoma where the ABB is believed to occur. Of these 438, about 30 percent involved petroleum production and distribution, and other industry distribution pipelines, including a 280 mile pipeline extending from the Gulf of Mexico in Texas to Cushing, Oklahoma. A programmatic biological opinion recently was completed with the Environmental Protection Agency (EPA) for oil and gas related construction activities requiring a Phase I stormwater discharge permit. The Service is also currently working with the Federal Highway Administration and other federal agencies to develop a programmatic consultation for their activities.

Currently 11 entities or individuals possess valid section 10 permits for the ABB in Oklahoma. Ten are section 10(a)(1)(A) scientific research permits to enhance the survival of the species and one is an incidental take permit issued in conjunction with a Habitat Conservation Plan (HCP). Although nine permits are enhancement of survival permits, some authorized take of ABBs is allowed. The research conducted must further conservation efforts for the species. The loss of some individual ABBs over the short-term from research is allowed as long as the survival of the ABB is not jeopardized. The Service requires that every available precaution be implemented to reduce and/or eliminate authorized take associated with research activities.

The HCP and related 10(a)(1)(B) incidental take permit was issued in 1996 to Weyerhaeuser Timber Company for ABBs on their lands in southeast Oklahoma. Habitat Conservation Plans with incidental take permits are available to private landowners, corporations, state or local governments, or other non-Federal entities who wish to conduct activities that might incidentally harm (or "take") a species listed as endangered or threatened. Before obtaining a permit, the applicant must develop an HCP, designed to minimize or mitigate any harmful effects the proposed activity might have on the species. The HCP process allows development to proceed while promoting listed species conservation.

The Weyerhaeuser HCP is valid for 35 years and does not estimate a number of ABBs that could potentially be taken. The HCP stipulates the following as foreseeable activities implemented by Weyerhaeuser over 35 years: 28,000 acres (average of 800 acres per year) of forest will potentially be harvested; 16 ponds constructed; 10 or less food plots planted; EPA approved application of pesticides for control of pales weevil damage to planted pine seedlings; right-of-way vegetation control; 2 miles of road constructed; 20 acres of mineral, oil, or gas exploration; and 600 acres or less of cattle grazing. From 1997 to 2000 approximately 10,710 acres were surveyed for the ABB annually and from 2001 to 2003 approximately 14,382 acres were surveyed. From 1997 to 2003 the following number of ABBs were captured: 106, 64, 26, 41, 16, 25, and 85, respectively.

There are two BOs with incidental take statements issued for the ABB in Oklahoma. One pertains to the Department of Defense, for Camp Gruber near Braggs, Oklahoma; and the other to the U.S. Forest Service regarding the Ouachita National Forest in southeast Oklahoma. The opinion for Camp Gruber allows for the take of 35 ABBs per year. The opinion for the Ouachita National Forest covers forest lands in both Oklahoma and Arkansas, and allows for the take of 30 ABBs per year.

In addition, the Service may recommend that ABBs be trapped and relocated in certain instances. While these activities can have an adverse impact, the existing recovery permit provides for take which may occur. The extent of take is unknown prior to implementation of this type of activity. However, all accidental deaths are required to be reported to the Service. From 1997 to 2003 ABB incidental deaths ranged from approximately 5 to 28 per year.

Status of the Least Tern within the Action Area

There are several errors in the BA and the 2003 BO (USFWS 2003) related to the status of least terns in the Action Area. The correct adult least tern numbers for the Arkansas and Red River surveys are provided in Table 5. The BA also incorrectly states that 1998 was the only year that the fledgling per breeding pair ratio for the Arkansas River was below 0.50. The fledgling per breeding pair ratio also went slightly below 0.50 in 2000 and 2001. The fledgling per breeding pair ratio for the Oklahoma portion of the Arkansas River in 2004 was 0.02 and was far below 0.50 for all monitored portions of the Action Area. A combination of unusually wet and cool weather, frequent flooding, and poor habitat conditions are the most likely causes for the poor reproductive success in 2004. The current fledgling per breeding pair ratio information was previously provided in Table 3.

Table 5. Least Tern Peak Adult Numbers for Areas Monitored Within the Action Area

	Arkansas R. Kaw to Muskogee	Arkansas R. Arkansas	Canadian R. Below L. Eufaula	Canadian R. Norman to L. Eufaula	Red R. Texoma To Index AR	Red R. Above L.Texoma	Salt Plains NWR
1990	210						
1991	195*				187	139-152	
1992	393						
1993	406*						
1994	471						
1995	322						116
1996	381						122
1997	277*						
1998	312						
1999	181**		106		694		
2000	384		107		631		
2001	628	198***	65		893		
2002	614	264***	71	286	782		
2003	569		59		993	597	130
2004	529	376	75		1009		

* No survey from Kaw Dam to Keystone L. (usually 20-100 adults in this reach)
** No survey from Tulsa to Muskogee, high flows entire nesting season
*** Only partial survey of this river reach

The existing recovery plan set delisting goals for least tern numbers by river drainages and required that these goals be met or exceeded for at least 10 years (USFWS 1990). The goals for all drainage basins have not been reached and most areas have not been monitored for 10 years (USFWS 2003). The total numbers of adult least terns within drainages in the Action Area have met or exceeded existing recovery plan goals in recent years, but only the Arkansas River in

Oklahoma has been monitored for 10 years. The Arkansas River in Oklahoma has met recovery plan goals for the last ten years with the possible exception of 1999 when flooding of nearly all nesting habitat occurred during the entire nesting season. Only a partial survey was conducted that year, and the tern numbers did not meet the recovery goal.

Least tern population information and recovery goals provided in the existing recovery plan do not reflect the current knowledge of least tern populations. The recovery plan was written in 1990 and was not the sole source used to assess the status of populations for this biological opinion. For example, least terns were not known to occur or nest in the portion of the Red River addressed in this opinion when the recovery plan was written; now it is known as an important nesting area with over 1,000 adults attempting to nest there in some recent years. The entire Red River in 2004 supported an estimated 2,000 or more adult least terns, but the existing recovery goal for this river is only 300 and was based on the habitat on the Prairie Dog Town Fork alone.

The total number of adult least terns has remained relatively stable or increased since 1998 (Table 5) for most of the monitored reaches of the Action Area. The adult least tern numbers for the short reach of the Canadian River below Lake Eufaula is an exception to this stable to increasing trend within the Action Area. This area of the Canadian River has experienced relatively poor reproductive success and the total number of adult birds has declined slightly in recent years. The greatest increase in adult least tern numbers has been on the Red River from Lake Texoma to Index Arkansas. Adult numbers have increased from 187 (1991) to 1009 (2004), and more than 600 adults have been counted each year since 1999 (Table 5).

Fledglings per breeding pair estimates (through 2003) averaged above 0.5 for monitored reaches of the Arkansas River, but less than 0.5 for the Red River (Table 3). The reproductive success monitored in 2000-2003 for this reach of the Red River (average of 0.32 fledglings per breeding pair) does not appear to support the observed population increase. The Service has not received the 2004 monitoring report for the Red River, but the preliminary information indicates very few fledglings were produced in the 2004 breeding season. The most plausible explanation for the increase in tern numbers for the Red River is immigration from other least tern populations. However, this reach of river did produce 0.53 fledglings per breeding pair in 2001, with an adult population of 893. This demonstrates this reach has the potential to support a relatively large population. Also, monitoring methods used to estimate fledglings per breeding pair may have underestimated the total number of fledglings in some years.

Fledgling per breeding pair ratios have been measured in most of the Action Area, but monitoring has been very limited on Arkansas portions of the Arkansas River. However, using available information, the average fledgling per breeding pair ratio is approximately 0.5 for all monitored areas of the Action Area (Table 3).

Adult least tern numbers in the Action Area in 2004 were at or above the average for the last ten years. However, reproductive success in nearly all of the Action Area was extremely poor in 2004 and habitat conditions also were relatively poor. The unusually wet and cool weather was a factor in the poor reproductive success in 2004, but habitat conditions in the Oklahoma portion of the Arkansas River were so poor that reproductive success would be low in most years. Effects of habitat changes on the Arkansas River in Oklahoma have previously been documented in the 1998 opinion (USFWS 1998). Least terns appear to be affected by nesting habitat availability and changes in habitat due to regulated flows released from Kaw and Keystone Dams. The frequency of high flow events downstream of Keystone Dam has declined significantly due to flood control operations. Analysis of pre and post impoundment flows at the Tulsa gage show 25 flow events exceeding 90,000 cfs between 1926 and 1964 (prior to completion of Keystone Dam). Only three flow events exceeding 90,000 cfs have occurred since 1964 and 1993 was the last large flood event. After scouring flows in 1993 that elevated existing sandbars and created new sandbars, the number of breeding colonies, adults observed, number of nests, chicks, and eggs observed, and number of terns fledged all increased the following year. In addition, loss of nests due to flooding declined the following year (Leslie *et al*. 2000). Leslie *et al*. (2000) reiterated the need for periodic ($\geq$ 7 years) scouring flows to maintain the quality of nesting habitat available to terns. However, habitat quality has declined since 1993 due to a lack of scouring flows. No major high flow events have occurred in recent years and habitat has declined in quantity and quality. In 2004, frequent flooding events and poor habitat conditions reduced or eliminated reproductive success on most of the least tern nesting areas within the Action Area.

Least tern nesting habitat quality and quantity has declined the most on the Arkansas River and is probably in the worst condition known since least tern monitoring began in the 1980s. The degree of habitat degradation cannot be accurately quantified due to the Corps' failure to fully implement some of the reasonable and prudent measures in the 1998 opinion that required monitoring of habitat in the Oklahoma reach. Nonetheless, differences in Arkansas River habitat quality relative to 1994 are apparent. Flows of 30,000 cfs in 1994 did not flood many of the least tern nesting sites, but flows of only 15,000 cfs would flood most of the suitable habitat and nests in 2004 and 2005. Most of the higher islands and sandbars are now vegetated to a degree that precludes least tern nesting. Zink Island is a relatively high island that previously supported 50 or more nests in high water years similar to 2004. In the last few years Zink Island has supported 15 or fewer nests. The reason for the decline is uncertain, but the most likely cause is the reduced availability of suitable habitat due to vegetative encroachment. The 1998 opinion included a reasonable and prudent measure to maintain habitat quality on Zink Island, but the Corps had only partially complied and vegetative encroachment had made most of the island unsuitable for nesting until March of 2005. The least tern nesting habitat on Zink Island was restored with heavy equipment in March through cooperative efforts of Tulsa County, the Corps and Tulsa River Parks Authority. The island supported at least 36 nests on June 9, 2005 and it appears that the habitat restoration was successful in attracting more nesting pairs. Storms destroyed most of those nests on June 12, 2005, and ensuing storms continued to increase flows in the Arkansas River. Releases from Keystone Dam completely inundated the island by June 18, 2005. Releases were increased in an attempt to hasten the evacuation of stored flood waters and return reservoir water elevations and river flows to levels that would allow least terns to renest. The success of renesting attempts will be monitored.

Relatively little monitoring of least tern nesting habitat conditions has occurred on the Arkansas River in Arkansas and the first complete boat survey for nesting terns was completed in 2004.

Seventeen tern nesting islands were identified in the 2004 survey. The quality of the nesting habitat varied, but all nesting islands were flooded and no successful reproduction was known to occur in 2004.

Habitat conditions also have declined on the Red River. Monitoring on the Red River below Lake Texoma has documented a decline in average freeboard for nests since 2001, an increase in the percentage of nesting colonies that land bridge, and an increase in the percentage of nesting colonies with disturbance. Disturbance includes evidence of predation, cattle trampling, and human disturbance. Disturbance increased from only 25 percent of the nests in 2000, to 89 percent of the nests in 2003 (Gulf South 2003).

Importance of the Action Area to the Least Tern

Least terns in the Action Area may currently (2004 adult count) account for approximately 16 percent of the interior population (1,989 in the action area /12,035 rangewide) based on the most recent population estimate. However, the rangewide estimate probably underestimates the size of the total population due to a lack of recent surveys in several areas of the least tern's range and recent increases in some areas. The Arkansas and Red River systems appear to be an important component of the overall distribution of the interior population. The numbers of adults in these river systems are second only to those on the Mississippi River.

Factors Potentially Affecting Least Terns within the Action Area

The Action Area defined in this consultation covers much of the known range of the least tern in Oklahoma and Arkansas. Adequate evaluation of the proposed action covered in this opinion must not only consider the impacts from the proposed activities, but also must consider other, separate effects currently ongoing and likely to occur in the foreseeable future that also could have adverse impacts to the least tern. In accomplishing this evaluation, the Service considers other incidental take statements issued, incidental take permits issued, recovery permits issued, other section 7 consultations conducted, and cumulative impacts within the action area.

The incidental take that is currently authorized for least terns in the Action Area is limited to collection (salvage) of eggs for genetics research proposed by the USGS and take associated with disturbance related to least tern surveys on the Arkansas, Canadian, and Red Rivers. The Corps has had authorization for incidental take related to operations of Kaw and Keystone projects, but this is no longer valid due to exceedance of incidental take limits and failure to implement reasonable and prudent measures. Unauthorized take has occurred each nesting season, including more than 300 nests, and unknown numbers of eggs and chicks in 2004.

EFFECTS OF THE ACTION

American Burying Beetle

Adverse impacts to ABBs occur primarily from ground disturbance associated with construction during the ABB's inactive and active periods. Construction activities associated with dredged material disposal pits and other proposed actions may disturb soils in areas within the ABB's range and have the potential to harm, harass, or kill individuals. Typical individual construction projects are relatively short-term, usually completed in fewer than 60 days. However, maintenance and additional disposal of dredged material are recurring impacts over the life of the project.

DIRECT EFFECTS

Direct adverse impacts to ABBs during their inactive and active periods may occur as a result of impacts from clearing vegetation; soil compaction due to heavy equipment operation; fuel and chemical contamination of the soil; grading; soil excavation and filling; and revegetation and reseeding of disturbed areas. Approximately 1,100 acres of terrestrial habitat are proposed to be converted to dredged material disposal pits with implementation of the proposed action.

During construction of dredge disposal pits and access roads, soil is excavated and vegetation is cleared. Excavating soils, clearing vegetation and constructing access roads involve displacement of soils that could uncover ABBs. Uncovered ABBs could be exposed to predation, adverse environmental conditions, or crushed by equipment. If construction occurs during the active season, ABB broods could be displaced during soil excavation, adults could be separated from larvae/eggs, and/or both could be crushed by equipment. Revegetation and associated planting activities could result in further disturbance as described above.

In addition, use of heavy construction equipment, such as bulldozers, excavators, track hoes, and back hoes during road and dredge spoil disposal pit construction could compact the soils. Soil compaction could result in destroying ABB brood chambers, including adults and larvae; and preventing use by ABBs for carcass burial if construction takes place during the reproductive season. If construction takes place during the winter season, adult individuals could be crushed and ABB re-emergence in late spring or early summer could be prohibited.

The periodic disposal of dredged material has the potential to bury adults and larvae if previously deposited materials provide suitable soils. The frequency of dredging and subsequent disposal in dredge disposal pits is highly variable and the potential for take related to periodic disposal will vary from pit to pit.

Prior to construction activities implemented in the ABB's active season, the Corps will determine the presence or absence of the ABB in the project county and immediate vicinity of the project site. A presence/absence survey for the ABB may be conducted. If ABBs are known to be in the area, then measures will be implemented to remove ABBs from the project site prior to soil disturbance. This minimizes or avoids adverse impacts to the ABB. Projects implemented during the ABB's inactive season will incorporate measures listed above to minimize soil disturbance, contamination, or compaction, and ABBs will be removed from the project site prior to the onset of the ABB's inactive season. These measures minimize adverse effects to the ABB, but do completely avoid potential for take.

All of these activities could result in the direct mortality of individual ABBs or broods, or create conditions that lessen the chance of survival of individuals or broods. In summary, ground disturbance associated with disposal of dredged material could result in take of individual ABBs, eggs, or larvae in eastern Oklahoma.

INDIRECT EFFECTS

Construction activities and related habitat disturbance may temporarily reduce local rodent populations that would provide carrion for ABBs.

Interior Least Tern

DIRECT EFFECTS

Least tern nesting habitat can be impacted by any action that changes river hydrology and morphology. The construction and operation of large Federal reservoirs is a major action impacting least tern nesting habitat within the Action Area. A major hydrologic effect of these reservoirs on nesting habitat is the reduction in the magnitude, frequency, and duration of peak flows that are necessary to move sediments to form new sandbars, maintain channel widths, and scour existing sandbars. The frequency of high flow events downstream of Keystone Dam has declined significantly due to flood control operations (Wood 1994). Seven day bankfull flows (110,000 cfs) on the Arkansas River at Tulsa were predicted to occur with a frequency of 6.7 years without project and 28.6 years with project-related flood control operations (USFWS 1998). Analysis of pre and post impoundment flows at the Tulsa gage show 25 flow events exceeding 90,000 cfs between 1926 and 1964 (prior to completion of Keystone Dam). Only three flow events exceeding 90,000 cfs have occurred since 1964 and the last large flood event occurred in1993.

These reservoirs also retain large volumes of sediment (sand) that normally would be distributed throughout an unregulated river system. For example, Lake Texoma traps an average of 17,700 acre-feet of sediment annually (USACE 2001). A 100-300 mile downstream recovery zone for sediment loads has been estimated for Lake Texoma (Williams and Wolman 1984). Recharge of drainage-basin sediments 60 miles below Kaw Dam and 15 miles below Keystone Dam has been insignificant because mean daily sediment loads of the Arkansas River at Ralston and Tulsa have been reduced approximately 91-96 percent (Wood 1994, USFWS 1998). This sediment is the basic building block of least tern nesting habitat. The substantial reduction of sediment movement by these reservoirs impacts the distribution, abundance, and quality of least tern nesting habitat.

The 1998 opinion documented the impacts of flood control operations on hydrology of the Arkansas River and similar impacts are documented in the original BAs prepared for the Canadian and Red Rivers. The direct effect of the reservoirs and flood control operations is reduced quantity and quality of least tern nesting habitat. For example, no suitable least tern nesting habitat exists for several miles below all major impoundments in the Action Area due to a lack of sand. The proposed action is primarily a continuation of the existing conditions for most of the Action Area and the proposed action includes few measures to avoid, or reduce most habitat impacts. The Corps has not monitored habitat conditions on the Arkansas River as required by the reasonable and measures in the 1998 opinion, so we cannot quantify the existing effects on the Kaw Lake to Muskogee reach. However, habitat has declined and we expect habitat degradation due to project-related alterations in flow and sediment transport to continue.

Nesting Habitat

Least tern nesting habitat is in poor condition over most of the Action Area, and the Corps' past and current operations appear to be the primary factors. The Corps has had limited opportunities to provide scouring flows in recent years without impacting other project purposes, and few efforts have been made to restore nesting habitat via other means. The Corps and SWPA did attempt to restore tern nesting habitat on two islands in lower portions of the Canadian River by scraping vegetation off existing vegetated islands with bulldozers. The attempt was unsuccessful, at least partially, because vegetation quickly reestablished itself on most of the cleared areas before the nesting season was completed. Limited hand pruning and some herbicide spraying also was implemented in two years at Zink Island and in 2005 the island habitat was greatly improved by moving new sand onto the island with heavy equipment. The Zink Island habitat improvement project was a cooperative effort involving Tulsa County, the Corps, and Tulsa River Parks Authority and the Service. Also, the Corps helped fund an Oklahoma State University student project to design a conceptual tern nesting island with promising results. However, the design has not been implemented and no new nesting islands have been constructed.

In June, 2005, the Corps cooperated by releasing relatively high flows (68,000-77,000 cfs) from Keystone Reservoir for several days to hasten the evacuation of the flood pools in Kaw and Keystone Reservoirs. These relatively large releases are less than the flows recommended in the 1998 opinion for enhancing nesting habitat, but they may provide some scouring and move enough sediment to enhance or create some downstream nesting sites. The effects of these releases will be evaluated when river flows decrease to levels that allow terns to renest.

Most least terns are currently nesting on relatively low elevation islands and sandbars. A lack of scouring flows has allowed vegetation to encroach on all but the lowest elevation nesting habitat. This increases the flooding risk for nesting least terns. The current habitat conditions on the Arkansas River make it extremely difficult for the Corps and SWPA to maintain other project functions and still protect terns from flooding. The peak flow generated by hydropower at the Keystone project is approximately 12,000 cfs and some nests were flooded in 2004 by this level of flow. Virtually all nests on the Arkansas River from Keystone dam to Muskogee are flooded at approximately 15,000 cfs (with the exception of Zink Island). The small 3,000 cfs buffer between peaking hydropower flows and flows that flood most of the nests means that nearly all nests are at a high risk of flooding on nearly a daily basis. Any significant rainfall event that adds 2,000-3,000 cfs or more to the hydropower peaking level will flood a majority of the nests. To prevent flooding nests under such conditions the Corps would have to predict all significant rainfall events and curtail hydropower generation at least 24 to 48 hrs ahead of the rainfall event. This solution is unlikely to be feasible or successful in avoiding relatively frequent flooding of least tern nests and chicks. Even one flooding event late in the nesting season can effectively eliminate most or all reproductive success for that year. While the Corps has improved communication with the Service and modified operations to reduce flooding of tern nests and chicks, avoiding flooding has become increasingly difficult. The Tulsa District developed Least Tern Management Guidelines for project operations and they have been implemented since 2002. However, the Corps' ability to reduce flooding of tern nesting sites is very limited with the existing habitat conditions described above.

Habitat conditions on the Arkansas River reach from Keystone Reservoir to Muskogee in 2004, allowed a water release of only about 9,000 cfs from Keystone Dam to protect nesting terns from downstream flooding. The inability to release more than 9,000 cfs for flood control without flooding tern nests means that reservoir water levels would quickly rise with any significant inflows. Reservoir water levels at Keystone Reservoir would reach the upper limits (730 ft, specified in the Least Tern Management Guidelines) for protecting least terns or even the upper limits of the flood storage capacity, in a relatively short period of time with even moderate inflows. The Corps must then release large quantities of water for safety reasons (usually greater than 20,000 cfs) to evacuate the flood pool. With existing habitat conditions, such a release would flood nearly all the least tern nests and chicks that may exist in this reach downstream to Muskogee. Frequent flooding and cool wet weather resulted in the loss of nearly all nests and chicks on the Arkansas River in 2004 (only 6 fledglings counted) and flooding has occurred again in 2005. Unless habitat improves, we expect relatively frequent flooding to continue on the Oklahoma reach of the Arkansas River in most years.

Another potential impact to habitat is that the height of some nesting islands are degraded by extended periods of relatively moderate to high flood pool releases that continue long after any significant amount of sediment is being delivered through tributaries. These moderate water releases from the reservoirs transport very little sediment from the reservoir, but do pick up some sediment below the dam and move some of this sediment downstream. These moderate flows are usually insufficient to scour vegetation from higher elevation sand bars or islands.

The poor habitat conditions on the Arkansas River can be enhanced to some degree through management of flows to minimize flooding and landbridging of nesting islands. However, with existing habitat conditions, this would require a very narrow range of flows and may not allow maximum hydropower releases at Keystone Dam.

Habitat conditions also have declined on the Red River and least tern reproductive success has been relatively low (see previous discussion in the Status of the Species in the Action Area section). The effects of the action on least terns nesting along the Red River are similar to those described for the Arkansas River. However, habitat is not as degraded within the Red River portion of the Action Area. Also, flooding of nests and chicks on the Red River is not as directly attributable to reservoir water releases. The Red River has more major tributaries without mainstem reservoirs and higher average annual rainfall over much of this reach. However, there are several Corps reservoirs in the watershed and the effects of reduced peak flows and sediment loads are evident. The proposed action does not include any measures to improve habitat on the Red River or change operations. Unless habitat improves, we expect relatively frequent flooding of nests and chicks and high rates of disturbance to continue.

Arkansas River Navigation System - The effects of the action on nesting terns on the Arkansas River in portions operated for navigation in Oklahoma and Arkansas are comparable in that limited habitat and flooding of nesting habitat is the greatest impact to nesting terns. Nesting habitat is very limited within the navigation system. Most of what is available was unintentionally created by sediment deposited behind manmade structures. Virtually all natural nesting habitat was destroyed when the navigation system was constructed. Only one least tern nesting island is proposed to be constructed within the navigation channel in the Corps' proposed action. Therefore, we expect nesting habitat would continue to be limited within the MCKARNS with implementation of the proposed action.

The Little Rock District of the Corps has not been monitoring the elevations and locations of tern nests in Arkansas and no coordination with the Tulsa District or the Service has occurred to attempt to minimize flooding of nests and chicks in Arkansas. The proposed action does not include any measures to reduce these flooding impacts. We expect the proposed action would result in continued flooding of nests and chicks on the Arkansas reach of the Arkansas River.

The Service does not concur with the Corps determination that Phase I of the ARNS will not adversely affect least terns. We agree that the effects are variable and the duration of the effects are usually limited to several days or less, but there are some adverse effects. According to information provided by the Corps, the changes in flood water storage at reservoirs related to Phase I operations would decrease the rate of water releases following the peak of a flood event. Reducing the rate of water releases can prolong the number of days that some reservoir elevations stay above or near the upper limits for protecting least terns stated in the Least Tern Management Guidelines implemented in 2002. This would increase the likelihood of flooding downstream nests and further delay the evacuation of stored flood water under some conditions. Phase I would slightly extend periods of relatively high flood pool releases that continue long after any significant sediment is being delivered through tributaries. Such releases could degrade the height and quality of nesting islands. Portions of the Corps modeling data that demonstrate this effect are included in Appendix B.

Phase I has potential to extend the effect of a flood and the time required to reduce flows to a level that will provide suitable habitat for terns attempting to renest. The risk of nests being flooded by water releases made due to subsequent rainfall or inflow events is increased when reservoir elevations stay near the upper limits for longer periods of time. Reservoirs such as Kaw and Keystone have relatively little flood storage and nesting least terns have very little buffer for future inflow events when reservoir water levels are near the upper limits. To provide nesting habitat and protect renesting least terns, reservoir water levels need to be dropped as quickly as possible following inflow events that cause upper limits to be exceeded and downstream flooding of least tern nests.

The deepening portion (Phase II) of the proposed action is not likely to adversely affect most of the current least tern nesting areas. The Arkansas River within Arkansas is the only portion of the existing navigation channel that supports nesting least terns in areas likely to be dredged. The maintenance dredging and proposed dredging to implement Phase II has the potential to benefit least terns, if the dredge spoils are used to create nesting habitat. No suitable tern nesting habitat is present on a large percentage of the existing navigation channel and creation of habitat could facilitate nesting by terns on portions of the river that have not supported tern reproduction since the MCKARNS project was constructed.

Dredging does have the potential to adversely affect least terns if contaminants in the sediments are released in concentrations that would impact nesting terns or their forage base. Contaminants released into the water through dredging activity could become available to the birds through direct contact or through the food chain. However, potential impacts related to contaminants in the dredged material cannot be thoroughly assessed until testing of sediments to be dredged is completed. The Corps should reinitiate consultation if testing of sediments indicates dredging could have potential adverse effects to terns and other federally-listed species, such as bald eagles.

Hydropower effects - Normal hydropower operations (when reservoirs are not in the flood pool) consist of peaking hydropower generation during portions of the day with the most demand and highest price for electricity. Little or no generation occurs during off peak hours. This results in higher downstream water releases (frequently 10,000-12,000 cfs) for a portion of the day and low flows (frequently less than 1,000 cfs) for the remainder of the day. During weekends and other periods of low demand, little or no generation occurs and the flows are correspondingly low (sometimes less than 100 cfs). These periods of low flows contribute to landbridging of nesting islands and increase access for mammalian predators and humans. Very few nesting islands that are not inundated at the higher peaking flows remain suitable nesting islands and are landbridged at the low flows. Least terns are frequently forced to nest on islands or sandbars that are not flooded at the higher flows, but become landbridged at the lower flows. The dramatic daily fluctuation in flows results in a change in stage or water height on the river of several feet for miles downstream of the reservoirs. These changes in flow and stage are moderated in intensity moving downstream, but severely limit the suitable nesting habitat available to least terns for at least 40 miles below Keystone Dam and all of the Canadian River below Lake Eufaula.

INDIRECT EFFECTS

Predation and Human disturbance

Ongoing reservoir operations in the Action Area likely contribute to loss of nests and eggs from predators because of the effects of water management on the shoreline and sandbar habitats. Moderation of extreme flows has reduced the amount of scouring taking place along shorelines;

consequently vegetation regrowth provides habitat for predators of least tern eggs and chicks. Reduced channel width and increased vegetation encroachment within the channel creates more suitable habitat for predators and reduces the amount of suitable habitat for least terns. Flood control operations influence predation by reducing the quantity of suitable nesting habitat, making it easier for predators to search the remaining habitat. Consequently, even unoccupied habitat has value for nesting least terns and can reduce predation by providing more potential habitat for predators to search.

The effects of hydropower operations and other flow manipulations also influence predation (see discussion under direct effects). The periods of low flows contribute to landbridging of nesting islands and increase access opportunity for mammalian predators such as coyotes, dogs, and raccoons.

The low flows also improve access for humans and domestic animals. Disturbance by humans walking in search of artifacts or using sandbars and islands for other recreational uses occurs relatively frequently in the Action Area. These people often have dogs with them which increases the risk for take of chicks or eggs. Low flows and landbridging also improve access for livestock; and trampling of least tern nesting sites has been documented each year on the Red River (Gulf South 2003). ATVs and other off-road vehicle use is increasingly popular and low flow conditions on the rivers allow such vehicles access to most of the river bed, including many least tern nesting areas. While monitoring least terns nesting on the Arkansas River in Oklahoma, Service and Corps biologists have witnessed the apparent abandonment of least tern nesting colonies with relatively high levels of human disturbance. Other studies have noted that human disturbance of nesting colonies may reduce reproductive success (Burger 1984) and may result in eventual abandonment of the site (Kotliar and Burger 1986). Monitoring on the Red River below Lake Texoma has documented an increase in the percentage of nesting colonies that land bridge, and an increase in the percentage of nesting colonies with disturbance. Disturbance includes evidence of predation, cattle trampling, and human disturbance. Disturbance increased from only 25 percent of the nests in 2000, to 89 percent of the nests in 2003 (Gulf South 2003).

Recreational use and human disturbance in the navigation system is more related to access by boaters and some ATV use. A least tern nesting colony on an island that was created with dredge spoils in Arkansas in 2001 was completely abandoned after high levels of human use and camping occurred. Human disturbance accounted for 29 percent of the losses of nests monitored in Arkansas in 2001 (Urbanic 2003).

Impacts to Fish and Fish Habitat

The spatial and temporal availability of small fishes, a component of tern foraging habitat, may affect the species in the Action Area. Changes in the basin and floodplain physiography and channel morphology due to river flow regulation can greatly alter the native fish community composition and ecology. Aspects of the annual flow regime determine timing of forage fish availability. Alteration of the historic flow regime may impact tern reproductive success by decoupling the timing of peak forage availability from timing of peak reproductive efforts (USFWS 2003). Particularly where the connections between the river and the floodplain have been reduced or eliminated completely by construction of levees, forage fish production may have been significantly altered (USFWS 2003). Such a linkage between forage availability and reproductive success has been demonstrated for some gull and tern species (Safina and Burger 1985, Safina et al. 1988, Sydeman et al. 1991, as reported by Tibbs and Galat 1998). In addition, Dugger (1997) demonstrated a link between aspects of least tern reproduction and variation in food availability. The abundance of small fish in the Action Area also may be reduced due to flood control operations that reduce the peaks and frequencies of flood events that inundate the floodplain. The effects of hydropower releases also have potential to negatively affect fish populations through rapid and frequent changes in flow volume and water temperature.

SPECIES RESPONSE

The least tern has maintained a relatively stable fledgling to breeding pair ratio in most of the Action Area until 2004. Little if any reproductive success has occurred in most of the Action Area in 2004 due to reduced nesting habitat quality, cool and wet weather, and frequent flooding events. Although the average fledgling to breeding pair ratio for the Arkansas River has been near 0.7, the average fledgling to breeding pair ratio for the Red River and Canadian River has been less than 0.5 (Table 3).

Essentially all the tern nesting habitat in the Action Area is affected by the proposed action to varying degrees. All nesting terns in the Kaw Dam to Muskogee reach of the Arkansas River are expected to experience very limited reproductive success until nesting habitat conditions improve. Terns nesting on Red River also will be affected by project-related reduced habitat quality, but to a lesser degree, and reproductive success is expected to be similar to recent years. Terns nesting in portions of the Arkansas River maintained for navigation may benefit from the proposed action, provided new nesting habitat is created and maintained with dredged material. Terns nesting on this created habitat could be very successful, assuming fish populations are adequate to support nesting terns, nesting habitat is maintained over time, and human disturbance is controlled. Artificially created nesting habitat in the navigation channel should experience relatively infrequent flooding and has the potential to support relatively large numbers of nesting least terns if they colonize the newly created habitat. However, construction and maintenance of the navigation channel has eliminated all suitable tern nesting habitat over a large portion of the Arkansas River for more than 30 years. The success of artificially created nesting habitat in areas lacking recent nesting history is unknown and can only be determined through monitoring.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local, and private actions that are reasonably certain to occur within the **action area** considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The impacts of future state, local, and private actions are difficult to predict because they are dependent upon the political climate within the action area and conditions and changing patterns of economic and human population growth. The Service anticipates that the Arkansas and Red River navigation systems will continue to be operated for commercial barge traffic for at least the next 50 years, but increasing and competing demands for water for municipal, industrial and recreational use may lead to changes in the management of reservoirs and river flows. Siltation at aging reservoirs will reduce water storage capacity for competing uses. Some of the changes in demands for water will be under Federal control and will require section 7 consultation, but others will be private or state controlled and would be considered cumulative effects.

Development in watersheds, including river floodplains and riparian areas, is likely to increase and contribute to potential flooding and flood control problems. Any structures constructed in or near the rivers have potential to impact flows and sediment transport. Farming within the floodplain already influences water management decisions. Most of these cumulative effects are likely to negatively affect the river ecosystems and the federally-listed species that depend on these river systems. Species such as bald eagles and least terns are relatively adaptable to human disturbance, but nesting and foraging habitat are likely to be adversely affected by altered flows and increased development. An example of the potential development-related impacts to bald eagles and least terns is the proposed development plan for the Arkansas River corridor in Tulsa County, Oklahoma. The Corps is involved in the feasibility study, but many of the proposed actions would be privately funded. Several low-head dams, pedestrian trails, and commercial development are included in the preliminary plan and many of these proposed developments have potential to impact habitat for bald eagles and least terns.

Some private actions, such as commercial sand and gravel operations that remove sand and gravel from rivers, may exacerbate the effects of sediment reduction caused by the Corps projects. Some of these sand and gravel operations do require a permit from the Corps under Section 404 of the Clean Water Act, but most do not (utilizing the current definition of Section 404 authorities). It is difficult to quantify the amount of material removed by sand and gravel operations and even more difficult to determine the effects of these actions. Most effects are assumed to be adverse, but there is potential to maintain or enhance tern nesting habitat with the cooperation of sand and gravel operators.

Another example of a beneficial cumulative effect is the artificial creation of least tern and bald eagle nesting habitat at Sooner Lake, a small reservoir near the Arkansas River in Pawnee County, Oklahoma. The reservoir is privately owned by OG+E Electric Services and is used as a source of water for cooling a coal-powered electric power plant. Sand was placed on an area of concrete dikes in the lake to create least tern nesting habitat. At least 19 least tern nests were recently documented on that dike. An artificial nesting platform for bald eagles also was erected at Sooner Lake in 2004.

EFFECTS OF THE ACTION – CONCLUSIONS

American Burying Beetle

Adverse effects to ABBs should be relatively minor, if protective measures included in the proposed action are implemented. Despite these protective measures, some ABBs may be disturbed or killed during dredged material disposal pit construction, dredged material disposal, and related ground disturbance activities, but most of the effects are expected to be infrequent and of short duration.

Interior Least Tern

The greatest impact of the proposed action is to nesting habitat quantity and quality. The proposed action does not include restoring or maintaining nesting habitat with water releases. Although the proposed action included creating artificial nesting habitat using spoil material at two sites, it does not propose to create or maintain any significant quantity of nesting habitat with mechanical methods. Periodic high flow events are likely to occur that will restore some nesting habitat despite continuing flood control efforts. However, the quality and quantity of tern nesting habitat will decline following those events (provided those events do not reoccur within 3-5 years) and project-related flood control operations and impacts on sediment transport would hasten the decline. Tern nesting habitat in the Action Area currently is in poor condition and could remain in poor condition for relatively long periods of time with the proposed action. The adverse indirect effects, such as predation, human disturbance, and trampling by livestock, associated with the poor habitat conditions, could increase or remain at relatively high levels until habitat is improved or protective measures are implemented. Manipulation of water releases to reduce flooding of nests would reduce the adverse effects somewhat, but overall, the proposed action is likely to continue to adversely affect terns in a manner similar to the existing operations.

BIOLOGICAL OPINION

Section 7(a)(2) of the Act requires federal agencies to ensure that any action authorized, funded, or carried out by such agency is not likely to: 1) jeopardize the continued existence of any endangered or threatened species, or 2) result in the destruction or adverse modification of critical habitat. The term "jeopardize the continued existence of" means to reduce appreciably the likelihood of both the survival **and** recovery of listed species in the wild by reducing the species' reproduction, numbers, or distribution. Jeopardy biological opinions must present reasonable evidence that the project will jeopardize the continued existence of the listed species or result in destruction or adverse modification of critical habitat.

After reviewing the current status of the ABB and least tern, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is the Service’s biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of either species, and is not likely to destroy or adversely modify designated critical habitat. No critical habitat has been designated for these species; therefore, none will be affected. However, the proposed action likely will result in incidental take of ABBs and least terns.

INCIDENTAL TAKE

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior or behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to, and not intended as a part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require a contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(I)(3)]

AMOUNT OR EXTENT OF TAKE ANTICIPATED

American Burying Beetle

The amount or extent of incidental take will be difficult to enumerate in the form of individual ABBs. This difficulty is due to multiple factors, including a lack of a comprehensive survey effort due to the ABBs large distribution across eastern Oklahoma. Recent survey efforts that are available are limited in scope and geographical range. Some counties have not been surveyed at all recently. Further, as stated above, conducting an accurate population estimate is not feasible due to the biology of the ABB, as well as the lack of surveys or the incompatibilities of survey methods implemented. In addition, the ABB has a small body size making it hard to locate, which makes encountering dead or injured individuals unlikely. Further, ABB losses may be masked by annual fluctuations in population numbers and geographic densities. These complications result in difficulty enumerating or estimating the quantity of ABBs in Oklahoma in order to accurately estimate the amount or extent of take. Consequently, the Service believes using habitat as a surrogate for take is the best method to determine the amount of take that is likely to occur.

Despite the proposed protective measures, some ABBs may be disturbed or killed during dredged material disposal pit construction, dredged material disposal, or other ground disturbance activities. Approximately 1,100 acres would be disturbed to create dredged material disposal pits with the proposed action. The Corps must reinitiate consultation with the Service if more than 1,100 acres of ABB habitat are disturbed.

Least Tern

Incidental take of least terns is expected to occur in the following manner:

1. *Take of eggs and chicks by flooding on the river and reservoir reaches that result from the operations of the water control system by the Corps.*

Certain reservoir levels and water releases (including hydropower releases) from dams along the Arkansas, Canadian, and Red rivers during the summer results in flooding of nests and mortality of eggs and chicks. Most least terns have been nesting on relatively low elevation islands and sandbars in recent years because flood control operations have reduced scouring flows and allowed vegetation to encroach on most of the higher elevation (former) nesting habitat. We estimate that existing operations can and have contributed to the flooding of nests with eggs and chicks through the impacts to nesting habitat. Potentially more than 1,000 eggs and chicks can be flooded in an individual year. For example in 2004, a minimum of 160 nests were flooded on the Arkansas River in Oklahoma, and an estimated 100 or more nests in Arkansas. An additional 150-200 nests were flooded on the Red River in 2004. The exact numbers of eggs or chicks flooded are unknown, although an estimate can be derived by multiplying the number of flooded nests (only nests with eggs are counted) by two since most nests average 2 or more eggs. Chicks are more difficult to count and any direct counts are certainly an underestimate of the actual chick numbers, but we do have direct counts of chicks prior to most flood events. We realize, however, that some nests would flood naturally without any Corps action, and that it is difficult to determine the level of take related to the Corps actions alone.

However, the operation of Corps projects over time has altered sediment delivery patterns and a lack of scouring flows has allowed vegetation to encroach on higher islands (Corps 2003). This has substantially reduced the elevation of islands and sandbars used for nesting habitat, and increased the likelihood or frequency of flooding of occupied habitat during the nesting season. In the Oklahoma portion of the Arkansas River, nesting habitat conditions are extremely poor and flooding is expected to potentially take nearly all eggs and chicks in most years until nesting habitat improves. River systems are highly variable and it is difficult to predict incidental take levels in any given year, but flood releases are expected to take eggs and/or chicks in the Red and Arkansas rivers (including the Canadian River) in most years. The timing of flood events determines the effect of this take. Least terns may renest if flooding of nests occurs early in the nesting season, but flood events late in the nesting season eliminate all potential for reproductive success during that year.

2. *Take of eggs, chicks, and adults by factors influenced by, but not directly attributable to the Corps*.

An unknown number of eggs and chicks have been lost due to predation, weather, trampling by livestock, erosion, and other factors that are influenced by, but not directly attributable to Corps activities. For example, modification of the historical hydrograph as a result of reservoir operations reduces the number of large scouring events that otherwise would maintain wide channel widths and limit vegetative encroachment on sandbars and islands used for nesting by least terns. Encroachment of vegetation on sandbars used by least terns increases the potential for predation of eggs, chicks, and adults by predatory mammals and birds. Vegetative encroachment also reduces the quantity and quality of suitable nesting habitat. Least terns usually will not initiate nesting at sites with greater than 30 percent vegetative cover.

Releases associated with hydropower operations that result in relatively high flows during a portion of the day and extremely low flows at other times effectively limit suitable nesting habitat for least terns and negatively impact forage fish populations. Low flow periods increase the potential for predation and human disturbance associated with landbridging. The Service expects increased human disturbance associated with Corps and SWPA operations will result in the mortality of eggs and chicks in the Action Area and harm or harassment of adult least terns. Extended periods of hydropower releases that leave relatively little freeboard for nesting terns also put nests at a greater risk of flooding due to the additive effect of increased flows from local rainfall events.

Quantification of Take

The amount or extent of incidental take is difficult to enumerate in the form of individual least terns. The incidental take occurs in many direct and indirect forms that cannot be easily measured with existing or proposed levels of monitoring. Numbers of least terns, and especially eggs and chicks, are difficult to accurately count over several hundred miles of riverine habitat.

The proposed action is very similar to the existing operations. All forms and amount of take for the proposed action are assumed to be similar to those known to occur under existing conditions. The estimates of incidental take in this opinion are, therefore, based on averages of existing tern population levels and reproductive success. These measures of tern population levels and reproductive success for the existing population's status are used as a surrogate measure of incidental take and a way to measure the effects of the proposed action. The direct and indirect take (in all forms) cannot be precisely determined, but can be estimated through least tern population numbers and breeding success via fledgling per breeding pair ratios.

Least tern numbers must be monitored and maintained at adequate levels to ensure that anticipated levels of incidental take do not jeopardize populations in the future. Tern population numbers, in addition to reproductive success and habitat conditions, are factored into evaluations of the impacts of take related to proposed actions. Population numbers for each reach of river are averages (rounded to the nearest multiple of ten) of adult least tern numbers from surveys conducted since 1990 (Table 5). However, two exceptions to using average adult counts were required to accommodate insufficient or inconsistent available survey data.

1. Arkansas River, Arkansas - There is only one year (2004) with complete survey data for the Arkansas River in Arkansas. Therefore, calculating the average number of adult terns was not possible for this river reach. It is likely that the 2004 adult least tern count of 376 is greater than the ten year average, if we assume this portion of the Action Area is similar to the Oklahoma portion of the Arkansas River. Therefore, the 2004 adult least tern count of 376 was adjusted down by the same percentage as the Oklahoma reach (420 average verses a 529 adult count in 2004 or about a 20 percent reduction) to account for the potential that 2004 may have been an above average year for adult least terns. The adjusted number of adult terns for the Arkansas River in Arkansas is 298; then this was rounded to 300. However, several partial surveys in the past counted 200 or more least terns and the Service considers 300 to be a reasonably conservative population estimate for this reach.

2. Red River - Because the number of adult terns is used to calculate breeding pairs (adults/2), the Red River population average was adjusted to more accurately represent the number of breeding adults used to calculate fledgling to breeding pair ratios. Adult least tern numbers along the Red River declined dramatically between the first and second surveys in 2002 and 2003 due to floods in June of those years. Past monitoring has demonstrated that most nesting pairs will renest if failures occur in June or early July. Most of the terns apparently renested in the surveyed area, but the decline in adult numbers after flooding events in 2002 (from 782 to 649) and 2003 (from 993 to 670) implies that some terns renested outside of the Red River reach surveyed by the Corps. For those years, the second or July survey adult count, rather than the first (peak) adult count, represented the number of breeding terns (in the monitored reach) used to calculate fledgling to breeding pair ratios for that reach of the Red River.

Fledgling per breeding pair ratios have been measured in all of the Action Area, but monitoring has been very limited on portions of the Arkansas River. However, using available information, the average fledgling per breeding pair ratio for monitored portions of the Action Area is approximately 0.5. The average number of adult terns in the entire Action Area is estimated to be approximately 1,420 or 710 breeding pairs. Consequently 710 breeding pairs with an average of 0.5 fledglings per breeding pair would annually produce 355 fledglings. The estimates of existing numbers of adult and fledgling terns by river reach are:

A. Arkansas River, Oklahoma, Kaw Reservoir to Oklahoma/Arkansas state line, including the lower Canadian River below Eufaula Reservoir – 500 adults and 125 fledglings annually.

B. Arkansas River, Arkansas - 300 adults and 75 fledglings annually.

C. Red River, Lake Texoma to Index, Arkansas - 620 adults and 155 fledglings annually.

While we cannot precisely quantify take due to a number of variables, an estimate of the actual amount or extent of take related to reproduction is the difference between the measured reproductive success and the potential reproductive success without project-related impacts. The highest fledgling per breeding pair ratio reported for the Action Area is 1.16. Since no without project reproductive data are available, this information was judged to be the best at hand for quantifying an estimate of take attributable to project operations.

Using this ratio, the average number of breeding pairs for the Action Area (710 breeding pairs) would produce 823 fledglings, compared to the 355 fledglings produced at the 0.5 fledgling per breeding pair ratio (existing average). The difference is 468 fledglings and we assume incidental take will vary but is unlikely to exceed this amount in any individual year. Until habitat is improved, take of at least 300-600 eggs and chicks is expected in most years. We assume all adults in the Action Area (1,989 is the highest count to date) could be harmed or harassed by flooding and other impacts associated with the proposed action.

The Corps must reinitiate consultation with the Service if direct and indirect take occurs to the degree that the number of adults and fledglings, in any river reach, average (over a five year period) fewer than the numbers identified above.

EFFECT OF THE TAKE

American Burying Beetle

Approximately 1,100 acres of soil disturbance is anticipated with the proposed action and is a very small percentage of the total project area. In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the ABB or adverse modification of critical habitat.

Least Tern

Our review of information that has become available since the 1998 biological opinion indicates that the adult tern numbers have increased in many areas. However, this may be partially due to increased survey effort; in addition, not all tern populations have increased. Approximately 12,000 adult terns is the most recent rangewide estimate (2003). We evaluated new information on the species and its habitat within the Action Area. Least terns in the Action Area currently may account for approximately 16 percent of the listed entity (1,989 action area /12,305 rangewide; Table 1) based on the most recent population estimate. However, the rangewide estimate probably underestimates the total population due to a lack of recent surveys in several areas of the least tern range and recent increases in some areas.

We suspect that fledge ratios and numbers of nesting birds may decline in the Action Area until nesting habitat quantity and quality improve. Existing habitat conditions are relatively poor in much of the Action Area. However, despite Corps flood control efforts, relatively high flow events do periodically occur and are likely to restore some habitat and tern nesting success for an unknown duration. We expect tern nesting habitat conditions to fluctuate over time, but be negatively impacted by the proposed action. However, if the existing average numbers of adults and fledglings are maintained, the least tern populations in the Action Area should remain stable. The proposed action should be able to average and maintain existing levels of reproductive success (average of 355 fledglings) and that should be adequate to support existing tern populations (average of 1,420 adults) and meet or exceed existing recovery plan goals. In the accompanying biological opinion, the Service determined that the anticipated take is not likely to result in jeopardy to the least tern or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the take of ABBs and least terns.

American Burying Beetle (ABB)

To minimize potential take of the ABB, the Service recommends the following RPM:

1. The Corps must implement all conservation measures outlined in the proposed action to minimize incidental take of ABBs. These measures are standard protective measures generally recommended by the Service and have been incorporated into the Corps' proposed action.

Interior Least Tern

To minimize potential take of least terns, the Service recommends the following RPMs:

1. Maintain suitable habitat for nesting least terns in the Action Area by:

   a) providing adequate flows to create and maintain nesting habitat, and/or

   b) artificially or mechanically enhancing, constructing, and maintaining nesting habitat.

2. Monitor, evaluate, and adjust operations as needed to minimize take of least terns.

3. Monitor and evaluate least tern habitat conditions.

4. Reduce predation and human disturbance of least terns in the Action Area.

TERMS AND CONDITIONS FOR IMPLEMENTATION

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions which implement the RPMs described above and outline required reporting/monitoring provisions. These terms and conditions are non-discretionary.

American Burying Beetle

RPM 1. The Corps must implement all measures in the proposed action to minimize incidental take of ABBs.

1. The Corps must provide an annual report detailing the area (acres) impacted by construction of dredge spoil pits and deposition of dredged materials on terrestrial habitat. This report must include a copy of all ABB survey results and a description of trap and relocation and baiting away activities.

2. If a dead or impaired ABB is found, care should be taken in its handling to preserve biological materials in the best possible state for later analysis of cause of death. In conjunction with the care of injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. The dead or impaired ABB should be photographed prior to disturbing it or the site. The Service is to be notified within three (3) calendar days upon locating a dead or injured ABB. Initial notification must be made to the nearest U. S. Fish and Wildlife Service Law Enforcement Office, at (918) 581-7469, then the Oklahoma Ecological Services Field Office, at (918)581-7458. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Formal written notification also must be submitted (Appendix 3).

3. All dead or moribund adults should be salvaged by placing them on cotton in a small cardboard box as soon as possible after collection. The date and location of collection should be included with the container. Specimens should then be furnished to the Sam Noble Museum of Natural History at the University of Oklahoma in Norman for deposition in their collection of invertebrates, or to another suitable site approved by the Service.

Least Tern

RPM 1. Maintain suitable habitat for nesting least terns in the Action Area.

Suitable nesting habitat can be established and maintained by provision of appropriate river flows and/or mechanically or artificially enhanced, constructed, and maintained. As our knowledge of river habitat conditions and tern populations changes over time, the exact locations, design, and number of constructed nesting sites may be modified if approved by the

Service. Initially, all constructed nesting habitat must be at locations approved by the Service and meet the following criteria:

a) Substrate – Nesting substrates consist of well drained particles ranging in size from fine sand to small stones < 1 in. (2.5 cm) in diameter.

b) Size/Shape – Nesting areas should be a minimum of 1 ac (.4 ha), and preferably 10 ac (4 ha) in size; circular to oblong in shape, maximizing surface area; recommended slopes of 1:25 with maximum slopes not exceeding 1:10; surface height above water to exceed 18 in. (45.7 cm) at nest initiation (usually May or June).

c) Visibility – Smooth topography with < 10 percent early successional vegetation.

d) At least 50 percent of the enhanced or constructed nesting habitat must be in place by April 2008 and 100 percent by April 2010.

1. Arkansas River, Oklahoma, Kaw Reservoir to Muskogee - Nesting habitat will be provided and maintained to support the minimum population (currently at least 420 adults). Habitat for at least 200 adults (100 nesting pairs) should be at an elevation that will not flood at 20,000 cfs flows or less. Least terns will not use created nesting habitat exclusively and existing data indicate it is not realistic to expect nesting colonies to average more than 20 nests per site. Currently 8 existing nesting sites in this reach average 20 or more nests and these sites could be enhanced. At least 6 nesting sites with suitable habitat above water levels at a 20,000 cfs flow would be required to maintain 100 nesting pairs. Nesting habitat enhancement at one site (Zink Island) was accomplished in March of 2005. Most of the remaining five sites could be enhanced through cooperative efforts with sand and gravel operations or in association with proposed bridge or dam projects. The nesting habitat improvements can include relatively temporary projects, such as vegetation removal conducted on an annual basis, or more permanent enhancement/creation projects, but must meet criteria a-d above and not be flooded at 20,000 cfs. Nesting habitat improvement is important because take of nearly all (at least 300- 600) eggs and chicks is expected in most years until habitat is improved (see discussion in the Effects of the Action section).

2. Arkansas River, Muskogee to Oklahoma/Arkansas state line, including the lower Canadian River below Eufaula Reservoir - Nesting habitat will be provided and maintained to support the minimum population (currently at least 80 adults). Habitat should be at elevations that will not flood on at least a ten year frequency (as measured over the period of record and including the water elevation fluctuations due to barge traffic). This will require at least 3 nesting sites with suitable habitat. The nesting habitat improvements can include relatively temporary projects, such as vegetation removal conducted on an annual basis, or more permanent enhancement/creation projects, but must meet criteria a-d above.

3. Arkansas River, Arkansas - Nesting habitat will be established and maintained to support the minimum population (currently at least 300 adults). Dredge spoil will be utilized to create and/or enhance potential least tern nesting habitat at sites recommended and approved by the Service and the Corps. The dredge spoil islands will be monitored and evaluated by the Service and the Corps, as discussed in Part 5, during the breeding season. Suitable nesting habitat will be maintained as defined by criteria a through c listed above at sites recommended by the Service, pending post construction monitoring and evaluation. An average of at least one nesting island per pool, or 12 islands (with the Dardanelle pool counting as 2 for pools 10 &11), will be constructed and/or enhanced with dredge material disposition and maintained to provide sustainable and viable nesting habitat above an elevation that will not flood during the breeding season on at least a ten year frequency (as measured over the period of record and including the water elevation fluctuations due to barge traffic). The location and number of nesting islands per navigation pool will be based on monitoring and evaluation of tern use, sustainability, habitat quality, and viability as determined by the Service and the Corps. Of the 12 islands, at least 1 (each) must be maintained in pools 2, 5, 7, 8, 9, 10, and 12. The remaining 5 islands will be maintained where determined appropriate and feasible by the Service and the Corps based on previously described methods and considerations.

4. Red River, Lake Texoma to Index, Arkansas – Nesting habitat will be maintained to support the minimum population (currently at least 600 adults). Least tern nesting habitat in most of the Red River is not as degraded as in the Arkansas River, but the average freeboard of nests is declining. Construction of artificial islands should be considered an option to improve existing conditions or creating habitat in areas where little if any nesting habitat currently remains.

5. The Corps will monitor and evaluate the created or enhanced island/sandbar habitat annually to determine if physical and biological requirements of the least tern are being achieved. The Corps shall report the data for created or vegetation-managed nesting habitat separately from natural nesting habitat. If the created island/sandbars are not providing habitat as anticipated, then the Corps will evaluate and implement methods to improve the habitat suitability. The Corps will coordinate these actions with the Service.

6. Following three years of creating, enhancing, evaluating, and monitoring sandbar habitat, the Corps will report the results and conduct a peer review of habitat creation methods and outcomes. The Corps will provide a copy of its report and the results of the peer review to the Service and the Interior Least Tern Working Group.

RPM 2. Monitor, evaluate, and adjust operations to minimize take of least terns.

1. The Corps will monitor and evaluate the effect of reservoir releases on least terns. Information collected under RPM 3, including elevations of sandbars and nests in relationship to water levels, plus any additional information necessary to assess flooding, human disturbance, predation, and impacts to forage fish populations, will be examined.

2. The Corps will utilize its authorities and operational flexibility in adjusting flows and other pertinent actions to reduce the flooding and landbridging of least tern nesting sites. The Corps will coordinate frequently and in a timely manner with the Service when it has determined that increased flow releases may flood terns or decreased flows may landbridge tern nesting sites. During these consultations, the Corps will provide the Service its recommendations to reduce flooding and landbridging. Nesting habitat shall be a priority and other management actions implemented to meet or exceed the minimum adult and fledgling numbers established for each river reach.

3. By January 1, 2007, the Little Rock District of the Corps will develop least tern management guidelines similar to those developed by the Tulsa District. At a minimum this document will include least tern management guidelines for each project and coordination procedures and contacts for April-September of each year. The Corps will coordinate the development of this document with the Service to minimize take of terns. This document, once approved by the Service, will be incorporated into the Corps future actions and will supercede any previous guidelines.

4. The Corps will conduct annual least tern monitoring at all nesting sites on the Arkansas, Canadian, and Red rivers within the Action Area, including reservoirs and the river reaches between reservoirs. The Corps will develop a monitoring plan with specific information on how monitoring will be conducted; this plan should be developed with input from the Interior Least Tern Working Group, but must be approved by the Service. Information to be collected will include, but not be limited to, the number of adult terns, elevation of nests and freeboard representing the highest and lowest nests at each nesting site, locations (as measured with a global positioning system) in latitude and longitude or UTMs of nesting sites, evidence of landbridging, evidence of predation or disturbance, and number of nests, chicks and fledglings. In conducting the annual least tern surveys, the Corps will continue to collect information on mortality, injury, and productivity. The number and type of mortality (in categories currently used by the Corps) will be recorded for adults, chicks, eggs, and nests along with any other useful observations. The Corps will record mortality caused by its operations, any measures taken to reduce mortality, and the effectiveness of these measures to reduce take. The Corps also will collect information on annual productivity, including the number of fledglings per breeding pair.

5. In accordance with other annual reporting requirements in this BO, the Corps will provide to the Service, by December 31 of each year, the information collected as described by these Terms and Conditions along with analyses, conclusions, and recommendations.

RMP 3. Monitor and evaluate least tern habitat conditions.

1. The Corps shall monitor and map, on a periodic basis (at least once every 3 years), all potential tern nesting habitat on the Arkansas, Canadian, and Red rivers within the Action Area. The mapping information will be used to determine the quantity and quality of least tern habitat over time. Habitat monitoring must include estimates, by reach, of the

average channel width, and area of vegetated and relatively unvegetated (<30 percent) sandbars and islands at flows that represent maximum hydropower releases, and relatively minor flood release flows that would occur during the least tern nesting season. A new habitat monitoring plan will be developed with input from the Interior Least Tern Working Group for each river system. Monitoring must be initiated during the 2007 nesting season. Mapping products or updates on data collection will be provided in the annual report.

RPM 4. Reduce predation and human disturbance of least terns.

1. The Corps will evaluate various measures to reduce predation of least terns. The Corps will prepare a report describing its findings from the predation reduction evaluation, along with its recommendations. This report will be completed by April 1, 2007 and provided to the Service for review.

2. The Corps will implement measures approved by the Service to reduce predation at all constructed or enhanced least tern nesting sites.

3. The Corps shall post signs at least tern nesting sites that the Service and Corps jointly deem could be affected by human disturbance and may benefit from posting signs (e.g., large colonies, areas with high human use, sites used by ATV's or other ORV's, sites with history of human disturbance). The Corps will contact landowners of nesting sites not owned or controlled by the Corps to obtain permission to post signs. With landowner permission, the signs will be placed at strategic locations and densities to best deter human entry. The signs should clearly deny entry, describe the potential for death and injury of least terns from entry, the penalties under the ESA for harming a threatened or endangered species, and general information on the life history of least terns. The Corps will coordinate with Service and State personnel on any nesting sites requiring surveillance and/or enforcement action.

4. All personnel involved with surveying, studying, maintaining habitat, and related activities will be trained to use current methods to avoid impacting terns.

5. At least tern nesting sites owned and managed by the Corps, monitor and manage recreation and other activities to avoid or minimize human disturbance.

6. The Corps will conduct a public outreach and education program on the conservation of the least tern. In addition to using traditional outreach products and activities (e.g., brochures, videos, interpretative programs, posters), the Corps will produce and distribute each year during the least tern nesting season Public Service Announcements about least terns in the Action Area. The Public Service Announcements should be available for public use as well as in the Corps' project offices.

PROCEDURES FOR HANDLING AND DISPOSING OF INTERIOR LEAST TERNS

Upon locating a dead or injured adult or juvenile least tern, the Oklahoma Ecological Services Field Office should be notified as expeditiously as possible. Care will be taken in handling sick or injured specimens to ensure effective treatment and when handling dead specimens to preserve biological materials in the best possible state for later analysis of cause of death. The finder must ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

All dead or moribund individuals will be frozen and the date and location of collection recorded. These specimens should then be furnished to the university, museum, or agency specified by the Service.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the amount or extent of the incidental take limit is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs and terms and conditions provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs and terms and conditions.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans or develop information. Implementation of these measures would help facilitate recovery of the least tern.

A. The Corps and SWPA should work with the Service to immediately establish a least tern coordination team (LTCT) to identify and implement the goals of this BO. That team will be responsible for ensuring implementation of future conservation measures; tracking, evaluating, and documenting the results of those measures; and tracking and documenting sufficient progress in conserving this listed species. The LTCT should involve additional agencies or groups, as appropriate, with biological and engineering expertise. The LTCT should coordinate with the Interior Least Tern Working Group to improve implementation of monitoring and recovery measures.

B. Conduct least tern monitoring on river reaches upstream of Corps reservoirs. Least tern populations nesting on the Cimarron, Canadian, and Red rivers upstream of Corps reservoirs should be monitored to help determine movements of terns from downstream areas during and after flood events or other disturbances. The reproductive success of these terns should be monitored to determine the comparative nesting success of terns above and below Corps reservoirs.

C. The Corps should initiate other studies as appropriate to investigate the long-term effects of riverbed changes/sediment transport and their impacts to least tern nesting habitat, forage availability, and forage areas.

D. The Corps should initiate studies to evaluate the abundance and availability of forage fish for least terns during the nesting season. The effects of operational flows on forage fish also should be investigated to develop modifications of flows to benefit forage fish populations. The abundance and availability of forage may be a limiting factor to the success of nesting least terns.

E. The Corps should research and develop methods to restore the dynamic equilibrium of sediment transport and associated turbidity in river reaches downstream of reservoirs.

F. The Corps should conduct or assist in research on the ABB to fill data gaps regarding the ecology and biology of the ABB. Data gaps involving the ABB include: suitable reproductive habitat, overwintering habitat, and diurnal active season habitat. The Service recommends coordinating research proposals with the Oklahoma Field Office.

G. The Corps should assist in monitoring and habitat management for Ivory-billed woodpeckers in appropriate portions of the project area.

In order for the Service to be kept informed of actions that either minimize or avoid adverse effects or benefit listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in your biological and environmental assessments. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation of consultation.

Thank you for the information and cooperation provided by the Corps in this consultation. Questions or comments should be referred to Mr. Kevin Stubbs of this office at 918/581-7458 (ext. 236).

Sincerely,

Jerry J. Brabander
Field Supervisor

cc: Regional Director, U.S. Fish and Wildlife Service, Albuquerque, NM (AES/SE).
U.S. Fish and Wildlife Service, ARESFO, Conway, Arkansas
Director, Natural Resource Section, ODWC, Oklahoma City, OK.
Director, Arkansas Game and Fish Commission, Little Rock, AR

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APPENDIX A

Corps Tulsa District Least Tern Management Guidelines and Little Rock District Least Tern Management Plan

Management Guidelines
And Strategies for
Interior Least Terns
USACE-Tulsa District
(Revised 4-1-2003)

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Management Guideline For
Interior Least Terns
USACE-Tulsa District
(Revised 4-1-2003)

1 **Purpose.** To provide comprehensive guidelines for the management and protection of interior least terns nesting below Corps of Engineers water resource projects on the Arkansas, Canadian and Red Rivers in Tulsa District, U. S. Army Corps of Engineers (USACE-TD). This guideline includes a comprehensive approach for both long-term and short-term strategies to achieve compliance with the Endangered Species Act (ESA) to the maximum extent possible while preserving authorized project purposes

2 **Management Strategy**.

a. Long-Term Strategy. The long-term strategy is to provide suitable nesting habitat, which is not adversely impacted by normal operation of water resource projects. The development of these activities will occur concurrently with the short-term strategy. Long-term actions include the following.

(1) Develop and maintain islands with suitable nesting habitat.

(a) Investigate and determine the feasibility of creating or enhancing islands to provide suitable nesting habitat. Identify potential funding sources to perform work. Incorporate least tern habitat evaluations as part of appropriate environmental studies.

(b) Utilize dredging activities from commercial sand plants and/or navigation dredging (Dredge Material Disposal Plan) to create or enhance nesting areas.

(c) Explore and implement ways to maintain and/or improve nesting islands by sand replenishment, vegetation control and removal, and structural methods.

(2) Evaluate and monitor project impacts.

(a) Population Surveys (Upstream and Downstream). Continue performing periodic surveys to identify colonies and nesting success.

(b) Habitat documentation/evaluation. Establish baseline GD&S information and perform periodic updates to monitor and evaluate nesting islands.

(c) Evaluate project impacts and identify methods to recover the species.

b. Short-Term Strategy. The short-term strategy utilizes reasonable and prudent management practices that comply with the ESA by minimizing impacts to habitat and nesting stage and initiate steps to achieve long-term goals.

(1) Non-nesting Period.

(a) Definition. The periods before birds arrive for breeding and after young birds are fledged and able to fly.

(b) High-flow Releases

Objective: Periodically release floodwater with sufficient flow rates and elevations to inundate and scour islands in order to remove vegetation and deposit silt and sand. Durations will be adjusted to provide optimum conditions for material deposition. Releases will be based on sound hydrological opportunities. During years when the hydrological conditions do not allow for this type of a release, the methods described in (c) and (d) may have to be considered.

Impacts: Provide sufficient sand deposits to replenish sand and raise island elevations. May adversely impact project purposes and create an imbalance in project evacuation plans. No significant impact to navigation flows is anticipated by this operation. Releases will have to be decreased at some lakes to make up for the increases at other lakes. The resulting total flow rate in the navigation system will be unchanged. Deviations may be required.

Schedule: Every 2-3 years during non-nesting periods. After coordination with the USFWS on a case-by-case basis, releases may extend into the early nesting periods if determined to be beneficial.

(c) Dredging Operations

Objective: Use dredge materials to replenish sand on existing islands and deepen water around islands to remove land bridges.

Impacts: Requires the voluntary cooperation with sand operators to perform work or O&M funds to hire the work done. Actions may require appropriate permits, access agreements, easements and volunteer agreements.

Schedule: During non-nesting periods

(d) Vegetative Manipulation

Objective: Use physical or chemical methods to remove vegetation from nesting islands to improve nesting habitat.

Impacts: Limited to isolated areas and requires extensive labor and material resources to physically remove vegetation and treat nesting areas. May require multiple applications or treatments. Activities may require landowner access or easements.

Schedule: Late spring before arrival of adults.

(2) Nesting Period

(a) Definition. The period when nests are being established until young birds are fledged and able to fly.

(b) Limit maximum water releases.

Objective. Prevent flooding of active nests

Impacts. Reduces the loss of nest and chicks from flooding. Conserves water in the flood control pool and may improve ability to provide sufficient flows for minimum water releases. May reduce flood storage capacity and extend periods of higher lake elevations.

Schedule. June (Nesting Season). Note: After coordination with USFWS on a case-by-case basis, releases during <u>early</u> nesting periods may be determined to be beneficial.

(c) Provide minimum water releases.

Objective. Prevent land bridging of islands to reduce nesting losses due to predation and human activities.

Impacts. May require extended periods of minimum flow releases could create regional impacts during periods of low lake levels and adversely impact multiple project purposes such as recreation, water supply, hydropower, flood control, navigation and fish and wildlife. Regional hydropower projects in Tulsa, Little Rock, St. Louis and Kansas City Districts could be required to generate additional energy no longer available from projects involved in tern management.

Schedule. June and July (Could extend into August)

3 Hydrological Considerations

a. Seasonal Pool Operations. Seasonal pool plans (SPP) will be implemented (if approved) for Kaw, Keystone, Eufaula, and Texoma to allow water to be stored in the lower part of the flood control pool during June and July. This water could then be used to provide minimum flow requirements during the remainder of the nesting season. This will decrease the amount the pool is drawn down later in the summer. Note: Texoma has an existing SPP and will not be modified. Kaw and Eufaula have existing SPP's that will be modified. A new SPP will be implemented for Keystone.

b. Deviation Request. Any change in the normal operation of the projects will require a deviation approval from SWD. The release of water specifically for least terns will require a deviation.

c. Normal Hydropower Demands. SWPA indicated the normal peak demand for power is approximately 6hrs per day Monday - Friday. OMPA will utilize "run of the river" to meet peak demands and multiple starts to satisfy low flow requirements. OMPA indicated the normal demand for power is approximately 6 hrs per day (2 - 8pm) Monday - Friday.

d. Water Conservation/Operations

(1) Initiate a strategy to schedule releases to maintain minimum water levels over land bridges at targeted sites and during critical periods.

(2) Evaluate various release strategies to determine the most efficient method to conserve water and reduce impacts on project purposes.

(3) Non-Hydropower Releases. There may be occasions where the needed flow to prevent land bridging is significantly less than the outflow from a generator loaded at its lowest safe operating level. In those cases, it <u>may</u> be economically justified to spill the necessary water in order to conserve lake storage to meet future power needs. SWPA has developed a procedure for evaluating the advisability of spilling the water based on the market prices of on-peak and off-peak generation prevailing at the time and will make recommendations to the USACE-TD on a

case-by-case basis. The procedure makes no attempt to evaluate the impacts to other project purposes.

(4) Water Supply Storage Accounting. The H&H Branch is required to begin water supply storage accounting when the conservation pools get to less than 75% full. The water released to protect the least terns from predators, will be treated as a loss to be shared by all storage owners (water supply, water quality, and hydropower). The losses are shared proportionally to a user's remaining storage. This is the same way evaporation losses are accounted for.

(5) Maximum Allowable Draw Down Rate (Dam Safety Criteria). Pool draw down rates <u>shall not</u> exceed the rates established in the water control manuals to allow sufficient time for saturated soil on the embankment to drain and prevent slippage. Generally 1 ft per week and 3 feet per month. Any deviation <u>must</u> be reviewed and approved by SWD after coordination by E&C Division (H&H and Dam Safety).

4 **<u>Stakeholder and Public Coordination</u>**

a. Section 7, Endangered Species Biological Assessments (BA) and Biological Opinions (BO) Consultation. Adjust actions to comply with BO conditions or re-initiate consultations to allow for changes of actions or conditions. Examples include revising the level of take, changing management actions, revising operating plan for least terns, etc.

b. Coordination Meetings.

(1) Pre-season Planning. Annual coordination meetings will be held with all agencies to review and plan for current year plan.

(2) Critical Time Evaluations and Analysis. Routinely meet with agency representatives during critical nesting period to assess current conditions and decide on appropriate courses of action.

(3) Post-season Operational Meeting. Meet with all agencies to review the past years activities and determine areas of improvement.

c. Surveys.

(1) Perform multiple surveys of the river systems in order to evaluate and monitor nesting success. (May - August)

(2) Evaluate habitat and determine allowable levels of discharge rates. (May - August)

d. Communication and Community Relations

(1) Establish lines of communications and protocols for coordinating general and time critical actions. (See Appendix E)

(2) Develop a community relations plan to inform the public, stakeholders and congressional delegations about the actions to protect least terns. (See Appendix G)

5 **Roles and Responsibilities**

a. Project and Program Management Division. (PPMD). Serves as the project manager and is responsible for overall management of least terns program. Serves as the team leader for the interdisciplinary Project Delivery Team (PDT) and is the primary point of contact for executive leadership and cooperating agencies. Provides upward reporting to PRB about the status of PDT activities, guidelines and management efforts. Monitors management activities and facilitates coordination and decision making meetings. Ensures adequate communication and information exchange, both internal and external.

b. PER Division. Coordinates with USFWS in accordance with the ESA. Implements terms and conditions of BO. Conducts annual surveys of nesting least terns for nesting success. Coordinates survey data with elements of USAED-TD and other agencies. Prepares reports of nesting success for USFWS. Responsible for life history, habitat evaluation, and assessment of biological implications of any modifications to Interior Least Tern populations and or habitats. Reviews habitat construction proposals for compliance with CWA Section 404(B)(1) guidelines and Section 10 of the Rivers and Harbors Act of 1899.

c. E&C Division (H&H / Dam Safety). Manages USAED-TD projects for flood control, hydropower, and low flow releases. Has the lead in coordinating any changes in reservoir regulation with appropriate agencies including, USFWS, SWPA, and project field offices. Reviews proposed releases to ensure dam safety criteria are not exceeded.

d. Operations Division. Operates USAED-TD projects for all other project purposes. Area Manager provides input on impacts of proposed actions on other project purposes including recreation. Coordinates with the local communities with respect to reservoir operations and potential impacts on recreation. Responsible for implementation of management practices within water resource project boundaries and authorities.

e. Office of Counsel. Provides advice on legal sufficiency of proposed actions with respect to the Endangered Species Act.

f. Public Affairs. Supports the management team in efforts to keep the public, stakeholders and congressional delegations apprised of changes in operation of USAED-TD reservoirs for least terns. Provides assistance, advice and communication products to area managers for local use.

6 **Authorities.**

a. Legal Authorities. The Corps of Engineers is under obligation operate water resource projects in compliance with the requirements of the Endangered Species Act and Migratory Bird Treaty Act. That obligation includes using reasonable and prudent alternatives to avoiding further harm to the listed species and to assist in the restoration of the species to a status that no longer requires listing.

b. O&M Authorities.
(1) Rivers and Harbors Act (RHA)
(2) Flood Control Act
(3) Environmental Impact Statement (EIS)
(4) Design Memorandums

c. Regulatory Permits - Certain activities that may be proposed under short-term or long-term strategies will require review and authorization under Section 404 of the Clean Water Act (CWA) and under Section 10 of the Rivers and Harbors Act (RHA) of 1899. Such activities include mechanical or physical manipulation of the riverbed and banks for the creation or enhancement of tern habitat.

d. Congressional Authorities

(1) Continuing Authorities Projects (CAP).

(a) <u>Aquatic Ecosystem Restoration (Sec 206, WRDA96)</u>. Authorizes aquatic ecosystem restoration and protection projects if it has been determined that it satisfies the following criteria: (1) it improves the quality of the environment, (2) it is in the public interest and (3) it is cost-effective. Non-federal interest shall provide 35% of the cost of construction and agree to 100% operations and maintenance cost.

(b) Environmental Restoration (Section 1135, WRDA 96) Authorizes the review of water resource projects to determine the need for modifications in the structures and operations of such projects for the purpose of improving the quality of the environment in the public interest and to determine if the operation of such project contributes to the degradation of the quality of the environment. If the water resource project contributes to the degradation of the quality of the environment, measures may be undertaken for restoration and enhancement of environmental quality if such measures do not conflict with the authorized project purposes. Non-federal share of the cost of any measure of modification shall be 25%.

(2) General Investigations (GI). Studies to address ecosystem restoration opportunities could also be conducted under the General Investigation program. The following authorities are utilized to examine water resource problems and identify solutions. Reconnaissance studies could be initiated if funded by U.S. Congress. Feasibility studies, if recommended during the reconnaissance phase, require non-Federal cost share sponsors.

(a) Arkansas River and Tributaries, Great Bend, Kansas to Tulsa, OK Study authorized by Section 208, 1965 Flood Control Act. No current studies underway.

(b) Canadian River and Tributaries, OK, TX and NM. Authorized by the Flood Control Act 1937, PL525. No current studies underway.

(c) Red River Waterway, LA, AR, OK, TX (Index, Arkansas to Denison Dam, Texas) Reconnaissance Study authorized by the Rivers and Harbor Act of 1968 (PL 90-483). A reconnaissance study is funded in the FY02 Budget and is underway.

7 **Partnerships.**

a. Environmental Organizations. Identify and encourage interested environmental groups to participate in voluntary efforts to monitor tern activities, modify habitat, increase public awareness, education programs, etc.

b. Corporate Sponsors

(1) Sand and Gravel Operators. Identify ways or incentives to encourage operators to beneficially maintain, modify, or improve least tern nesting islands and habitat.

(2) Water Storage Customers. Identify water users who benefit from long-range goals. (i.e. SWPA Customers, PSO, Private Power, concessionaires, water supply customers, etc)

c. Section 404 CWA Permits - Evaluates proposed actions in least tern territory for potential habitat improvement opportunities. Inform permit applicants and the public regarding the qualities and importance of least tern nesting habitat and practices that best maintain and protect habitat. Consider how potential incentive plans for private landowners may be integrated into the Regulatory Permit program.

d. Special Interest Groups and Associations. Identify and encourage individual groups or associations involved with water resource projects to participate in long-term actions. These groups include individual lake associations at Kaw, Keystone and Eufaula and the Lake Texoma Advisory Council.

Appendix A

Kaw Lake and Arkansas River Operation Plan

Appendix A
Interior Least Tern
Project Operation Plan
Kaw Lake and Arkansas River System

1 **Area Description.** Kaw Lake, located at river mile 653.7 near Ponca City, and the Arkansas River from Kaw Dam to Keystone Lake.

2 **Kaw Lake - Least Tern Operation Plan.**

a. Upper limit for flood control protection of the terns is elevation 1021.5 (25% of flood pool). A rainfall event resulting in 2.0 inches of runoff over the 6250 square mile drainage basin will fill the remaining flood storage. This is about a 5-year frequency event. When the pool is above this level, the project will be operated for flood control according to the approved water control plan.

b. Use the current seasonal pool modified from 15 May through 15 August, with a 3 feet rise to elevation 1013 from 1 June through 15 July.

c. Stop making low flow releases when the pool gets to elevation 1008.0 (90% of conservation storage). This allows net inflows to be generated by OMPA and keep the pool at or above elevation 1008.0 by 30 September. Operations Division identified elevation 1008.0 as being a critical low pool condition.

d. Limit drawdown rate to a maximum of 1 foot per week and 3 feet in a consecutive 4-week period when pool elevation is below 1010.

e. Minimum release capacity. The average flow requirement to protect least terns below Kaw Lake is 2,200 cfs.

f. The upper and lower pool limits are intended as a guide and serves as triggers to activate technical review. These limits may be exceeded on a case-by-case basis after the PDT reviews all pertinent data and circumstances.

3 Kaw Lake - Least Tern Operation Plan Table

Pool Level	Elevation	Percent Full	Potential Actions
Top Flood Pool	1044	100% (flood)	
Upper Limits	>1021.5	25% (flood)	Stop flood protection of nest
Top Seasonal Pool	1013	100% (cons)	
Drawdown Limit	<1008	90% (cons)	Stop low flow releases
Critical Low Pool	1008	90% (cons)	

Appendix B

Keystone Lake and Arkansas River Operation Plan

Appendix B
Interior Least Tern
Project Operation Plan
Keystone Lake and Arkansas River System

1 **Area Description.** Keystone Lake, located at river mile 538.8 near Tulsa, OK, and the Arkansas River from Keystone Dam to Muskogee, OK.

2 Keystone Lake - Least Tern Operation Plan

a. Beginning 1 June of each year, CESWT-EC-HM begins computing 2-week average inflows for Keystone. These flows will be compared with median inflows to predict a trend. This process will be repeated every 2 weeks through the end of the nesting period. This data will be used to forecast pool drawdowns due to minimum flow requirements for the terns as well as hydropower generation. This process identifies the maximum release rate, which will not exceed the drawdown limits identified for the lake.

b. Upper limit for flood control protection of the terns is elevation 730 (10% of flood storage). This limit is required because Keystone Lake has a frequent rate of filling the flood control storage and has a high population center immediately downstream. A rainfall event resulting in 1.2 inches of runoff over the 14,500 square mile contributing drainage basin will fill the remaining flood storage. This is about a 2-year frequency event.

c. Implement a Seasonal Pool Plan (SPP) to elevation 726 from 1 June through 15 July.

d. Assuming median (normal) inflow conditions, low flow releases will be discontinued when the pool is forecast to fall to elevation 719.8 (60% of conservation storage remaining) by 31 July. This provides adequate storage to generate hydropower to meet peaking power demands and stay above elevation 718.0 (51% of conservation storage remaining) by 30 September. Operations Division identified elevation 718 as being a critical low pool condition.

e. Assuming 5-year frequency low flow conditions, low flow releases will be discontinued when the pool is forecast to fall to elevation 724.0 (86% of conservation storage remaining) by 31 July. This provides enough storage to generate hydropower to meet peaking power demands and stay above elevation 718.0 (51% of conservation storage remaining) by 30 September.

f. Limit drawdown rate to a maximum of 1 foot per week and 3 feet in a consecutive 4-week period when the pool elevation is below 723.

g. Minimum release requirements. The average flow requirement for the Arkansas River below Keystone Lake is 4,500 cfs. The minimum outflow from a hydropower generator at its lowest safe operating level is 5,200 cfs

h. The upper and lower pool limits are intended as a guide and will serve as triggers to activate technical review. These limits may be exceeded on a case-by-case basis after the PDT reviews all pertinent data and circumstances.

3 Keystone Lake -Least Tern Operation Plan Table

Pool Level	Elevation	Percent Full	Potential Actions
Top Flood Pool	754	100% (flood)	
Upper Limits	>730	10% (flood)	Stop flood protection of nest
Top Seasonal Pool	726	100% (cons)	
Drawdown Limit	* <724	86% (cons)	Stop low flow releases
Drawdown Limit	**<719.8	60% (cons)	Stop low flow releases
Critical Low Pool	718	51% (cons)	

*Based on 5-year low flow conditions **Based on median flows

Appendix C

Canadian River Operation Plan

Appendix C
Interior Least Tern
Project Operation Plan
Canadian River

1 **Area Description.** Eufaula Lake, located at river mile 27 and the Canadian River from Eufaula Dam to RS Kerr L&D Reservoir.

2 **Eufaula Lake - Least Tern Operation Plan**

a. Beginning 1 June of each year, CESWT-EC-HM will begin computing 2-week average inflows for Eufaula Lake. These flows can be compared with median inflows to predict a trend. This process will be repeated every 2 weeks through the end of the nesting period. This data will be used to forecast pool drawdowns due to minimum flow requirements for the terns as well as hydropower generation. This process identifies the maximum release rate, which will not exceed the drawdown limits identified for Eufaula Lake.

b. Upper limit for flood control protection of the terns is elevation 588.0 (22% of flood storage). This limit is required because elevations above this limit cause extensive shoreline erosion and endanger private property. A rainfall event resulting in 2.5 inches of runoff over the 8,700 square mile contributing drainage basin will fill the remaining flood storage. This is about a 5-year frequency event.

c. Modify the existing seasonal pool plan to allow for a pool rise to elevation 587 from 1 June through 15 July.

d. Assuming median (normal) inflow conditions, low flow releases will be discontinued when the pool is forecast to fall to elevation 581.8 (78% of conservation storage remaining) by 31 July. This provides adequate storage to generate hydropower to meet peaking power demands and stay above elevation 580.0 (67% of conservation storage remaining) by 30 September. Operations Division identified elevation 580 as a critical low pool condition.

e. Assuming 5-year frequency low flow conditions, low flow releases will be discontinued when the pool is forecast to fall to elevation 583.2 (87% of conservation storage remaining) by 31 July. This provides enough storage to generate hydropower to meet peaking power demands and stay above elevation 580.0 (67% of conservation storage remaining) by 30 September.

f. Limit the drawdown rate to a maximum of 1 foot per week and 3 feet in a consecutive 4-week period when the pool is below elevation 585.

g. The upper and lower pool limits are intended as a guide and serves as triggers to activate technical review. These limits may be exceeded on a case-by-case basis after the PDT reviews all pertinent data and circumstances.

3 Eufaula Lake - Least Tern Operation Plan Table

Pool Level	Elevation	Percent Full	Potential Actions
Top Flood Pool	507	100% (flood)	
Upper Limits	>588	22% (flood)	Stop flood protection of nest
Top Seasonal Pool	587	100% (cons)	
Drawdown Limit	* <583.2	87% (cons)	Stop low flow releases
Drawdown Limit	**<581.8	78% (cons)	Stop low flow releases
Critical Low Pool	580	57% (cons)	

*Based on 5-year low flow conditions **Based on median flows

Appendix D

Denison Dam and Red River
Operation Plan

Appendix D
Interior Least Tern
Project Operation Plan
Denison Dam and Red River

1 **Area Description.** Denison Dam, located at river mile 725.9 near Denison, TX, and the Red River from Denison Dam to Index, AR.

2 **Lake Texoma - Least Tern Operation Plan**

a. Beginning 1 June of each year, CESWT-EC-HM will begin computing 2-week average inflows for Lake Texoma. These flows can be compared with median inflows to predict a trend. This process will be repeated every 2 weeks through the end of the nesting period. This data will be used to forecast pool drawdowns due to minimum flow requirements for the terns as well as hydropower generation. This process identifies the maximum release rates, which will not exceed the drawdown limits identified for Lake Texoma.

b. The upper limit for flood control protection for the terns is elevation 624 (25% full). A rainfall event resulting in 1.4 inches of runoff over the 26,100 square mile drainage basin will fill the remaining flood storage. This is about a 5-year frequency event. When the pool is above this level, the project will be operated for flood control according to the approved water control plan.

c. The current permanent seasonal pool plan will be followed. This plan provides for a pool rise to elevation 619 (2 feet above normal) from 1 June through 15 July.

d. Assuming median (normal) inflow conditions, low flow releases will be discontinued when the pool is forecast to fall to elevation 613.5 (74% of conservation storage remaining) by 31 July. This provides adequate storage to generate hydropower to meet peaking power demands and stay above elevation 613.0 (72% of conservation storage remaining) by 30 September. Operations Division identified 613 as being a critical low pool condition.

e. Assuming 5-year frequency low flow conditions, low flow releases will be discontinued when the pool is forecast to fall to elevation 616.1 (85% of conservation storage remaining) by 31 July. This provides enough storage to generate hydropower to meet peaking power demands and stay above elevation 613.0 (72% of conservation storage remaining) by 30 September.

f. The maximum pool draw down rate will be limited to 1 foot per week and 3 feet in a consecutive 4-week period when the pool elevation is below 617.

g. The upper and lower pool limits are intended as a guide and will serve as triggers to activate technical review. These limits may be exceeded on a case-by-case basis after the PDT reviews all pertinent data and circumstances.

3 **Texoma Lake - Least Tern Operation Plan Table**

Pool Level	Elevation	Percent Full	Potential Actions
Top Flood Pool	640	100% (flood)	
Upper Limits	>624	25% (flood)	Stop flood protection of nest
Top Seasonal Pool	619	100% (cons)	
Drawdown Limit	* <616.1	85% (cons)	Stop low flow releases
Drawdown Limit	**<613.5	74% (cons)	Stop low flow releases
Critical Low Pool	613	72% (cons)	

*Based on 5-year low flow conditions **Based on median flows

Appendix E

Notification Responsibilities, Protocols and Contacts

Appendix E
Notification Responsibilities, Protocols and Contacts.

1. <u>Notification of least tern arrival for nesting season</u>. The responsibility for notification that least terns have arrived on the Arkansas River, Canadian River, and Red River is a joint responsibility of the USFWS and USACE-TD.

Protocol. As soon as USFWS and CESWT-PE-E field personnel observe birds on these rivers, CESWT-PE-E POC's or alternates initiates the following notification protocol.

CESWT-PE-E notifies: CESWT-PP-C,CESWT-EC-HM, USFWS and ODWC.
CESWT-PP-C notifies: Area Managers, CESWT-OD-R and CESWT-PA
CESWT-EC-HM notifies: reservoir regulator, SWPA and OMPA
Area Managers notifies: local news media and interest groups

Copies of the notification are sent to all POCs and the least tern committee members. All notifications are by phone and followed by e-mail for recording purposes.

See list of phone numbers and e-mail addresses in paragraph 9 for appropriate POCs.

2. <u>Notification that least terns have begun nesting</u>. Notification that least terns have begun nesting is a joint responsibility of the USFWS and USACE-TD.

Protocol. As soon as USACE-TD or USFWS personnel determine the start of nesting, CESWT-PE-E initiates the following notification protocol.

CESWT-PE-E or alternate notifies: CESWT-PP-C, CESWT-EC-HM, USFWS and ODWC
CESWT-PP-C notifies: Area Manager, CESWT-OD-R and CESWT-PA.
CESWT-HM notifies: OMPA and SWPA.
Area Managers notifies: local news media and interest groups

CESWT-PA will prepare a news release about the nesting terns in accordance with the communication plan and provide to Area Managers and major news media.

Survey Coordination. CESWT-PE-E and USFWS schedules dates for conducting summer surveys and reporting results to CESWT-EC-HM who contacts appropriate reservoir regulators.

All notifications are by phone and followed by e-mail for recording purposes. See list of phone numbers and e-mail in paragraph 9 addresses for POCs.

3. Determination of least tern nesting locations and freeboard. Upon completion of the initial survey, data results including locations and numbers of nesting colonies, and critical elevations are furnished to CESWT-EC-HM.

Protocol. As soon as USACE-TD and USFWS personnel compiled the first summer survey data, CESWT-PE-E initiates the following notification protocol.

CESWT-PE-E notifies: CESWT-PP-C, CESWT-EC-HM, USFWS and ODWC
CESWT-EC-HM notifies: OMPA and SWPA
CESWT-PP-C notifies: Area Manager, CESWT-OD-R, CESWT-PA

All notifications are by phone and followed by e-mail for recording purposes. See list of phone numbers and e-mail addresses in paragraph 9 for appropriate POCs.

4. Notification of flood control operation. During the nesting period, it may be necessary to begin flood control operation. CESWT-EC-HM will determine if the required changes in reservoir regulation will potentially impact nesting least terns.

Protocol. As soon as CESWT-EC-HM determines when flood operations will begin and the magnitude, the following notification protocol will be initiated.

CESWT-E-HM notifies: CESWT-PP-C, CESWT-EC, CESWT-EC-DD, and CESWT-PE-E, OMPA and SWPA
CESWT-PE-E notifies: ODWC and USFWS.
CESWT-PP-C notifies: Area Manager, CESWT-OD-R, CESWT-PA
Area Managers notifies: local news media and interest groups

CESWT-PA updates a news release about the nesting terns and provide to Area Managers and major news media. All notifications are by phone and followed by an e-mail for recording purposes. See list of phone numbers and e-mail addresses in paragraph 9 for appropriate POCs.

5. Notification of flood control to conservation transition. When it becomes necessary to reduce or cease flood control operations during the least tern-nesting season and birds have not fledged, it is necessary to predict when flows will be reduced. This permits consideration of special flow conditions to prevent land bridging of islands.

Protocol. CESWT-EC-HM has the lead in predicting when flood operations will cease. As soon as practicable and to provide critical lead-time the CESWT-EC-HM will initiate the following notification protocol.

CESWT-EC-HM notifies: CESWT-PP-C, CESWT-EC, CESWT-PE-E, OMPA and SWPA.
CESWT-PE-E notifies: USFWS and ODWC
CESWT-PP-C notifies: Area Manager, CESWT-OD-R, and CESWT-PA.

CESWT-PP-C will convene the least tern committee to discuss and evaluate probable impacts to least terns and reservoir operations. The tern committee evaluates all data and impacts and makes a recommendation about special operations for least terns. CESWT-PP-C and CESWT-EC-H notifies and brief the commander on the committee recommendation.

CESWT-PP-C notifies all members of the tern committee by phone and by e-mail of the USACE-TD Commander's decision.

CESWT-PA provides a news release to Area Managers, major news media and notify congressional delegation about the nesting terns and any special low flow releases that might be required.

If the least tern committee recommends special low flow releases for least terns, the CESWT-EC-HM notifies SWD-EC-HH of the proposed action and requests a deviation. All notifications involving SWD are by phone and email followed up by written notification.

All notifications are by phone and followed by an e-mail for recording purposes. See list of phone numbers and e-mail addresses in paragraph 9 for appropriate POC's.

6. Notification of special low flow operations. Under certain conditions it may become necessary to provide special low flow releases from selected reservoirs. CESWT-EC-HM has the lead in providing these releases.

Protocol. Based upon the recommendation of the least tern committee, and the USACE-TD Commander, CESWT-EC-HM shall initiate the following notification protocol.

CESWT-EC-HM notifies: CESWST-EC, CESWT-EC-DD, OMPA and SWPA
CESWT-PP-C notifies: Area Managers, CESWT-OD-R, CESWT-PE-E,
CESWT-PE-E notifies the ODWC and USFWS.

CESWT-PE-E is responsible for conducting any special studies or surveys associated with any special releases and reporting requirements. Field project offices may be called upon to help with special operations or surveys.

CESWT-PA may choose to provide a media release and notify congressional delegation about the status of nesting terns and any special low flow releases that might be required, and potential impacts to reservoirs.

7. Notification upon end of Nesting Season. Upon completion of the tern-nesting season all parties will be notified.

Protocol. After USFWS and CESWT-PE-E biologist review of survey data and upon a joint consensus the nesting season will be declared to be officially over. The consensus shall be based upon the fact that (1) all least terns have fledged or (2) that most of the least terns have a chance to fledge have been adequately protected. Upon reaching this consensus CESWT-PE-E initiates the following notification protocol.

CESWT-PE-C notifies: CESWT-PP-C, CESWT-EC-HM and ODWC.
CESWT-PP-C notifies: CESWT-OD, Area Managers, CESWT-PA
CESWT-EC-HM notifies: SWPA and OMPA

Copies of the e-mail notification will be furnished to all POC's and members of the least tern committee.

CESWT-PA provides a media release and notify congressional delegations of this event.

8. Emergency Notifications (After Hours Protocol) During periods when flow releases are required after normal working hours that will result in flooding nests or causing land bridging, all parties will be notified as soon as possible.

Protocol. CESWT-EC-HM has the lead in determining the necessity for releases that may flood some or all the nest. This necessity will usually be caused by large rainfall events that may occur at night or on weekends.

9. Point of Contacts

USFWS
Primary: Kevin Stubbs, 918-581-7458 x236, Kevin_Stubbs@fws.gov
Alternate: Hayley Dikeman, 918-581-7458 x239, Hayley_Dikeman@fws.gov
Alternate: Ken Collins, 918-581-7458 x230, Ken_Collins@fws.gov

ODWC
Primary: Mark Howery, 405-521-4619, mhowery@odwc.state.ok.us
Alt: Ron Suttles, 405-521-4602, rsuttles@odwc.state.ok.us

CESWT-PE-E
Primary: Steve Nolan, 918-669-7660, Stephen.L.Nolen@usace.army.mil
Alt: Sandra Stiles, 918-669-7662, Sandra.Stiles@usace.army.mil
Alt: Jerry Sturdy, 918-669-7232, Jerry.Sturdy@usace.army.mil

CESWT-EC-HM
Primary: Ron Bell, 918-669-7306, Ron.W.Bell@swt03.usace.army.mil
Alt 1: Greg Estep, 918-669-7132, Gregory.Estep@swt03.usace.army.mil
Alt 2: William Chatron, 918-669-7094, William.Chatron@swt03.usace.army.mil
Alt 3: Kelita Stephens,918-669-7002, Kelita.Stephens@swt03.usace.army.mil

CESWT-EC-DS
Primary: Randy Mead, 918-669-7145, Randy.J.Mead@usace.army.mil
Alt 1: Mark Burkholder, 918-669-7146, Mark.Burkholder@usace.army.mil

CESWT-OD-R
Project Manager: Michael Diggs, 918-669-7398, Michael.Diggs@usace.army.mil
Alt: Jim Harris, 918-669-7410, Jim.L.Harris@usace.army.mil

Northern Oklahoma Area
Primary: Jay Jones, 918-443-2250, Jay.L.Jones@usace.army.mil
Alt Keystone Lake: Kent Dunlap, 918-865-2621, Kent.Dunlap@usace.army.mil
Alt Kaw Lake: Jim Anderson, 580-762-5611, Jim.M.Anderson@usace.army.mil

Texoma Area Office
Primary: Mike Calavan, 903-455-4990, Mike.Calavan@usace.army.mil
Alt Texoma Lake: Ron Jordan, 903-465-4990, Ron.W.Jordon@usce.army.mil

Eastern Oklahoma Area Office
Primary: John Marnell, 918-484-5135, John.Marnell@usace.army.mil
Alt Eufaula Lake: James Holder, 918-484-5135, James.A.Holder@usace.army.mil

CESWT-PA
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CESWT-PPC
Primary: Jan Holsomback, 918-669-7089, Janet.Holosomback@usace.army.mil

SWPA
Primary: David Kannady, 918-595-6682, david.kannady@swpa.gov
Alt: George Robbins, 918-595-6680, george.robbins@swpa.gov

OMPA
Primary: Jake Langthorn, 405-340-5047, jlangthorn@ompa.com
Alt: Harry Dawson, 405-340-5047, hdawson@ompa.com

Appendix F

Milestones and Schedule

Kaw Lake and Arkansas River Activity Office Funding Source Year 1 Year 2 Year 3 Year 4 Year 5 Monitor Nesting Activity and Success CESWT-PE Gen O&M $ 25.00 $ 25.00 $ 25.00 $ 25.00 $ 25.00 Section 7 Consultation CESWT-PE Gen O&M $ - $ 25.00 $ - $ - $ - Short Term Management CESWT-EC-H Gen O&M $ 10.00 $ 10.00 $ 10.00 $ 10.00 $ 10.00 Nesting Site Maint. CESWT-OD Gen O&M $ - $ - $ - $ - $ - Identify Potential Nesting Sites CESWT-PE $ - $ 10.00 $ - $ - $ - Island Development Methods CESWT-PE $ - $ - $ - $ - $ - Habitat Development Projects CESWT-PE $ - $ - $ - $ - $ 200.00 Habitat Baseline Surveys CESWT-PE Gen O&M $ - $ - $ - $ - $ - Monitoring Upstream Activities CESWT-PE Gen O&M $ - $ - $ - $ - $ - $ 35.00 $ 70.00 $ 35.00 $ 35.00 $ 235.00 Keystone Lake and Arkansas River Activity Office Funding Source Year 1 Year 2 Year 3 Year 4 Year 5 Monitor Nesting Activity and Success CESWT-PE Gen O&M $ 25.00 $ 25.00 $ 25.00 $ 25.00 $ 25.00 Section 7 Consultation CESWT-PE Gen O&M $ - $ 25.00 $ - $ - $ - Short Term Management CESWT-EC-H Gen O&M $ 20.00 $ 20.00 $ 20.00 $ 20.00 $ 20.00 Nesting Site Maint CESWT-OD Gen O&M $ - $ - $ - $ - $ 10.00 Identify Potential Nesting Sites CESWT-PP Gen Inv. $ - $ - $ - $ - $ - Arkansas River Nav. Study Island Development Methods CESWT-PE $ - $ - $ - $ - $ - CAP with City of Tulsa Habitat Development Projects CESWT-PE $ - $ - $ - $ 200.00 $ - Habitat Baseline Surveys CESWT-PE Gen O&M $ - $ 50.00 $ - $ - $ - Monitoring Upstream Activities CESWT-PE Gen O&M $ - $ - $ - $ - $ - $ 45.00 $ 120.00 $ 45.00 $ 245.00 $ 55.00 Denison Dam Lake and Red River Activity Office Funding Source Year 1 Year 2 Year 3 Year 4 Year 5 Monitor Nesting Activity and Success CESWT-PE Gen O&M $ 100.00 $ 100.00 $ 100.00 $ 100.00 $ 100.00 Section 7 Consultation CESWT-PE Gen O&M $ 10.00 $ 10.00 $ - $ - $ - Short Term Management CESWT-EC-H Gen O&M $ 20.00 $ 20.00 $ 20.00 $ 20.00 $ 20.00 Nesting Site Maint CESWT-OD Gen O&M $ - $ - $ - $ 10.00 $ 10.00 Identify Potential Nesting Sites CESWT-PP Gen Inv. $ - $ - $ - $ - $ - Red River Waterway Study Island Development Methods CESWT-PE $ - $ - $ - $ - $ - Habitat Development Projects CESWT-PE $ - Habitat Baseline Surveys CESWT-PE Gen O&M $ - $ - $ - $ 80.00 $ - Monitoring Upstream Activities CESWT-PE Gen O&M $ - $ - $ 80.00 $ - $ - $ 130.00 $ 130.00 $ 400.00 $ 210.00 $ 130.00 Eufaula Dam Lake and Canadian River Activity Office Funding Source Year 1 Year 2 Year 3 Year 4 Year 5 Monitor Nesting Activity and Success CESWT-PE Gen O&M $ 30.00 $ 30.00 $ 30.00 $ 30.00 $ 30.00 Section 7 Consultation CESWT-PE Gen O&M $ 10.00 $ 10.00 $ - $ - $ - Short Term Management CESWT-EC-H Gen O&M $ 20.00 $ 20.00 $ 20.00 $ 20.00 $ 20.00 Nesting Site Maint CESWT-OD Gen O&M $ 5.00 $ 5.00 $ 10.00 $ 10.00 $ 10.00 Identify Potential Nesting Sites CESWT-PE $ - $ - $ - $ - $ - Island Development Methods CESWT-PE $ - $ - $ - $ - $ - Habitat Development Projects CESWT-PE $ - $ 200.00 $ - $ - $ - Habitat Baseline Surveys CESWT-PE Gen O&M $ - $ - $ 25.00 $ - $ - Monitoring Upstream Activities CESWT-PE Gen O&M $ - $ - $ - $ - $ - $ 65.00 $ 265.00 $ 85.00 $ 60.00 $ 60.00 Summary: Monitor Nesting Activity and Success CESWT-PE Gen O&M $ 180.00 $ 180.00 $ 180.00 $ 180.00 $ 180.00 Section 7 Consultation CESWT-PE Gen O&M $ 20.00 $ 70.00 $ - $ - $ - Short Term Management CESWT-EC-H Gen O&M $ 70.00 $ 70.00 $ 70.00 $ 70.00 $ 70.00 Nesting Site Maint CESWT-OD Gen O&M $ 5.00 $ 5.00 $ 10.00 $ 20.00 $ 30.00 Identify Potential Nesting Sites CESWT-PE $ - $ 10.00 $ - $ - $ - Island Development Methods CESWT-PE $ - $ - $ - $ - $ - Habitat Development Projects CESWT-PE $ - $ 200.00 $ 200.00 $ 200.00 $ 200.00 Habitat Baseline Surveys CESWT-PE Gen O&M $ - $ 50.00 $ 25.00 $ 80.00 $ - Monitoring Upstream Activities CESWT-PE Gen O&M $ - $ - $ 80.00 $ - $ - $ 275.00 $ 585.00 $ 565.00 $ 550.00 $ 480.00

Appendix G

Community Relations Plan

Appendix G

Interior Least Terns Management Communications/Community Relations Plan

Overview - This document sets forth the Communications/ Community Relations Plan for Tulsa District's Interior Least Tern Management Program.

Goal - To establish effective communications and community relations in order to foster communication, public awareness, and mutual trust among the federal agencies involved, their partners and stakeholders, and the public.

Expectations - This Communications/Community Relations Plan is intended to:

- Educate employees and the public on efforts to meet requirements of the Endangered Species Act while continuing to fulfill mission mandates;
- Enhance public understanding of the Interior Least Tern Management and Protection Program;
- Keep the public and customers informed in a timely and effective manner.

Communication methods - Internal communication among project delivery team members is vital, and certain crucial steps have been outlined in the Implementation Guideline. In addition to those, the following **Tools and Strategies** will be employed:

- **Interagency Coordination** - The Project Delivery Team consists of representatives from Tulsa District, SWPA, OMPA USFWS, and ODWC. Members will be invited to attend all team meetings and any public meetings scheduled.

- **Talking Points** - Prior to 1 May, the PDT for informational purposes will develop Talking Points. They will be provided to all PDT members and any others in a position to speak about the program. They will always include Command Messages and will be updated bi-weekly throughout the program's span to address current issues.

- **Briefing Presentation** - An educational PowerPoint presentation will be developed by PM and PAO before 1 May for use in the district office and to be localized and used at affected lake projects.

- **News Releases** - Information of interest to the public and stakeholders will be provided by PAO through news releases to media outlets.

An educational release coordinated with PDT member agencies will be made in early May before the birds arrive. Another will be made between arrival and nesting (mid to late May). During manipulation of water releases, the media will be informed of coordination efforts as is situationally warranted. Once the birds have fledged (Aug 1 - 15), a final news release will be made.

Each news release will be provided by PAO to the major media outlets. Copies will be furnished lake project offices for localization and release to their regional media entities. Any project-generated news releases will be staffed through the Public Affairs Office. PAO-generated media releases will be coordinated with appropriate agencies and the program manager. All news releases will also be posted on the Tulsa District's Internet news page.

PAO will also coordinate with PER on the plausibility of inviting a reporter along for an inspection or surveillance trip.

- **Project Facts and Information Products** - Educational information will be created by PDT and PAO and provided to appropriate lake office for posting on their project web page. Information for the page will be provided by 19 April.

- **Subscriptions to local or regional newspapers** - Public Affairs Office will scan the Tulsa World each day and project offices will review local papers. Articles related to the least tern management program will be clipped and sent to Public Affairs Office for distribution, archiving, and response, if appropriate

- **Web Meeting Announcements** - All public meetings or events will be announced on the Tulsa District's Internet calendar. (Coordinate with PAO.)

Methods of evaluating success - The following indicators will help determine the effectiveness of the communication plan:

- Was publicity generated?
- Were media reports balanced?
- Was accurate information used in reports?
- Was there evidence of effective communications among the elements of the PDT?

Lessons Learned - PDT and Area Managers prepare after-action report describing both successful and unsuccessful communication strategies.

Emergency Notification -- The Tulsa District Public Affairs Office (918) 669-7366 should always be contacted when an emergency situation arises in connection with any Tulsa District project or program.

Internal Communications Reporting Requirements

- Keep PDT members, district management, and other action offices abreast of the community relation's aspects of this project. All District Office News releases will be coordinated through PAO. Reports of media interviews or significant public contact will be provided to PAO.

- The activities outlined in this Communications/Community Relations Plan will be subject for discussion at appropriate Project Review Board Meetings.

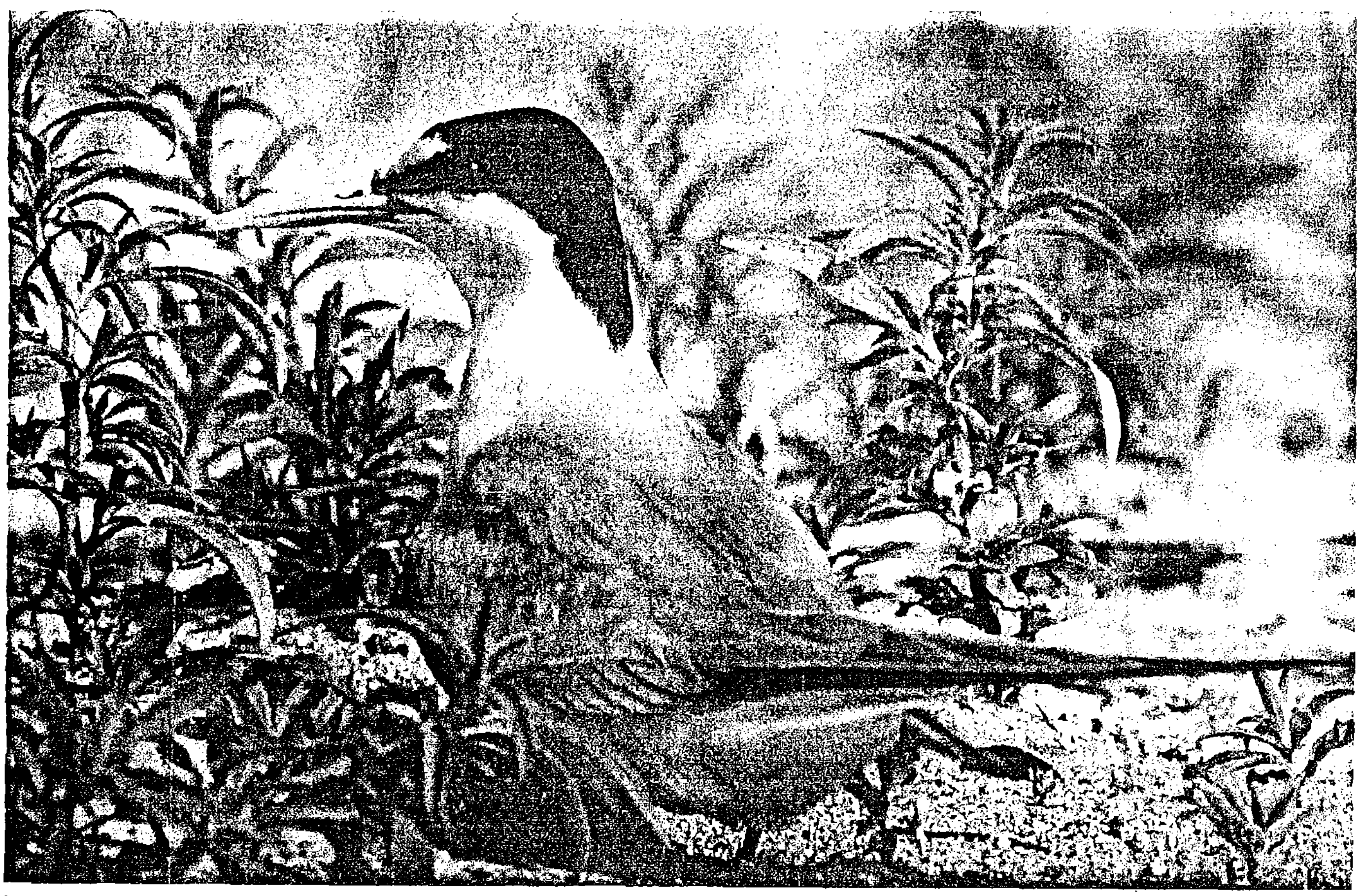
Points of Contact

Project Activities - Michael Diggs, program manager, OD-R, x7398

Communication Resources - Mary Beth Hudson, PA Spec, PAO, x7366

MANAGEMENT PLAN

US Army Corps
of Engineers
Little Rock District



For the Recovery of the Interior Least Tern

Along the McClellan-Kerr Arkansas River Navigation System in Arkansas

MAY 1986

MANAGEMENT PLAN
For the Recovery of The Interior Least Tern
(*Sterna antillarum*)
along the McClellan-Kerr Arkansas River Navigation System
in Arkansas

INTRODUCTION: Least terns are the smallest members of the subfamily Sterninae, measuring about 20-22 cm (8-10 in.)long with a 50 cm (19-20 in.) wingspread. Sexes are alike, characterized by a black crown, white forehead, grayish back and dorsal wing surfaces, snowy white undersurfaces, orange legs, and a black-tipped yellow bill. Immature birds have darker plumage, a dark bill, and dark eye stripes on their white heads. The interior least tern is migratory, breeding on sandbars and islands on the Arkansas, lower Colorado, Mississippi, Missouri, Ohio, Red, and Rio Grande Rivers, and wintering at various locations along the coasts of Central and South America.

GENERAL: Prior to the construction of the McClellan-Kerr Arkansas River Navigation System, the Arkansas River was a meandering stream subject to severe seasonal flooding, channel carving, and sediment deposition. The numerous islands and sand bars that were created and reformed provided desirable nesting habitat for the interior least tern. With the completion of construction in 1970, the Arkansas River became a navigable waterway from its confluence with the Verdigris River near Muskogee, Oklahoma to the Arkansas Post canal that connects the Arkansas River to the White River for the remainder of the navigation system to the confluence of the White River with the Mississippi River. The revetments, dikes, and channel cutoffs that were necessary to stabilize the banks, straighten and deepen the channel, and increase the navigational capability of the river, inundated a portion of the nesting habitat of the least tern. There are no records of the least tern nesting along the Arkansas River for a number of years after the navigation system became operational. The continued natural deposition of sediment and placement of dredged material into slackwater areas and behind revetments has created new islands and sand bars in and along the Arkansas River that are being used as nesting sites by the least tern. The breeding habitat of the least tern is generally characterized as open sand, soil, or dried mud in the proximity of a lagoon, estuary, or river close to feeding areas. These feeding areas are usually fairly extensive areas of shallow water.

CURRENT PRACTICE: The location of problem areas that may require maintenance dredging are located and reported by reconnaissance survey crews. These crews monitor the depths in each navigation pool a minimum of once every 2 weeks when flows are less than 70,000 cubic feet per second (cfs) and as needed when flows are above 70,000 cfs. The locations of problem areas are reported to the resident offices and the Little Rock District Office. A second survey crew from each resident office of the Corps of Engineers performs detailed surveys of the problem areas. The priority of dredging locations is determined from the detailed surveys, long range flow forecasts, and the availability of dredging equipment. The quantity of material removed and the location of the disposal field determine the amount of money that the contractor is paid. The progress and alignment of the dredge are checked and the disposal areas are monitored on a daily basis.

SPECIAL CONSIDERATIONS: Nesting sites generally are characterized as unstable areas created and maintained by sediment deposition in association with flooding. Due to the sometimes transitory nature of nesting habitat, least terns have been described as having strong group adherance and weak site tenacity. This characteristic may aid them in the discovery of newly created habitat. Least tern colonies have been reported to continue to use an area year after year for as long as the site remains suitable. Other reports indicate that the least terns returned to and nested at sites where colonies were completely wiped out the previous year when such sites had been in use for several years. It has also been documented that least terns tend to nest in the vicinity of their natal colonies.

OBJECTIVE: The interior population of the least tern has been placed on the Endangered Species List by the Department of the Interior, U.S. Fish and Wildlife Service because of the loss of suitable habitat by overvegetation, regulation of rivers, and human disturbance. The actions presented in this plan are derived from the draft of the Least Tern Recovery Plan prepared by the Endangered Specie Division of the Department of the Interior, U. S. Fish and Wildlife Service. The objective of this plan is to stabilize or increase the available nesting habitat for the population of the interior least tern along the Arkansas River in Arkansas.

PROPOSED ACTIONS:

1. On or about May 22, 1986, and at approximate 3 week intervals thereafter, 4 aerial reconnaissance survey flights of the McClellan-Kerr Arkansas River Navigation System will be conducted to locate pre-nesting populations and nesting colonies of the interior least tern. The surveys will be coordinated and conducted in cooperation with state and federal agencies responsible for managing endangered species. These multiagency surveys will be confirmed with on site censuses to establish the size of the populations of each colony. The number and frequency of aerial surveys in subsequent years will be determined by the success of this management plan. The information gained from the aerial surveys will be reported to the endangered species program representative of the U. S. Fish and Wildlife Service.

2. During 1986, contour line surveys of 1- or 2-foot intervals will be made to ascertain the physical characteristics of the sand bars and islands on which the least tern nested along the Arkansas River. Parameters that will be recorded in the physical description of the area will include the size and shape of the area, elevation of nesting areas above pool levels, frequency and

time of flooding, slope profiles, amount and density of vegetation, and location with respect to nearby water areas.

3. The importance of identifying and locating populations of the least tern will be stressed to the personnel of the Pine Bluff and Russellville Resident Offices. The navigation survey crews and the natural resource management staff of these resident offices will be trained in the identification characteristics of the least tern. This training will include both in-flight and on-ground identification of the least tern.

4. The navigation reconnaissance survey crews and the detailed survey crews will include any observations of the least tern as an integral part of the navigation surveys conducted during the months of May, June, July, and August that are performed on the Arkansas River. The locations of least tern sightings will be entered into the daily log and reported to the Resident Engineer and the project biologist or ranger with wildlife management/environmental responsibilities. The district biologist in the Recreation-Resource Management Branch will be notified within 3 working days of the sightings. The sightings will be confirmed and any potential nesting sites will be examined. Any nesting sites located as a result of the river surveys will be documented and reported to the state agencies involved with endangered species and to the endangered species program coordinator of the Department of the Interior, U. S. Fish and Wildlife Service. The dredged materials will be discharged into designated areas so as to not affect any known nesting colonies of the least tern. No disturbance of a nesting area by a dredge crew or survey crew will be allowed. No equipment will be moved through a nesting area. No discharge of dredged material and water will be allowed within 100 meters of a nesting site.

5. The information collected in the contour line surveys of the sites previously used for nesting by the least tern will be used to establish tentative environmental parameters of the nesting sites. Dredged material disposal practices will be modified in selected locations to experimentally create nesting sites to provide additional nesting and feeding habitat for the least tern. The effectiveness of the attempts to create additional nesting sites will be documented and reported to the Least Tern Recovery Team.

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Tomkins, I. R. 1959. Life history notes on the least tern. Wilson Bulletin 71(4):313-322.

Youngworth, William. 1930. Breeding of the least tern in Iowa. Wilson Bulletin, June 1930.

Lindsey -
Look these over - it seems the Oct 86 must be the revised plan. I'm assuming it was sent electronically by Corps to our Office.
- Linda

MAIL
Send, Read or Scan: READ

To: CSWL (ACE2046)
To: FWS201
From: CSWL (ACE2046) Posted: Thu 9-Oct-86 9:27 EDT Sys 57 (283)
Subject: tern

MANAGEMENT PLAN

For the Recovery of The Interior Least Tern

(Sterna antillarum)

along the McClellan-Kerr Arkansas River Navigation System

in Arkansas

INTRODUCTION: Least terns are the smallest members of the subfamily Sterninae, measuring about 20-22 cm (8-10 in.)long with a 50 cm (19-20 in.) wingspread. Sexes are alike, characterized by a black crown, white forehead, grayish back and dorsal wing surfaces, snowy white undersurfaces, orange legs, and a black-tipped yellow bill. Immature birds have darker plumage, a dark bill, and dark eye stripes on their white heads. The interior least tern is migratory, breeding on sandbars and islands on the Arkansas, lower Colorado, Mississippi, Missouri, Ohio, Red, and Rio Grande Rivers, and wintering at various locations along the coasts of Central and South America.

GENERAL: Prior to the construction of the McClellan-Kerr Arkansas River Navigation System, the Arkansas River was a meandering stream subject to severe seasonal flooding, channel carving, and sediment deposition. The numerous islands and sand bars that were created and reformed provided desirable nesting construction in 1970, the Arkansas River became a navigable waterway from its confluence with the Verdigris River near Muskogee, Oklahoma to the Arkansas Post canal that connects the Arkansas River to the White River for the remainder of the navigation system to the confluence of the White River with the Mississippi River. The revetments, dikes, and channel cutoffs that were necessary to stabilize the banks, straighten and deepen the channel, and increase the navigational capability of the river, inundated a portion of the nesting habitat of the least tern. There are no records of the least tern nesting along the Arkansas River for a number of years after the navigation system became operational. The continued natural deposition of sediment and placement of dredged material into slackwater areas and behind revetments has created new islands and sand bars in and along the Arkansas River that are being used as nesting sites by the least tern. The breeding habitat of the least tern is generally characterized as open sand, soil, or dried mud in the proximity of a lagoon, estuary, or river close to feeding areas. These feeding areas are usually fairly extensive areas of shallow water.

CURRENT PRACTICE: ~~The location of~~ Problem areas that may require maintenance dredging are located and reported by reconnaissance survey crews. These crews monitor the depths in each navigation pool a minimum of once every 2 weeks when flows are less than 70,000 cubic feet per second (cfs) and as needed when flows are above 70,000 cfs. The locations of problem areas are reported to the resident offices and the Little Rock District Office. A second survey crew from each resident office of the Corps of Engineers performs detailed surveys of the problem areas. The priority of dredging locations is determined from the detailed surveys, long range flow forecasts, and the availability of dredging equipment. The quantity of material removed and the location of the disposal field determine the amount of money that the contractor is paid. The progress and alignment of the dredge are checked and the disposal areas are monitored on a daily basis.

SPECIAL CONSIDERATIONS: Nesting sites generally are characterized as unstable areas created and maintained by sediment deposition in association with flooding. Due to the sometimes transitory nature of nesting habitat, least terns have been described as having strong group adherance and weak site tenacity. This characteristic may aid them in the discovery of newly created habitat. Least tern colonies have been reported to continue to use an area year after year for as long as the site remains suitable. Other reports indicate that the least terns returned to and nested at sites where colonies were completely wiped out the previous year when such sites had been in use for several years. It has also been documented that least terns tend to nest in the vicinity of their natal colonies.

OBJECTIVE: The interior population of the least tern has been placed on the Endangered Species List by the Department of the Interior, U.S. Fish and Wildlife Service because of the loss of suitable habitat by overvegetation, regulation of rivers, and human disturbance. The actions presented in this plan are derived from the draft of the Least Tern Recovery Plan prepared by the Endangered Species Division of the Department of the plan is to stabilize or increase the available nesting habitat for the population of the interior least tern along the Arkansas River in Arkansas.

PROPOSED ACTIONS:

1. Survey for terns

On or about 15 May of each year, and at approximate 3 week intervals thereafter, aerial reconnaissance survey flights of the McClellan-Kerr Arkansas River Navigation System will be conducted, weather and scheduling permitted, to locate pre-nesting populations and nesting colonies of the interior least tern. The surveys will be coordinated and conducted in cooperation with state and federal agencies responsible for managing endangered species. These multiagency surveys will be confirmed with on site censuses to establish the size of the populations of each colony. The number and frequency of aerial surveys in subsequent years will be determined by the success of this management plan. The information gained from the aerial surveys will be reported to the endangered species program

representative of the U. S. Fish and Wildlife Service.

2. Create new nesting habitat

During years of successful nesting, contour line surveys of 1- or 2-foot intervals will be made to ascertain the physical characteristics of the sand bars and islands on which the least tern nested along the Arkansas River. Parameters that will be recorded in the physical description of the area will include the size and shape of the area, elevation of nesting areas above pool levels, frequency and time of flooding, slope profiles, amount and density of vegetation, and location with respect to nearby water areas. The information collected in the contour line surveys of the sites previously used for nesting by the least tern will be used to establish tentative environmental parameters of the nesting sites. Dredged material disposal practices will be modified in selected locations to experimentally create nesting sites to provide additional nesting and feeding habitat for the least tern. The effectiveness of the attempts to create additional nesting sites will be documented and reported to the endangered specie coordinator of the U. S. Department of the Interior, Fish and Wildlife Service.

3. Protection of existing tern habitat

3.1 Personnel training. The importance of identifying and locating populations of the least tern will be stressed to the personnel of the Pine Bluff and Russellville Resident Offices. The navigation survey crews and the natural resource management staff of these resident offices will be trained in the identification characteristics of the least tern. This training will include both in-flight and on-ground identification of the least tern.

3.2 Tern observation and reporting procedures. The navigation reconnaissance survey crews and the detailed survey crews will include any observations of the least tern as an integral part of the navigation surveys conducted during the months of May, June, July and August that are performed on the Arkansas River. The locations of least tern sightings will be entered into the daily log and reported to the Resident Engineer and the project biologist or ranger with wildlife management or environmental responsibilities. The district biologist in the Recreation-Resource Management Branch will be notified within 3 working days of the sightings. The sightings will be confirmed and any potential nesting sites will be examined. Any nesting sites located as a result of the river surveys will be documented and reported to the state agencies involved with endangered species and to the endangered species program coordinator of the Department of the Interior, U. S. Fish and Wildlife Service.

3.3 Standards for protection of habitat

3.3.1 The dredged materials will be discharged into designated areas so as to not affect any known nesting colonies of the least tern. Direction will be provided to the detailed survey crews by the district biologist, Recreation-Resource Management Branch, in consultation with personnel of the previously identified state and Federal agencies.

3.3.2 No disturbance of a nesting area by a dredge crew or survey crew will be allowed. The survey personnel will be trained to identify the least tern and to recognize the characteristics of a nesting area and the behavior of the least tern during nesting season.

3.3.3 No equipment will be moved through a nesting area. The nesting area is defined as the area where the least tern create the conical depressions that are used as nests, or the area defended as nesting grounds by the least terns, whichever is greater.

3.3.4 No discharge of dredged material and water will be allowed within 100 meters of a nesting site or in such a manner as to allow the dredged material to flow within 100 meters of a nesting site.

3.4 SECTION 7 CONSULTATIONS. Actions occurring within 300 meters of an interior least tern colony site that are proposed or permitted by the Little Rock District Corps of Engineers will be coordinated with U.S. Fish and Wildlife Service. An assessment of potential effect of the proposed action will be determined and remedies to any 'may affect' situations will be discussed. Formal consultation proceedings will be instigated if the 'may affect' judgement can not be resolved through the informal consultation process.

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Brubeck, M. V., B. C. Thompson, and R. D. Slack. 1981. The effects of trapping, banding, and patagial tagging on the parental behavior of least terns in Texas. Colonial Waterbirds 4:54-60

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Arkansas. Report to the Least Tern Recovery Team, U. S. Fish and Wildlife Service. 17pp.

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Disposition:

End of Mail.

Send, Read or Scan: Q

>OFF
Off At 12:21 10/09/86 EDT

Connect Mins = 4
Compute Secs = 4/1

Mail call (1 Read)
301 241 DISCONNECTED 00 40 00:00:03:30 223 13

0

June 3, 1986

IN REPLY REFER TO:
Log No. 4-3-86-321

Colonel Robert W. Whitehead
Little Rock District, Corps of Engineers
P.O. Box 867
Little Rock, Arkansas 72203-0867

Dear Colonel Whitehead:

This refers to your May 23, 1986, letter (received May 27, 1986) which provided the Management Plan for the Recovery of the Interior Least Tern. The document contains several excellent points which will contribute significantly to the conservation of this endangered species. We were particularly impressed with your plans to survey terns, create new nesting habitat, and train field crews to report colony sightings. These efforts will contribute to fulfilling Tasks 11., 111., and 21 of the draft Recovery Plan for the Interior Population of the Least Tern.

In addition to these contributions, the plan provides an opportunity which, if taken, will allow the Service to process your requirements under Section 7 of the Endangered Species Act. There are two obvious channels, either of which allows our respective agencies to achieve compliance. Please evaluate the following options and let us know how you wish to proceed:

(a) engage in endangered species consultation now on project-wide activities covered by the Operation and Maintenance Environmental Impact Statement for the McClellan-Kerr Arkansas River Navigation System, 1974, and the tern management plan; or

(b) reach an agreement between our agencies on a process which will ensure Section 7 compliance for those individual, specific activities under the project which may affect the terns.

Discussions between Mr. Clyde Gates of your staff and Fred Bagley of our office indicate that a single project-wide consultation (a above) would likely be unwieldy in dealing effectively with the many considerations of specific dredging and spoiling situations and their impacts to terns. If, in a single Biological Opinion, we are to deal with all the possible variation in conditions of specific situations (such as distances between the navigation channel and tern habitat, presence or lack of line of sight barriers between dredging locations and nesting sights, etc.), it seems rather rigid requirements would be necessary to ensure that needed protection is provided in all possible cases.

Alternative b would allow our agencies to implement a process which would provide for coordination on individual, specific situations which might "affect" the endangered tern. This coordination would allow for recognition of the unique condition of each specific situation in question and would lead to either: 1.) agreement that a 'may affect' situation does not exist; 2.) identification and implementation of provisions to remove the 'may affect' situation; or 3.) initiation of formal consultation. This process allows for increased flexibility and would result in measures taken specifically to achieve needed protection of terns. We anticipate that most such coordination efforts could be handled by phone and would result in agreement that there was not an affect situation or the identification of and agreement on action to be taken to remove the effects.

Certainly, this process would require some coordination. However, we feel this is necessary and appropriate if both our agencies are to achieve compliance under the provisions of the Endangered Species Act.

We have outlined a procedure to implement alternative b (on page 2, Section 7 Coordination section) of our attached rewrite of the Proposed Actions section of the plan. Please be assured that we support your plan. We do, however, feel that it must go farther to ensure Section 7 compliance. If our agencies do not carry out either alternative a or b above, it is our opinion that your Section 7 responsibilities will not be met. We feel that alternative b best meets the needs of our agencies.

Aside from our major comment above, we have only two other remarks. On page 3, item 4, the last four sentences of the paragraph you seem to be establishing standards for protection of habitat. The significance of these statements can be enhanced by following each statement with another discussing how you intend to accomplish that statement. Finally, we took the liberty of rearranging the Proposed Actions sections to, in our opinion, add clarity and consolidate ideas.

We hope our comments will be received in the positive spirit in which they are intended. We feel you have a plan which incorporates some fine ideas which if implemented will enhance least tern conservation. We are recommending you go one step further and incorporate Section 7 compliance at the same time.

In regard to Public Notice LRD-85-87, we recommend the above comments be incorporated in the subject plan and that plan be made a part of the

Public Notice. If you wish to discuss this matter further, please contact Mr. Fred Bagley of our staff (FTS 490-4900).

We appreciate the opportunity to review and comment on your plan.

Sincerely yours,

Dennis B. Jordan
Field Supervisor
Jackson Endangered Species Office

Attachment

cc: ES, FWS, Vicksburg, MS
Regional Director, FWS, Atlanta, GA (AFA/SE)
Game and Fish Commission, Little Rock, AR
Arkansas Natural Heritage Program

FMB:vs 6/3/86
SURNAME

Bagley

Proposed Actions

1. Survey for terns

   On or about May 22, 1986, and at approximate 3 week intervals thereafter, 4 aerial reconnaissance survey flights of the McClellan-Kerr Arkansas River Navigation System will be conducted to locate pre-nesting populations and nesting colonies of the interior least tern. The surveys will be coordinated and conducted in cooperation with state and federal agencies responsible for managing endangered species. These multiagency surveys will be confirmed with on site censuses to establish the size of the populations of each colony. The number and frequency of aerial surveys in subsequent years will be determined by the success of this management plan. The information gained from the aerial surveys will be reported to the endangered species program representative of the U.S. Fish and Wildlife Service.

2. Create new nesting habitat

   During 1986, contour line surveys of 1- or 2-foot intervals will be made to ascertain the physical characteristics of the sand bars and islands on which the least tern nested along the Arkansas River. Parameters that will be recorded in the physical description of the area will include the size and shape of the area, elevation of nesting areas above pool levels, frequency and time of flooding, slope profiles, amount and density of vegetation, and location with respect to nearby water areas.

   The information collected in the contour line surveys of the sites previously used for nesting by the least tern will be used to establish tentative environmental parameters of the nesting sites. Dredged material disposal practices will be modified in selected locations to experimentally create nesting sites to provide additional nesting and feeding habitat for the least tern. The effectiveness of the attempts to create additional nesting sites will be documented and reported to the Least Tern Recovery Team.

3. Protect existing tern habitat

   3.1 Train personnel - The importance of identifying and locating populations of the least tern will be stressed to the personnel of the Pine Bluff and Russellville Resident Offices. The navigation survey crews and the natural resource management staff of these resident offices will be trained in the identification characteristics of the least tern. This training will include both in-flight and on-ground identification of the least tern.

3.2 Establish tern observation reporting procedures - The navigation reconnaissance survey crews and the detailed survey crews will include any observations of the least tern as an integral part of the navigation surveys conducted during the months of May, June, July, and August that are performed on the Arkansas River. The locations of least tern sightings will be entered into the daily log and reported to the Resident Engineer and the project biologist or ranger with wildlife management/environmental responsibilities. The district biologist in the Recreation-Resource Management Branch will be notified within 3 working days of the sightings. The sightings will be confirmed and any potential nesting sites will be examined. Any nesting sites located as a result of the river surveys will be documented and reported to the state agencies involved with endangered species and to the endangered species program coordinator of the Department of the Interior, U.S. Fish and Wildlife Service.

3.3 Standards for protection of habitat -

3.3.1 The dredged materials will be discharged into designated areas so as to not affect any known nesting colonies of the least tern. This will be accomplished by direction provided to navigation reconnaissance survey crews and the detailed survey crews by the district biologist, Recreation-Resource Management Branch and by . . . . (we left this blank thinking you might want to elaborate on specific criteria you plan to use to ensure disturbance does not occur).

3.3.2 No disturbance of a nesting area by a dredge crew or survey crew will be allowed. This will be accomplished by training personnel in the recognition of least terns and by . . . . . . (you may wish to eleborate on standards you will provide crews to ensure they do not affect tern colonies).

3.3.3 No equipment will be moved through a nesting area. The nesting area for purposes of the field crew will be defined as . . . . (we left this blank thinking you might want to state specifically the area around nest sites which you consider to be the nesting area).

3.3.4 No discharge of dredged material and water will be allowed within 100 meters of a nesting site.

3.4 Section 7 Coordination - Section 7 of the Endangered Species Act states that each agency shall, in consultation with and with the assistance of the Secretary (as represented by the Fish and Wildlife Service) ensure their actions are not likely to jeopardize the continued existence of any endangered species. The Little Rock District shall meet this responsibility by coordinating with the U.S. Fish and Wildlife Service on all dredge and fill activities which may occur within 1,000 feet of an interior least tern colony site. This coordination will:

3.4.1 discuss whether or not a 'may affect' situation exists;

3.4.2 identify means to remove the 'may affect' situation;

3.4.3 ensure implementation of the means identified above by modifications placed in permits or provided directly to field crews; and

3.4.4 ensure that if the 'may affect' situation can not be removed through the informal consultation discussed above, formal consultation will be initiated.

APPENDIX B

Data for Phase I Effects at Keystone Lake, 1992 Example

Existing		60,000 cfs		Different?	Existing	60,000 cfs	Difference
	1992		1992				
Day	elev	Day	elev				
177	731.32	177	732.22	TRUE	731.32	732.22	0.9
178	731.24	178	731.25	TRUE	731.24	731.25	0.01
179	731.19	179	732.32	TRUE	731.19	732.32	1.13
180	731.46	180	731.03	TRUE	731.46	731.03	-0.43
181	730.38	181	731.32	TRUE	730.38	731.32	0.94
182	730.74	182	733.12	TRUE	730.74	733.12	2.38
183	730.93	183	733.40	TRUE	730.93	733.40	2.47
184	731.14	184	733.90	TRUE	731.14	733.90	2.76
185	730.94	185	734.45	TRUE	730.94	734.45	3.51
186	730.78	186	733.54	TRUE	730.78	733.54	2.76
187	730.35	187	732.77	TRUE	730.35	732.77	2.42
188	730.72	188	732.68	TRUE	730.72	732.68	1.96
189	727.79	189	732.58	TRUE	727.79	732.58	4.79
190	728.15	190	732.45	TRUE	728.15	732.45	4.3
191	728.50	191	732.08	TRUE	728.50	732.08	3.58
192	728.82	192	731.95	TRUE	728.82	731.95	3.13
193	728.26	193	732.12	TRUE	728.26	732.12	3.86
194	728.53	194	732.34	TRUE	728.53	732.34	3.81
195	727.14	195	730.03	TRUE	727.14	730.03	2.89
196	727.47	196	730.24	TRUE	727.47	730.24	2.77
197	727.99	197	730.62	TRUE	727.99	730.62	2.63
198	727.47	198	728.33	TRUE	727.47	728.33	0.86
199	728.26	199	729.15	TRUE	728.26	729.15	0.89
200	728.52	200	729.99	TRUE	728.52	729.99	1.47
201	729.48	201	730.72	TRUE	729.48	730.72	1.24
202	730.23	202	731.23	TRUE	730.23	731.23	1
203	729.69	203	731.42	TRUE	729.69	731.42	1.73
204	729.25	204	731.50	TRUE	729.25	731.50	2.25
205	727.15	205	731.70	TRUE	727.15	731.70	4.55
206	727.38	206	731.84	TRUE	727.38	731.84	4.46
207	727.83	207	732.02	TRUE	727.83	732.02	4.19
208	728.22	208	732.12	TRUE	728.22	732.12	3.9
209	728.50	209	731.17	TRUE	728.50	731.17	2.67
210	728.98	210	731.38	TRUE	728.98	731.38	2.4
211	729.53	211	731.62	TRUE	729.53	731.62	2.09
212	728.11	212	731.96	TRUE	728.11	731.96	3.85
213	728.28	213	732.15	TRUE	728.28	732.15	3.87
214	728.76	214	732.10	TRUE	728.76	732.10	3.34
215	729.19	215	731.99	TRUE	729.19	731.99	2.8
216	729.43	216	731.61	TRUE	729.43	731.61	2.18
217	728.84	217	728.56	TRUE	728.84	728.56	-0.28
218	727.19	218	729.03	TRUE	727.19	729.03	1.84
219	726.76	219	730.37	TRUE	726.76	730.37	3.61
220	730.44	220	729.94	TRUE	730.44	729.94	-0.5
221	730.10	221	728.33	TRUE	730.10	728.33	-1.77
222	727.57	222	729.95	TRUE	727.57	729.95	2.38
223	728.97	223	727.78	TRUE	728.97	727.78	-1.19
224	730.25	224	729.06	TRUE	730.25	729.06	-1.19
225	728.42	225	730.13	TRUE	728.42	730.13	1.71

226	729.51	226	728.75	TRUE	729.51	728.75	-0.76
227	730.28	227	730.64	TRUE	730.28	730.64	0.36
228	730.70	228	731.37	TRUE	730.70	731.37	0.67
229	730.53	229	731.63	TRUE	730.53	731.63	1.1
230	727.13	230	731.48	TRUE	727.13	731.48	4.35
231	727.69	231	731.11	TRUE	727.69	731.11	3.42
232	728.30	232	730.74	TRUE	728.30	730.74	2.44
233	728.79	233	727.94	TRUE	728.79	727.94	-0.85
234	728.22	234	728.46	TRUE	728.22	728.46	0.24
235	728.56	235	728.79	TRUE	728.56	728.79	0.23
236	728.78	236	729.01	TRUE	728.78	729.01	0.23
237	727.22	237	729.00	TRUE	727.22	729.00	1.78
238	727.49	238	727.15	TRUE	727.49	727.15	-0.34
239	727.58	239	727.43	TRUE	727.58	727.43	-0.15
240	727.39	240	727.69	TRUE	727.39	727.69	0.3
241	727.63	241	727.94	TRUE	727.63	727.94	0.31
242	727.13	242	728.02	TRUE	727.13	728.02	0.89
243	727.07	243	727.93	TRUE	727.07	727.93	0.86
244	726.87	244	727.71	TRUE	726.87	727.71	0.84
245	727.04	245	727.91	TRUE	727.04	727.91	0.87
246	726.60	246	727.13	TRUE	726.60	727.13	0.53
247	726.71	247	727.40	TRUE	726.71	727.40	0.69
248	726.70	248	727.41	TRUE	726.70	727.41	0.71
249	727.24	249	727.42	TRUE	727.24	727.42	0.18
250	726.76	250	727.25	TRUE	726.76	727.25	0.49
251	726.25	251	727.02	TRUE	726.25	727.02	0.77
252	726.47	252	727.14	TRUE	726.47	727.14	0.67
253	726.99	253	727.35	TRUE	726.99	727.35	0.36
254	727.28	254	728.02	TRUE	727.28	728.02	0.74
255	727.87	255	728.55	TRUE	727.87	728.55	0.68
256	727.95	256	728.89	TRUE	727.95	728.89	0.94
257	728.26	257	728.73	TRUE	728.26	728.73	0.47
258	727.81	258	727.41	TRUE	727.81	727.41	-0.4

Existing		60,000 cfs		Different?	Existing	60,000 cfs	Difference
	1992		1992				
Day	elev	Day	elev				
177	731.32	177	732.22	TRUE	731.32	732.22	0.9
178	731.24	178	731.25	TRUE	731.24	731.25	0.01
179	731.19	179	732.32	TRUE	731.19	732.32	1.13
180	731.46	180	731.03	TRUE	731.46	731.03	-0.43
181	730.38	181	731.32	TRUE	730.38	731.32	0.94
182	730.74	182	733.12	TRUE	730.74	733.12	2.38
183	730.93	183	733.40	TRUE	730.93	733.40	2.47
184	731.14	184	733.90	TRUE	731.14	733.90	2.76
185	730.94	185	734.45	TRUE	730.94	734.45	3.51
186	730.78	186	733.54	TRUE	730.78	733.54	2.76
187	730.35	187	732.77	TRUE	730.35	732.77	2.42
188	730.72	188	732.68	TRUE	730.72	732.68	1.96
189	727.79	189	732.58	TRUE	727.79	732.58	4.79
190	728.15	190	732.45	TRUE	728.15	732.45	4.3
191	728.50	191	732.08	TRUE	728.50	732.08	3.58
192	728.82	192	731.95	TRUE	728.82	731.95	3.13
193	728.26	193	732.12	TRUE	728.26	732.12	3.86
194	728.53	194	732.34	TRUE	728.53	732.34	3.81
195	727.14	195	730.03	TRUE	727.14	730.03	2.89
196	727.47	196	730.24	TRUE	727.47	730.24	2.77
197	727.99	197	730.62	TRUE	727.99	730.62	2.63
198	727.47	198	728.33	TRUE	727.47	728.33	0.86
199	728.26	199	729.15	TRUE	728.26	729.15	0.89
200	728.52	200	729.99	TRUE	728.52	729.99	1.47
201	729.48	201	730.72	TRUE	729.48	730.72	1.24
202	730.23	202	731.23	TRUE	730.23	731.23	1
203	729.69	203	731.42	TRUE	729.69	731.42	1.73
204	729.25	204	731.50	TRUE	729.25	731.50	2.25
205	727.15	205	731.70	TRUE	727.15	731.70	4.55
206	727.38	206	731.84	TRUE	727.38	731.84	4.46
207	727.83	207	732.02	TRUE	727.83	732.02	4.19
208	728.22	208	732.12	TRUE	728.22	732.12	3.9
209	728.50	209	731.17	TRUE	728.50	731.17	2.67
210	728.98	210	731.38	TRUE	728.98	731.38	2.4
211	729.53	211	731.62	TRUE	729.53	731.62	2.09
212	728.11	212	731.96	TRUE	728.11	731.96	3.85
213	728.28	213	732.15	TRUE	728.28	732.15	3.87
214	728.76	214	732.10	TRUE	728.76	732.10	3.34
215	729.19	215	731.99	TRUE	729.19	731.99	2.8
216	729.43	216	731.61	TRUE	729.43	731.61	2.18
217	728.84	217	728.56	TRUE	728.84	728.56	-0.28
218	727.19	218	729.03	TRUE	727.19	729.03	1.84
219	726.76	219	730.37	TRUE	726.76	730.37	3.61
220	730.44	220	729.94	TRUE	730.44	729.94	-0.5
221	730.10	221	728.33	TRUE	730.10	728.33	-1.77
222	727.57	222	729.95	TRUE	727.57	729.95	2.38
223	728.97	223	727.78	TRUE	728.97	727.78	-1.19
224	730.25	224	729.06	TRUE	730.25	729.06	-1.19
225	728.42	225	730.13	TRUE	728.42	730.13	1.71

226	729.51	226	728.75	TRUE	729.51	728.75	-0.76
227	730.28	227	730.64	TRUE	730.28	730.64	0.36
228	730.70	228	731.37	TRUE	730.70	731.37	0.67
229	730.53	229	731.63	TRUE	730.53	731.63	1.1
230	727.13	230	731.48	TRUE	727.13	731.48	4.35
231	727.69	231	731.11	TRUE	727.69	731.11	3.42
232	728.30	232	730.74	TRUE	728.30	730.74	2.44
233	728.79	233	727.94	TRUE	728.79	727.94	-0.85
234	728.22	234	728.46	TRUE	728.22	728.46	0.24
235	728.56	235	728.79	TRUE	728.56	728.79	0.23
236	728.78	236	729.01	TRUE	728.78	729.01	0.23
237	727.22	237	729.00	TRUE	727.22	729.00	1.78
238	727.49	238	727.15	TRUE	727.49	727.15	-0.34
239	727.58	239	727.43	TRUE	727.58	727.43	-0.15
240	727.39	240	727.69	TRUE	727.39	727.69	0.3
241	727.63	241	727.94	TRUE	727.63	727.94	0.31
242	727.13	242	728.02	TRUE	727.13	728.02	0.89
243	727.07	243	727.93	TRUE	727.07	727.93	0.86
244	726.87	244	727.71	TRUE	726.87	727.71	0.84
245	727.04	245	727.91	TRUE	727.04	727.91	0.87
246	726.60	246	727.13	TRUE	726.60	727.13	0.53
247	726.71	247	727.40	TRUE	726.71	727.40	0.69
248	726.70	248	727.41	TRUE	726.70	727.41	0.71
249	727.24	249	727.42	TRUE	727.24	727.42	0.18
250	726.76	250	727.25	TRUE	726.76	727.25	0.49
251	726.25	251	727.02	TRUE	726.25	727.02	0.77
252	726.47	252	727.14	TRUE	726.47	727.14	0.67
253	726.99	253	727.35	TRUE	726.99	727.35	0.36
254	727.28	254	728.02	TRUE	727.28	728.02	0.74
255	727.87	255	728.55	TRUE	727.87	728.55	0.68
256	727.95	256	728.89	TRUE	727.95	728.89	0.94
257	728.26	257	728.73	TRUE	728.26	728.73	0.47
258	727.81	258	727.41	TRUE	727.81	727.41	-0.4

C.5

Terrestrial Habitat Evaluation Procedures

C.5 Terrestrial Habitat Evaluation Procedures

C.5.1 Introduction

The U.S. Army Corps of Engineers (USACE), Little Rock and Tulsa Districts, in association with the preparation of an Environmental Impact Statement (EIS) to evaluate the environmental impacts of the proposed dredging and flow changes on the McClellan-Kerr Arkansas River Navigation System (MKARNS), have completed Habitat Evaluation Procedures (HEP) to determine impacts resulting from dredge disposal on terrestrial habitat along the MKARNS and ecological benefits resulting from the proposed mitigation. The use of a community habitat assessment approach for a HEP application in a navigation study demonstrates the effectiveness of these models in the evaluation of potential impacts and mitigation success.

The HEP methodology is an environmental accounting process developed to appraise habitat suitability for fish and wildlife species in the face of potential change (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. When applied correctly, HEP provides an impartial look at environmental effects, and delivers measurable products to the user for comparative analysis.

In HEP, a Suitability Index, or 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 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, a Habitat Suitability Index (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).

The HEP was designed to evaluate the future changes in quantity (acres) and quality (habitat suitability and functional capacity) of terrestrial ecosystems. Outputs were calculated in terms of annualized changes anticipated over the life of the project [i.e., Average Annual Habitat Units (AAHUs)] in the HEP analyses.

C.5.2 Building a Multidisciplinary Evaluation Team

Early in the evaluation process, a Multiagency Ecosystem Evaluation Team (MEET) was convened. This was a multidisciplinary team that included various interests and technical expertise. To date, the following team members have contributed to the effort:

- Mr. Johnny McLean, USACE Little Rock District
- Mr. Tony Hill, USACE Little Rock
- Ms. Sandra Stiles, USACE Tulsa District
- Mr. Wesley Fowler, USACE Tulsa District
- Mr. Charles Schrodt, USACE Tulsa District

- Mr. Richard Stark, U.S. Fish and Wildlife Service (USFWS), Oklahoma
- Mr. Kevin Stubbs, USFWS, Oklahoma
- Mr. Lindsey Lewis, USFWS, Arkansas
- Ms. Marge Harney, USFWS
- Mr. Craig Uyeda, Arkansas Game & Fish Commission (AGFC)
- Mr. Jeff Quinn, AGFC
- Mr. J.D. Ridge, Oklahoma Department of Wildlife Conservation (ODWC)
- Mr. Gary Peterson, ODWC
- Mr. Mike Plunkett, ODWC
- Mr. Randy Hyler, ODWC
- Mr. Stephen Weber, Oklahoma Department of Environmental Quality
- Ms. Antisa Webb, U.S. Army Engineer Research and Development Center Environmental Laboratory (ERDC-EL)
- Ms. Kelly Burks-Copes, ERDC-EL
- Mr. Richard Hall, Contractor, Parsons Corp.
- Mr. Randy Norris, Contractor, Parsons Corp.
- Ms. Virginia Flynn, Contractor, Parsons Corp.
- Ms. Enid McNutt, Contractor, Parsons Corp.
- Mr. Luke Eggering, Contractor, Parsons Corp.

C.5.3 Defining the Project

C.5.3.1 Geographic Location, Watersheds, and Primary Water Resources

The affected environment includes the MKARNS from the Port of Catoosa near Tulsa, Oklahoma downstream to the confluence of the Mississippi River in southeastern Arkansas as well as 11 reservoirs in Oklahoma that influence river flow within the MKARNS.

The MKARNS is approximately 445 miles in length and consists of a series of 18 locks and dams (17 existing and 1 currently under construction). The principal components of the MKARNS waterways include:

- A 50 mile portion of the Verdigris River (navigation miles 445-394);
- Lower Arkansas River, which comprises 375 miles of the MKARNS (navigation miles 394 to 19);
- The Arkansas Post Canal, a nine mile canal connecting the Arkansas River to the lower portion of the White River (navigation miles 19 to 10); and
- The lower 10 miles of the White River (navigation miles 10 to 0);

- The Lower Arkansas River downstream of Dam 2 (not formally part of the MKARNS). This portion of the Arkansas River is included in the Arkansas River Navigation Study project area because MKARNS river flows may also influence this segment of the river.

River flows on the MKARNS are primarily influenced by flows on the upper Arkansas River upstream of the confluence with the Verdigris River (river mile 394); as well as water storage and release from 11 reservoirs in Oklahoma. These reservoirs provide flood control, water supply, hydroelectric power, fish & wildlife, recreation, and other benefits.

More detailed information on the MKARNS environment is available in Section 4 of the EIS.

C.5.3.2 Lead District

The MKARNS falls under the purview of the USACE, Little Rock District, Arkansas. The effort is being carried out in conjunction with the USACE, Tulsa District, Oklahoma. These Districts are two of four districts that make up the USACE Southwestern Division. The planning lead for the Navigation Study is Mr. Ron Carman (Little Rock District), and the environmental leads for the study are Mr. Johnny McLean (Little Rock District) and Ms. Sandra Stiles (Tulsa District).

C.5.4 Project Purpose

Site-specific HEPs were conducted to evaluate potential impacts of the construction and use of proposed dredge disposal areas. The primary purpose was to assist the study team in formulating a recommended plan by providing a quantitative measure or qualitative evaluation of environmental impacts and estimated habitat replacement costs. Detailed analysis of site-specific impacts, based on any recommended/authorized measures, will not be possible until detailed design information for those measures is available. Should future construction activities be recommended, detailed site-specific evaluations would be completed for each incremental step towards completion of the action. Site surveys would be conducted to determine the potential for environmental impacts.

C.5.5 Determining Goals and Objectives, Project Life, and Target Years.

A meeting was convened early in March of 2004 to conduct the HEP for the MKARNS EIS. The MEET was asked to outline the primary systems or communities within the project area in order to gauge the impacts of the proposed alternatives. Specifically, these impact parameters focused on the existing habitat quantity and quality. First, the MEET developed a list of existing cover types in the region. These are shown in Table C-1.

Table C-1. Cover Types Within the ARNS Region.

Code	Description
AGCROP	Farms and Croplands
BLHFOREST	Bottomland Hardwood Forest (BLH)
OLDFIELD	Old Fields Dominated by Grasses with > 25% Woody Cover (OLF)
OPENFIELD	Open Fields Dominated by Grasses with < 25% Woody Cover (OF)
OPENWATER	Open Bodies of Water Deeper than 1-3m

Table C-1. Cover Types Within the ARNS Region.	
PARKS	Parks and Recreation Areas
PASTURES	Haylands and Pastures
UPFOREST	Upland Forest (UPL)
URBAN	Existing Residential, Industrial and Transportation Avenues
DISPOSAL	Disposal Pit Footprint
Source: ERDC-EL, 2004	

The MEET then outlined the potential project alternatives and mitigation activities, and created a list of proposed changes to the cover types over time resulting from natural succession or mitigation activities. These changes resulted in "newly developed" cover types including those listed in Table C-2. The MEET chose two alternatives for the study to intensively evaluate with HEP:

- Dredge disposal from deepening, and/or continued operation and maintenance of the ARNS; and
- No action alternative.

Table C-2. Potential Newly Created Cover Types Within the ARNS.

Code	Description
NEWBLHFOR	Newly Developed Bottomland Hardwood Forest
NEWOLD	Newly Developed Old Field (> 25% Woody Cover)
NEWOPEN	Newly Developed Open Fields (< 25% Woody Cover)
NEWUPFOR	Newly Developed Upland Forest
NEWMARSH	Newly Developed Emergent Marsh
Source: ERDC-EL, 2004	

C.5.6 Cover Type Mapping the Sites

To evaluate the habitat conditions for a species or community using HEP, the study area was divided into manageable sections and quantified in terms of acres. This process is known as cover typing. A cover type in HEP is a parcel of land (or water) that has similar physical, chemical, and biological characteristics contained within its borders. Cover typing includes defining the differences between vegetative covers (e.g., tall grass prairie, forested wetlands, shrub lands, lakes, and streams, etc.), and clearly delineating these distinctions on a map. The quality of each cover type for the selected species or community is determined by measuring individual variables within the site. Some examples of HEP variables used in this study included the amount of herbaceous cover, the amount of woody cover, the distance to water, the number of pools, number of species, and adjacent land use for a given cover type. In most instances, these variables are measured using aerial photographs, maps and/or onsite sampling activities.

Cover type for each site evaluated was mapped using existing aerial photography and information from transects in the field. All areas adjacent to and within the proposed site were mapped.

C.5.7 Capturing Changes Over Time in HEP Applications

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 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 or the span of the project's life. 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, Habitat Units (HUs) generated for indicator species/communities are estimated for several TYs to reflect the life of the project. In such analyses, future habitat conditions are estimated for both the without-project (e.g., No Action Alternative) and with-project conditions. Projected long-term effects of the project are reported in terms of AAHUs. Based on the AAHU outcomes, alternative designs can be formulated and trade-off analyses can be conducted to promote environmental optimization (ERDC-EL, 2004a).

The USACE designated a "Project Life" of 50 years for the ARNS, and asked the MEET to develop a series of Target Years within this 50-year setting to generate projections of both Without Project and With Project activities. Target years for the ARNS therefore included TY0 (Baseline Conditions), TY1 (Year of Construction), TY11 (Early in Project), T31 (Middle of Project) and TY51 (End of Project) to capture this 50-year span. The TY11 and TY31 were added to capture important anticipated changes in vegetative cover and structure in the study area.

C.5.8 Selecting, Modifying, and/or Creating Models

With the cover types identified, and their distributions and quantities revealed, the MEET attempted to set quantifiable impact measures and mitigation performance measures for the proposed actions. The impact measures focused on the quantity (measured in acres) and quality (measured in terms of Habitat Suitability Indices or HSIs) of habitat lost or created throughout the life of the project. The mitigation criteria focused on the recovery of a specific habitats, defined on the basis of quantity recovered, and obtainable habitat quality.

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). HEP combines both the habitat quality (HSI) and quantity of a site (measured in acres) to generate habitat units (HUs). Once the HSI and habitat quantities have been determined, the HU values can be mathematically 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 (ERDC-EL, 2004a).

Three HSI models, each with three sub-models, were deployed in the HEP assessments. The forest and grassland models applied to the impact sites, while the marsh model applied to the mitigation sites. The HSI models were developed and modified by the MEET, and used to evaluate the relationships within terrestrial and marsh communities in the Arkansas River ecosystem setting.

Table C-3. HSI Model List for ARNS EIS.

Model	Model Codes	Description
FORESTS	FBIOTA	Biota of the Forest Community
	FWATER	Water Component of the Forest Community
	FLANDSCAPE	Landscape Component of the Forest Community
GRASSLANDS	GBIOTA	Biota of the Grassland Community
	GLANDSCAPE	Landscape Component of the Grassland Community
MARSH	MBIOTA	Habitat (Biota) Component for Marsh Community
	MLANDSCAPE	Landscape Component for Marsh Community
Source: ERDC-EL, 2004b		

C.5.9 Site Data Collection

In the spring of 2004, members of the MEET completed intensive baseline habitat sampling at 22 sites across the Arkansas River ecosystem. These sites were considered upland/terrestrial sites. Of the 22 HEP sites, 6 sites served as reference standard sites (RSS) for the calibration of the HEP models. These sites were not potential dredge disposal sites, but examples of typical forest and grassland habitat within the study area. Twelve of the HEP sites were targeted as potential dredge disposal locations above the floodplain. These sites were used as reference impact sites (RIS) to develop baseline conditions in the HEP analysis and used to extrapolate impacts to sites not surveyed. A total of 13 HSI variables were measured during the field sampling effort in an attempt to develop a description of the baseline (Spring 2004) conditions at these sites. Variables ranged from measurements of vegetative cover to the counting of the number of species. These variables are described in detail in Table C-4 below. The sampling effort could be completed efficiently on 100-meter (m) transects.

Some variables could be obtained through various historical records, aerial photos or mathematical calculations rather than through active field sampling. Six HSI variables were obtained from Geographic Information System (GIS) resources and spreadsheet calculations. These variables are described in detail in Table C-5.

The following methods were used to obtain some of those variables:

- Landcover types were mapped using aerial photography and information from transects in the field. Mapped areas were immediately adjacent to proposed sites.
- Acreage for PATCH variable was calculated within the GIS software.
- A 100m buffer was applied inside patch and acreage of buffer calculated using GIS software. Buffer acreage was divided by the PATCH variable to obtain an edge variable.

- Buffer acreage was subtracted from total PATCH variable acreage to obtain core acreage. The difference in PATCH acreage and buffer acreage was divided by PATCH acreage to obtain the CORE variable.
- An automated routine within the GIS software was used to determine a centerpoint for each patch. Using the centerpoint, the DISTOPW (distance to open water) variable was measured using the measure tool in ArcGIS. The NEIGHBOR (nearest neighbor) variable was determined the same way.
- The ADLAND variable was obtained by generating 30 random points within the patch and visually determining the adjacent land use.

Table C-4. Variables Measured in the Field.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
CANEMERG	Emergent Herbaceous Vegetation Canopy Cover (%)	Starting at a random location within each marsh-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the percent of the water surface shaded by a vertical projection of the canopies of emergent herbaceous vegetation, both persistent and nonpersistent.	MARSH MBIOTA	NEWMARSH	100-m Transect Tape and 1-m2 Quadrat
CANFORB	Proportion of the Herbaceous Canopy Cover Comprised of Forbs (%)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the proportion of the herbaceous canopy cover within the quadrat that is comprised of forbs. Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
CANHERB	Herbaceous Canopy Cover (%)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the herbaceous canopy cover within the quadrat. Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
CANHMAST	Proportion of the Tree Canopy Comprised of Hard Mast Species (%)	Starting at a random location within each forest-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground. Stand in the center of this quadrat and use an optic tube to determine the percent of the tree canopy within the viewer that is comprised of hard mast species. By definition, trees must be at least 20 feet tall and/or have a dbh of 6 inches to be included in this measurement. Repeat the process two more times (total number of data points = 30 per cover type).	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape, 1-m2 Quadrat and Optic Tube

Table C-4. Variables Measured in the Field.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
CANNATIVE	Proportion of the Herbaceous Canopy Cover Comprised of Native Species (%)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the proportion of the herbaceous canopy cover within the quadrat that is comprised of native species. Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
CANSHRUB	Shrub Canopy Cover (%)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the shrub canopy cover within the quadrat. By definition, shrubs are defined as woody vegetation less than 20 feet tall (dbh < 6 inches). Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
CANSMAST	Proportion of the Tree Canopy Comprised of Soft Mast Species (%)	Starting at a random location within each forest-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground. Stand in the center of this quadrat and use an optic tube to determine the percent of the tree canopy within the viewer that is comprised of soft mast species. By definition, trees must be at least 20 feet tall and/or have a dbh of 6 inches to be included in this measurement. Repeat the process two more times (total number of data points = 30 per cover type).	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape, 1-m2 Quadrat and Optic Tube
CANTREE	Percent Tree Canopy Cover (%)	Starting at a random location within each forest-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground. Stand in the center of this quadrat and use an optic tube to determine the percent tree canopy within the viewer. By definition, trees must be at least 20 feet tall and/or have a dbh of 6 inches to be included in this measurement. Repeat the process two more times (total number of data points = 30 per cover type).	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape, 1-m2 Quadrat and Optic Tube

Table C-4. Variables Measured in the Field.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
CANWOOD6	Percent Canopy Cover of Woody Vegetation < 6m Tall (%)	Starting at a random location within each marsh-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the percent of the ground surface that is shaded by a vertical projection of the canopies of all woody vegetation.	MARSH MBIOTA	NEWMARSH	100-m Transect Tape and 1-m2 Quadrat
DBHTREE	Average Tree Diameter (dbh) (cm)	Starting at a random location within each forest-based cover type, lay out a 100-m transect tape. Establish a 10-m wide belt transect parallel to the 100-m transect tape (5-m on each side of the tape). Walk along this belt for 10-m, and measure the diameter at breast height of all trees >10 dbh or taller than 20 feet within the belt. Repeat the 10x10 belt approach for the length of the 100-m transect tape (10 sets of data points are collected per 100-m transect). Repeat the process two more times (total number of data point sets = 30 per cover type).	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape and DBH Tape
DEPTHWATER	Average Water Depth in centimeters (cm)	Starting at a random location within each marsh-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a graduated rod or meter stick perpendicular to the ground and measure the water depth (cm).	MARSH MBIOTA	NEWMARSH	100-m Transect Tape and Graduated Rod or Meter Stick
DIVERSVEG	Diversity of Indicator Species	Starting at a random location within each marsh-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, walk out 5m in all 4 directions of the tape and record the category of indicator species that best represents the 10-m square section along the belt.Class Data:0 = No Data Collected1 = Cattails, Cordgrasses, Bulrushes2 = Bluejoint Reedgrass, Reed Canary-Grass, Sedges3 = Buttonbush, Mangrove4 = Other Growth Forms not listed.	MARSH MBIOTA	NEWMARSH	100-m Transect Tape and 10-m2 belt section

Table C-4. Variables Measured in the Field.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
NUMSPP	Number of Species Present (Count)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and record then total number of species present within the quadrat. Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
NUMTREESP	Number of Tree Species Present (Count)	Starting at a random location within each forest-based cover type, lay out a 100-m transect tape. Establish a 10-m wide belt transect parallel to the 100-m transect tape (5-m on each side of the tape). Walk along this belt for 10-m, and identify (to species) trees within the belt. By definition, trees must be at least 20 feet tall and/or have a dbh of 6 inches to be included in this measurement. Repeat the 10x10 belt approach for the length of the 100-m transect tape (10 sets of data points are collected per 100-m transect). Repeat the process two more times (total number of data point sets = 30 per cover type). Sum the number of species found per transect.	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape and DBH Tape
VEGSTRATA	Number of Vegetation Strata Present (Count)	Starting at a random location within each forest-based cover type, lay out a 100-m transect tape. Establish a 10-m wide belt transect parallel to the 100-m transect tape (5-m on each side of the tape). Walk along this belt for 10-m, and identify all vegetative layers present (see list below). Repeat the 10x10 belt approach for the length of the 100-m transect tape (10 sets of data points are collected per 100-m transect). Repeat the process two more times (total number of data point sets = 30 per cover type). Vegetative Layers to Record Include: Herbaceous - herbaceous vegetation layer less than 1m (39 inches) in height. Shrubs - woody vegetation layer less than 3m (~10ft) in height. Midstory Tree Canopy - woody vegetation layer 3-6m (~10-20 ft) in height.	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape

Table C-4. Variables Measured in the Field.					
VAR Code	**Variable Description**	**Methodology, Techniques and Assumptions**	**Model Applicability**	**Cover Type Cross-Reference**	**Equipment List**
		Overstory Tree Canopy - woody vegetation layer greater than 6m (~20 ft) in height. Vines - woody vines allowing for travel lanes Duff, Twigs, Leaf Litter - down or dead wood or herbaceous litter Coarse Woody Debris - down or dead wood debris greater than or equal to 10 cm (2.5 inches) diameter. Snags - dead but standing trees. Micro Relief - small pockets or mounds that may allow for cover or ponding water.			
Source: ERDC-EL, 2004b					

Table C-5. Variables Gathered via GIS & Historical Records.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
ADJLANDUSE	Identification of Adjacent Lands Use (Class Data)	Using GIS, select 30 random points within each cover type and identify the predominant adjacent landuse type based on the following categories. Class data: NEED Better definitions 1 = Pristine, Uninhabited Areas 2 = Parks 3 = Pasturelands 4 = Utility Rights-of-way and Rail Roads 5 = Dirt and Gravel roads, Oil and Gas Fields 6 = Agricultural Croplands 7 = Residential and Golf Courses 8 = Paved Roads, Highways 9 = Commercial/Industrial	FORESTS FLANDSCAPE GRASSLANDS GLANDSCAPE MARSH MLANDSCAPE	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR OLDFIELD NEWOLD OPENFIELD NEWOPEN NEWMARSH	GIS & Calculations
CORE	Proportion of Total Area that is Core (%)	Using GIS, determine the proportion (%) of the total area of the cover type polygon that is core area.	FORESTS FLANDSCAPE GRASSLANDS GLANDSCAPE	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR OLDFIELD NEWOLD OPENFIELD NEWOPEN	GIS & Calculations
DISTOPW	Average Distance to Open Water (m)	Using GIS, use a centroid point in the cover type polygon and measure the distance from the centroid to the edge of the nearest open water body.	FORESTS FLANDSCAPE	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	GIS & Calculations
NEIGHBOR	Distance to Nearest Neighbor of Similar Cover Type (m)	Using GIS, use a centroid point in the cover type polygon and measure the distance from the centroid to the edge of the nearest neighbor (neighbor = polygon of similar land use classification).	FORESTS FWATER MARSH MBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR NEWMARSH	GIS & Calculations

Table C-5. Variables Gathered via GIS & Historical Records.					
VAR Code	**Variable Description**	**Methodology, Techniques and Assumptions**	**Model Applicability**	**Cover Type Cross-Reference**	**Equipment List**
PATCHSIZE	Patch Size (acres)	Using GIS, calculate the average patch size(in acres) of the polygons for each cover type present.	FORESTS FLANDSCAPE GRASSLANDS GLANDSCAPE MARSH MLANDSCAPE	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR OLDFIELD NEWOLD OPENFIELD NEWOPEN NEWMARSH	GIS & Calculations
REGIME	Hydrologic Regime (Class Data)	Using the Cowardin Classification System, record the predominant hydrologic regime for the site. Refer to the categories listed below. 1 = Permanently flooded 2 = Intermittently exposed 3 = Semipermanently flooded 4 = Seasonally flooded 5 = Temporarily flooded 6 = Saturated 7 = Intermittently flooded	FORESTS FWATER MARSH MBIOTA	BLHFOREST NEWBLHFOR NEWMARSH	Historical Data
Source: ERDC-EL, 2004b					

C.5.9.1 Field Sampling Protocol

As indicated in the HEP variable tables above, three 100-m transect were laid down within the boundaries of the indicated cover type at each site, and variables were measured at 10 meter intervals (i.e., 10 sampling stops or stations per transect were made). In this manner, 750 separate stations (i.e., 25 cover type areas x 30 stations per cover type = 750) of data were recorded in the study. In most instances, data collected on the cover type transects were averaged to generate a cover type score for the site. This strategy reduced the coefficients of variance (i.e., standard deviations of the field data). The one exception to this data-handling rule was the management of class data (e.g., VEGSTRATA), in which the modes were calculated instead of averages across transects within the cover type.

C.5.9.2 Field Sampling Locations

Reference standard sites were not potential or existing dredge disposal sites, but represented low, moderate, and high quality examples of different habitats within the study area. Data collected for these sites was used to calibrate the HSI models and compare them to the dredge disposal sites. These ten sites are listed in Table C-6.

Table C-6. Reference standard sites (non-disposal sites) used in the HEP analysis for the ARNS EIS.

Site Name	Navigation Miles	Size (Acres)	BLH	OF	OLF	UPL	Notes
RSR 1	352.0-356.0	1		X			Sequoyah Refuge, OK
RSR 2	352.0-356.0	1			X		Sequoyah Refuge, OK
RSR 3	352.0-356.0	1			X		Sequoyah Refuge, OK
RSR 4	352.0-356.0	1				X	Sequoyah Refuge, OK
RSR 5	352.0-356.0	1				X	Sequoyah Refuge, OK
RSKR	434.4 – 434.6	1	X				Skelly Ranch (Private)
RBL #1	440.4 – 440.8	1	X				Big Lake, OK
RBL#2	440.1 – 440.2	1	X				Big Lake – East of dam
RBL #3	440.5 – 441.0	1	X				Big Lake, OK
RTGP	Site not along the Arkansas River	1		X			Tallgrass Prairie Preserve west of Bartlesville, Oklahoma

RTGP = Reference Tallgrass Prairie Preserve OF = Open Field
RSR = Reference Sequoyah Refuge OLF = Old Field
RSKR = Reference Skelly Ranch BLH = Bottomland Hardwood
RBL = Reference Big Lake UPL= Upland Forest

Source: USACE-Tulsa, 2004

Reference impact sites were potential dredge disposal sites that served as the baseline of data with which the rest of the potential dredge disposal sites could be extrapolated from. The reference impact sites along with the extrapolation impact sites are shown in Table C-7.

C.5.10 Performing Data Management and Statistical Analysis

Some limits to the assessment's data should be acknowledged. In some instances, extrapolations or corrections were made several weeks after sampling was concluded. In addition, some of the cover type mapping originally developed was ground-truthed, and found to be inaccurate. As a result of these area-based changes, some transects were thrown out due to incompatibility with the new classification. In those instances where transects were discarded or absent, extrapolations were made from watershed means. When data management problems arose, ERDC-EL consulted with the MEET prior to data handling, and solutions were devised with their knowledge and consent.

C.5.11 Calculating Baseline Conditions

Once the baseline data inventory was conducted, and both the variable means/modes and the cover type acreages were determined, the baseline conditions in terms of HUs were generated by multiplication. Strictly speaking, the means/mode values for each variable were applied to Suitability Index graphs (entered into the "X-axis" on the Suitability Index curve) and the resultant SI score (Y-axis) was recorded. An example Suitability Index graph is shown in Figure C.5-1.

Figure C.5-1 Example HSI Curve (*Source: ERDC-EL, 2004b*).

Table C-7. Dredge disposal sites considered in the HEP analysis for the ARNS EIS.

Site Name	Deepening Disposal Site	Long Term Dredge Material Disposal Plan	Navigation Mile(s)	Acres	Cover Type					Comments
					BLH	UPL	OF	OLF	Other	
OK PRL-DI	X	X	1.5PR – 1.8PR	9			9			Poteau River; new O&M site
OK 309.1 R-DI	X	X	309.05 – 309.3	28		5	23			
OK 312.5 R-DI		X	312.5 – 312.9	19			19			
OK 315.4 R-DI	X	X	315.4 – 315.8	36		8		28		
OK 318.3 R-DI		X*	311	80		20			60	Lock 14; new O&M site
OK 335.8 R-DI*	X		335.8 – 336.1	22	8		14			Robert Kerr L&D
OK 335.9 L-DI*	X		335.8 – 336.1	22			22			Robert Kerr L&D
OK 337.2 R-DI*	X		337.7 – 337.5	28		28				Short Mountain Park
OK 338.0 R-DI	X		338.0 – 338.2	28			28			
OK-SBC 8.7 L-DI		X	SBC 8.7 – 9.3	35	8			27		Unconfined island
OK-SBC 9.7 R-DI		X	SBC 9.7 – 10.0	20	10	10				Unconfined island
OK-SBC 10.0 R-DI		X	SBC 10 – 11	20		16		4		Unconfined island
OK 342.3 L-DI	X		342.1 – 342.3	29		14		15		Two diked ponds
OK 366.5 L-DI*	X		366.3 – 366.6	6				6		Old spoil area near Lock 16
OK 382.0 L-DI	X		381.9 – 382.5	23			23			
OK 383.9 R-DI*	X		383.9 – 384.3	42		2	13	27		
OK 394.0 R-DI		X	393.9 – 394.6	48				48		3 Forks Area; new site for O&M
OK 395.2 L-DI		X	395.0 – 395.5	42				42		3 Forks Area
OK 398.2 R-DI*	X		398.2 – 398.8	44			34	10		North of Hwy 16 bridge; old disposal site
OK 400.7 R-DI*	X	X	400.0 – 401.5	31				31		
OK 400.0 L-DI		X	400.2	23				23		New site for O&M
OK 401.6 R-DI	X	X	401.5 – 402.2	39			39			

Table C-7. Dredge disposal sites considered in the HEP analysis for the ARNS EIS.

Site Name	Deepening Disposal Site	Long Term Dredge Material Disposal Plan	Navigation Mile(s)	Acres	Cover Type					Comments
					BLH	UPL	OF	OLF	Other	
OK 407.6 R-DI	X		407.6 – 407.8	10		2		8		
OK 414.9 R-DI	X		414.9 – 415.15	8				8		Old disposal pit
OK 416.4 L-DI	X		416.4 – 416.65	14				14		
OK 420.8 L-DI		X	420.5 – 421.8	63		10	43		10	
OK 421.3 R-DI*	X		421.3 – 421.7	13			13			Old spoil site; closed park
OK 422.9 L-DI	X	X	421.85 – 422.0	7			7			Existing spoil site
OK 434.3 R-DI*	X		434.0 – 434.8	10				10		Old disposal pits
OK 436.1 L-DI*	X		436.1 – 436.3	13			13			
OK 441.1 L-DI*	X		441.0 – 441.5	12			12			Between river and old dredge pit
OK 443.7 L-DI	X		443.7 – 444.0	27			27			Old disposal site
OK 444.6 L-DI		X	444.5 – 445.0	15				15		
OK 444.6 R-DI		X	444.5 – 445.2	9		9				

* Reference impact sites where field, GIS, and historical data was collected for HEP.

BLH = Bottomland Hardwood Forest UPL=Upland Forest OLF = Old Field OF=Open Field

Ag = Agriculture OK = Oklahoma

Source: USACE-Tulsa, 2004

The process was repeated for every associated variable and cover type per model. The individual SI scores were then entered into the HSI formula on a cover type-by-cover type basis, and individual cover type HSIs were generated. Each answer, referred to as the cover type HSI (CT HSI), was weighted by the relative area (RA) of the cover type, and combined with the answers from the remaining associated cover types in an additive fashion. The model's formula was considered to be the sum of the CT HSIs.

The final step was to multiply the HSI result by the habitat acres (i.e., cover type acres associated with the model). The final results, referred to as Habitat Units (HUs), quantified the quality and quantity of the habitats at the site at TY0 (Baseline).

In HEP, the relative area is a mathematical process used to "weight" the various applicable cover types on the basis of quantity. To derive the relative area of a model's cover type for the study, the following equation was utilized:

$$\textit{Relative Area} = \frac{\textit{Cover Type Area}}{\textit{Total Area}}$$

Cover Type Area = only those acres assigned to the cover type of interest
Total Area = the sum of the acres utilized in the model

$$\textit{HSI Model} = \sum (\textit{CT HIS} \times \textit{RA})X$$

CT HSI = Results of the cover type HSI calculation
X = Number of cover types associated with the model

RA = Relative area of each cover type (ERDC-EL, 2004a). The sheer number of calculations necessary to conduct a HEP analysis on a project the size of the ARNS-EIS led the District to utilize the ERDC-EL for technical assistance. Using the latest technological advancements, ERDC-EL performed the necessary evaluations in less than six months. In addition to facilitating the application of HEP in the study, ERDC's biologists used the EXHEP (Expert Habitat Evaluation Procedures) software package to generate habitat loss and mitigation calculations in a timely manner (ERDC-EL, 2004b).

The baseline analysis results for the reference and potential disposal sites sampled in the field are presented in Table C-7.

Table C-7. Baseline HEP Results for RIS and RSS.

Site Name	Model name	Habitat Suitability Index (HSI)	Applicable Acres	Baseline Habitat Units (HUs)
RBL #1	Upland Forest Community Model	0.83	525	435.9
	Grassland Community Model	0.00	0	0.0
RBL #2	Upland Forest Community Model	0.65	158	103.1
	Grassland Community Model	0.00	0	0.0
RBL #3	Upland Forest Community Model	0.55	97	53.3
	Grassland Community Model	0.00	0	0.0

Table C-7. Baseline HEP Results for RIS and RSS.				
Site Name	**Model name**	**Habitat Suitability Index (HSI)**	**Applicable Acres**	**Baseline Habitat Units (HUs)**
RSKR1	Upland Forest Community Model	0.33	55	18.1
	Grassland Community Model	0.00	0	0.0
OK335.8R-DI	Upland Forest Community Model	0.29	8	2.3
	Grassland Community Model	0.31	14	4.3
OK434.3R-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.28	10	2.8
RSR 4	Upland Forest Community Model	0.79	289	228.1
	Grassland Community Model	0.00	0	0.0
RSR 5	Upland Forest Community Model	0.60	132	79.4
	Grassland Community Model	0.00	0	0.0
OK 398.2 R-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.41	44	17.9
OK 337.2 R-DI	Upland Forest Community Model	0.69	28	19.3
	Grassland Community Model	0.00	0	0.0
OK 383.9 R-DI	Upland Forest Community Model	0.69	2	1.4
	Grassland Community Model	0.379	40	15.2
RSR 2	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.65	58	37.6
RSR 3	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.66	113	74.7
OK366.5L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.59	6	3.6
RSR 1	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.69	1066	739.3
RTGP	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.95	790	751.9
OK 422.9 L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.16	7	1.1

Table C-7. Baseline HEP Results for RIS and RSS.

Site Name	Model name	Habitat Suitability Index (HSI)	Applicable Acres	Baseline Habitat Units (HUs)
OK441.1L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.53	12	6.4
OK 421.3 R-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.31	13	4.1
OK 335.9 L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.30	22	6.5
OK400.7R-DI	Upland Forest Community Model	0.0	0	0.0
	Grassland Community Model	0.39	31	12.0
OK 436.1 L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.22	13	2.8

Source: ERDC-EL, 2004b

C.5.12 Generating Without Project Conditions and Calculating Outputs

Future impacts were projected as change from these baseline conditions over the 50-year project life in the HEP assessments. The ERDC-EL facilitated a series of workshops, beginning in the winter of 2004 and continuing through the summer of 2004, in which the MEET derived future projections for each site.

To analyze impacts to a community or region, it becomes necessary to predict both the short-term and long-term future conditions of the environment. The Without Project condition is universally regarded as a vital and important element of the evaluation. No single element is more critical to the impacts analysis than the prediction of the most likely future conditions anticipated for the study area if no action is taken as a result of the study. NEPA regulations require that the No Action Alternative always be considered during the formulation of plans. The Without Project descriptions had to adequately describe the future. Significant variables, elements, trends, systems, and processes were sufficiently described to support good decision-making. Forecasts were based on appropriate methods, and professional standards were applied to the use of those methods. Without Project conditions are not "before-and-after" comparisons. "Before-and-after" comparisons can overlook the causality that is important to effective plan evaluation. Without Project conditions are future oriented.

Rules and assumptions were developed for acreage projections of the Without Project condition for all ARNS-EIS sites:

- Because of the rural nature of most of the dredge disposal sites, there would likely be little change in ownership and/or change in function of land within these project areas.
- Pasture would likely remain pasture due to grazing pressure.

- Open fields would likely undergo succession and develop into old fields and then forest.
- Old fields would likely undergo succession to develop into forest.
- Forest would likely continue to develop into a more mature forest.
- Marsh would likely undergo succession to develop into a forested wetland.

Some of the projections were based on data collected at the RISs, while others were adjusted based on expert opinion. These assumptions were applied as results to the Habitat Suitability curves and new HSIs and HUs were generated for the without project condition.

C.5.12.1 Calculating Annualized Units for the Without Project Condition

Most Federal agencies use annualization as a means to display benefits and costs. Federal projects are evaluated over a period of time that is referred to as the "life of the project." This is defined as that period between the time that the project becomes operational and the end of the project life. 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 Average Annual Habitat Units (AAHUs).

The total acres of each habitat projected to be gained plus the AAHUs for each terrestrial site under the without project or no action alternative is shown in Table C-8.

Table C-8. Without Project Projected Acres and AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WOP Target Year 51 Size (acres)	Target Year 51 AAHUs
OK PR L-DI	Extrapolated Site	NewOldField	2.3	0.85
		NewUpland	2.3	0.16
		OpenField	4.5	1.69
OK PR L-DI Total			9.0	2.69
OK 309.1 R-DI	Extrapolated Site	NewOldField	5.8	3.00
		NewUpland	5.8	0.81
		OpenField	11.5	6.00
		UplandForest	5.0	3.57
OK 309.1 R-DI Total			28.0	13.38
OK 312.5 R-DI	Extrapolated Site	NewOldField	4.8	1.02
		NewUpland	4.8	0.31
		OpenField	9.5	2.04
OK 312.5 R-DI Total			19.0	3.37
OK 315.4 R-DI	Extrapolated Site	NewUpland	14.0	4.11
		OldField	14.0	7.24

Table C-8. Without Project Projected Acres and AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WOP Target Year 51 Size (acres)	Target Year 51 AAHUs
		UplandForest	8.0	2.35
OK 315.4 R-DI Total			36.0	13.70
OK 318.3 R-DI	Extrapolated Site	UplandForest	20.0	5.88
OK 318.3 R-DI Total			20.0	5.88
OK 335.8R-DI	Reference Impact Site	Bottomland	8.0	3.91
		NewOldField	3.5	0.85
		NewUpland	3.5	3.91
		OpenField	7.0	1.69
OK 335.8R-DI Total			22.0	10.36
OK 335.9L-DI	Reference Impact Site	NewOldField	5.5	0.85
		NewUpland	5.5	0.36
		OpenField	11.0	1.69
OK 335.9L-DI Total			22.0	2.90
OK 337.2R-DI	Reference Impact Site	UplandForest	28.0	20.01
OK 337.2R-DI Total			28.0	20.01
OK 338.0 R-DI	Extrapolated Site	NewOldField	7.0	1.50
		NewUpland	7.0	0.46
		OpenField	14.0	3.01
OK 338.0 R-DI Total			28.0	4.97
OK 342.3 L-DI	Extrapolated Site	NewUpland	7.5	1.05
		OldField	7.5	3.91
		UplandForest	14.0	10.01
OK 342.3 L-DI Total			29.0	14.97
OK-SBC 10.0 R-DI	Extrapolated Site	NewUpland	1.0	0.29
		OldField	1.0	0.52
		UplandForest	16.0	4.70
OK-SBC 10.0 R-DI Total			18.0	5.51
OK-SBC 8.7 L-DI	Extrapolated Site	Bottomland	2.0	0.98

Table C-8. Without Project Projected Acres and AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WOP Target Year 51 Size (acres)	Target Year 51 AAHUs
		NewUpland	4.0	0.56
		OldField	4.0	2.09
OK-SBC 8.7 L-DI Total			10.0	3.63
OK-SBC 9.7 R-DI	Extrapolated Site	Bottomland	5.0	2.44
		UplandForest	5.0	1.47
OK-SBC 9.7 R-DI Total			10.0	3.91
OK 366.5L-DI	Reference Impact Site	NewUpland	3.0	0.72
		OldField	3.0	2.35
OK 366.5L-DI Total			6.0	3.07
OK 382.0 L-DI	Extrapolated Site	NewOldField	5.8	2.38
		NewUpland	5.8	0.39
		OpenField	11.5	4.77
OK 382.0 L-DI Total			23.0	7.54
OK 383.9R-DI	Reference Impact Site	NewOldField	3.3	1.68
		NewUpland	16.8	4.92
		OldField	13.5	6.98
		OpenField	6.5	3.36
		UplandForest	2.0	0.59
OK 383.9R-DI Total			42.0	17.53
OK 394.0 R-DI	Extrapolated Site	NewUpland	24.0	5.78
		OldField	24.0	18.82
OK 394.0 R-DI Total			48.0	24.60
OK 395.2 L-DI	Extrapolated Site	NewUpland	9.0	2.17
		OldField	9.0	7.06
OK 395.2 L-DI Total			18.0	9.23
OK 398.2R-DI	Reference Impact Site	NewOldField	8.5	4.43
		NewUpland	13.5	1.90
		OldField	5.0	2.61
		OpenField	17.0	8.87
OK 398.2R-DI Total			44.0	17.81

Table C-8. Without Project Projected Acres and AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WOP Target Year 51 Size (acres)	Target Year 51 AAHUs
OK 400.0 L-DI	Extrapolated Site	NewUpland	11.5	2.83
		OldField	11.5	6.01
OK 400.0 L-DI Total			23.0	8.84
OK 400.7R-DI	Reference Impact Site	NewUpland	15.5	3.81
		OldField	15.5	8.10
OK 400.7R-DI Total			31.0	11.91
OK 401.6 R-DI	Extrapolated Site	NewOldField	9.8	6.59
		NewUpland	9.8	0.68
		OpenField	19.5	13.18
OK 401.6 R-DI Total			39.0	20.45
OK 407.6 R-DI	Extrapolated Site	NewUpland	4.0	0.56
		OldField	4.0	2.09
		UplandForest	2.0	1.43
OK 407.6 R-DI Total			10.0	4.08
OK 414.9 R-DI	Extrapolated Site	NewUpland	4.0	0.96
		OldField	4.0	3.14
OK 414.9 R-DI Total			8.0	4.10
OK 416.4 L-DI	Extrapolated Site	NewUpland	7.0	1.69
		OldField	7.0	5.49
OK 416.4 L-DI Total			14.0	7.18
OK 420.8 L-DI	Extrapolated Site	NewOldField	10.8	5.56
		NewUpland	10.8	1.69
		OpenField	21.5	11.11
		UplandForest	10.0	2.94
OK 420.8 L-DI Total			53.0	21.30
OK 421.3R-DI	Reference Impact Site	NewOldField	3.3	1.35
		NewUpland	3.3	0.22
		OpenField	6.5	2.69
OK 421.3R-DI Total			13.0	4.26
OK 422.9L-DI	Reference Impact Site	NewOldField	1.8	0.61

Table C-8. Without Project Projected Acres and AAHUs at Target Year 51.				
Site Name	**Site Type**	**Habitat**	**WOP Target Year 51 Size (acres)**	**Target Year 51 AAHUs**
		NewUpland	1.8	0.12
		OpenField	3.5	1.22
OK 422.9L-DI Total			7.0	1.95
OK 434.3R-DI	Reference Impact Site	NewUpland	5.0	0.52
		OldField	5.0	1.99
OK 434.3R-DI Total			10.0	2.51
OK 436.1L-DI	Reference Impact Site	NewOldField	3.3	1.22
		NewUpland	3.3	0.23
		OpenField	6.5	2.44
OK 436.1L-DI Total			13.0	3.89
OK 441.1L-DI	Reference Impact Site	NewOldField	3.0	2.03
		NewUpland	3.0	0.21
		OpenField	6.0	4.05
OK 441.1L-DI Total			12.0	6.29
OK 443.7 L-DI	Extrapolated Site	NewOldField	6.8	1.45
		NewUpland	6.8	0.44
		OpenField	13.5	2.90
OK 443.7 L-DI Total			27.0	4.79
OK 444.6 L-DI	Extrapolated Site	NewUpland	7.5	1.81
		OldField	7.5	5.88
OK 444.6 L-DI Total			15.0	7.69
Grand Total			**270.0**	**102.59**
Source: ERDC-EL, 2004b				

C.5.13 <u>Generating With Project Conditions and Calculating the Outputs</u>

Between June of 2004 and September of 2004 the MEET met on a regular basis (in person and via conference calls) to develop projection trends for the deepening and maintenance dredging disposal sites across the MKARNS. As they did in the without project setting, the MEET generated a list of general trends for the overall study. It was assumed that if a site was used for disposal, the entire site would be covered by dredged material. The Team made an effort to distinguish clearly between forest vs. open/old field communities, and the outcomes of each were incorporated into the forecasting.

Table C-9 shows with project total acres, AAHUs, and net AAHUs at target year 50.

Table C-9. With Project Total Acres, AAHUs, and Net AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WP TY50 Size (ac)	AAHUs	Net AAHUs
OK 309.1 R-DI	Extrapolated Site	NewOldField	0	0.03	-2.97
		NewUpland	0	0.00	-0.81
		OpenField	0	0.08	-7.10
		UplandForest	0	0.13	-3.45
OK 309.1 R-DI Total			0	0.24	-14.32
OK 312.5 R-DI	Extrapolated Site	NewOldField	0	0.01	-1.01
		NewUpland	0	0.00	-0.64
		OpenField	0	0.03	-2.33
OK 312.5 R-DI Total			0	0.05	-3.97
OK 315.4 R-DI	Extrapolated Site	NewUpland	0	0.01	-4.11
		OldField	0	0.00	-6.59
		UplandForest	0	0.00	-2.35
OK 315.4 R-DI Total			0	0.01	-13.05
OK 318.3 R-DI	Extrapolated Site	UplandForest	0	0.13	-5.75
OK 318.3 R-DI Total			0	0.13	-5.75
OK 335.8R-DI	Reference Impact Site	Bottomland Forest	0	0.02	-3.89
		NewOldField	0	0.01	-0.84
		NewUpland	0	0.02	-3.89
		OpenField	0	0.02	-1.71
OK 335.8R-DI Total			0	0.06	-10.33
OK 335.9L-DI	Reference Impact Site	NewOldField	0	0.01	-1.17
		NewUpland	0	0.00	-0.36
		OpenField	0	0.03	-2.70
OK 335.9L-DI Total			0	0.05	-4.23
OK 337.2R-DI	Reference Impact Site	UplandForest	0	0.13	-19.89
OK 337.2R-DI Total			0	0.13	-19.89
OK 338.0 R-DI	Extrapolated Site	NewOldField	0	0.01	-1.49
		NewUpland	0	0.00	-0.70
		OpenField	0	0.03	-3.45
OK 338.0 R-DI Total			0	0.05	-5.64
OK 342.3 L-DI	Extrapolated Site	NewUpland	0	0.00	-1.05
		OldField	0	0.02	-4.66
		UplandForest	0	0.13	-9.88
OK 342.3 L-DI Total			0	0.15	-15.59
OK 366.5L-DI	Reference Impact Site	NewUpland	0	0.00	-0.72
		OldField	0	0.02	-2.33
OK 366.5L-DI Total			0	0.02	-3.05

Table C-9. With Project Total Acres, AAHUs, and Net AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WP TY50 Size (ac)	AAHUs	Net AAHUs
OK 382.0 L-DI	Extrapolated Site	NewOldField	0	0.01	-2.38
		NewUpland	0	0.00	-0.47
		OpenField	0	0.02	-4.75
OK 382.0 L-DI Total			0	0.02	-7.60
OK 383.9R-DI	Reference Impact Site	NewOldField	0	0.00	-1.68
		NewUpland	0	0.01	-4.91
		OldField	0	0.00	-6.36
		OpenField	0	0.00	-2.84
		UplandForest	0	0.00	-0.59
OK 383.9R-DI Total			0	0.02	-16.38
OK 394.0 R-DI	Extrapolated Site	NewUpland	0	0.00	-5.78
		OldField	0	0.02	-18.80
OK 394.0 R-DI Total			0	0.02	-24.58
OK 395.2 L-DI	Extrapolated Site	NewUpland	0	0.00	-2.17
		OldField	0	0.02	-7.04
OK 395.2 L-DI Total			0	0.02	-9.20
OK 398.2R-DI	Reference Impact Site	NewOldField	0	0.03	-4.40
		NewUpland	0	0.00	-1.90
		OldField	0	0.02	-3.10
		OpenField	0	0.08	-10.53
OK 398.2R-DI Total			0	0.13	-19.92
OK 400.0 L-DI	Extrapolated Site	NewUpland	0	0.00	-2.83
		OldField	0	0.08	-5.93
OK 400.0 L-DI Total			0	0.08	-8.76
OK 400.7R-DI	Representative Site	NewUpland	0	0.00	-3.81
		OldField	0	0.08	-8.02
OK 400.7R-DI Total			0	0.08	-11.83
OK 401.6 R-DI	Extrapolated Site	NewOldField	0	0.01	-6.58
		NewUpland	0	0.00	-0.16
		OpenField	0	0.03	-15.27
OK 401.6 R-DI Total			0	0.05	-22.00
OK 407.6 R-DI	Extrapolated Site	NewUpland	0	0.00	-0.56
		OldField	0	0.02	-2.47
		UplandForest	0	0.13	-1.30
OK 407.6 R-DI Total			0	0.15	-4.34
OK 414.9 R-DI	Extrapolated Site	NewUpland	0	0.00	-0.96
		OldField	0	0.02	-3.11
OK 414.9 R-DI Total			0	0.02	-4.08
OK 416.4 L-DI	Extrapolated Site	NewUpland	0	0.00	-1.69
		OldField	0	0.02	-5.47

Table C-9. With Project Total Acres, AAHUs, and Net AAHUs at Target Year 51.					
Site Name	**Site Type**	**Habitat**	**WP TY50 Size (ac)**	**AAHUs**	**Net AAHUs**
OK 416.4 L-DI Total			0	0.02	-7.15
OK 420.8 L-DI	Extrapolated Site	NewOldField	0	0.00	-5.56
		NewUpland	0	0.00	-0.67
		OpenField	0	0.00	-9.39
		UplandForest	0	0.00	-2.94
OK 420.8 L-DI Total			0	0.00	-18.56
OK 421.3R-DI	Reference Impact Site	NewOldField	0	0.01	-1.34
		NewUpland	0	0.00	-0.22
		OpenField	0	0.02	-2.68
OK 421.3R-DI Total			0	0.02	-4.24
OK 422.9L-DI	Reference Impact Site	NewOldField	0	0.00	-0.61
		NewUpland	0	0.00	-0.12
		OpenField	0	0.00	-0.98
OK 422.9L-DI Total			0	0.01	-1.71
OK 434.3R-DI	Reference Impact Site	NewUpland	0	0.00	-0.52
		OldField	0	0.02	-1.97
OK 434.3R-DI Total			0	0.02	-2.49
OK 436.1L-DI	Reference Impact Site	NewOldField	0	0.01	-1.21
		NewUpland	0	0.00	-0.23
		OpenField	0	0.01	-1.58
OK 436.1L-DI Total			0	0.01	-3.02
OK 441.1L-DI	Reference Impact Site	NewOldField	0	0.01	-2.01
		NewUpland	0	0.00	-0.21
		OpenField	0	0.03	-4.68
OK 441.1L-DI Total			0	0.05	-6.90
OK 443.7 L-DI	Extrapolated Site	NewOldField	0	0.01	-1.44
		NewUpland	0	0.00	-0.44
		OpenField	0	0.03	-3.32
OK 443.7 L-DI Total			0	0.05	-5.20
OK 444.6 L-DI	Extrapolated Site	NewUpland	0	0.00	-1.81
		OldField	0	0.02	-5.86
OK 444.6 L-DI Total			0	0.02	-7.67
OK 444.6 R-DI	Extrapolated Site	UplandForest	0	0.13	-8.45
OK 444.6 R-DI Total			0	0.13	-8.45
OK PR L-DI	Extrapolated Site	NewOldField	0	0.01	-0.84
		NewUpland	0	0.00	-0.40
		OpenField	0	0.01	-1.09
OK PR L-DI Total			0	0.01	-2.33
OK-SBC 10.0 R-DI	Extrapolated Site	NewUpland	0	0.01	-0.29

Table C-9. With Project Total Acres, AAHUs, and Net AAHUs at Target Year 51.					
Site Name	**Site Type**	**Habitat**	**WP TY50 Size (ac)**	**AAHUs**	**Net AAHUs**
		OldField	0	0.00	-0.47
		UplandForest	0	0.00	-4.70
OK-SBC 10.0 R-DI Total			0	0.01	-5.45
OK-SBC 8.7 L-DI	Extrapolated Site	Bottomland Forest	0	0.02	-0.96
		NewUpland	0	0.00	-0.56
		OldField	0	0.02	-2.47
OK-SBC 8.7 L-DI Total			0	0.04	-4.00
OK-SBC 9.7 R-DI	Extrapolated Site	Bottomland Forest	0	0.02	-2.43
		UplandForest	0	0.00	-1.47
OK-SBC 9.7 R-DI Total			0	0.02	-3.89
Grand Total			0	1.89	-305.57
Source: ERDC-EL, 2004b					

C.5.14 Mitigation

As part of mitigation the MEET selected dredge disposal sites based upon criteria for avoidance and minimization. Wherever possible, potential dredged material disposal sites were not located where they would impact mature upland forest, bottomland hardwoods, or wetlands, and relocating the sites was logistically feasible. Where sites could not be relocated outside these three habitat types, the design of the pit was configured to reduce impacts as much as possible. Priority was given to sites on USACE owned land. If suitable USACE land was not available, the team looked for private agricultural lands and possible in-water disposal locations where there was the potential for beneficial use of the dredged material. This ultimately reduced the acreage of land needed for mitigation.

Ten sites in Oklahoma were chosen as potential mitigation sites. The MEET team evaluated these sites to determine the amount and type of habitat that could be created to mitigate for habitat lost during dredge disposal on terrestrial sites. Many of the potential mitigation sites occurred on agricultural land. Incremental costs analyses were conducted using the procedures identified in the Corps procedures manual for conducting cost effectiveness and incremental cost analyses (IWR Report #95-R-1, Corps, May 1995). The detailed incremental cost analyses report is located in the Feasibility Report for the Arkansas River Navigation Study.

Two sites were ultimately selected that both satisfied all members of the MEET team and fulfilled the acreage and habitat quality requirement needed to mitigate for the potential habitat loss. These sites were adjacent to ODWC currently managed lands, and allowed ODWC to easily maintain and operate the mitigation sites using funds from the USACE. Figure C.5-2 shows a map of the mitigation sites selected.

C.5.14.1. Baseline Assumptions for Mitigation

The assumptions for mitigation were as follows:

- All mitigation sites will be continually disturbed and will have no fish and wildlife value.
- All mitigation sites begin as agricultural cropland (AGCROP).
- Without project – all mitigation sites remain the same cover type & quality (HSI=0) over time.
- It was agreed among the agencies paying for and managing the mitigation land that the sites would be flooded and maintained to facilitate development of marsh and bottomland forest habitat. Between the time the sites are flooded with water and the time that BLHFOREST has developed, the sites were considered "NEWMARSH." ERDC suggested using the Marsh Wren HSI model published by the USFWS with the modifications of adding the landscape parameters to capture the NEWMARSH creation.
- BLHFOREST can only be replaced with NEWBLHFOREST.
- UPFOREST can only be replaced with NEWBLHFOREST.
- OLDFIELD and OPENFIELD can be replaced with NEWBLHFOREST and/or NEWMARSH.

Table C-10 shows the total acres and AAHUs of terrestrial habitat that could potentially be lost during 50 years of dredge disposal.

Table C-10 Acres and AAHUs of each habitat type potentially lost via dredge disposal over the entire 50 years of the project.

BLHFOREST		UPFOREST		OLDFIELD		OPENFIELD	
Acres Lost	AAHUs Lost	Acres Lost	AAHUs Lost	Acres Lost	AAHUs Lost	Acres Lost	AAHUs Lost
-15	-7.3	-287	-76.4	-220	-123.8	-170	-71.0

Source: ERDC-EL, 2004b

The mitigation sites were run through HEP, which resulted in 130 acres of newly created bottomland forest and 248 acres of newly created marsh (Table C-11).

Table C-11 Acres and AAHUs gained by habitat type at two mitigation sites over the entire 50 years of the project.

	BLHFOREST		UPFOREST		OLDFIELD		OPENFIELD		MARSH	
Mitigation Site	Acres Gained	Net AAHUs Gained	Acres Gained	AAHUs Gained	Acres Gained	AAHUs Gained	Acres Gained	AAHUs Gained	Acres Gained	AAHUs Gained
OK408.9L-M	**69**	**48.3**	0	0.0	0	0.0	0	0.0	**91**	**66.6**
OK405.0L-M	**61**	**42.7**	0	0.0	0	0.0	0	0.0	**157**	**131.3**

Totals	**130**	**91.0**	0	0.0	0	0.0	0	0.0	**248**	**197.9**
Source: ERDC-EL, 2004b										

C.5.15 Conclusions

It was determined that though the HEP analysis 302 acres of forested habitat and 390 acres of grassland habitat would be lost with the use of all potential dredge disposal sites over the 50 year project life. A total of 130 acres of higher quality bottomland forest habitat and 248 acres of higher quality marsh habitat would mitigate for these lost acres through wetland creation along portions of the MKARNS.

The "Net HSI Gain" column in Table C-12 is the level of quality that the mitigation will be designed to meet. The new bottomland forest and marsh habitat created would mitigate for the impacts from disposing dredge material on the terrestrial sites because the quality of the habitat created through mitigation (HSI = 0.70-0.75) is much higher than that lost through dredge disposal (0.28-0.50), and therefore, far fewer acres of new habitat is required to replace it.

The actual acreages needed to fully mitigate for the forest and grassland habitat lost is 120 acres of bottomland forest and 258 acres of marsh (0.7 HSI * 120 acres = 84 AAHUs of bottomland forest; 0.75 HSI * 248 acres = 194 AAHUs). Approximately 10 surplus acres of NEWBLHFOR created and a shortage of 10 acres of NEWMARSH would be created, resulting in no total surplus or shortage of acres.

Table C-12 Summary of acres, AAHUs, and Annual HSI lost on dredge disposal sites and gained on mitigation sites.

Mitigation Sites Selected: OK408.9L-M, OK405.0 L-M

Cover Type Mitigated For	Sum of Acres Lost	Sum of AAHUs Lost	Average Annual HSI of Acres Lost	Total Acres of Proposed Mitigation Sites Combined	Net Gain in AAHUs from Mitigation Plans	Net HSI Gain	# Acres Needed to Fully Mitigate	Surplus or Shortage of Acres	Mitigation Ratio
FOREST (BLHFOREST, UPFOREST)	**-302**	**-83.7**	**0.28**	**130 (NEWBLHFOR)**	**91.0**	**0.70**	**120**	**10**	**0.4:1**
GRASSLAND (OLDFIELD, OPENFIELD)	**-390**	**-194.8**	**0.50**	**248 (NEWMARSH)**	**187.0**	**0.75**	**258**	**-10**	**0.7:1**
							Total Surplus or Shortage of Acres:	**0**	
Source: ERDC-EL, 2004b									

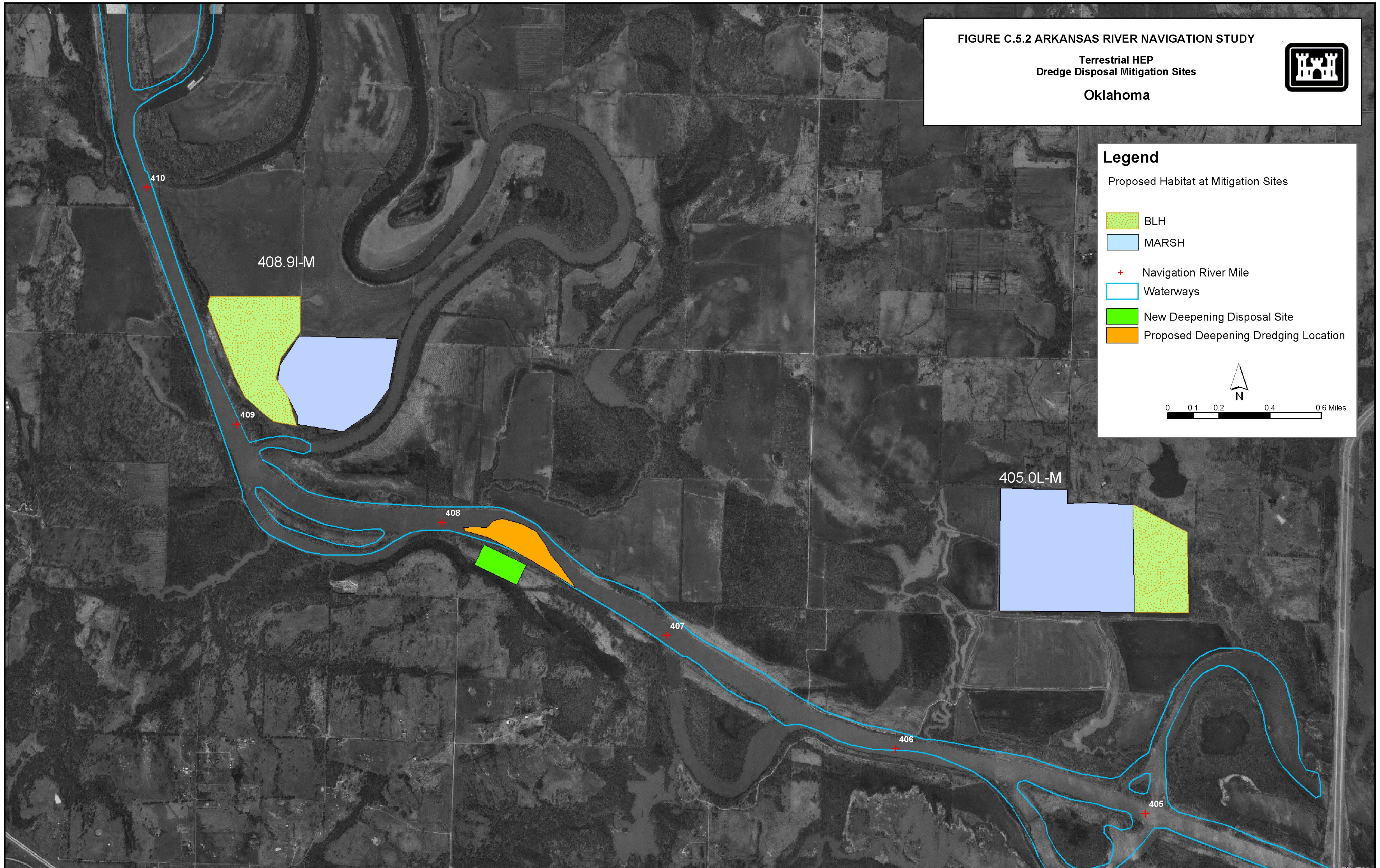

FIGURE C.5.2 ARKANSAS RIVER NAVIGATION STUDY
Terrestrial HEP
Dredge Disposal Mitigation Sites
Oklahoma
Legend
Proposed Habitat at Mitigation Sites
BLH
MARSH
Navigation River Mile
Waterways
New Deepening Disposal Site
Proposed Deepening Dredging Location
N
0 0.1 0.2 0.4 0.6 Miles
408.9I-M
405.0L-M
410
409
408
407
406
405

C.5.16 References

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C.5.17 Acronyms

AAHU	Average Annual Habitat Units
AGFC	Arkansas Game and Fish Commission
cm	centimeters
CT-HSI	Cover Type HSI
dbh	diameter at breast height
EIS	Environmental Impact Study
ERDC-EL	Engineer Research and Development Center – Environmental Laboratory
GIS	Geographic Information Systems
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
HU	Habitat Units
m	meters
MEET	Multiagency Ecosystem Evaluation Team
MKARNS	McClellan-Kerr Arkansas River Navigation System
ODWC	Oklahoma Department of Wildlife Conservation
RA	Relative Acres
RIS	Reference Impact Sites
RSS	Reference Standard Sites
SI	Suitability Index
TY	Target Year
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

C.6

Aquatic Habitat Evaluation Procedures

ARKANSAS RIVER NAVIGATION PROJECT
AQUATIC EVALUATION

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Abstract

An evaluation was conducted to determine aquatic impacts of increasing the depth of the Arkansas River navigation channel from 9 to 12 feet. Field studies were conducted to establish baseline conditions of fish and aquatic habitat. In addition, primary impacts of the project identified by an interagency team of biologists and engineers were evaluated including dike filling rates and associated effects on habitat quality, and the potential of degrading or removing gravel during dredging activities. There are 117 fish species native to the lower Arkansas Drainage. Fish collections from this study area indicate a community that is moderately species-rich (65 species) and representative of most major groups (15 families) within the drainage. Collections were taxonomically dominated by minnows (17 spp.), sunfishes (12 spp.), and suckers (8 spp.). The Arkansas River is inhabited by a high percentage of non-native species five of which were collected in this study: common carp, grass carp, fathead minnow, inland silverside, and striped bass. Gravel bar surveys in proposed dredging locations indicated that 165 acres of gravel could potentially be impacted and would require mitigation by relocating or creating gravel bars. For dike field impacts, the 11-foot channel alternative would result in a loss of 391 average annual habitat units (AAHU) along the entire project length. However, mitigation for the 11-foot alternative resulted in a gain of 494 AAHU. Impacts from the 12-foot alternative would result in a loss of 664 AAHU while approved mitigation projects yielded 108 AAHU. Additional impacts associated with the Verdigris River resulted in a loss of 91 AAHU for both project alternatives. Therefore, the net effect of mitigating impacts, including the Verdigris River channel impacts, was a net gain of 403 and 17 AAHU for the 11- and 12-foot alternatives, respectively. Uncertainty in impacts and mitigation will require a long term monitoring program.

Introduction

The Arkansas River is the fourth largest river in the United States, spanning 1,450 miles. It begins in Colorado, flows through Kansas and Oklahoma, and eventually empties into the Mississippi River. The lower portion of the river is navigable from eastern Oklahoma to the Mississippi River. The McClellan-Kerr Arkansas Navigation system was authorized by the River and Harbors Act of 1946. Construction of the system began in 1949 and was completed in 1970. It spans 445 miles beginning at the mouth of the White River in Arkansas to the Verdigris River in Oklahoma. The navigation channel includes 17 locks and dams, along with hydroelectric facilities at some dams and tributary reservoirs for flood control and recreation. Currently, the authorized navigation channel is 9 feet and is maintained by dredging and dikes.

The Little Rock and Tulsa Districts are evaluating the feasibility of the 12-ft channel. This study, referred to as Phase II of the Arkansas River Navigation Study, will evaluate alternatives and assess impacts of channel deepening by dredging and construction or modification of dikes. The aquatic study was initiated to evaluate potential impacts of channel deepening on riverine habitats and associated fish communities. Coordination with Arkansas Game and Fish Commission, Oklahoma Department of Wildlife Conservation, and U. S. Fish and Wildlife Service identified several areas of concern related to environmental impacts, most notably effects of dredging on gravel substrates and location of disposal areas particularly in dike fields.

A limited field study was initiated in summer 2004 to describe baseline conditions and evaluate impacts. In addition, several interagency meetings were conducted to determine evaluation protocol, agree upon habitat value of dike fields and gravel bars, and discuss mitigation and monitoring needs of the project. The objectives of this report are to:

(a) Describe aquatic habitat and fish communities in representative pools;
(b) Quantify amount and location of gravel bars that could be potentially impacted by dredging;
(c) Quantify amount and relative fishery value of dike fields that will be used as disposal sites to accommodate a deeper navigation channel;
(d) Determine mitigation requirements to compensate for adverse impacts.

Methods

Fish and Habitat Sampling

Of the 17 pools within the project, representative pools were selected for detailed sampling in April and May 2004 (Table 1). In most pools, a minimum of three locations was sampled that corresponded to the lower, middle, and upper reaches. Within each reach, multiple sampling sites were established to incorporate major habitat features (e.g., side channel, main channel, connected backwater, tributary mouths), frequently dredged areas, and dredge disposal sites. This sampling approach provided baseline information and an opportunity to compare aquatic habitats with different levels of anthropogenic disturbances.

Multiple sampling gears were used to assess three distinct habitats at each site: seining for littoral/shoreline fishes, electroshocking for pelagic/slackwater fishes, and benthic trawls for demersal and main channel fishes. Concurrent with fish collections, physical parameters were measured so that habitat conditions could be described synoptically for all macrohabitats (e.g., littoral zone, channel border, main channel, side channel). Water temperature, conductivity, pH, dissolved oxygen, and turbidity were recorded at a representative position near-shore. Stream width was measured and shoreline position marked so that a representative cross-sectional transect was established. At equidistant intervals, from water's edge to water's edge, depth and velocity were measured. Substrate composition, percent instream cover, and occurrence of major backwaters adjacent to the sampling site were noted.

Comprehensive characterization of the ichthyofauna and aquatic habitats were provided for baseline conditions. Multiple metrics of community diversity were calculated, including indices of species richness and heterogeneity (diversity index). Relative abundance of individual species, including species of special concern (e.g., sturgeon and paddlefish), was summarized. Quantitative relationships between fishes and habitat conditions were developed and used to recommend potential measures of impact prediction. In addition, a complete list of fishes and their distribution within the navigation project were provided.

Gravel Bars

Dredging may alter or remove gravel bars, which are used by a variety of sensitive and protected fishes. A study was initiated to determine the aerial extent of gravel in the project area that could be impacted from channel deepening. Potential gravel bars were identified from a preliminary study, and these locations were later visited by a survey boat to measure substrate composition.

Preliminary estimates of impacts from proposed channel dredging on gravel substrates in the McClellan-Kerr Arkansas River Navigation System were based on both direct observations and indirect indicators from several sources. These sources included current and historical GIS data, Red Hen video footage and observations recorded by field crews during fish sampling. A list of 1-6 mile long sites that were observed to contain or to have a high probability of containing gravel substrates was compiled from these combined sources. The rough area of each site was estimated by multiplying a representative stream width (bank to bank) by the site length.

GIS layers included gravel deposits (obtained from 1981 USGS database, Arkansas Geological Commission and Arkansas Highway and Transportation Department), topographic maps, digital orthophotos and proposed dredging locations (provided by Little Rock District). Locations of current and historical gravel mining operations were used as indirect indicators of possible gravel deposits. Red Hen video footage was collected the week of August 9-13, 2004, during which time stages on the Arkansas River were almost normal. The footage was examined for exposed gravel bars and areas that, due to surrounding hydrologic and geologic features, might contain gravel substrates.

Substrate observations were made during velocity transects or in the event that a channel trawl yielded gravel in the sample. Velocity transects were taken along a representative cross-section of the channel at ten equidistant points from right bank to left bank, looking upstream. A metal weight carrying a velocity meter was lowered into the water and the flow was measured at the surface and bottom of the water column. When the weight was lowered to the bottom, the operator determined the substrate based on the sensation of the metal striking the river bottom. Substrate was categorized as detritus/woody debris, soft mud, sand, gravel, riprap or bedrock. A 16-foot otter trawl with 1-inch mesh was used to sample benthic fishes of the navigation channel and adjacent areas. Trawls were dragged along the river bottom at 2-5 miles per hour for 10-20 minutes and then hauled in to collect the sample. Any occurrence of gravel in the sample was recorded. GPS coordinates were recorded at each transect and at the beginning and end of each trawl. These locations were incorporated as a layer in the GIS.

The GIS maps were utilized to examine each of the potential gravel sites individually for features that influence substrate composition. These features included channel morphology, channel width, channel depth, scour, adjacent bars, dike fields and size of tributaries. The potential proportion of gravel substrate at each site was estimated as a percent of the stream width. Multiplying the potential proportion of gravel for each site by the site area and summing the resulting acreages approximated total possible amount of gravel along the project length. These estimates assumed simple rectangular site geometry and a normal hydraulic regime with a predictable effect on substrate for each "feature." There was insufficient information to make assumptions about substrate particle size or to differentiate between mixed substrates and "pure gravel." Therefore, these estimates implied that a "gravel substrate" included any substrate containing any amount of gravel of any size.

Little Rock District provided the proposed locations of project dredging in the navigation channel as geo-referenced polygons. The acreage of each of these polygons was calculated by GIS query. Portions of the dredging polygons that fell outside the site range were estimated and the area subtracted from the area of the polygon. These estimates were performed by measuring the total length of the polygon in tenths of miles, then measuring the length of the polygon outside the site range in tenths of miles and dividing the latter by the former to calculate a rough percentage. To estimate area outside the site range, this percentage was multiplied by the total area of the polygon. The resulting area was subtracted from the total area of the polygon to estimate the acres within the site range that could be affected by dredging. For the purpose of simplicity, these estimates assumed that the dredging polygons were rectangular in shape.

In order to verify the quantity of impacted gravel substrate, the potential locations of gravel bars that could be impacted from channel deepening were provided to a hydrographic survey crew with Memphis District. The survey crew visited each potential site to map gravel substrates. A sounding chain was used to identify predominate substrates classified as sand,

sand/gravel mix, and pure gravel. The survey boat established longitudinal transects within the polygon that delineated the dredge cut, and while slowly moving downstream and dragging the chain, each substrate type was mapped and digitally recorded. Maps were transferred to GIS and the actual acres by pool of sand/gravel mix and pure gravel were determined.

Dike Fields and Potential Mitigation Sites

On November 16, 2004, the Little Rock and Tulsa Districts met with biologists from the Engineer Research and Development Center (ERDC), Arkansas Game and Fish Commission (AGFC), Oklahoma Department of Wildlife Conservation (ODWC) and US Fish and Wildlife Service (FWS) at the Corps of Engineers Russellville, AR Project Office to discuss dredge disposal impacts to aquatic habitat in the Arkansas River and compile a list of potential mitigation projects. Aquatic impacts for the Arkansas River Navigation Project were measured in the dike fields and backwater areas using the Habitat Evaluation Procedure (HEP). Red Hen flight video, as well as local knowledge of depth and utilization by fishes, was used to visually assess the habitat value, or existing Habitat Suitability Index (HSI), of each site. AGFC, ODWC and FWS representatives provided valuable local knowledge and suggestions for mitigation. In order to quantify potential benefits from mitigation actions, the participating agencies also provided HSI values for mitigation projects annualized over the project life. These values were based on best professional judgment and experience with similar projects. Acreages for the sites were digitized and provided by the Districts. The result of this inter-agency collaboration was a detailed database containing both qualitative and quantitative information on 180 disposal/mitigation sites in the Arkansas portion and 37 sites in Oklahoma.

Results and Discussion

Fish and Aquatic Habitat

<u>Species composition</u> - Fish collections from the study area indicate a community that is moderately species-rich (65 species) and representative of most major groups (15 families) within the drainage (Table 2). Collections were taxonomically dominated by minnows (17 spp.), sunfishes (12 spp.), and suckers (8 spp.). Gars, herring, catfishes, topminnows, temperate basses, and darters were represented by only a few (3-5) species, but most of these taxa are oligotypic globally or within the drainage (Robison and Buchanan 1988). Bowfin, mooneye, livebearers, silversides, darters, drum, and mullet were each represented by a single species, although all of these taxa are oligotypic or monotypic. The Arkansas River is inhabited by a high percentage of non-native species, five of which were collected in this study: common carp, grass carp, fathead minnow, inland silverside, and striped bass (Cross et al. 1986)

Nine species comprised almost 80% of all fishes collected (Table2). Threadfin shad (35.5%) were the most abundant species and dominated catches made by seining, electrofishing, and trawling. Gizzard shad were also abundant (7.5 %), but only in collections made by electrofishing. Inland silverside (9.5%) were abundant, but only in seine samples. Red and blacktail shiners, bullhead minnow, and bluegill and longear sunfishes (3-7%) were commonly caught by seining and electrofishing. Blue and channel catfishes were also commonly caught (4%), but only in large numbers when trawling. Twenty species were rare, represented by fewer than 5 specimens (0.03% of total catch).

There are 117 fish species native to the lower Arkansas Drainage (Cross et al., 1986) and previous surveys of the study area (Buchanan 1976) suggest a more speciose fauna for the river (106 spp.). Those data indicate greater diversity for nearly all major groups of fishes including minnows (46 spp.), sunfishes (17 spp.), suckers (17 spp.), catfishes (15 spp.), and darters (24 spp.). The previous surveys, however, were conducted over a greater period of time (7-month period in 1976 versus a 2-month period in 2004), consisted of a greater number of collections (75 seine samples in 1976 vs 33 seine samples in 2004), used disparate techniques (rotenone in 1976, trawling in 2004), and included habitats outside the current project area (clear tributaries). Most of the 45 species reported in 1976 but not collected in 2004 were rare (represented by 5 or fewer specimens). Failure to obtain these was at least partly attributable to their natural rarity in the system and the numerical domination of Arkansas River assemblages by a few species.

Several patterns in fish abundance and distribution were similar in 1976 and 2004. In both surveys, gizzard and threadfin shad were the most abundant species, and inland silversides were common or abundant. Red shiners were the most abundant minnow. River shiner were common upstream from Little Rock, and Mississippi silvery minnow and blacktail shiner downstream from Little Rock. Wetland species, like lake chubsucker, redspotted sunfish, and bantam sunfish were collected only from Merrisach Lake. One important difference between the two surveys is the apparent disappearance of brook silverside – common in 1976 and absent from 2004 surveys. This may be attributable to changes in habitat, but is more likely the result of competitive displacement by the inland silverside, a phenomenon observed previously in impounded rivers (McComas and Drenner 1982).

<u>Fish-Habitat Relationships</u> - Unlike seining and trawling, which could only be done in certain conditions, electrofishing was possible in a wide range of conditions, making it possible to compare fish diversity in a variety of habitats (Table 3). Number of documented species was high ($\geq$ 30 spp.) in dike fields, armored banks, sand bars, and wooded banks; it was moderate (20-26 spp.) in impoundments, aquatic vegetation, and rock outcroppings, and low (< 10 spp.) in other habitats. Sampling effort (number of samples taken to obtain number of individuals) was variable, however, making it impossible to compare number of observed species in an ecologically meaningful manner. To compensate for differences in effort, and to address variation in species-abundance relationships, we used rarefaction (Ludwig and Reynolds 1988; Holland 2003) to estimate the number of species expected for a sample size of 25 randomly drawn individuals from any single habitat. Based on rarefaction, the more diverse or species-rich communities are found on sand bars and in dike fields ($\geq$ 11 spp/25 individuals), and around impoundments, rock outcroppings, wooded or armored banks (approx 10 spp./25 individuals). Species richness is appreciably lower in other habitats (5-7 spp./25 individuals). We believe that

species richness on gravel bars is probably underestimated due to the low number of samples and difficulty of sampling that kind of habitat with a boat-mounted electrofishing setup.

To identify the direction of project impacts on fish communities, we performed a multiple regression analysis. Fish species were classified as: 1) pool-dwelling or backwater species; 2) gravel-associated or channel species; 3) ubiquitous, habitat generalists (excluded from subsequent analysis). Total numbers of fish collected at each site, within each of the two specialist groups, or "guilds," were used as dependent or response variables. Water depth and amount of gravel, which will decrease over the life of the project, were used as independent or predictor variables. Analysis of seining data provided the following statistically significant model for gravel associated species:

$$\text{Number of fish} = 1.27 + 2.72[\text{Pool depth}] + 0.53[\text{Sand and Gravel Acreage}]$$

($N = 31$, $r^2 = 0.19$, $p = 0.055$). Model illustrates a significant positive relationship between fish abundance and the depth of dike pools and the amount of gravel and sand-and-gravel mixture available. It implies that reducing water depth in a dike field and reducing the amount of gravel in the channel will significantly impact those fishes. Analysis of electroshocking data for pool-dwelling fishes did not provide a significant model. This is probably attributable to the prevalence of pool like habitat throughout the system, and insufficient variation in physical habitat for identification of predictive relationships.

Gravel Bars

Gravel bars support a diverse array of fishes, many of which are obligate riverine species and sensitive to habitat degradation and are protected by state and federal regulations. Compared to pools, riffle-oriented fish often have specific requirements for stable, course substrates and low to moderate velocities and many preferentially utilize gravel bars for spawning and foraging. These include sturgeon, paddlefish, suckers, benthic minnows, madtoms, and darters. Resource agencies recognized that impacts to gravel bars needed to be quantified and mitigated if necessary.

Pursuant with the concern about gravel bars, the gravel survey for this project was conducted during the summer of 2005. A total of 28 potential gravel sites were initially identified in the project area ranging from river miles 6.5 - 421.0. The preliminary estimate of total available acres of gravel along the project length was 6,984 acres. However, 96.5 miles of gravel bars, or 23% of the project length, were identified as potential sites that could be impacted by dredging. Estimated total acres of gravel that could be impacted from dredging activities within these 96.5 miles were 967 acres, or 13.8% of the available gravel. These locations, encompassing the 96.5 miles, were provided to the survey boat, and over a 3-week period, the aerial extent and composition of the substrates were measured. These surveys subsequently identified 620 acres of sand/gravel mix, and 165 acres of pure gravel (Table 4).

The survey indicated that sand and sand/gravel mix are relatively ubiquitous throughout the project area. However, pure gravel is a finite resource, and any impacts from dredging will be a primary concern because of the inherent habitat value of gravel bars in riverine systems. Conservation of imperiled species and the overall loss of gravel substrates from anthropogenic disturbances fully justify creation or relocation of gravel bars as a mitigation technique. Studies have reported that created gravel bars are a successful management technique and can provide spawning and rearing habitat for a variety of fishes (Bell 1986; Edwards et al. 1984).

An environmentally conservative assumption is to mitigate gravel bars at a 1:1 ratio, which for this project would be 165 acres. Although gravel bars may not be utilized by all species, those fishes that are found on gravel substrates represent a guild of rare, protected, or commercially important species. Therefore, the goal of the mitigation is to have no-net loss of pure gravel bars either by relocating gravel that is dredged to a nearby, suitable area or transporting dredged gravel to other sites within the project area.

Based on field assessments of gravel bars in the lower Mississippi River basin, environmental guidelines of gravel bar creation are suggested. Design criteria include placement of gravel in relatively high velocity areas to prevent sedimentation such as below dike notches and the tip of dikes. To be functionally equivalent to natural bars, gravel should be of varying sizes (1/8 to 1 inch in diameter). Depth of gravel should be a minimum of 6-12 inches. Preferably, larger grade gravel should be placed first, followed by smaller grade gravel to ensure compactness and reduce loss during placement. Larger boulders and cobble can be initially scattered throughout the restoration site to enhance compactness, minimize loss of smaller gravel, and increase topographic variation of the substrate. Larger stones also collect organic debris that is utilized by madtoms, darters, and other benthic fishes. Variation in gravel size will provide stable substrates for permanent residents that burrow or hide in fine gravel (e.g., darters, macroinvertebrates), species that spawn over a range of gravel sizes (e.g., paddlefish and sturgeon), and fishes that utilize larger gravel for velocity refugia and feeding areas within interstitial spaces.

Impacts and Mitigation Related to Dike Fields

Impacts were directly associated with disposal of dredged material in dike fields. As dike fields become shallower over time, the habitat value to fishes declines. The rate of decline is related to the sediment filling rates associated with dredge disposal and ambient sedimentation rates. Little Rock District engineers met with ERDC on January 6, 2005 and again on April 13, 2005 to discuss dike-filling rates and alternative disposal sites. Limited information was available for dike filling, and realistic numbers are difficult to determine for dynamic and unpredictable processes. Filling occurs based on the specific geomorphology, sediment composition, and flow regime of a particular site. The Arkansas River differs morphologically upstream to downstream within the project area. Therefore, dike filling rates were estimated by Little Rock District for each project alternative and site use (disposal or non-disposal) for Pools 2 through 18 (Table 5). The fill rate (percent per year) was used to estimate percent full at year 50, the life of the project. This value provided a proportion by which the HSI value could be reduced over the life of the project (with 100% full yielding HSI=0). Figures 1.1, 1.2 and 1.3 illustrate the differences among Navigation Pools 2, 3 and 4. In order to obtain average annual habitat units (AAHU), percent full at time (proportional to HSI) was calculated by multiplying the filling rate during the first 10 years by (10) and using the remaining life of the dike field as the point at which it is 100% full (Figure 2). This two-part linear model is used to annualize the HSI value by: (1) multiplying the average (midpoint) for each linear portion by the beginning HSI value for that part and subtracting the result from the beginning value (i.e. reducing the HSI value by the appropriate amount for that part); and (2) multiplying the results by the number of years for that part, adding and dividing by 50 (time-weighted average) (Figure 3).

<u>Assumptions</u> - Calculation of annualized impacts followed several assumptions. The first was that a dike pool being filled with dredge disposal would gradually become shallower and lose habitat value even though surface acreage may not change appreciably. The rate of change was assumed to follow a two-part linear function (rapid accumulation during the first 10 years and normal accumulation thereafter) to conservatively simplify the naturally dynamic process of sediment accretion behind a dike. Since filling may not affect surface acreage directly, the reduction factor was applied to the HSI value in order to compute impacts to habitat units. The current McClellan Kerr Arkansas River Navigation System (MKARNS) requires maintenance dredging to maintain a 9-foot navigation channel. Since this maintenance activity would likely continue without the proposed deepening, the filling rate for the 9-foot channel was used to calculate “without project” AAHU. The “without project” values, therefore, reflect the continually changing condition of the system rather than a static, “snapshot” of existing conditions typically used in Habitat Evaluation Procedures and referred to as “baseline.”

Dike-notching was proposed as a means of minimizing the impacts from this navigation project. Notches in dikes are assumed to cause scour and increase habitat complexity in dike pools. Scour and bathymetric variation add value to aquatic habitat by providing an assortment of microhabitats for different species to exploit. Therefore, it is assumed that the HSI value of the area behind a notched dike will decline 50% less than that of an un-notched dike. Areas with un-notched dikes and other mitigation measures are assumed to fill at the previously specified rates (Table 5). A conceptual model is given in Figure 4 to explain how impacts were calculated under each set of circumstances.

Mitigation projects were proposed to compensate for the potential loss in habitat units from deepening the navigation channel. These measures were organized into three categories: avoid, minimize and compensate. “Avoid” projects entailed avoiding disposal of dredge spoil in an area of high habitat value and moving it to an area of lesser value. In this case, the original location maintains its value and the new disposal area contributes to the overall loss of habitat units. As previously mentioned, notching a dike is assumed to minimize impacts to the dike pool habitat. Proposed dike notches and revetment notches were therefore classified as “minimize” projects and benefits were derived in the form of “reduced impacts.” The third category was composed of true compensation measures such as restoring access to backwaters and construction of specific types of habitats. These projects result in actual benefits in that “new” acres may be added at a higher value, increasing habitat units. A conceptual model is given in Figure 5 to explain how benefits were calculated under each set of circumstances.

Impacts and benefits for each project alternative are given by navigation pool and state in Table 6. Pool 2 (navigation mile 19-50) contained the most proposed dredge disposal areas, but due to higher filling rates, Pools 12 (NM 257-292) and 10 had the greatest aquatic impacts for the 11-ft (-66.1 AAHU) and 12-ft (-112.6 AAHU) alternatives, respectively. Pool 2 also provided for the most benefits of any one pool with 135.3 AAHU gained with the mitigated 11-ft project alternative and 104.3 AAHU gained for the 12-ft alternative. Pool 14 (NM 319-336) and the Post Canal (NM 19 to White River) contained only proposed mitigation and did not contribute to the overall project impacts. For the entire project (Arkansas and Oklahoma combined), the 11-foot channel alternative would result in a loss of 391 average annual habitat units (AAHU) (Table 6). However, mitigation for the 11-foot alternative would result in a gain of 494 AAHU. Impacts from the 12-foot project would result in a loss of 664 AAHU while approved mitigation projects yielded 108 AAHU.

Additional impacts for the Verdigris River were identified. The Verdigris River was straightened and channelized to provide a reliable navigation channel. The channel was shortened from cutoffs, high spoil banks were created on both sides for 50 miles, and the floodplain and associated backwaters became isolated from the river. Isolation of backwaters prevents transfer of organic matter and nutrients between river and floodplain and reduces important spawning and rearing areas for fishes. The navigation channel is 150-ft wide in the Verdigris River compared to a 250-ft channel in the Arkansas River. Therefore, impacts of navigation-related activities have been proportionally greater in the narrow, incised channel of the Verdigris River compared to the wider channel in the Arkansas River. To quantify this impact, the number of acres associated with the navigation channel in Verdigris river pools (i.e., 909.1 acres) was multiplied by an HSI of 0.1, indicating low habitat quality for existing conditions, to obtain impacts of 90.9AAHU for both alternatives. These additional impacts when compared to the mitigation resulted in a net gain of 403 and 17 AAHU for the 11- and 12-foot alternatives, respectively.

Monitoring

The U. S. Fish and Wildlife Service has promoted a long term monitoring program to address the uncertainties in predicting impacts and success of proposed mitigation projects. A monitoring program has been outlined that includes both biological and engineering studies (included as Appendix in EIS). These studies address sediment dynamics in dike fields and backwaters, developing a better understanding of biological responses of fish and other aquatic organisms to dike modifications such as notching, field surveys of gravel bar characteristics and fish utilization, and potential of headcutting and associated impacts to fish in tributaries. A more detailed monitoring program will be developed in cooperation with state and federal agencies to address these topics.

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Table 1. Fish Sampling Sites for the Arkansas River Navigation Project, 2004

Site #	Location (pool)	Station	Mile	Seine	Shock	Trawl
1	Chouteau	Below Newt Graham L&D 18	420.8	√	√	√
2	Chouteau	Channel near Afton Landing	411.0			√
2.5	Chouteau - bw	Afton Landing backwater	BW	√	√	
3	Chouteau	Above Chouteau L&D 17	402			√
4	Chouteau - bw	Backwater at RM 403.2	BW	√		
5	Pool 16	Below Chouteau L&D 17	401.2		√	√
6	Pool 16 - bw	Falls Park Backwater at RM 398	BW		√	
7	Pool 16	Confluence of AR and Verdigris R.	394.5	√	√	√
7.5	Pool 16 - bw	Sandbar Pool at Confluence	394.5	√		
8	Pool 16	Channel at Coody Creek mouth	389.5	√	√	√
8.5	Pool 16 - bw	Backwater at 389.5 (inside sandbar)	BW	√		
9	Pool 16 - trib	Mouth of Coody Creek	389.5		√	
10	Pool 16 - trib	Mouth of Maynard Bayou	387		√	
11	Neosho	Neosho (Grand) River 4 mi. upst. of AR R.	--			√
12	Pool 13	Island above Trimble L&D 13	293.3	√	√	√
13	Pool 13	Right bank upst. of Trimble L&D 13	293.3	√	√	
14	Ozark	Below Trimble L&D 13	289.5	√	√	√
15	Ozark	Channel at mouth of Mulberry River	272	√	√	√
15.5	Ozark	Channel upst. of Mulberry River mouth	277			√
16	Ozark - trib	Lower mouth of Mulberry River	272		√	√
17	Dardanelle	Below Ozark-Jeta L&D 12	256.5	√	√	√
18	Dardanelle	Rock weir at Rogers Cabin	231.5		√	√
19	Dardanelle	Across from Spadra Park	229.8	√	√	√
20	Dardanelle	Mouth of Cabin Creek at ramp nr. old RR bridge	--		√	
21	Pool 9	Below Dardanelle L&D 10	205	√	√	√
22	Pool 7	Below Toad Suck L&D 8 – pool	155.3	√	√	
22.5	Pool 7	Below Toad Suck L&D 8 – channel	155.3	√	√	√
23	Pool 7	Mouth of Fouche La Fave	146.8	√	√	
24	Pool 7	AR @ Fouche La Fave mouth – rt. bank	146.8	√		√
24.5	Pool 7	AR @ Fouche La Fave mouth – lft. bank	146.8	√		
25	Pool 7	2^o Channel at Beaver Dam Island	141.5	√	√	√
26	Terry Lake	Below Murray L&D 7 – main channel	124.3	√	√	√
26.5	Terry Lake	Below Murray L&D 7 – side channel	124.3	√		
27	Terry Lake	AR @ downtown Little Rock	120	√	√	
28	Terry Lake - bw	Willow Bend Cutoff nr. Terry L&D 6	108.4		√	
29	Terry Lake	Above David D. Terry L&D 6	109.8	√	√	√
30	Pool 5	Below David D. Terry L&D 6	107.6	√	√	√
31	Pool 2	Below Joe Hardin L&D 3	49.6	√	√	√
32	Pool 2	AR @ Mud Lake entrance	44.6	√		√
32.5	Pool 2 - bw	Inside Mud Lake entrance	44.4	√	√	
33	Pool 2	Upst. of mouth of Big Bayou Meto	31.7	√	√	√
34	Pool 2 - bw	AR @ mouth of Big Bayou Meto	31.2	√	√	
35	Pool 2	Post Canal at Merrisach Lake	14.4	√	√	
36	Pool 2	Above L&D 2	13.4		√	√
37	Wild AR R.	1 mile dnst. of Wilbur D. Mills Dam – channel	--	√	√	√
37.5	Wild AR R.	1 mile dnst. of Wilbur D. Mills Dam – bw	--	√		
38	Wild AR R.	Below Wilbur D. Mills Dam	--		√	

Table 2. Number of individual fish collected by species and gear type in the Arkansas River below Newt Graham Lock & Dam in 2004. Gear types were 20-foot seine (n=33), electroshock boat (n=35), and 16-foot otter trawl (n=27).

Scientific name	Common name	Seine	Shock	Trawl	All Gear
Family Lepisosteidae					
Lepisosteus oculatus	Spotted gar		16	3	19
L. osseus	Longnose gar	3	4		7
L. platostomus	Shortnose gar		9		9
Lepisosteus spp.	YOY Gar	1			1
Family Amiidae					
Amia calva	Bowfin		1		1
Family Clupeidae					
Alosa chrysochloris	Skipjack herring	6	2	2	10
Dorosoma cepedianum	Gizzard shad	104	1131	59	1294
D. petenense	Threadfin shad	4630	1107	423	6160
Family Hiodontidae					
Hiodon tergisus[1]	Mooneye			1	1
Family Cyprinidae					
Ctenopharyngodon idella	Grass carp		2		2
Cyprinella lutrensis	Red shiner	1123	71		1194
C. venusta	Blacktail shiner	665	99		764
C. whipplei	Steelcolor shiner		1		1
Cyprinus carpio	Common carp	16	21		37
Hybognathus nuchalis	Mississippi silvery minnow	40	7		47
Extrarius aestivalis	Speckled chub	443		3	446
Macrhybopsis storeriana	Silver chub	7		1	8
Notemigonus crysoleucas	Golden shiner	3	1		4
Notropis atherinoides	Emerald shiner	198	60		258
N. blennius	River shiner	509	6	1	516
N. buchanani	Ghost shiner	33			33
N. volucellus[1]	Mimic shiner	1		1	2
Opsopoedus emiliae	Pugnose minnow		4		4
Pimephales notatus	Bluntnose minnow	1			1
P. promelas	Fathead minnow	1			1
P. vigilax	Bullhead minnow	583	51		634
Family Catostomidae					
Carpiodes carpio	River carpsucker	8	138	3	149
C. cyprinus	Quillback carpsucker		5		5
C. velifer	Highfin carpsucker		1		1
Carpiodes spp.	YOY Carpsucker	20			20
Erimyzon sucetta	Lake chubsucker	2			2
Ictiobus bubalus	Smallmouth buffalo		70	4	74
I. cyprinellus	Bigmouth buffalo		10		10
I. niger	Black buffalo		2		2
M. macrolepidotum	Shorthead redhorse		2		2
Family Ictaluridae					
Ameiurus natalis	Yellow bullhead	1			1
Ictalurus furcatus	Blue catfish	30	60	583	673
I. punctatus	Channel catfish	78	38	554	670

(continued)

Table 2. Number of individual fish collected by species and gear type in the Arkansas River below Newt Graham Lock & Dam in 2004. Gear types were 20-foot seine (n=33), electroshock boat (n=35), and 16-foot otter trawl (n=27).

Scientific name	Common name	Seine	Shock	Trawl	All Gear
Noturus nocturnus	Freckled madtom			1	1
Pylodictis olivaris	Flathead catfish		26	2	28
Family Cyprinodonitdae					
Fundulus chrysotus	Golden topminnow	12	1		13
F. notatus	Blackstripe topminnow	2			2
F. olivaceus	Blackspotted topminnow	2			2
Family Poeciliidae					
Gambusia affinis	Mosquitofish	22			22
Family Atherinidae					
Menidia beryllina	Inland silverside	1561	82		1643
Family Moronidae					
Morone chrysops	White bass	28	137	9	174
M. mississippiensis	Yellow bass		25		25
M. saxatilis	Striped bass		38	14	52
Morone spp.	YOY temperate bass	2			2
Family Centrarchidae					
Lepomis cyanellus	Green sunfish	2	39		41
L. cyanellusXspp.	Hybrid green sunfish	1	1		2
L. gulosus	Warmouth	2	20		22
L. humilis	Orangespotted sunfish	4	19		23
L. macrochirus	Bluegill	159	431	8	598
L. megalotis	Longear sunfish	327	415	2	744
L. microlophus	Redear sunfish	16	46		62
L. microlophusXspp.	Hybrid redear sunfish	1	2		3
L. miniatus	Red spotted sunfish	14	10		24
L. symmetricus	Bantam sunfish	4			4
Micropterus punctulatus	Spotted bass	29	35		64
M. salmoides	Largemouth bass	88	212		301
Pomoxis annularis	White crappie	1	34	7	42
P. nigromaculatus	Black crappie	1	7	29	37
Family Percidae					
Percina caprodes	Logperch	6	10		16
P. shumardi	River darter	13			13
Stizostedion canadense	Sauger	1	2	2	5
Family Sciaenidae					
Aplodinotus grunniens	Freshwater drum	33	176	89	298
Family Mugilidae					
Mugil cephalus	Striped mullet		2		2
Total number of species		47	50	23	65
Total number of individuals		10837	4689	1801	17328

[1] *Collected only below Wilbur D. Mills Dam*

Table 3. Number of individual fish collected by species and habitat in the Arkansas River below Newt Graham Lock & Dam in 2004. Gear type for this analysis was electroshock boat (n=35).

Scientific name	Common name	Armored Bank	Bank Without Cover	Open Channel	Dike Field	Eroding Bank	Gravel Bar	Rock Outcrop	Sand Bar	Dam or Weir	Aquatic Vegetation	Wooded Bank
Family Lepisosteidae												
Lepisosteus oculatus	Spotted gar	1	1		2			2		1	4	5
L. osseus	Longnose gar	2			2							
L. platostomus	Shortnose gar	2			3				1	3		
Lepisosteus spp.	YOY Gar											
	TOTAL	5	1	0	7	0	0	2	1	4	4	5
Family Amiidae												
Amia calva	Bowfin	1										
	TOTAL	1	0	0	0	0	0	0	0	0	0	0
Family Clupeidae												
Alosa chrysochloris	Skipjack herring	1					1					
Dorosoma cepedianum	Gizzard shad	160	27	3	326	5	32	33	77	65	182	221
D. petenense	Threadfin shad	131	3	2	29		8	23	30	74	644	163
	TOTAL	292	30	5	355	5	41	56	107	139	826	384
Family Hiodontidae												
Hiodon tergisus[1]	Mooneye											
	TOTAL	0	0	0	0	0	0	0	0	0	0	0
Family Cyprinidae												
Ctenopharyngodon idella	Grass carp				1				1			
Cyprinella lutrensis	Red shiner	1			6			1	36		10	17
C. venusta	Blacktail shiner	2	3		73			4	7	4	1	5
C. whipplei	Steelcolor shiner									1		
Cyprinus carpio	Common carp	5			2				3	1	1	9
Hybognathus nuchalis	Mississippi silvery minnow									7		
Extrarius aestivalis	Speckled chub											
Macrhybopsis storeriana	Silver chub											
Notemigonus crysoleucas	Golden shiner				1							
Notropis atherinoides	Emerald shiner	1			4				1	48		6
N. blennius	River shiner				4				1		1	
N. buchanani	Ghost shiner											

Table 3. Number of individual fish collected by species and habitat in the Arkansas River below Newt Graham Lock & Dam in 2004. Gear type for this analysis was electroshock boat (n=35).

Scientific name	Common name	Armored Bank	Bank Without Cover	Open Channel	Dike Field	Eroding Bank	Gravel Bar	Rock Outcrop	Sand Bar	Dam or Weir	Aquatic Vegetation	Wooded Bank
N. volucellus[1]	Mimic shiner											
Opsopoedus emiliae	Pugnose minnow									2	2	
Pimephales notatus	Bluntnose minnow											
P. promelas	Fathead minnow											
P. vigilax	Bullhead minnow	1	2		2	1		1	16		2	26
	TOTAL	10	5	0	93	1	0	6	65	63	17	63
Family Catostomidae												
Carpiodes carpio	River carpsucker	12			33		2	3	21		6	61
C. cyprinus	Quillback carpsucker	2			2		1					
C. velifer	Highfin carpsucker						1					
Carpiodes spp.	YOY Carpsucker											
Erimyzon sucetta	Lake chubsucker											
Ictiobus bubalus	Smallmouth buffalo	10			10	4		2	6		2	36
I. cyprinellus	Bigmouth buffalo	1			3	1			4		1	
I. niger	Black buffalo				2							
M. macrolepidotum	Shorthead redhorse						1		1			
	TOTAL	25	0	0	50	5	5	5	32	0	9	97
Family Ictaluridae												
Ameiurus natalis	Yellow bullhead											
Ictalurus furcatus	Blue catfish	7		1	33			4	3	8		4
I. punctatus	Channel catfish	3			7	6		3	9	3		7
Noturus nocturnus	Freckled madtom											
Pylodictis olivaris	Flathead catfish	3		1	14			3	1	3		1
	TOTAL	13	0	2	54	6	0	10	13	14	0	12
Family Fundulidae												
Fundulus chrysotus	Golden topminnow	1										
F. notatus	Blackstripe topminnow											
F. olivaceus	Blackspotted topminnow											
	TOTAL	1	0	0	0	0	0	0	0	0	0	0
Family Poeciliidae												
Gambusia affinis	Mosquitofish											
	TOTAL	0	0	0	0	0	0	0	0	0	0	0

Table 3. Number of individual fish collected by species and habitat in the Arkansas River below Newt Graham Lock & Dam in 2004. Gear type for this analysis was electroshock boat (n=35).

Scientific name	Common name	Armored Bank	Bank Without Cover	Open Channel	Dike Field	Eroding Bank	Gravel Bar	Rock Outcrop	Sand Bar	Dam or Weir	Aquatic Vegetation	Wooded Bank
Family Atherinidae												
Menidia beryllina	Inland silverside	18			12			1	4	20	20	7
	TOTAL	18	0	0	12	0	0	1	4	20	20	7
Family Moronidae												
Morone chrysops	White bass	7			58		31		13	16	3	9
M. mississippiensis	Yellow bass				17		1		2	2	1	2
M. saxatilis	Striped bass	1			2		32		2			1
Morone spp.	YOY temperate bass											
	TOTAL	8	0	0	77	0	64	0	17	18	4	12
Family Centrarchidae												
Lepomis cyanellus	Green sunfish	15			13			4	1	3	1	2
L. cyanellusXspp.	Hybrid green sunfish											1
L. gulosus	Warmouth	4			9							7
L. humilis	Orangespotted sunfish	1			3			5	4	2	1	3
L. macrochirus	Bluegill	39	2		87	13	1	17	41	13	68	150
L. megalotis	Longear sunfish	115	11		128	3		22	33	21	6	76
L. microlophus	Redear sunfish	4			12				8	4	14	4
L. microlophusXspp.	Hybrid redear sunfish				1							1
L. miniatus	Red spotted sunfish	6								4		
L. symmetricus	Bantam sunfish											
Micropterus punctulatus	Spotted bass	2			16		1	2	3	4	1	6
M. salmoides	Largemouth bass	40	3		73	2		3	12	14	34	31
Pomoxis annularis	White crappie	7			7		3	2		1		14
P. nigromaculatus	Black crappie				2							5
	TOTAL	233	16	0	351	18	5	55	102	66	125	300
Family Percidae												
Percina caprodes	Logperch	10										
P. shumardi	River darter											
Stizostedion canadense	Sauger								1			1
	TOTAL	10	0	0	0	0	0	0	1	0	0	1
Family Sciaenidae												
Aplodinotus grunniens	Freshwater drum	23	2		31	3	7	1	14	4	14	77

Table 3. Number of individual fish collected by species and habitat in the Arkansas River below Newt Graham Lock & Dam in 2004. Gear type for this analysis was electroshock boat (n=35).												
Scientific name	Common name	Armored Bank	Bank Without Cover	Open Channel	Dike Field	Eroding Bank	Gravel Bar	Rock Outcrop	Sand Bar	Dam or Weir	Aquatic Vegetation	Wooded Bank
	TOTAL	23	2	0	31	3	7	1	14	4	14	77
Family Mugilidae												
Mugil cephalus	Striped mullet	1			1							
	TOTAL	1	0	0	1	0	0	0	0	0	0	0
Total number of species		36	9	4	38	9	14	20	30	26	23	31
Total number of families		13	5	2	10	6	5	8	10	8	8	10
Total number of individuals		640	54	7	1031	38	122	136	356	328	1019	958
Sample number (N)		14	3	2	24	1	3	4	12	6	7	19
Total catch per effort		45.7	18	3.5	42.9	38	40.6	34	29.6	54.6	145.5	50.4
Expected number of species for 25 individuals		9.7	7.2	N/a	11.0	8.1	7.0	10.2	11.9	10.5	5.4	10.0

[1] *Collected only below Wilbur D. Mills Dam*

Table 4. Summary of location and amount (acres) of gravel substrate in project area.

Pool	River Mile	Gravel (acres)	Total per pool	Mix sand/gravel (acres)	Total per pool
Pool 5	108	1.6		7.47	
			1.6		7.47
Pool 7	140	0.11		4.94	
	146	3.42		36.45	
	150	17.44		36.88	
	150.5	20.43		1.4	
			41.4		79.67
Pool 9	186	23.36		144.25	
	205	27.8		6.77	
			51.16		151.02
Pool 10	229	0.61		54.15	
			0.61		54.15
Pool 15	361	36.7		154.15	
					154.15
Pool 16	374	1.23		55.81	
	393	0.83		41.06	
	395	3.54		32.93	
			5.6		129.8
Pool 17	402	7.24		32.14	
	421	20.69		11.82	
			27.93		43.96
Total		**165**		**620**	

Table 5. Filling rates by project alternative and site use for each navigation pool.

LOCATION	FILL RATE IN PERCENT AND REMAINING LIFE IN YEARS OF DIKE FIELDS											
	McClellan-Kerr Arkansas River Navigation System											
	EXISTING PROJECT AREAS		PLAN 12' PROJECT AREAS		PLAN 11' PROJECT AREAS		EXISTING DISPOSAL AREAS		PLAN 12' DISPOSAL AREAS		PLAN 11' DISPOSAL AREAS	
	FILL RATE %	LIFE YRS	FILL RATE %*	LIFE YRS	FILL RATE %*	LIFE YRS	FILL RATE %	LIFE YRS	FILL RATE %*	LIFE YRS	FILL RATE %*	LIFE YRS
POOL 18	1.107	90	1.661/1.107	85	1.661/1.107	85	N/A	N/A	N/A	N/A	N/A	N/A
POOL 17	1.107	90	1.661/1.107	85	1.661/1.107	85	N/A	N/A	N/A	N/A	N/A	N/A
POOL 16	1.107	90	1.661/1.107	85	1.661/1.107	85	2.927	34	5.661/3.774	21	4.705/3.136	27
POOL 15	1.786	56	2.679/1.786	51	2.679/1.786	51	2.927	34	5.661/3.774	21	4.705/3.136	27
POOL 14	1.230	81	1.846/1.230	76	1.846/1.230	76	N/A	N/A	N/A	N/A	N/A	N/A
POOL 13	1.667	60	2.500/1.667	55	2.500/1.667	55	N/A	N/A	N/A	N/A	N/A	N/A
POOL 12	1.884	53	2.827/1.884	48	2.827/1.884	48	2.927	34	5.661/3.774	21	4.705/3.136	27
POOL 10	1.088	92	1.632/1.088	87	1.632/1.088	87	1.555	64	3.412/2.275	39	2.545/1.697	54
POOL 09	1.064	94	1.596/1.064	89	1.596/1.064	89	1.518	66	3.163/2.109	42	2.462/1.642	56
POOL 08	1.883	53	2.824/1.883	48	2.824/1.883	48	2.314	43	3.661/2.441	36	3.262/2.326	41
POOL 07	1.716	58	2.574/1.716	53	2.574/1.716	53	2.494	40	4.033/2.689	32	3.607/2.661	37
POOL 06	1.667	60	1.667	60	1.667	60	NC	NC	NC	NC	NC	NC
POOL 05	1.454	69	2.181/1.454	64	2.181/1.454	64	1.717	58	3.647/2.431	36	3.067/2.049	44
POOL 04	1.753	57	2.630/1.753	52	2.630/1.753	52	3.720	27	5.862/3.908	21	5.143/3.750	24
POOL 03	1.148	87	1.722/1.148	82	1.722/1.148	82	1.877	53	3.450/2.300	38	2.934/1.956	46
POOL 02	1.547	65	2.320/1.547	60	2.320/1.547	60	2.108	47	3.307/2.205	40	3.066/2.131	44

- Fill Rate is assumed to directly correlate to the Historical Dredging amounts that averaged 60 percent of total in the first 10 years of the project and 40 percent of the total over the last 24 years for Pools 18 through Pool 7, 60 percent for first 12 yrs for Pool 5 and 60 percent for first 14 yrs for Pools 4 through 2 (Based on 34 years of Dredging Records 1971-2004).
- Pool 18 and 17 project areas are all backwater areas.
- N/A = All Dredge Disposal is Upland.
- NC = No Change as no structures or dredging required except at L&D 7 Lock Approach with disposal just outside of channel.
- *Fill Rate first 10 years/Fill Rate remaining life - Sediment Deposition Increased +50% for 10 years in Project Areas due to Modified Dike Fields

Table 6. Summary of impacts and benefits by state and pool.

All Projects									
	Total Existing HUs	Total HUs with 11-ft Project	HUs Effected by 11-ft Project	Total HUs with Mitigated 11-ft Project	Change in Mitigated 11-ft HUs Relative to Baseline	Total HUs with 12-ft Project	HUs Effected by 12-ft Project	Total HUs with Mitigated 12-ft Project	Change in Mitigated 12-ft HUs Relative to Baseline
Arkansas									
Canal	22.055	22.055	0.000	26.216	4.161	22.055	0.000	26.216	4.161
Pool 2	700.451	653.155	-47.296	836.278	135.827	636.911	-63.540	804.738	104.287
Pool 3	93.142	88.694	-4.447	109.752	16.610	83.238	-9.904	100.374	7.233
Pool 4	108.210	106.455	-1.755	170.057	61.847	105.577	-2.633	169.076	60.865
Pool 5	374.035	322.574	-51.460	391.655	17.620	288.563	-85.471	342.606	-31.428
Pool 6	55.475	55.475	0.000	87.145	31.670	55.475	0.000	87.145	31.670
Pool 7	395.266	337.768	-57.498	431.569	36.303	316.889	-78.376	384.729	-10.537
Pool 8	150.737	130.164	-20.573	161.383	10.647	122.092	-28.644	149.546	-1.190
Pool 9	536.465	494.445	-42.020	558.589	22.123	426.855	-109.610	472.054	-64.411
Pool 10	440.170	394.722	-45.448	526.481	86.311	327.552	-112.618	437.892	-2.278
Pool 12	425.334	359.241	-66.093	399.366	-25.967	318.531	-106.803	350.991	-74.342
Pool 13	24.497	24.497	0.000	38.550	14.054	24.497	0.000	38.550	14.054
Oklahoma									
Pool 13	11.665	11.583	-0.082	24.150	12.485	11.583	-0.082	24.150	12.485
Pool 14	90.845	90.845	0.000	131.529	40.684	90.845	0.000	131.529	40.684
Pool 15	32.269	18.095	-14.174	15.974	-16.295	15.022	-17.247	13.961	-18.308
Pool 16	134.501	117.023	-17.478	160.550	26.049	113.339	-21.162	155.747	21.247
SBC	46.494	23.729	-22.765	29.379	-17.115	18.794	-27.700	23.268	-23.226
Pool 17	127.581	127.581	0.000	164.873	37.292	127.581	0.000	164.873	37.292
Pool 18	11.283	11.283	0.000	11.283	0.000	11.283	0.000	11.283	0.000
Totals									
AR	3325.836	2989.245	-336.591	3737.041	411.205	2728.237	-597.599	3363.917	38.081
OK	454.637	400.139	-54.499	537.737	83.099	388.447	-66.190	524.812	70.174
TOTAL	3780.474	3389.384	-391.089	4274.778	494.304	3116.684	-663.790	3888.729	108.255

Figure 1.1 Effect of fill rates on habitat suitability index over life of project for each project alternative in Pool 2.

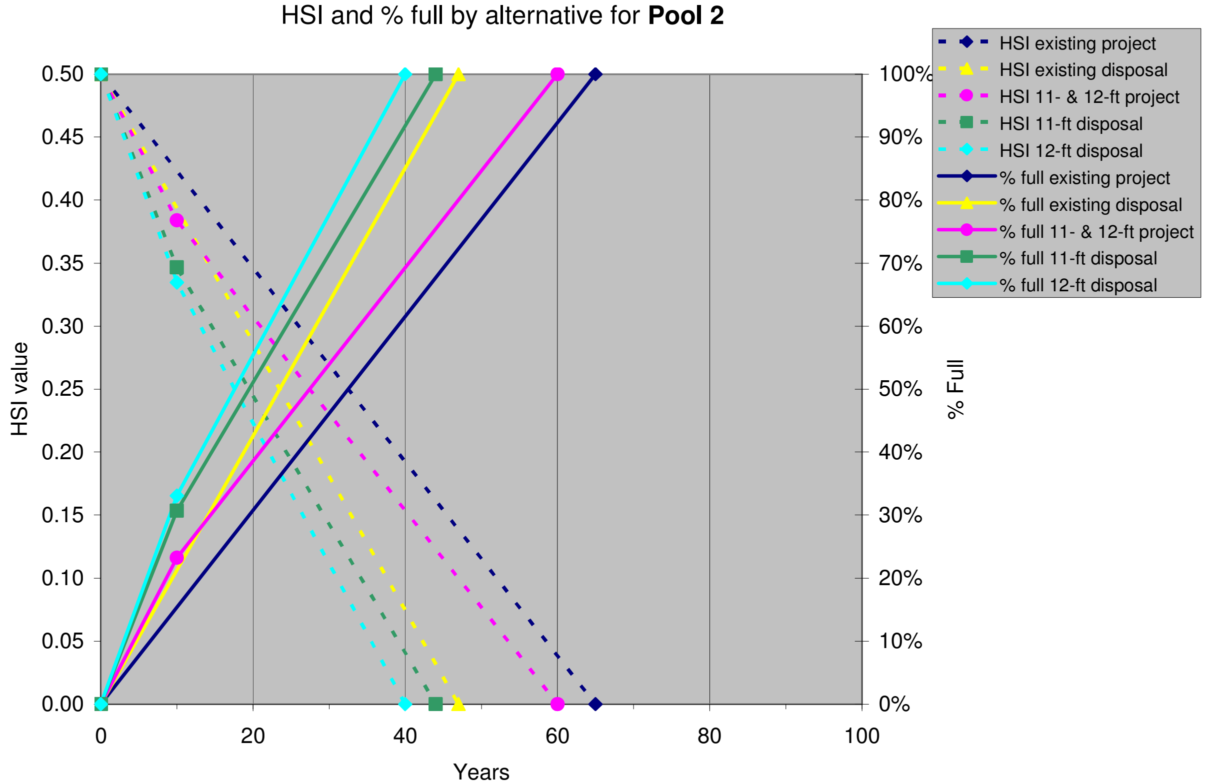


Figure 1.2 Effect of fill rates on habitat suitability index over life of project for each project alternative in Pool 3.

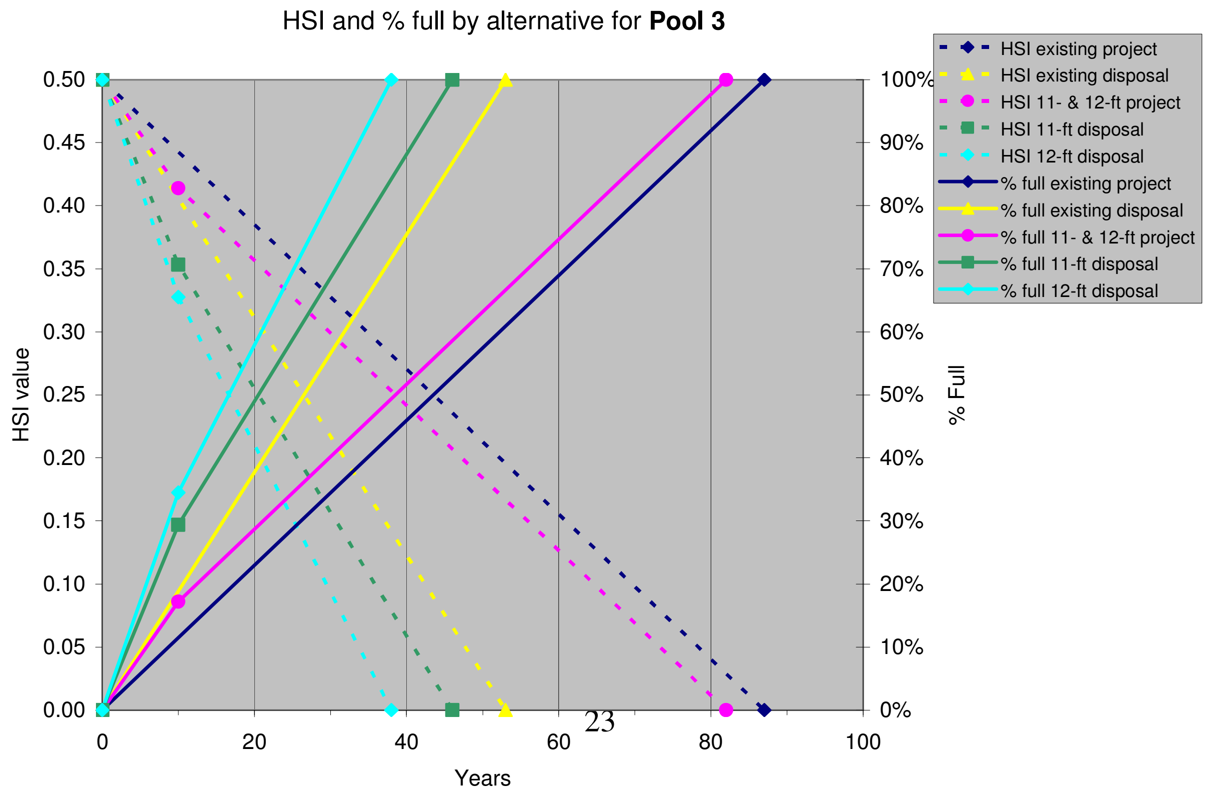


Figure 1.3 Effect of fill rates on habitat suitability index over life of project for each project alternative in Pool 4.

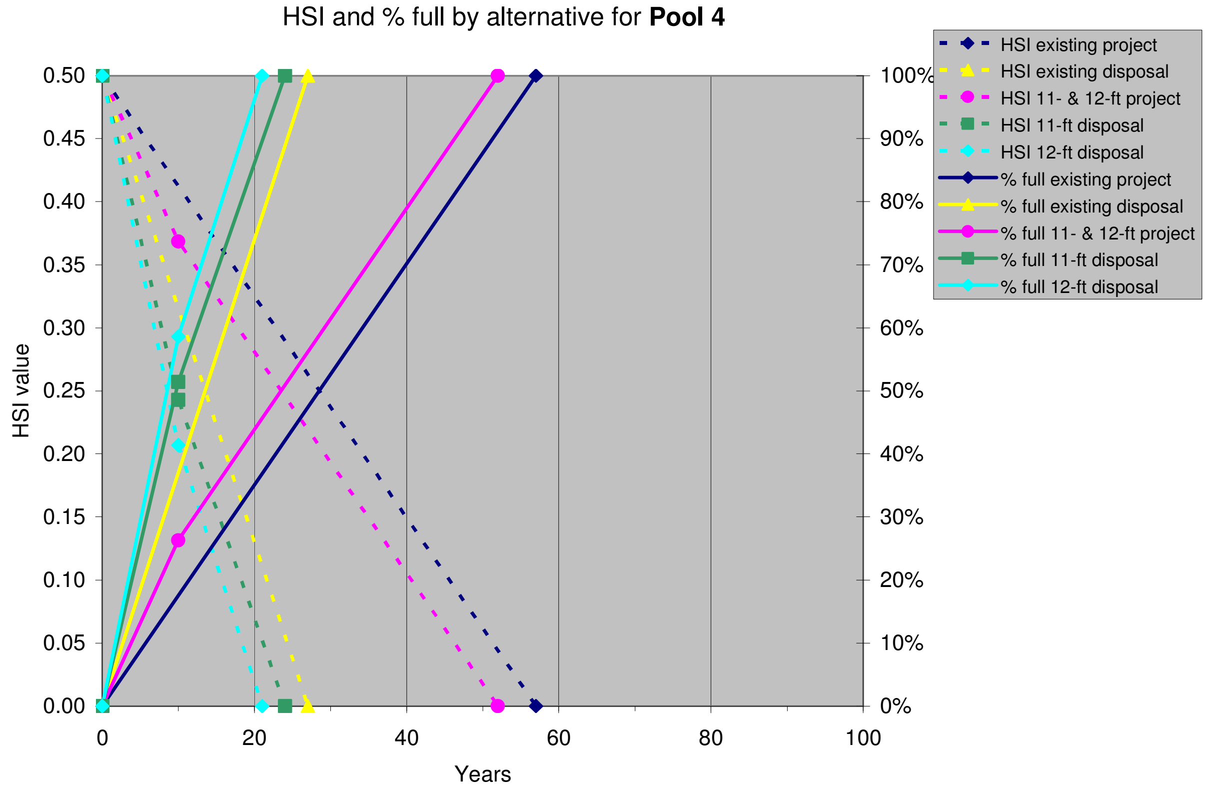


Figure 2. Effect of filling rate (illustrated as % full) on HSI value.

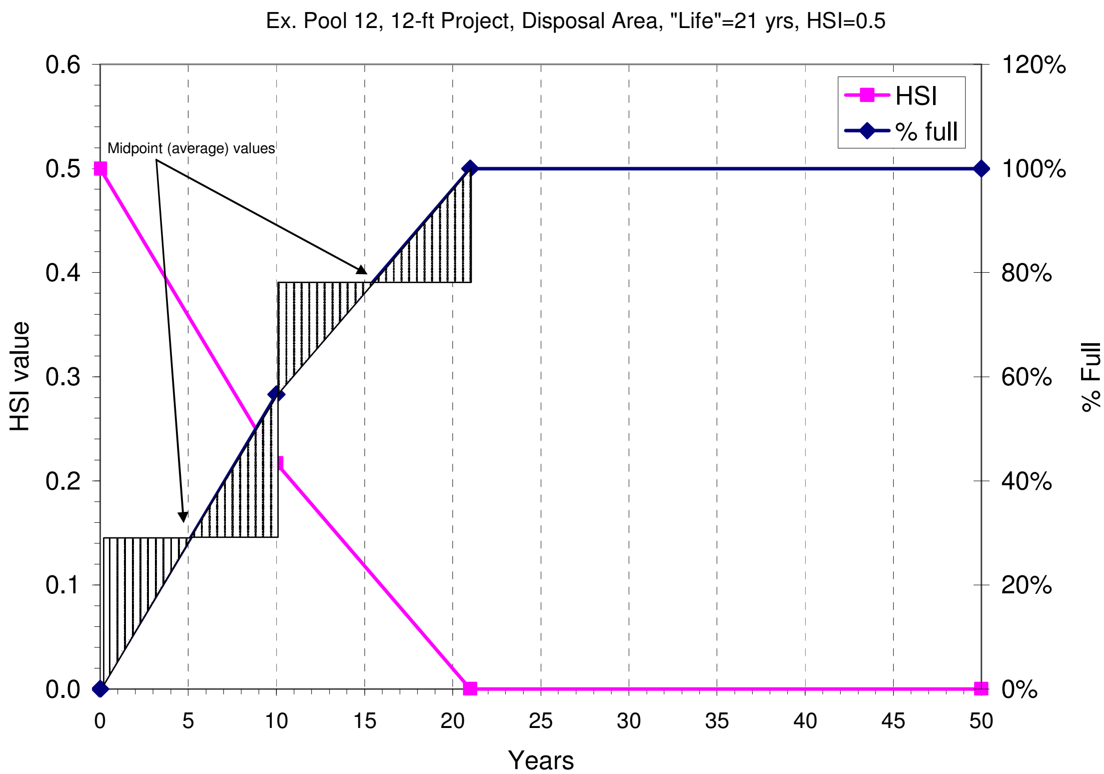


Figure 3. Average annualized HSI value calculation, in general.

$$=((HSI_{0}-(((FR_{0\text{-}10}/100*10)/2)*HSI_{0}))*10+((HSI_{0}-(((FR_{0\text{-}10}/100*10)/2*HSI_{0}))-((FR_{10\text{-}EY}/100*(EY-10)+FR_{0\text{-}10}/100*10)/2)*(HSI_{0}-(((FR_{0\text{-}10}/100*10)/2*HSI_{0})))*(EY-10))/50$$

$$=((HSI_{0}-(MidPt_{0\text{-}10})*HSI_{0})*10+((HSI_{0}-(MidPt_{0\text{-}10})*HSI_{0})-((MidPt_{10\text{-}EY})*(HSI_{0}-(MidPt_{0\text{-}10})*HSI_{0})))*Y_{10\text{-}EY})/50$$

$$=(HSI_{0\text{-}10}*10+(HSI_{0\text{-}10}-MidPt_{10\text{-}EY}*HSI_{0\text{-}10})*\ Y_{10\text{-}EY})/50$$

$$=(HSI_{0\text{-}10}*10+HSI_{10\text{-}EY}*\ Y_{10\text{-}EY})/50$$

$$=HSI_{AA}$$

Where:

HSI = Habitat Suitability Index
FR = Filling Rate
EY = End Year
Y = Years

Figure 4. Conceptual model used to calculate project impacts by alternative.

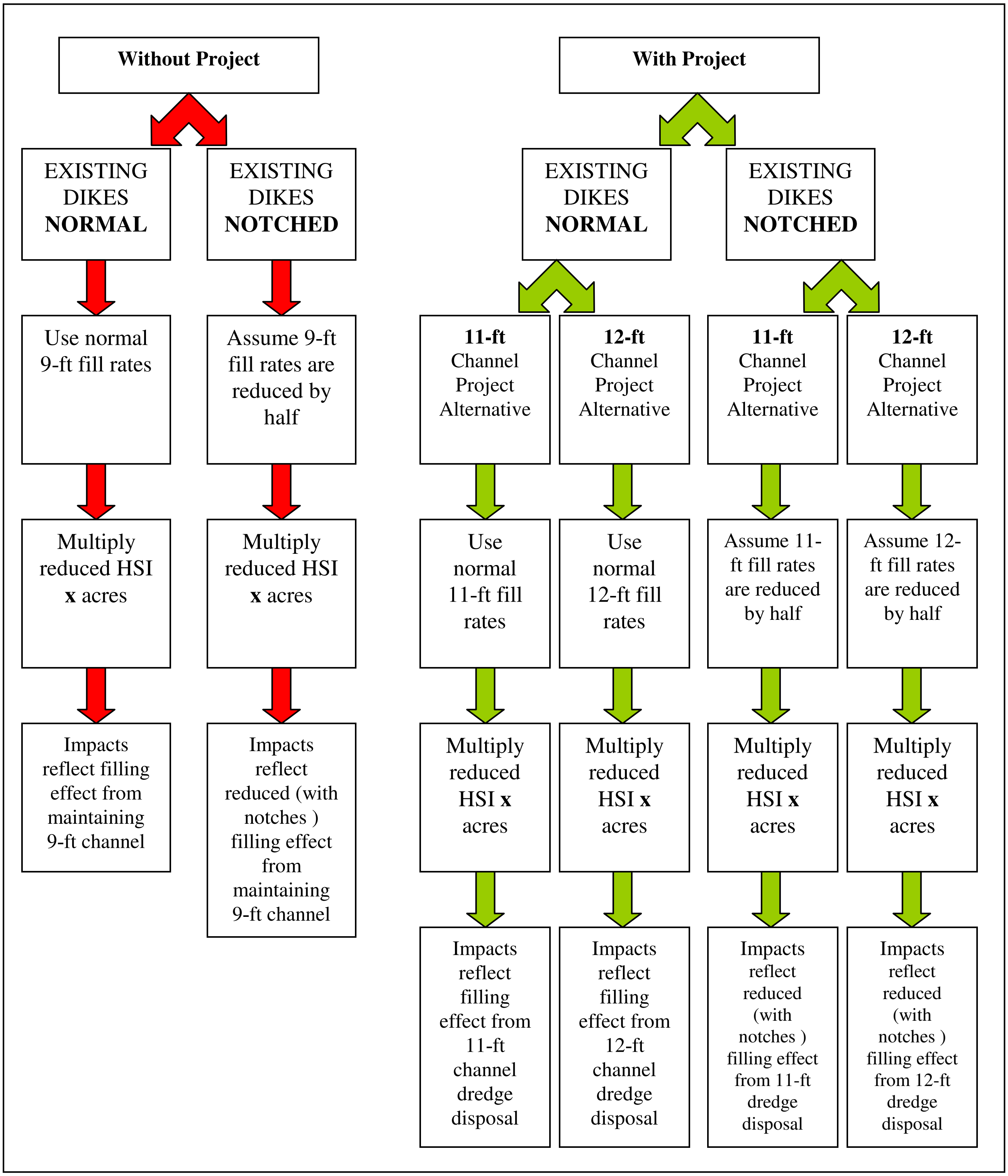
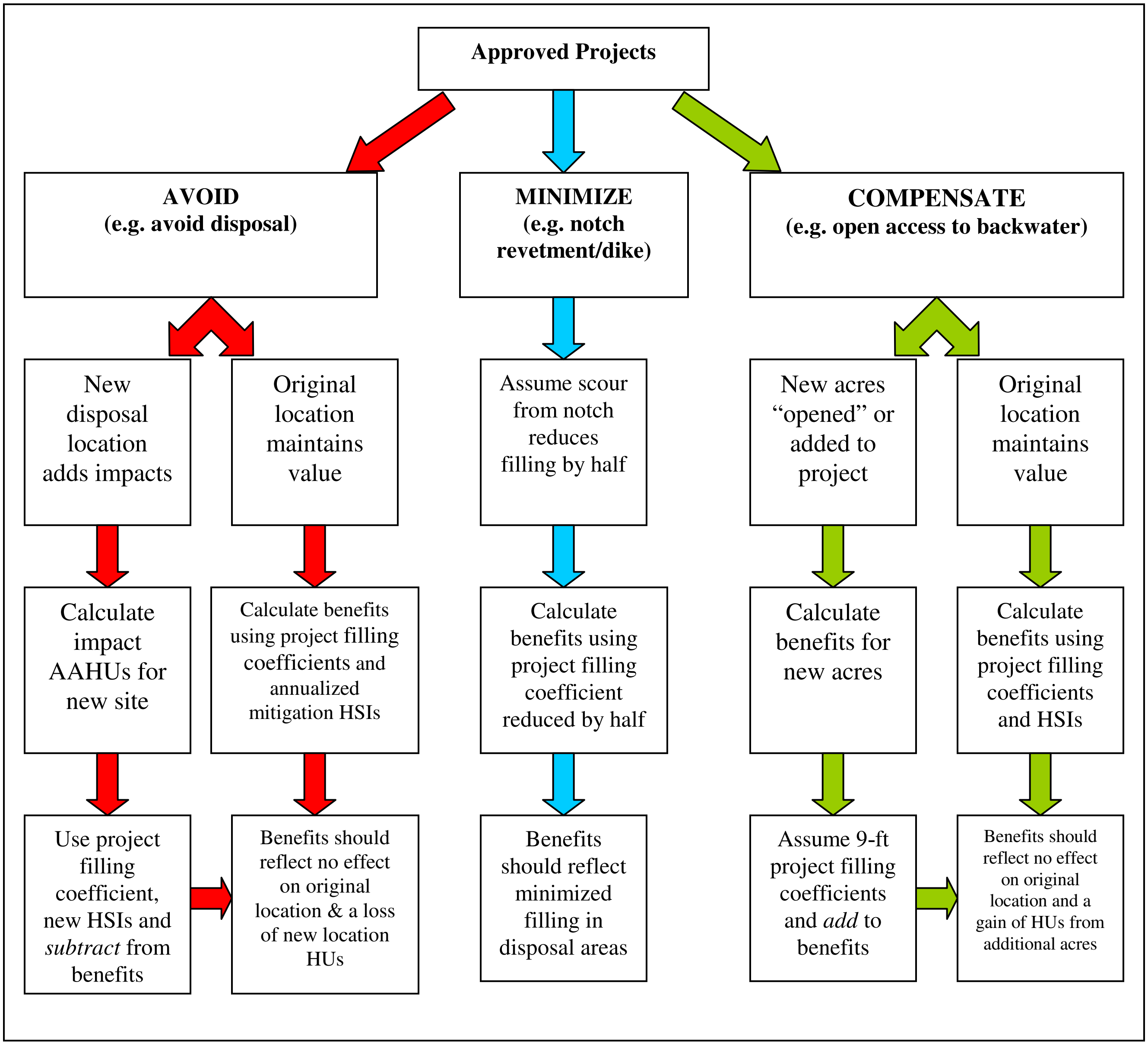


Figure 5. Conceptual model used to calculate project benefits by alternative.



C.7

Aquatic Mitigation Summary

Aquatic Mitigation Summary

Nav. Mile	Mitigation Category	Project Description	Corps Technical Acceptability	Total Existing HUs	HUs Effected by 11-ft Project	Total HUs with Mitigated 11-ft Project	Change in Mitigated 11-ft HUs Relative to Baseline	HUs Effected by 12 ft Project	Total HUs with Mitigated 12-ft Project	Change in Mitigated 12-ft HUs Relative to Baseline
Canal										
15.3R	Compensate	Reconnect Lower Merrisach Lake to Canal with culvert or water control structure for fish passage	Approved	22.055	0.000	26.216	4.161	0.000	26.216	4.161
Pool 2										
19.0R	Minimize	Construct island	Approved-recommend constructing on existing island so it will stay	7.969	-0.438	7.531	-0.438	-0.925	7.044	-0.925
19.8L	Compensate	Notch existing revetment (1)	Approved	9.505	0.000	16.963	7.458	0.000	16.963	7.458
22.8R	Compensate	Maintain entrance to Coal Pile by periodically dredging	Approved	118.280	0.000	140.595	22.315	0.000	140.595	22.315
23.6 R	Avoid	Avoid RB disposal	Approved	3.558	-0.196	2.321	-1.237	-0.413	0.948	-2.610
23-24L	Minimize	Construct string of islands	Approved	15.938	-0.877	19.744	3.806	-1.850	18.468	2.530
23-24L	Minimize	Construct string of islands	Approved	13.282	-0.731	16.454	3.172	-1.542	15.390	2.108
24-25L	Minimize	Notch modified revetment (2) and modified dike (1)	Approved-recommend fish notch only in modified dike	92.917	0.000	118.441	25.524	0.000	118.441	25.524
27L	Avoid	Avoid aquatic disposal, utilize land	Approved	2.453	-0.660	1.793	-0.660	-0.776	1.677	-0.776
27.5-29R	Minimize	Notch modified dikes (4) and existing dike (1)	Approved-10' notches instead of 20' due to narrow channel	43.173	-11.616	45.809	2.636	-13.656	42.052	-1.120
27.8-28.5L	Minimize	Notch modified revetment (1) and existing dike (1)	Approved-20' revetment notch, 10' dike notch	33.116	-8.910	35.137	2.022	-10.474	32.256	-0.859
31.7-32.8R	Minimize	*Existing tern island – enhance/create islands where feasible and avoid June-August construction, utilize disposal area and extend d/s to NM 31.0R	Approved	27.474	-7.392	23.457	-4.017	-8.690	21.941	-5.533
32.2R	Avoid & Compensate	Maintain entrance to backwater channel by avoiding disposal and periodically dredging	Approved-only included entrance channel in surface water acreage	2.146	0.000	2.041	-0.105	0.000	2.041	-0.105
32L	Minimize & Compensate	Notch revetment (4) and existing dike (1)	Approved-surface water acreage includes all water inside revetment and dike across small backwater area.	84.322	0.000	107.485	23.163	0.000	107.485	23.163
31.8-33.1L	Avoid & Minimize	Avoid LB disposal, utilize RB, notch modified revetment (4) and existing dike (1) across backwater	Approved	38.022	-10.230	34.106	-3.916	-12.026	29.703	-8.319
35R	Minimize	Notch modified dikes (2)	Not approved-due to bend and bank erosion, however, engineers stated that this area would not likely fill due to its location.	6.439	0.000	6.439	0.000	0.000	6.439	0.000
35.3-36.5L	Minimize	*Existing tern island – enhance/create islands where feasible and avoid June-August construction	Approved	13.803	-0.759	30.436	16.633	-1.602	28.469	14.666
36-36.5L	Minimize & Compensate	Notch modified dikes (3) and existing dike (1)	Not approved-due to proximity to bank, engineers agreed that two longest dikes could be notched, but not all four.	7.727	0.000	7.727	0.000	0.000	7.727	0.000
36.4-37.0R	Minimize	Extend disposal area u/s to 38.1R, avoid blocking entrance to chute at 36.4R and 38.1R	Approved	5.692	-0.313	4.622	-1.070	-0.661	3.434	-2.258
37.5-38.6L	None	Notch raised L-dikes	Not Approved due to short length of dikes	10.671	0.000	10.671	0.000	0.000	10.671	0.000
37.8-38.4L	Avoid & Minimize	Avoid disposal, utilize RB.	Approved	5.692	-0.313	4.513	-1.179	-0.661	3.203	-2.489
38.8L	Avoid & Minimize	Avoid disposal, utilize RB, notch modified revetment	Approved	4.269	-0.235	3.977	-0.292	-0.496	3.652	-0.617
39.8L	Minimize	Notch modified revetment at 39.3L and 39.7L	Approved	24.469	0.000	31.190	6.722	0.000	31.190	6.722
38.8-39.6R	Minimize & Compensate	*Existing tern island, notch existing dikes (5) and enhance/construct tern islands where feasible	Approved	1.755	-0.097	14.870	13.115	-0.204	13.651	11.896
40R	Minimize	Notch existing revetment/dike (1)	Not approved-erosion problem area	1.533	0.000	1.533	0.000	0.000	1.533	0.000
39.8-40.0L	Avoid	Avoid disposal, utilize right bank	Approved	1.518	-0.083	1.377	-0.141	-0.176	1.221	-0.297

Aquatic Mitigation Summary

Nav. Mile	Mitigation Category	Project Description	Corps Technical Acceptability	Total Existing HUs	HUs Effected by 11-ft Project	Total HUs with Mitigated 11-ft Project	Change in Mitigated 11-ft HUs Relative to Baseline	HUs Effected by 12 ft Project	Total HUs with Mitigated 12-ft Project	Change in Mitigated 12-ft HUs Relative to Baseline
42.1-42.7L	Minimize	*Existing tern island, use disposal to enhance/construct tern islands, notch backside of existing dikes to maintain flow and islands 42.5L	Approved	5.408	-0.297	7.157	1.749	-0.628	6.259	0.851
42.3-43.3L	Minimize & Compensate	Construct islands and notch existing (3) dikes	Approved	4.743	-0.261	19.521	14.777	-0.551	17.920	13.177
42.8-44.6R	Minimize & Compensate	Notch existing and modified dikes (10-12)	Not approved-this is one of worst depositional areas on river and notches would make short dikes ineffective.	10.671	0.000	10.671	0.000	0.000	10.671	0.000
42.8-43R	Avoid & Minimize	Utilize this disposal area, notch existing and modified dikes (10-12) and extend disposal u/s	Partially Approved-utilizing this area for disposal is approved, but notching dikes is not.	1.423	-0.078	1.345	-0.078	-0.165	1.258	-0.165
43.4-44.1L	Avoid & Minimize	Avoid disposal in LB aquatic areas, utilize land and RB disposal, notch existing dikes/revetments (3)	Partially Approved-avoiding disposal in this area is approved, but engineers only want most d/s part of revetment notched in 1 place rather than 3 places as recommended since this area has an erosion problem.	10.388	-0.571	9.817	-0.571	-1.206	9.182	-1.206
44-44.7R	Minimize	Utilize AR44.3R-D for disposal and extend d/s to 43.0R	Approved	0.854	-0.047	0.807	-0.047	-0.099	0.755	-0.099
44.6L	Compensate	Maintain a 1/2 mile boating lane at the entrance to Little Bayou Meto (44.6L) and 1/2 mile lane at u/s end of Bayou Meto by periodically dredging	Approved	28.100	0.000	33.401	5.301	0.000	33.401	5.301
46.2R	Minimize	Notch modified revetment/dike (1)	Not approved-engineers do not want notches on right bank	0.368	0.000	0.368	0.000	0.000	0.368	0.000
45.4-46L	Avoid	Avoid disposal in aquatic areas of AR45.3L-D, dispose on land or preferably on RB	Approved	8.348	-0.459	6.783	-1.565	-0.969	5.045	-3.304
46.5-46.7L	None	Notch modified revetment (1)	Not approved-see note below	1.227	0.000	1.227	0.000	0.000	1.227	0.000
45.4-47.3R	Minimize & Compensate	Construct islands where feasible in AR46.5R-D, utilize two most d/s cells for disposal first, notch dikes/revetments (4-8)	Partially approved-disposal in this area is approved, but engineers do not want any notches	32.255	-1.774	30.481	-1.774	-3.744	28.511	-3.744
48.7-48.9R	Minimize	Notch modified dikes (4)	Approved	3.496	0.000	4.456	0.960	0.000	4.456	0.960
46.8-49.2L	Avoid & Minimize	Utilize land within cells for disposal at AR48.0L-D, avoid aquatic areas	Approved	11.289	-0.621	10.668	-0.621	-1.311	9.979	-1.311
48.7-50.2R	Avoid & Minimize & Compensate	Utilize land within cells for disposal in 49.4R-D, avoid aquatic areas, notch existing revetments/dikes in two most u/s cells (2)	Approved	5.118	-0.281	9.361	4.243	-0.594	8.593	3.475
49.6-49.9	Avoid	Utilize existing in-channel disposal	Approved	1.044	-0.057	0.986	-0.057	-0.121	0.922	-0.121
Pool 3										
50.9L	Compensate	Maintain entrance to Swan Lake by periodically dredging	Approved	38.463	0.000	42.991	4.528	0.000	42.991	4.528
58.3L	Compensate	Notch revetment at 58.3L	Approved-need to check, there may be another levee inside the revetment	17.112	0.000	28.093	10.981	0.000	28.093	10.981
61.0-62.1L	Minimize	*Probable tern island on RB, avoid aquatic areas in AR61.4L-D, utilize land within disposal cells or enhance/create tern islands on RB	Approved	9.978	-0.980	8.758	-1.220	-2.463	6.913	-3.065
61.5-62.5R	Minimize	Place disposal in string of islands along RB	Approved	3.280	-1.078	1.555	-1.725	-1.441	0.758	-2.521
64-65R	Avoid & Compensate	Avoid disposal in AR64.5R-D, notch existing revetments and/or dikes (3)	Approved	11.677	-1.147	16.964	5.287	-2.882	12.105	0.428
64.8-65.3L	Avoid & Minimize	Utilize AR65.2L-D or in-channel disposal at AR65.5Channel-D	Approved	10.084	-0.991	9.093	-0.991	-2.489	7.595	-2.489

Aquatic Mitigation Summary

Nav. Mile	Mitigation Category	Project Description	Corps Technical Acceptability	Total Existing HUs	HUs Effected by 11-ft Project	Total HUs with Mitigated 11-ft Project	Change in Mitigated 11-ft HUs Relative to Baseline	HUs Effected by 12 ft Project	Total HUs with Mitigated 12-ft Project	Change in Mitigated 12-ft HUs Relative to Baseline
65.2-65.6	Avoid & Minimize	Utilize AR65.2L-D or in-channel disposal at AR65.5Channel-D	Approved	2.548	-0.250	2.297	-0.250	-0.629	1.919	-0.629
Pool 4										
70.0-70.7L	Minimize	Notch two longest existing dikes (2)	Approved	14.815	0.000	23.203	8.387	0.000	23.203	8.387
70.6L	Compensate	Maintain channel to backwater by periodically dredging	Approved	12.583	0.000	14.939	2.356	0.000	14.939	2.356
71.3L	Compensate	Dredge canals at Island Harbor Estates	Approved	5.618	0.000	7.239	1.622	0.000	7.239	1.622
75.3L	Compensate	Maintain channel to backwater by periodically dredging	Approved	2.022	0.000	2.401	0.379	0.000	2.401	0.379
78.7L	Compensate	Dredge mouth of Pastoria Bend chute and periodically dredge to maintain and notch existing dike (1) if needed to open access to backwater	Approved	11.504	0.000	21.621	10.116	0.000	21.621	10.116
78.9-79.7L	Avoid & Minimize	79.0L - First option - Inquire about upland disposal on Pine Bluff Arsenal property first to avoid any impacts, second option - investigate island disposal upstream on LB at 80.1, third option to place in proposed location and notch modified dikes (4)	Approved-third option (AR79.0L-D) is most likely since there are security issues with disposing on PB Arsenal property and engineers do not want dikes on left bank notched for island construction upstream at 81L.	2.247	-1.253	1.420	-0.827	-1.375	1.243	-1.004
80.0-82.0L	Minimize & Compensate	Place disposal along dike fields to create islands and notch backside of dikes (9) at 80-82L	Not approved-see comment above.	10.786	0.000	10.786	0.000	0.000	10.786	0.000
82.6R	Compensate	Notch existing dike and maintain entrance to backwater at 82.6R by periodically dredging	Approved	18.425	0.000	44.376	25.951	0.000	44.376	25.951
82.5-85.5R	Compensate	Notch existing dikes along RB (14)	Approved	23.570	0.000	37.968	14.398	0.000	37.968	14.398
85.5-85.8R	Avoid & Minimize	Avoid disposal if possible and utilize in-channel disposal	Approved	6.210	-0.470	5.707	-0.502	-1.176	4.952	-1.258
85.9L	Compensate	Construct boat ramp immediately d/s of Dam No. 5 if feasible	Approved-engineers recommended moving to right bank at proposed park location	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85.6-85.8	Minimize	Utilize in-channel disposal	Approved	0.430	-0.033	0.398	-0.033	-0.081	0.349	-0.081
Pool 5										
87.7L	Compensate	Investigate dredging channel into oxbow lake	Not approved-this is highly unlikely due to ownership issues.	69.697	0.000	69.697	0.000	0.000	69.697	0.000
88.2R	Compensate	Maintain entrance to Tar Camp Creek by periodically dredging	Approved	8.987	0.000	10.694	1.708	0.000	10.694	1.708
90.5-91.0L	Minimize	Construct island(s) at 90.5-91.0L behind underwater revetment	Approved	2.673	-0.757	1.916	-0.757	-1.091	1.583	-1.091
91.4-91.7R	Avoid & Minimize	Recommend constructing island downstream at 90.5-91.0L behind underwater revetment, if proposed location must be utilized, place disposal off bank and create island(s) and notch backside of existing dikes	Approved-see comment above, island will be constructed on LB.	29.788	-8.437	35.008	5.219	-12.154	28.207	-1.581
91.5L	Compensate	Bank stab and revetment at 91.5 is needed (current – 0.3)	Approved	2.291	0.000	3.636	1.344	0.000	3.636	1.344
92.6L	Compensate	Notch existing revetment (1) and maintain entrance to backwater by periodically dredging	Approved	3.310	0.000	6.195	2.885	0.000	6.195	2.885
94	Compensate	Notch existing revetment (1)	Approved	1.591	0.000	2.383	0.792	0.000	2.383	0.792
94.3-96.3L	Avoid & Minimize & Compensate	Avoid aquatic disposal in uppermost cells of AR95.5L-D, extend disposal area d/s to create a series of islands for a braided system and terns, notch existing dikes (5) to enhance backwater areas	Approved-note AR95.5L-D is 144 acres, however, with all the islands and notches, the total acreage is approximately 244.	65.750	-13.193	81.262	15.511	-22.342	60.160	-5.591
96.0-98.2R	Minimize	Enlarge and utilize RB disposal, investigate disposing behind modified revetment and dikes, investigate terrestrial disposal if needed	Approved	5.347	-1.514	3.832	-1.514	-2.181	3.165	-2.181
98.5R	Compensate	Notch existing revetment to access backwater (1)	Approved	0.637	0.000	0.953	0.317	0.000	0.953	0.317
99.4L	Compensate	Notch existing revetment to access backwater (1)	Approved-engineers recommended fish notch	0.382	0.000	0.635	0.254	0.000	0.635	0.254
100.3-101.1L	Compensate	Notch existing dikes (2), *Existing tern island on LB, avoid work during nesting season	Partially approved-engineers are okay with notch at 100.3L, but not 101.1L.	39.718	0.000	39.718	0.000	0.000	39.718	0.000
100.6-101.3R	Minimize	Utilize this area as alternative disposal site	Approved	4.710	-1.334	3.376	-1.334	-1.922	2.788	-1.922
102-104R	Minimize	Utilize RB disposal as alternative, construct/enhance tern islands if feasible	Approved	5.283	-1.496	3.787	-1.496	-2.155	3.128	-2.155

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101.5-103.7L	Avoid & Compensate	Avoid disposal, notch existing dikes (10-12) for flow-through and to enhance diversity	Partially approved-engineers approved notching the 6 longest most d/s L-dikes, but not all of the dikes since notching the short ones might cause an erosion problem.	82.702	-16.595	66.107	-16.595	-28.102	54.599	-28.102
105.2-106.0L	Avoid & Compensate	*Existing tern island(s), avoid work during nesting season, construct high water notches in dikes (4) to restore and maintain islands	Approved	2.162	0.000	21.582	19.420	0.000	21.582	19.420
106.5-107.7L	Avoid	Avoid aquatic disposal in AR107.1L, utilize land areas or in-channel disposal	Approved	49.007	-8.133	40.874	-8.133	-15.524	33.483	-15.524
Pool 6										
110.4L	Compensate	Install culvert through land mass at Willow Beach Park to connect backwater to river	Approved	3.263	0.000	5.584	2.321	0.000	5.584	2.321
110.4	Compensate	Install culvert through structure at Willow Beach Lake for fish passage	Approved	27.191	0.000	46.537	19.346	0.000	46.537	19.346
113-114L	Compensate	Notch underwater dikes on backside of islands (4)	Approved	9.040	0.000	14.853	5.813	0.000	14.853	5.813
116.2R	Compensate	Dredge backwater at 116.2R	Approved	0.350	0.000	0.733	0.383	0.000	0.733	0.383
116.6-116.8R	Compensate	Notch existing dikes 116.6 to 116.8R (2) *may have already been done	Approved	2.333	0.000	3.993	1.660	0.000	3.993	1.660
117.1-117.7R	Compensate	Notch existing dikes (3)	Approved	1.750	0.000	3.194	1.445	0.000	3.194	1.445
122.9-123.6R	Compensate	Notch existing dikes (2-4) for flow-through and access	Approved-engineers noted that a lot of bank fishermen use this area, so we need to make sure we do not restrict their access.	4.374	0.000	7.986	3.611	0.000	7.986	3.611
123.7L	Compensate	Notch existing dike for access and fish passage	Approved-engineers recommended a fish notch here	0.875	0.000	1.198	0.323	0.000	1.198	0.323
124.2-124.5L	Avoid	Avoid disposal in AR124.8L-D, utilize in-channel disposal	Approved	3.500	0.000	0.133	-3.366	0.000	0.133	-3.366
124.8-125.1	Minimize	Utilize in-channel disposal at AR124.8 Channel-D	Approved	2.800	0.000	2.933	0.133	0.000	2.933	0.133
Pool 7										
126.7-127.4L	Minimize	Utilize LB for disposal and notch modified dikes (4)	Approved	3.609	-0.299	12.166	8.558	-0.583	10.734	7.125
126.6-127.0R	Avoid	Avoid disposal on RB	Approved	8.220	-0.682	7.538	-0.682	-1.327	6.892	-1.327
131.0L	Compensate	Dredge upper end of Rector Brake to improve habitat	Approved	5.139	0.000	8.136	2.997	0.000	8.136	2.997
131.8-132.5R	Minimize	Notch upper end of modified revetment (1)	Not approved-engineers noted bad erosion problem inside revetment	3.540	0.000	3.540	0.000	0.000	3.540	0.000
132.2L	Compensate	Maintain entrance to Rector Chute by periodically dredging	Approved	13.082	0.000	15.532	2.450	0.000	15.532	2.450
133.5-135.2L	Avoid & Minimize	Avoid aquatic disposal on LB, utilize land disposal on island or construct another island on RB, notch longest existing dike for flow-through (*potential existing tern site)	Approved	23.015	-1.908	27.393	4.378	-3.717	15.561	-7.455
134.2R	Compensate	Notch existing revetment (1) at 134.2R and	Approved	13.247	0.000	22.012	8.765	0.000	22.012	8.765
134.5R	Compensate	Notch existing dike (1) at 134.7R for fish passage and access to Mill Bayou	Appears that dike has a road across it, therefore, we will have to consult real estate to determine if it can be notched or a large culvert installed.	35.402	0.000	35.402	0.000	0.000	35.402	0.000
135-138.2R	Avoid & Compensate	Avoid disposal in aquatic areas, utilize island disposal, (*potential existing tern site), notch two lower dikes	Approved	86.607	-7.181	89.355	2.747	-13.987	81.698	-4.909
139.5-141R	Avoid & Minimize	Avoid disposal from 140R u/s to 141R to prevent blockage of opening between islands, utilize 140R d/s to tip of island	Approved	12.991	-1.077	10.897	-2.094	-2.098	8.912	-4.079
141.5-142.5R	Minimize	Utilize disposal behind raised and extended L-dikes at 142.0R	Approved	6.897	-0.572	0.000	-6.897	-1.114	0.000	-6.897
142.5-143.4R	Minimize	Notch modified dikes (2) at entrance to beaver dam channel for flow-through	Approved	11.991	0.000	18.217	6.226	0.000	18.217	6.226

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143.7-144.2L	Compensate	Construct L-dike or revetment and use disposal to slope and protect bank	Approved	6.509	-2.317	5.589	-0.920	-2.677	5.110	-1.399
145.2-146.2L	Minimize	Notch modified dikes (7)	Approved	17.130	0.000	26.566	9.436	0.000	26.566	9.436
146.5-147.5L	Avoid & Minimize	* Existing tern island – enhance/construct a series of islands along LB where feasible, notch dikes (5), move disposal from LB to RB for excess disposal	Approved	5.448	-0.452	8.758	3.310	-0.880	7.273	1.826
146.3R	Avoid	Avoid disposal in this area	Approved-Note: 3 dikes are already notched in this area, so fill rate should be reduced.	22.218	-2.211	19.581	-2.637	-4.566	16.823	-5.395
146.6-147.8R	Minimize	Utilize land within disposal cells	Approved	4.651	-0.386	4.265	-0.386	-0.751	3.900	-0.751
147.8-150L	Avoid & Minimize	Avoid disposal from 149-150L that would block the entrance to backwater area, utilize disposal area d/s of 149L	Approved	28.322	-10.083	7.184	-21.138	-11.646	5.005	-23.316
148.7-150.4R	Avoid & Compensate	Avoid disposal, notch dike at 149R	Approved	22.383	-7.969	17.351	-5.032	-9.204	13.537	-8.846
150-151.7L	Avoid & Minimize	Avoid disposal from 150-151L that would block side channel and backwater entrance, construct a series of tern islands where feasible, notch existing dike at 150.8L for fish passage and backwater entrance	Approved	62.810	-22.361	88.672	25.862	-25.827	76.463	13.653
154-154.6L	Avoid	Avoid RB disposal, Utilize land disposal within cells at AR154.1L-D	Approved	0.000	0.000	0.000	0.000	0.000	0.000	0.000
155.4L	Miniimize	Utilize land within cell at AR155.4L-D	Approved	0.000	0.000	0.000	0.000	0.000	0.000	0.000
155.6R	Compensate	Notch existing revetment (2)	Approved-engineers recommended not restricting bank fishermen with notches	2.056	0.000	3.416	1.360	0.000	3.416	1.360
Pool 8										
158.8-159.2R	Minimize	Utilize existing island for disposal and/or construct tern islands	Approved	2.382	-0.516	0.547	-1.835	-0.691	-0.076	-2.458
161.2-162.2L	Compensate	Notch existing dikes (3-4) from 161.2-162.2L	Approved-engineers stated that dikes should be notched close to the island-check with Regulatory regarding obstruction	13.337	0.000	20.621	7.284	0.000	20.621	7.284
163.6-165.2R	Compensate	163.6-165.3 - Revetment is needed for bank stabilization	Approved	1.059	-0.229	0.829	-0.229	-0.307	0.751	-0.307
164.2-164.7L	Avoid	Avoid LB disposal, utilize disposal behind revetment on RB	Approved	11.379	-2.466	6.734	-4.645	-3.303	5.157	-6.221
164.5-165.2L	Minimize & Compensate	165 - Notch on upstream end of revetment for flow in and out of Plummerville cutoff, and notch raised dikes (3), maintain entrance by periodically dredging	Approved	29.056	0.000	43.676	14.620	0.000	43.676	14.620
165.5-166.2R	Avoid	Avoid disposal in AR166.0R-D	Approved	22.440	-4.863	15.398	-7.042	-6.513	13.008	-9.432
165.8-167.0L	Avoid & Minimize & Compensate	Avoid aquatic disposal, dispose on land within cells, notch existing revetment (4)	Approved-engineers stated they recommend fish notches only at this location	9.262	-2.007	12.081	2.819	-2.688	10.718	1.456
169.2-169.8R	Minimize	Utilize AR169.4R-D for disposal first, AR169.0L-D second, construct tern islands where feasible	Approved	2.506	-0.102	2.404	-0.102	-0.328	2.179	-0.328
168.7-169.5L	Minimize	Utilize AR169.4R-D for disposal first, AR169.0L-D second, construct tern islands where feasible	Approved	1.426	-0.058	4.641	3.215	-0.186	4.205	2.779
169.4-169.7L	Minimize	Notch raised dikes (4)	Approved	1.799	0.000	2.434	0.635	0.000	2.434	0.635

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169.6-172L	Minimize	Notch raised dike at 170.1L and existing dikes at 170.7L and 171L, utilize land within cells for disposal or create/enhance tern island, (*existing tern island)	Partially approved-engineers approved the notch at 170.1, but not the notches at 170.7 or 171.0	45.727	-9.909	35.818	-9.909	-13.272	32.455	-13.272
174.1-176.7R	Avoid & Compensate	Utilize land disposal on Lentz property, notch existing dikes (4))	Approved	7.943	-0.323	13.879	5.936	-1.039	12.314	4.370
176.2-176.4	Avoid	Avoid disposal in AR176.2L-D, utilize RB land disposal on Lentz property	Approved	2.420	-0.098	2.322	-0.098	-0.316	2.104	-0.316
Pool 9										
179.3-179.7R	Minimize	Utilize disposal at 179.6R behind revetment	Approved	11.010	-2.608	6.108	-4.902	-4.408	2.723	-8.287
180.2R	Compensate	Notch existing dike at 180.2R for fish passage and access to backwater	Approved	15.414	0.000	22.889	7.475	0.000	22.889	7.475
180.4-181.3R	Minimize	Extend disposal area upstream to raised dike at 181.5R and dispose along bank downstream of dike, notch existing dikes (2)	Approved	5.285	-1.252	3.659	-1.626	-2.116	1.344	-3.940
181.8-184.9R	Minimize	Notch existing and raised dikes (8-10) and create a series of islands for braided system and terns	Approved	37.027	-3.600	53.994	16.966	-10.763	36.261	-0.767
185.8-186.4	Avoid & Minimize	Avoid disposal in AR186.2L-D, create artificial gravel bar downstream of dikes from 185L-186L	Approved	7.446	-0.724	6.648	-0.798	-2.164	2.591	-4.855
187.2R	Compensate	Notch long L-dike at 187.2R (2)	Not approved-engineers do not want to notch this dike	82.208	0.000	82.208	0.000	0.000	82.208	0.000
186.9-189.9R	Avoid & Minimize & Compensate	*Existing least tern island - avoid construction during nesting, limited disposal to avoid elevating island and maintain fish access to backwater, notch revetment and dikes (3-6) for flow-through, fish passage and access	Partially approved-disposal will be limited, however, engineers do not want to create a series of notches. They did agree to notch the revetment in two places from 189 to 189.5R.	201.663	-19.609	182.053	-19.609	-58.618	143.045	-58.618
189.2	Minimize	189.2 - Notch revetment and dikes for fish passage and access to backwater	This part approved - See above	67.852	0.000	88.160	20.309	0.000	88.160	20.309
188.9-190.4L	Avoid & Minimize & Compensate	*Existing least tern island, avoid disposal, notch raised revetment (1) and existing dike (1), utilize area upstream at 191R for disposal	Approved-engineers prefer to notch revetment in 2 places	40.705	-3.958	50.444	9.739	-11.832	41.166	0.461
190R	Minimize	Notch Sweeden island dike in chute on RB lowest for fisheries and rec access	Not approved-need to consult with real estate and determine if there are any ownership issues.	0.000	0.000	0.000	0.000	0.000	0.000	0.000
190.5-192R	Minimize	New dredge disposal alternative to 189.5L will create elevated vegetated shoreline on Sweeden Island	Approved	4.918	-1.165	6.697	1.779	-1.969	5.262	0.344
189.9.190.5L	Minimize	Notch modified revetment in two places (2)	Approved	13.525	0.000	10.995	-2.530	0.000	10.995	-2.530
193.6-195L	Compensate	Notch existing dikes (5) in AR194.1L-D	Approved	5.475	-1.297	8.604	3.129	-2.192	7.021	1.546
200.2L	Avoid & Minimize	Utilize land disposal within cells from 200.8L d/s to 200L, avoid disposal u/s of 200.8L	Approved	25.323	-5.997	19.326	-5.997	-10.138	15.185	-10.138
204.6-205.1R	Mimimize	Utilize in-channel disposal (gravel)	Approved	18.615	-1.810	16.805	-1.810	-5.411	13.204	-5.411
Pool 10										
222.5R	Minimize	Construct islands along RB if feasible	Approved-no adverse impact	0.000	0.000	0.000	0.000	0.000	0.000	0.000
225.5L	Minimize	Construct islands along LB if feasible	Approved-no adverse impact	0.000	0.000	0.000	0.000	0.000	0.000	0.000
227.2,229,230,233.5,233.3, 234	Minimize	Construct islands where feasible	Approved-no adverse impact	0.000	0.000	0.000	0.000	0.000	0.000	0.000
232R	Compensate	No adverse impact, bank stabilization is needed at this area	Approved-no adverse impact	0.364	0.000	0.349	-0.015	0.000	0.349	-0.015
233L	Avoid	Utilize land disposal in AR233.0L-D if needed	Approved	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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235-236.8R	Minimize & Compensate	Notch existing dike and raised dike (2-3) in AR236.0R-D, place dredged material on existing islands within disposal area	Approved-engineers approved notches, but only after some channel work has been performed and the channel is moved toward left bank.	105.624	-11.114	131.603	25.979	-35.437	100.346	-5.278
236.6L	Avoid	Utilize this site for disposal	Approved	0.000	0.000	0.000	0.000	0.000	0.000	0.000
238.5-239.9L	Avoid & Minimize	*Existing tern island at 239.5L, avoid disposal in AR238.5L-D, alternately use 240.1-241.0 L, investigate terrestrial disposal, create and/or exend island, notch land side of dikes, do not cut off backwater at 241.1L	Approved	89.120	-9.377	109.053	19.932	-29.900	78.331	-10.790
238.5-241.2	Minimize	Maintain and/or notch existing and modified dikes (3)	Approved	74.279	0.000	96.925	22.646	0.000	96.925	22.646
239.5R	Minimize	239RB-Maintain fish access through revetmetment. Modified revetment along RB will have no adverse impacts	Approved	27.373	0.000	26.266	-1.107	0.000	26.266	-1.107
241.8-242.2R	Minimize	Utilize this site for disposal	Approved	5.685	-0.598	0.000	-5.685	-1.907	0.000	-5.685
242-244.1L	Avoid & Minimize	Avoid disposal in AR242.2L-D at entrance to Hartman Lake, utilize AR241.8R-D and AR244.0R-D if needed, deepen notch in modified revetment	Approved	12.531	-1.318	17.114	4.584	-4.204	9.118	-3.413
243.7-244.2L	Minimize & Compensate	Notch revetment and dike at u/s end to Hartman lake to allow flow-through and fish passage	Approved. Check for road, possible culvert	16.727	0.000	51.738	35.011	0.000	51.738	35.011
244R	Minimize & Compensate	Utilize two downstream cells for disposal if needed and notch two existing upper dikes for fish passage and access	Approved	2.184	-0.543	3.046	0.862	-0.965	2.323	0.139
243.8-246.8L	Avoid & Compensate	Avoid disposal (none currently scheduled) in AR245.6L-D, notch dike d/s of most d/s island at 244.5L	Not approved-engineers do not want dike at 244.5L notched	88.234	-21.945	66.289	-21.945	-39.005	49.229	-39.005
249.7L	Minimize	Alternative disposal site for AR248.0R-D	Approved	0.874	-0.217	0.349	-0.525	-0.386	-0.060	-0.933
254.1-254.5L	Minimize	Alternative disposal site inside closed revetment at 254.1L, no previously approved disposal area indicated on map	Approved	0.728	-0.181	-0.109	-0.837	-0.322	-0.193	-0.921
251.8-253.8L	Compensate	Notch dikes (5-10) on left and right bank up and downstream	Approved	14.982	0.000	22.545	7.563	0.000	22.545	7.563
255.7-256.1R	Avoid	Avoid, use AR256.2L-D for disposal instead of AR256.0R-D	Approved	1.467	-0.154	1.313	-0.154	-0.492	0.975	-0.492
255.9-256.2L	Avoid	Prefer to use this terrestrial area for disposal	Approved	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pool 12										
271.2-273R	Minimize	Utilize this RB site for disposal	Approved	1.323	-0.616	-0.576	-1.898	-0.763	-1.028	-2.351
273.7-276L	Avoid	Avoid disposal in AR274.0L-D and AR275.0L-D, alternatively use RB disposal to create or enlarge islands,	Approved	6.559	-1.136	5.565	-0.994	-2.264	3.939	-2.621
275-276L	Minimize	Notch modified dikes (3)	Approved	10.157	0.000	13.744	3.587	0.000	13.744	3.587
275.7-276.4R	Minimize	Notch modified dikes (2) that connect to shoreline and extend RB disposal downstream within dike field	Partially approved-engineers do not want dikes notched, constructing islands is approved.	1.913	-0.331	1.582	-0.331	-0.660	1.253	-0.660
275.2-276.6R	Minimize	Notch dikes (2) that connect to shoreline	Not approved-see comment above	31.740	0.000	31.740	0.000	0.000	31.740	0.000
276.0R	Compensate	Maintain entrance to Courthouse Slough by periodically dredging	Approved	7.046	0.000	8.299	1.253	0.000	8.299	1.253
276.8-277.5R	Avoid	Avoid backwater disposal in 277.0R-D, place disposal on land and d/s along bottom end to extend island	Approved	1.162	-0.201	0.960	-0.201	-0.401	0.761	-0.401
278.9-280.3L	Avoid	At AR279.5L-D avoid disposal in aquatic areas, utilize land within disposal area and AR280.0R-D,	Approved	131.189	-22.714	108.475	-22.714	-45.275	85.914	-45.275
279-280.1L	Minimize	Notch modified revetment at 279L and 280.2L to maintain high value for backwater area	Approved	67.644	0.000	91.534	23.890	0.000	91.534	23.890
279-280.1R	Minimize	Utilize AR280.0R-D for disposal and construction of string of islands, notch modified dikes (4) to create and maintain backwater channel	Approved-engineers varied slightly on this, they want to notch the revetment and 3 dikes.	9.737	-1.686	10.665	0.929	-3.360	7.423	-2.314
280.6-280.9	Minimize	280.8L - Notch modified dikes (3)	Approved	11.850	0.000	16.034	4.185	0.000	16.034	4.185

Aquatic Mitigation Summary

Nav. Mile	Mitigation Category	Project Description	Corps Technical Acceptability	Total Existing HUs	HUs Effected by 11-ft Project	Total HUs with Mitigated 11-ft Project	Change in Mitigated 11-ft HUs Relative to Baseline	HUs Effected by 12 ft Project	Total HUs with Mitigated 12-ft Project	Change in Mitigated 12-ft HUs Relative to Baseline
281.9-283.3L	Avoid	Place disposal on lower end of disposal area on existing sand bars, construct islands where feasible, avoid disposal from 283.2-283.5L	Approved	33.481	-5.797	25.412	-8.068	-11.555	17.398	-16.082
283.1-283.9L	Minimize	283.9L - Notch modified revetment in upper cell (High priority)	Approved	21.579	0.000	41.715	20.135	0.000	41.715	20.135
283.5-284.7R	Avoid	Recommend constructing new disposal at 284R	Approved	1.746	-0.813	0.932	-0.813	-1.007	0.738	-1.007
284.7-287.4	Avoid	Avoid disposal in d/s cells on LB and RB, prefer disposal d/s in new area	Approved	46.658	-21.742	21.661	-24.996	-26.924	15.704	-30.954
285.6-286.2L	Avoid & Minimize	Extend disposal area to 286.2L dike, place disposal behind dikes on LB from 286.2-285.6L to create islands and maintain gravel instream, notch modified (2) and existing (2) dikes	Approved	7.036	-3.279	2.748	-4.288	-4.060	0.974	-6.062
288.4-289L	Avoid	Avoid disposal in AR289.0L-D and place dredged gravel along right bank downstream and extend downstream gravel bar at 289.7R	Approved	7.776	-3.624	0.899	-6.878	-4.487	-0.741	-8.517
288.8-289.8R	Minimize	Utilize this alternative disposal area	Approved	6.348	-2.958	0.136	-6.212	-3.663	-1.345	-7.693
290R	Compensate	Notch existing dike if feasible	Not approved-probably not feasible, appears dike is totally covered	13.490	0.000	13.490	0.000	0.000	13.490	0.000
290.5-291.4R	Minimize	Utilize dry cells in this disposal area	Approved	1.640	-0.284	0.000	-1.640	-0.566	0.000	-1.640
291.8-292.3L	Avoid	Avoid disposal at 292.3L	Approved	5.261	-0.911	4.350	-0.911	-1.816	3.446	-1.816
Pool 13										
305.3-306R	Compensate	Notch revetment at 305.7 and 306R	Approved	24.497	0.000	38.550	14.054	0.000	38.550	14.054
OK										
309.8-310.3	Compensate	Notch 4 dikes for scour	Approved	6.999	0.000	14.700	7.701	0.000	14.700	7.701
310.4	Compensate	Notch parallel dikes (1) for scour	Approved	3.033	0.000	5.972	2.939	0.000	5.972	2.939
311.5-313.7	Minimize	New Dikes, designed to maintain variable habitat (J-hook)	Approved	0.758	-0.038	2.034	1.276	-0.038	2.034	1.276
314.8-315.8	Minimize	New & existing dikes LD recommend J-hook design	Approved	0.875	-0.044	1.445	0.570	-0.044	1.445	0.570
Pool 14										
320-321	Compensate	Notch 3 interior dikes	Approved	14.127	0.000	22.434	8.307	0.000	22.434	8.307
321-323	Compensate	Notch 5 dikes	Approved	23.614	0.000	31.640	8.026	0.000	31.640	8.026
323.7 - 323.9	Compensate	Notch 2 dikes	Approved	2.909	0.000	4.041	1.133	0.000	4.041	1.133
323-324	Compensate	Notch 9 dikes	Approved	33.576	0.000	45.702	12.126	0.000	45.702	12.126
326.7-328.1	Compensate	notch 7 dikes interior/exterior	Approved	16.620	0.000	27.712	11.092	0.000	27.712	11.092
Pool 15										

Aquatic Mitigation Summary

Nav. Mile	Mitigation Category	Project Description	Corps Technical Acceptability	Total Existing HUs	HUs Effected by 11-ft Project	Total HUs with Mitigated 11-ft Project	Change in Mitigated 11-ft HUs Relative to Baseline	HUs Effected by 12 ft Project	Total HUs with Mitigated 12-ft Project	Change in Mitigated 12-ft HUs Relative to Baseline
336.4	Avoid	NOTE: Site will be avoided to preserve mussel bed	Approved	0.000	0.000	0.000	0.000	0.000	0.000	0.000
336.4		None	Approved	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
348.3		Add to existing island + riprap	Approved	**15.941**	**-7.805**	**4.068**	**-11.873**	**-9.497**	**3.222**	**-12.719**
353.5-354.3		aquatic area converted to terrestrial	Approved	**0.996**	**-0.488**	**0.508**	**-0.488**	**-0.594**	**0.403**	**-0.594**
355	Minimize	Create 3 - 10 acre tern island w/riprap	Approved	**12.011**	**-5.881**	**5.100**	**-6.911**	**-7.156**	**4.039**	**-7.972**
360.6	Compensate	Notch 2 dike	Approved	**3.321**	**0.000**	**6.298**	**2.977**	**0.000**	**6.298**	**2.977**
361-363	Compensate	Relocate gravel to dike field on left descending bank at 360.6. Relocate downstream between rm 360 - 361; monitor & adapt as needed	Approved							
Pool 16										
367.5-367.7	Avoid	No action	Approved	0.000	0.000	0.000	0.000	0.000	0.000	0.000
367.4	Minimize	alternative disposal site for 367.5 - create tern island/w riprap	Approved	**6.310**	**-3.090**	**3.220**	**-3.090**	**-3.759**	**2.551**	**-3.759**
374-375	**Compensate**	**Relocate gravel downstream to rm 373; monitor & adapt as needed**	**Approved**							
379 - 380	Compensate	dredge upper end of oxbow; maintain upper/lower openings	Approved	**89.667**	**0.000**	**127.760**	**38.093**	**0.000**	**127.760**	**38.093**
383.2	Compensate	Dredge mouth of Hopewell Creek	Approved	**0.221**	**0.000**	**0.210**	**-0.011**	**0.000**	**0.210**	**-0.011**
392.1-393.0	Minimize	Notch dikes, create tern island in middle cell	Approved	**13.284**	**-6.504**	**6.545**	**-6.739**	**-7.914**	**5.126**	**-8.158**
393	Compensate	Relocate gravel to dike fields created on Right descending banck at rm 392.1-393.0; monitor & adapt as needed	Approved							
393.2 - 394.1	Avoid & Minimize	1st priority dispose in terrestrial cell, notch internal & lower end dikes; 2nd priority dispose in dike cell above and below bridge. I	Approved	**15.111**	**-7.399**	**12.518**	**-2.593**	**-9.003**	**9.804**	**-5.307**
393.8-394.6	Minimize	Notch added dikes to avoid fill,design to minimize fill (J-hook)	Approved	**9.686**	**-0.485**	**10.033**	**0.347**	**-0.485**	**10.033**	**0.347**
395	Compensate	Relocate gravel to dike fields on left descending bank at rm 393.8; monitor & adapt as necessary	Approved							
sbc 0.4	Minimize	aquatic disposal; create HQ marsh; variable depth 6-in - 2 ft; mussels will be protected from impacts resulting from disposal	Approved	**22.140**	**-10.841**	**16.949**	**-5.191**	**-13.191**	**13.424**	**-8.716**
sbc.4.8	Minimize	**NOTE: site will be redesigned to preserve mussel patch.aquatic disposal will only occur if mussels won't be impacted; create HQ marsh; variable depth 1 - 2 ft;**	**Approved**	**19.926**	**-9.756**	**10.170**	**-9.756**	**-11.872**	**8.054**	**-11.872**
sbc 6.6	Avoid & Minimize	**expand island, design to avoid impacts to mussels; height of disposal will be 1 - 2 ft below water surface**	**Approved**	**2.214**	**-1.084**	**1.130**	**-1.084**	**-1.319**	**0.895**	**-1.319**
sbc 6.9	Avoid & Minimize	**expand island, design to avoid impacts to mussels; height of disposal will be 1 - 2 ft below water surface**	**Approved**	**2.214**	**-1.084**	**1.130**	**-1.084**	**-1.319**	**0.895**	**-1.319**
398.8	Compensate	dredge upper/lower end Okay oxbow install culvert structure	Approved	**0.221**	**0.000**	**0.263**	**0.041**	**0.000**	**0.263**	**0.041**
Pool 17										
402	Compensate	Relocate gravel upstream to rm 403.5 - 404; monitor & adapt as necessary	Approved							
407	Compensate	Dredge Upper/lower end Tullahassee Loop; rework culvert structure	Approved	**0.289**	**0.000**	**0.347**	**0.058**	**0.000**	**0.347**	**0.058**
408.8	Compensate	Dredge mouth of Strawberry Creek	Approved	**6.654**	**0.000**	**7.977**	**1.323**	**0.000**	**7.977**	**1.323**

Aquatic Mitigation Summary

Nav. Mile	Mitigation Category	Project Description	Corps Technical Acceptability	Total Existing HUs	HUs Effected by 11-ft Project	Total HUs with Mitigated 11-ft Project	Change in Mitigated 11-ft HUs Relative to Baseline	HUs Effected by 12 ft Project	Total HUs with Mitigated 12-ft Project	Change in Mitigated 12-ft HUs Relative to Baseline
408.9	Compensate	dredge mouth of Billy Creek Cutoff	Approved	**39.923**	**0.000**	**57.432**	**17.508**	**0.000**	**57.432**	**17.508**
414.7	Compensate	Dredge at culvert structure	Approved	**25.169**	**0.000**	**30.172**	**5.003**	**0.000**	**30.172**	**5.003**
416.7	Compensate	Dredge/rework culvert structure	Approved	**35.295**	**0.000**	**42.311**	**7.016**	**0.000**	**42.311**	**7.016**
418.8	Compensate	Dredge/rework culvert structure	Approved	**10.415**	**0.000**	**12.485**	**2.070**	**0.000**	**12.485**	**2.070**
419.5	Compensate	Dredge mouth of Bull Creek	Approved	**9.836**	**0.000**	**14.150**	**4.314**	**0.000**	**14.150**	**4.314**
421	**Compensate**	**Relocate gravel to rm 417-418.5; monitor & adapt as needed**	**Approved**							
Pool 18										
426.7	Compensate	Dredge mouth of Commodore Creek	Approved	**2.604**	**0.000**	**2.604**	**0.000**	**0.000**	**2.604**	**0.000**
439.7	Compensate	Dredge lower end of oxbow	Approved	**2.314**	**0.000**	**2.314**	**0.000**	**0.000**	**2.314**	**0.000**
442	Compensate	Dredge lower end of oxbow	Approved	**6.365**	**0.000**	**6.365**	**0.000**	**0.000**	**6.365**	**0.000**

C.8

Long Term Monitoring and Adaptive Management

C.8 Long Term Monitoring and Adaptive Management

C.8.1 Purpose

Large river riparian, wetland, and aquatic ecosystems are complex and dynamic. Our understanding of the Arkansas River Ecosystem and our ability to predict how the river will respond to management actions is limited. These knowledge gaps lead to uncertainty over how best to implement mitigation measures to achieve the desirable outcome. Despite these uncertainties, the U.S. Army Corps of Engineers (USACE) must make decisions and implement plans. The purpose of this document is to develop the process framework for monitoring and managing the biological mitigation measures. The McClellan Kerr Arkansas River Navigation System (MKARNS) adaptive management plan will serve as a template for task requirements to achieve defined goals and measurable objectives to accomplish mitigation results. It is the ultimate goal of the USACE to achieve a functioning, self-sustainable ecosystem by mitigating for impacts as a result of the navigation deepening and flow modification project.

C.8.2 Goals and Objectives

The goals and objectives for the adaptive management plan include:

- Form a multi-agency Executive Committee and a scientific advisory review panel.
- Determine the relevant questions that need to be answered by monitoring and scientific research studies.
- Develop standardized monitoring procedures that will be used to determine long term changes in the river and to quantify impacts of the navigation project.
- Develop measurable parameters to determine if mitigation has been adequate to offset losses to fish and wildlife habitat and populations.
- Evaluate long term trends for habitat and fish and wildlife populations using monitoring data
- Based on analysis and recommendations of committee members, modify the adaptive management plan to achieve goals
- The USACE will fund and implement additional mitigation if monitoring information suggests that mitigation was not sufficient or if project impacts are more severe than anticipated.

C.8.3 Adaptive Management Process

C.8.3.1 Executive Committee Composition

A committee charged with implementation of the adaptive management plan should be composed of representatives from the following agencies: USACE, U.S. Fish and Wildlife Service (USFWS), Oklahoma Department of Wildlife Conservation (ODWC), and Arkansas Game and Fish Commission (AGFC). The panel should be charged with responsibilities of evaluating adequacy of monitoring plans, reviewing monitoring data, predicting future-conditions, calling on needed resources (e.g. subject matter experts) for assistance, and evaluating and recommending corrective measures if needed. Multi-agency membership on the committee should take advantage of various areas of expertise and agency perspective for a balanced evaluation of the Arkansas River Watershed.

USACE responsibilities should include convening and organizing panel meetings, funding and conducting monitoring studies, preparing reports, summarizing monitoring activities, conducting panel briefings on monitoring\results and implementing corrective measures and any associated studies as recommended by the committee. While committee meetings could be convened at the request of any member or as warranted by changing conditions, it is anticipated that the committee should initially meet once annually or more frequently as new data area available for review.

An independent scientific review panel would be developed from local, regional, and national experts for each major area of study to ensure scientific rigor of the long term monitoring studies.

C.8.3.2 Committee Decision and Recommendations

Committee decisions and recommendations should be by consensus of committee members. If consensus cannot be reached on any subject matter, it is likely that this process should provide the advantage of generating the necessary information and scientific data (based on input from all agencies) to facilitate science based resolution of these matters in the most appropriate forum. In the event a consensus cannot be reached, the scientific review panel will be consulted for their opinion.

C.8.4 <u>Baseline Development</u>

C.8.4.1 General

Baseline data would be collected from four sites within each identified trend pool. The trend pools and representative sites within each trend pool would be selected by the Executive Committee. Stratified random sampling should be performed so ensure scientific rigor. The sites to be sampled would include proposed mitigation backwater areas and tributaries, representative notched dike fields compared to reference sites and comparison of natural to mitigated gravel bars. Sites sampled would include replicated areas where dikes will be raised and where dredge spoil will be placed in the dike field.

The goal of gathering baseline data would be to document pre-project conditions before the navigation project is implemented, so that meaningful comparisons can be made to post-project conditions. These data would allow us to better assess how stream flow quantity (hydrology) and stream flow quality (water quality) factors affect ecosystem components of the Arkansas River Basin. It is also needed to compare to long-term data to assess impacts related to MKARNS deepening project. However, we are aware that because of natural variations in hydrology and biological populations that several years of pre-project monitoring would be required to make scientifically rigorous decisions.

Biological evaluation criteria used would include:

- species composition
- relative abundance of species
- distribution of species
- sportfish stock descriptors
- water quality factors that affect biotic communities
- water quality and flow regime factors that affect biotic communities
- habitat substrate, depth, velocity, and woody structure
- determination of appropriate sampling times, locations and efforts

Sampling sites would be selected based on the following criteria

- Stratified random sampling with replication to ensure scientific rigor.
- long-term availability and access for sampling
- likelihood of consistently obtaining samples that adequately reflect fish communities within the reach
- diversity of habitat types within the site location

Replicated sample sites would be randomly selected to complement the collection of data for other components of the biological community. Repeated-measures statistical designs will be evaluated since they may allow for more consistency in sample sites, and it would allow greater determination of the relationships of the fish community structure to other ecosystem components including the benthic invertebrate community, the aquatic macrophyte community, in-stream habitat and water quality.

C.8.4.2 Methodology

All sampling methods will be agreed upon before sampling is initiated by the Executive Committee, and committee members may request a review by the Independent Science Review Panel. Sampling methods may need to vary depending upon the physical characteristics of sampling reaches and stations and microhabitats present. Sampling methods and effort would be standardized within each sample site and would remain consistent, when possible, throughout both the baseline and long-term sampling periods. Sampling effort would be recorded for determination of catch-per-unit effort. All sampling would generally follow the protocol contained in the USGS's National Water-Quality Assessment Program (1993 Open File Report 93-104), *"Methods for Sampling Fish Communities as a Part of the National Water-Quality Assessment Program"*.

I believe that a review of the Upper Mississippi and Missouri monitoring protocols is needed before we can agree to use USGS protocols. This is going to depend on study questions.

C.8.5 <u>Long Term Monitoring</u>

The long term monitoring program would be used to detect ecosystem changes attributable to the MKARNS deepening project. Long term monitoring data would be evaluated in the context of baseline data.

Study questions that are important must first be identified before any study design or methods are discussed.

C.8.6 <u>Aquatic</u>

Some questions concerning aquatic resources include:

1. How much surface acreage of water would be converted to terrestrial land by the project.
2. What is the measured dike-filling rate for each pool and how does that compare to previous model predictions?
3. How many major new dredge areas develop in the main channel after project completion, and what habitat impacts are realized from dredging those areas?
4. How many new unanticipated dikes and revetments are constructed?

C.8.6.1 Sediment Dynamics

Monitoring would be conducted on representative pools of the river throughout the navigation system at replicated sites. Monitoring parameters would include bathymetry, substrate (faces) sampling, LIDAR and GIS. The sedimentation analysis would be used in conjunction with the habitat quality to determine if mitigation measures are effective. Sedimentation analysis would determine if the dike filling coefficient is realistic and how much additional aquatic habitat is converted to terrestrial habitat by the project.

C.8.6.2 Quality of Habitat

Some questions concerning quality of habitat include:

1. What is the impact of the project on woody debris abundance and distribution?
2. What is the fish community response to reduced habitat volume in dike field that are raised or aquatic areas where dredge spoil is deposited?
3. How does opening the mouth of the backwater influence water quality and the fish community?
4. Do artificial gravel bars persist and function like natural gravel bars?
5. Do mussel recovery efforts lead to sustainable mussel populations in the impacted areas and outside of impacted areas?
6. Are state water quality standards met by the project?

(1) Backwaters and Tributary mouths - Monitoring would include substrate sampling and water quality parameters. Representative sites would be re-evaluated for HSI values to determine if projected habitat values are achieved from opening backwaters. Fish samples would

be taken. Emphasis on tributary mouth is important because the transition zone facilities high diversity.

GOAL: Improve habitat value. This is a habitat goal and objective vs. a study objective, so we should state that or it becomes confusing.

OBJECTIVES: Improve HSI value and maintain current fish diversity.

(2) Gravel bars – Baseline data would be gathered from gravel bars identified to be impacted by the deepening project. Baseline core samples would be obtained to determine depth of gravel beds and classification for heavily impacted large gravel beds. USACE H&H staff would model current location of gravel bars to determine site characteristics and velocities and select new sites for relocating the gravel to based on those characteristics. Representative relocated gravel beds and reference (non-impacted) gravel beds would be monitored to determine changes to substrate and quality of habitat.

GOAL: No net loss of gravel bar habitat.

OBJECTIVES: Status quo of function and value of gravel bar habitat as compared to baseline conditions.

(3) Dike fields – Monitoring would include seasonal and nighttime sampling of fish to determine presence, relative abundance, and diversity. Bathymetry and LIDAR data would be used for general analysis and trends. Comparison of replicated notched and un-notched dike fields, with and without dredge spoil placement and dike raising would be made to determine if assumptions and predicted HSI values were correct.

GOAL: Active Disposal – Minimize impact to habitat quality
Non-Active Disposal - Improve habitat quality and diversity.

OBJECTIVES: Active Disposal – Minimize acceleration of sedimentation through notching;
In-Active Disposal – achieve higher HSI values through greater fish diversity, and improved water quality.

Raised dikes - ??

(4) Mussel Patches and Beds - Relocated mussels would be monitored in their new location once a year for three years and then every other year for a maximum of 10 years of monitoring. Monitoring would be conducted during disposal operations (OK/AR) to determine if existing mussel populations are adversely impacted. Monitoring of relocation sites would be conducted to ensure sustainability of new populations.

GOAL: Minimize impacts to population and maintain species diversity through re-establishing in decimated areas.

OBJECTIVES: 75% survival rate of relocation population and eventual sustainability.

(5) Physical and Chemical Quality of Water – Monitoring will occur throughout the system and used as an overall indicator of healthy and sustainability of the target habitats. Parameters and methodologies include temperature, dissolved oxygen, turbidity, and suspended solids.

GOAL: Minimize impacts.

OBJECTIVES: Obtain state water standards for all parameters, and where possible improve water quality.

C.8.7 <u>Terrestrial</u>

C.8.7.1 Quality of Habitat

1. Bottomland Hardwoods – The ODWC would maintain the mitigation areas. Anticipated HSI values were calculated to create expected objectives on diversity and health of ecosystem. Sustainability of the area is the ultimate goal. Performance standards may include: achieving a survival rate of installed trees and shrubs exceeding 75 percent after 3 years, achieving a stems per acre count for bare-root seedling reforestation of greater than 300 individuals of native species surviving after 5 years, and species diversity of plantings and volunteer recruitment with no single species constituting greater than 30 percent of the individuals at the end of the monitoring term.

2. Marshlands – The ODWC would maintain the mitigation areas. Anticipated HSI values were calculated to create expected objectives on diversity and health of ecosystem. Hands-on management of the system by ODWC is anticipated to achieve restoration goals. Performance standards may include: achieving percent ground cover rate with desirable wetland or aquatic plant species exceeding 80 percent at 3 years, species diversity of plantings and volunteer recruitment with no single species constituting greater than 30 percent of the individuals at the end of the monitoring term.

C.8.7.2 Monitoring

Monitoring would generally require a minimum of three inspections each year, all during the growing season for three years and then 3 additional periods every 5 years for a total of 6 years of monitoring. These inspections should be scheduled to correspond to the spring, summer, and fall seasons. The information gathered during site inspections should focus on the performance standards developed by the executive committee. Monitoring activities would include assessment of the hydrologic, vegetative, and physical features of the mitigation site. Depending on the vegetative plan for the site and the plans performance standards, herbaceous, shrub, and tree strata would likely require independent assessment. Hydrologic monitoring may include the installation and monitoring of wells or staff gauges, observation and recording of water levels, and documentation of interactions with adjacent aquatic areas (in-flow and out-flow). Vegetative assessment should include identification of dominant plants to the species level, size, density, and condition of growth (health and vigor). Physical feature monitoring includes such aspects as the stability of construction disturbed soils, condition and stability of constructed features, adequacy of soil compaction or preparation, influences from adjoining lands, etc. Appendix A is a summary of the project timeline and costs for long-term monitoring.

C.8.7.3 Threatened and Endangered Species

1. Interior Least Tern – Monitoring would be conducted in accordance with USFWS Biological Opinion.

2. American Burying Beetles – Prior to construction of terrestrial disposal sites in potential habitat areas baseline surveys would be conducted to determine presence of species. Standard procedures would be implemented to bait and avoid any impact during construction.

In addition to basic monitoring described above, the committee could recommend and oversee additional monitoring efforts as appropriate. Responsibilities for funding and implementing all monitoring studies should rest with the USACE though other agencies could participate in sample collection or other monitoring activities as desired. Initial estimates of frequency of monitoring data collection are provided in the adaptive management plan but could be altered by recommendation of the committee.

C.8.8 Adaptive Management

C.8.8.1 Aquatic

1. Sediment Dynamics – Sediment dynamics would be affected by dike notching, dredging, dredge disposal, and constructing or modifying river training structures. Monitoring data of sedimentation and habitat quality would be compared to baseline data and assumptions to determine if changes should be made to any of the above features to achieve higher habitat values.
2. Quality of Habitat

(1) Backwaters and Tributary mouths – Maintenance dredging of backwater areas would occur periodically during routine operations and maintenance of the navigation channel. If through monitoring, the projected HSI values are not being achieved additional dredging or other innovative measures would be investigative and implemented. .

(2) Gravel bars – If relocation of gravel does not achieve the anticipated results, additional analysis and re-modeling would occur to determine more sustainable locations for gravel beds.

(3) Dike fields – It is anticipated that dike notching and modification to training structures would positively affect habitat quality in the dike fields where disposal is not anticipated. . Notching is anticipated to reduce the filling rates of the dike fields and increase habitat diversity. If fish sampling, water quality, and sediment analysis do not indicate predicted

HSI values have been realized, additional dredging and habitat creation would be evaluated and implemented.

(4) Mussel beds – If relocated populations are not thriving alternate sites would be evaluated. If monitoring indicates mussel beds are being adversely affected from in-stream disposal then disposal techniques would be re-evaluated and new methodologies would be implemented.

C.8.8.2 Terrestrial

Quality of Habitat. Hardwoods and Marshlands – ExHEP monitoring is used as an indicator of the expected health and sustainability of the ecosystem. If monitoring indicates degradation or system failure based on predetermined criteria, the reasons for the failure would need to be evaluated and measures taken to achieve the stated goals. This may include operational and maintenance changes or additional plantings.

C.8.8.3 Threatened and Endangered Species

1. Interior Least Tern – Not evaluated for adaptive management as part of the project. However, compliance and requirements of the ESA dictate requirements and adjusted would be made in consultation between USACE and USFWS.

2. American Burying Beetles – Not required.

APPENDIX A – SUMMARY LONG TERM MONITORING

MONITORING TASK	TARGET PARAMETERS	SAMPLING
SEDIMENT DYNAMICS		
Bathymetry	Trends – Depth changes over time	Select areas at the following times (baseline, 4 water years with an attempt at one each low, medium, high)
Backwater & Tributary Mouth	HSI values	Reduce excessive sedimentation that is degrading aquatic habitat through dredging.
Substrate Sampling	Classification and diversity of river bottom habitat	Select areas to include dike fields and backwaters, four sampling periods for comparison, sites determine by executive committee for appropriate representation.
LIDAR/GIS	General Trends of deposition and vegetation growth; Aquatic habitat volume and acreage.	Entire river (3 time periods: preconstruction, immediately following construction, post construction)
AQUATIC HABITAT		
Backwater reevaluations	HSI values from mitigation measure assumptions – Based on 11 year target	Delphi committee re-evaluates some reference areas and dredged areas – baseline and 3 times post baseline
Tributary Mouths	Diversity and Presence	Delphi committee re-evaluates some reference areas and dredged areas – baseline and 3 times post baseline
Gravel Modeling	Areas of sustainable substrate	Baseline models
Gravel Monitoring	Habitat quality and diversity	Baseline core sampling for depth and classification, invertebrate presence/absence (baseline / two post construction). Fish use of the gravel habitat
Fish Sampling	Diversity, relative abundance, presence, and sportfish stock	Backwaters and Dike fields (baseline season and 3 water years varied)

	descriptors	
Mussel Bed Monitoring	Sustainability of relocated populations and turbidity at mussel beds during in-stream disposal operations adjacent to known large populations	Patch will be sampled before dredging, 6 mo and 1 yr after dredging This appears to be differerent from what was said above.
TERRESTRIAL HABITAT		
Hardwoods	Habitat Quality and Sustainability	EC re-evaluates using ExHEP protocol on new sites. Monitoring 3 inspections/yr for 3 years and then 3 additional survey cycles on 5 year intervals for a total of 6 years.
Marshlands	Healthy functions and values	EC evaluates site using exhep protocol. Monitoring includes 3 inspections/year for 3 years and then 3 additional cycles on 5 yr intervals for a total of 6 years.
PHYSICAL AND CHEMICAL WATER PARAMETERS		
Water Quality (all Gravel beds, representative backwaters, representative dike fields)	Dissolved Oxygen, Turbidity, Temperature, …	Baseline, plus 3 water years

APPENDIX B – SUMMARY ADAPTIVE MANAGEMENT

HABITAT	TARGET PARAMETERS	ADAPTIVE MANAGEMENT
Backwater & Tributary Mouth	Improve HSI values over baseline	If degradation of aquatic habitat is occurring from sedimentation, then dredging would be implemented
GRAVEL BARS	No net loss	If gravel bars are not able to be relocated additional modeling and relocation activities will be implemented
DIKE FIELDS	HSI values minimize sedimentation	If desired results are not achieved, additional notching would occur or exploration of advanced techniques. Other aquatic mitigation measures would need to be identified and

		implemented.
MUSSEL BEDS	Re-colonization	If relocated mussels are not thriving habitat improvement and additional relocations would be implemented
Terrestrial	HSI value goals	If desired results are not achieved, additional plantings and adjustment to management techniques would be implemented.

C.9

Aquatic Mitigation Cost Effective and Incremental Cost Analysis

C.9 Cost Effectiveness and Incremental Cost Analyses of Aquatic Mitigation Sites

Following identification of the recommended plan, including consideration of estimated environmental impacts in habitat units, cost estimates were developed for the individual mitigation measures. As required by ER 1105-2-100, C-3.e., mitigation costs must be justified by demonstrating cost effectiveness and reasonableness of incremental costs. The mitigation measures (ordered by river mile in summary table C.6.2) were developed by the inter-agency collaboration team for numerous potential mitigation sites and activities. The team evaluated impacts and benefits in habitat units, and focused on best development of the site based on combined professional expertise and familiarity with riverine processes and habitat. Thus the team evaluation produced what may be termed optimum development for each measure, thereby creating a single measure that is the cost effective alternative for the site or activity. The measures were further screened for engineering and other technical feasibility, reducing the number of options available to meet the mitigation targets identified for the lower waterway (Arkansas) and the upper waterway (Oklahoma).

The incremental cost analysis (ICA) was performed by dividing implementation costs for each item by its average annual habitat units to estimate the cost per AAHU. The measures were sorted in ascending order of cost per AAHU so that the incremental cost of each succeeding measure is greater than the previous measure. The amount of change from existing HUs were accumulated measure by measure until the mitigation targets were achieved This ensures that the incremental costs of the measures included in the aquatic mitigation plan are the least costly of the measures available. ICA results are shown in the following tables.

Table C.9-1. Aquatic Mitigation Features – Arkansas Portion

Nav. Mile	Project	Future without Project AAHUs	Total AAHUs with 12-ft Project	AAHUs Effected by 12-ft Project	Total AAHUs with Mitigated 12-ft Project	Change in Mitigated 12-ft AAHUs Relative to Baseline (1)	Cost	Cost Per AAHU	Running Total AAHU's	Percent Mitigation	Running Total Cost	Incremental Change in AAHU's	Incremental Cost
23.6 R	Avoid RB disposal	3.558	3.145	-0.413	0.948	-2.610	$0.00	$0.00	0.948	0.03%	$0.00	0.948	$0.00
27L	Avoid aquatic disposal, utilize land	2.453	1.677	-0.776	1.677	-0.776	$0.00	$0.00	2.625	0.08%	$0.00	1.677	$0.00
35R	Notch modified dikes (2)	6.439	6.439	0.000	6.439	0.000	$0.00	$0.00	9.064	0.27%	$0.00	6.439	$0.00
36.4-37.0R	Extend disposal area u/s to 38.1R, avoid blocking entrance to chute at 36.4R and 38.1R	5.692	5.031	-0.661	3.434	-2.258	$0.00	$0.00	12.498	0.38%	$0.00	3.434	$0.00
37.8-38.4L	Avoid disposal, utilize RB.	5.692	5.031	-0.661	3.203	-2.489	$0.00	$0.00	15.701	0.47%	$0.00	3.203	$0.00
40R	Notch existing revetment/dike (1)	1.533	1.533	0.000	1.533	0.000	$0.00	$0.00	17.235	0.52%	$0.00	1.533	$0.00
39.8-40.0L	Avoid disposal, utilize right bank	1.518	1.342	-0.176	1.221	-0.297	$0.00	$0.00	18.455	0.55%	$0.00	1.221	$0.00
44-44.7R	Utilize AR44.3R-D for disposal and extend d/s to 43.0R	0.854	0.755	-0.099	0.755	-0.099	$0.00	$0.00	19.210	0.58%	$0.00	0.755	$0.00
45.4-46L	Avoid disposal in aquatic areas of AR45.3L-D, dispose on land or preferably on RB	8.348	7.379	-0.969	5.045	-3.304	$0.00	$0.00	24.254	0.73%	$0.00	5.045	$0.00
46.8-49.2L	Utilize land within cells for disposal at AR48.0L-D, avoid aquatic areas	11.289	9.979	-1.311	9.979	-1.311	$0.00	$0.00	34.233	1.03%	$0.00	9.979	$0.00
49.6-49.9	Utilize existing in-channel disposal	1.044	0.922	-0.121	0.922	-0.121	$0.00	$0.00	35.156	1.06%	$0.00	0.922	$0.00
64.8-65.3L	Utilize AR65.2L-D or in-channel disposal at AR65.5Channel-D	10.084	7.595	-2.489	7.595	-2.489	$0.00	$0.00	42.751	1.29%	$0.00	7.595	$0.00
65.2-65.6	Utilize AR65.2L-D or in-channel disposal at AR65.5Channel-D	2.548	1.919	-0.629	1.919	-0.629	$0.00	$0.00	44.670	1.34%	$0.00	1.919	$0.00
85.5-85.8R	Avoid disposal if possible and utilize in-channel disposal	6.210	5.033	-1.176	4.952	-1.258	$0.00	$0.00	49.621	1.49%	$0.00	4.952	$0.00
85.6-85.8	Utilize in-channel disposal	0.430	0.349	-0.081	0.349	-0.081	$0.00	$0.00	49.970	1.50%	$0.00	0.349	$0.00
87.7L	Investigate dredging channel into oxbow lake	69.697	69.697	0.000	69.697	0.000	$0.00	$0.00	119.667	3.60%	$0.00	69.697	$0.00
91.5L	Bank stab and revetment at 91.5 is needed (current – 0.3)	2.291	2.291	0.000	3.636	1.344	$0.00	$0.00	123.302	3.71%	$0.00	3.636	$0.00
96.0-98.2R	Enlarge and utilize RB disposal, investigate disposing behind modified revetment and dikes, investigate terrestrial disposal if needed	5.347	3.165	-2.181	3.165	-2.181	$0.00	$0.00	126.468	3.80%	$0.00	3.165	$0.00
100.6-101.3R	Utilize this area as alternative disposal site	4.710	2.788	-1.922	2.788	-1.922	$0.00	$0.00	129.256	3.89%	$0.00	2.788	$0.00
106.5-107.7L	Avoid aquatic disposal in AR107.1L, utilize land areas or in-channel disposal	49.007	33.483	-15.524	33.483	-15.524	$0.00	$0.00	162.739	4.89%	$0.00	33.483	$0.00
124.2-124.5L	Avoid disposal in AR124.8L-D, utilize in-channel disposal	3.500	3.500	0.000	0.133	-3.366	$0.00	$0.00	162.873	4.90%	$0.00	0.133	$0.00
124.8-125.1	Utilize in-channel disposal at AR124.8 Channel-D	2.800	2.800	0.000	2.933	0.133	$0.00	$0.00	165.806	4.99%	$0.00	2.933	$0.00
126.6-127.0R	Avoid disposal on RB	8.220	6.892	-1.327	6.892	-1.327	$0.00	$0.00	172.698	5.19%	$0.00	6.892	$0.00

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Nav. Mile	Project	Future without Project AAHUs	Total AAHUs with 12-ft Project	AAHUs Effected by 12-ft Project	Total AAHUs with Mitigated 12-ft Project	Change in Mitigated 12-ft AAHUs Relative to Baseline (1)	Cost	Cost Per AAHU	Running Total AAHU's	Percent Mitigation	Running Total Cost	Incremental Change in AAHU's	Incremental Cost
139.5-141R	Avoid disposal from 140R u/s to 141R to prevent blockage of opening between islands, utilize 140R d/s to tip of island	12.991	10.893	-2.098	8.912	-4.079	$0.00	$0.00	181.609	5.46%	$0.00	8.912	$0.00
141.5-142.5R	Utilize disposal behind raised and extended L-dikes at 142.0R	6.897	5.783	-1.114	0.000	-6.897	$0.00	$0.00	181.609	5.46%	$0.00	0.000	$0.00
143.7-144.2L	Construct L-dike or revetment and use disposal to slope and protect bank	6.509	3.833	-2.677	5.110	-1.399	$0.00	$0.00	186.720	5.61%	$0.00	5.110	$0.00
146.3R	Avoid disposal in this area	22.218	17.652	-4.566	16.823	-5.395	$0.00	$0.00	203.542	6.12%	$0.00	16.823	$0.00
146.6-147.8R	Utilize land within disposal cells	4.651	3.900	-0.751	3.900	-0.751	$0.00	$0.00	207.442	6.24%	$0.00	3.900	$0.00
147.8-150L	Avoid disposal from 149-150L that would block the entrance to backwater area, utilize disposal area d/s of 149L	28.322	16.676	-11.646	5.005	-23.316	$0.00	$0.00	212.448	6.39%	$0.00	5.005	$0.00
154-154.6L	Avoid RB disposal, Utilize land disposal within cells at AR154.1L-D	0.000	0.000	0.000	0.000	0.000	$0.00	$0.00	212.448	6.39%	$0.00	0.000	$0.00
155.4L	Utilize land within cell at AR155.4L-D	0.000	0.000	0.000	0.000	0.000	$0.00	$0.00	212.448	6.39%	$0.00	0.000	$0.00
163.6-165.2R	163.6-165.3 - Revetment is needed for bank stabilization	1.059	0.751	-0.307	0.751	-0.307	$0.00	$0.00	213.199	6.41%	$0.00	0.751	$0.00
164.2-164.7L	Avoid LB disposal, utilize disposal behind revetment on RB	11.379	8.076	-3.303	5.157	-6.221	$0.00	$0.00	218.356	6.57%	$0.00	5.157	$0.00
165.5-166.2R	Avoid disposal in AR166.0R-D	22.440	15.927	-6.513	13.008	-9.432	$0.00	$0.00	231.365	6.96%	$0.00	13.008	$0.00
176.2-176.4	Avoid disposal in AR176.2L-D, utilize RB land disposal on Lentz property	2.420	2.104	-0.316	2.104	-0.316	$0.00	$0.00	233.468	7.02%	$0.00	2.104	$0.00
179.3-179.7R	Utilize disposal at 179.6R behind revetment	11.010	6.602	-4.408	2.723	-8.287	$0.00	$0.00	236.191	7.10%	$0.00	2.723	$0.00
185.8-186.4	Avoid disposal in AR186.2L-D, create artificial gravel bar downstream of dikes from 185L-186L	7.446	5.282	-2.164	2.591	-4.855	$0.00	$0.00	238.782	7.18%	$0.00	2.591	$0.00
186.9-189.9R	*Existing least tern island - avoid construction during nesting, limited disposal to avoid elevating island and maintain fish access to backwater, notch revetment and dikes (3-6) for flow-through, fish passage and access	201.663	143.045	-58.618	143.045	-58.618	$0.00	$0.00	381.827	11.48%	$0.00	143.045	$0.00
190.5-192R	New dredge disposal alternative to 189.5L will create elevated vegetated shoreline on Sweeden Island	4.918	2.949	-1.969	5.262	0.344	$0.00	$0.00	387.089	11.64%	$0.00	5.262	$0.00
200.2L	Utilize land disposal within cells from 200.8L d/s to 200L, avoid disposal u/s of 200.8L	25.323	15.185	-10.138	15.185	-10.138	$0.00	$0.00	402.274	12.10%	$0.00	15.185	$0.00
204.6-205.1R	Utilize in-channel disposal (gravel)	18.615	13.204	-5.411	13.204	-5.411	$0.00	$0.00	415.478	12.49%	$0.00	13.204	$0.00
232R	No adverse impact, bank stabilization is needed at this area	0.364	0.364	0.000	0.349	-0.015	$0.00	$0.00	415.827	12.50%	$0.00	0.349	$0.00
233L	Utilize land disposal in AR233.0L-D if needed	0.000	0.000	0.000	0.000	0.000	$0.00	$0.00	415.827	12.50%	$0.00	0.000	$0.00

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236.6L	Utilize this site for disposal	0.000	0.000	0.000	0.000	0.000	$0.00	$0.00	415.827	12.50%	$0.00	0.000	$0.00
239.5R	239RB-Maintain fish access through revetmetment. Modified revetment along RB will have no adverse impacts	27.373	27.373	0.000	26.266	-1.107	$0.00	$0.00	442.093	13.29%	$0.00	26.266	$0.00
241.8-242.2R	Utilize this site for disposal	5.685	3.777	-1.907	0.000	-5.685	$0.00	$0.00	442.093	13.29%	$0.00	0.000	$0.00
243.8-246.8L	Avoid disposal (none currently scheduled) in AR245.6L-D, notch dike d/s of most d/s island at 244.5L	88.234	49.229	-39.005	49.229	-39.005	$0.00	$0.00	491.322	14.77%	$0.00	49.229	$0.00
249.7L	Alternative disposal site for AR248.0R-D	0.874	0.487	-0.386	-0.060	-0.933	$0.00	$0.00	491.262	14.77%	$0.00	-0.060	$0.00
254.1-254.5L	Alternative disposal site inside closed revetment at 254.1L, no previously approved disposal area indicated on map	0.728	0.406	-0.322	-0.193	-0.921	$0.00	$0.00	491.069	14.77%	$0.00	-0.193	$0.00
255.7-256.1R	Avoid, use AR256.2L-D for disposal instead of AR256.0R-D	1.467	0.975	-0.492	0.975	-0.492	$0.00	$0.00	492.044	14.79%	$0.00	0.975	$0.00
255.9-256.2L	Prefer to use this terrestrial area for disposal	0.000	0.000	0.000	0.000	0.000	$0.00	$0.00	492.044	14.79%	$0.00	0.000	$0.00
271.2-273R	Utilize this RB site for disposal	1.323	0.559	-0.763	-1.028	-2.351	$0.00	$0.00	491.016	14.76%	$0.00	-1.028	$0.00
278.9-280.3L	At AR279.5L-D avoid disposal in aquatic areas, utilize land within disposal area and AR280.0R-D,	131.189	85.914	-45.275	85.914	-45.275	$0.00	$0.00	576.930	17.35%	$0.00	85.914	$0.00
283.5-284.7R	Recommend constructing new disposal at 284R	1.746	0.738	-1.007	0.738	-1.007	$0.00	$0.00	577.668	17.37%	$0.00	0.738	$0.00
284.7-287.4	Avoid disposal in d/s cells on LB and RB, prefer disposal d/s in new area	46.658	19.733	-26.924	15.704	-30.954	$0.00	$0.00	593.372	17.84%	$0.00	15.704	$0.00
288.4-289L	Avoid disposal in AR289.0L-D and place dredged gravel along right bank downstream and extend downstream gravel bar at 289.7R	7.776	3.289	-4.487	-0.741	-8.517	$0.00	$0.00	592.631	17.82%	$0.00	-0.741	$0.00
288.8-289.8R	Utilize this alternative disposal area	6.348	2.685	-3.663	-1.345	-7.693	$0.00	$0.00	591.287	17.78%	$0.00	-1.345	$0.00
290.5-291.4R	Utilize dry cells in this disposal area	1.640	1.074	-0.566	0.000	-1.640	$0.00	$0.00	591.287	17.78%	$0.00	0.000	$0.00
291.8-292.3L	Avoid disposal at 292.3L	5.261	3.446	-1.816	3.446	-1.816	$0.00	$0.00	594.732	17.88%	$0.00	3.446	$0.00
189.2	189.2 - Notch revetment and dikes for fish passage and access to backwater	67.852	67.852	0.000	88.160	20.309	$726.00	$8.23	682.893	20.53%	$726.00	88.160	$8.23
187.2R	Notch long L-dike at 187.2R (2)	82.208	82.208	0.000	82.208	0.000	$726.00	$8.83	765.101	23.00%	$1,452.00	82.208	$8.83
283.1-283.9L	283.9L - Notch modified revetment in upper cell (High priority)	21.579	21.579	0.000	41.715	20.135	$726.00	$17.40	806.815	24.26%	$2,178.00	41.715	$17.40
135-138.2R	Avoid disposal in aquatic areas, utilize island disposal, (*potential existing tern site), notch two lower dikes	86.607	72.621	-13.987	81.698	-4.909	$1,452.00	$17.77	888.513	26.72%	$3,630.00	81.698	$17.77
24-25L	Notch modified revetment (2) and modified dike (1)	92.917	92.917	0.000	118.441	25.524	$2,178.00	$18.39	1006.954	30.28%	$5,808.00	118.441	$18.39

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134.5R	Notch existing dike (1) at 134.7R for fish passage and access to Mill Bayou	35.402	35.402	0.000	35.402	0.000	$726.00	$20.51	1042.356	31.34%	$6,534.00	35.402	$20.51
235-236.8R	Notch existing dike and raised dike (2-3) in AR236.0R-D, place dredged material on existing islands within disposal area	105.624	70.187	-35.437	100.346	-5.278	$2,178.00	$21.70	1142.702	34.36%	$8,712.00	100.346	$21.70
238.5-241.2	Maintain and/or notch existing and modified dikes (3)	74.279	74.279	0.000	96.925	22.646	$2,178.00	$22.47	1239.627	37.27%	$10,890.00	96.925	$22.47
279-280.1L	Notch modified revetment at 279L and 280.2L to maintain high value for backwater area	67.644	67.644	0.000	91.534	23.890	$2,178.00	$23.79	1331.161	40.02%	$13,068.00	91.534	$23.79
58.3L	Notch revetment at 58.3L	17.112	17.112	0.000	28.093	10.981	$726.00	$25.84	1359.254	40.87%	$13,794.00	28.093	$25.84
180.2R	Notch existing dike at 180.2R for fish passage and access to backwater	15.414	15.414	0.000	22.889	7.475	$726.00	$31.72	1382.143	41.56%	$14,520.00	22.889	$31.72
134.2R	Notch existing revetment (1) at 134.2R and	13.247	13.247	0.000	22.012	8.765	$726.00	$32.98	1404.155	42.22%	$15,246.00	22.012	$32.98
305.3-306R	Notch revetment at 305.7 and 306R	24.497	24.497	0.000	38.550	14.054	$1,278.00	$33.15	1442.705	43.38%	$16,524.00	38.550	$33.15
32L	Notch revetment (4) and existing dike (1)	84.322	84.322	0.000	107.485	23.163	$3,630.00	$33.77	1550.190	46.61%	$20,154.00	107.485	$33.77
100.3-101.1L	Notch existing dikes (2), *Existing tern island on LB, avoid work during nesting season	39.718	39.718	0.000	39.718	0.000	$1,452.00	$36.56	1589.908	47.80%	$21,606.00	39.718	$36.56
19.8L	Notch existing revetment (1)	9.505	9.505	0.000	16.963	7.458	$726.00	$42.80	1606.871	48.31%	$22,332.00	16.963	$42.80
27.8-28.5L	Notch modified revetment (1) and existing dike (1)	33.116	22.641	-10.474	32.256	-0.859	$1,452.00	$45.01	1639.127	49.28%	$23,784.00	32.256	$45.01
275.2-276.6R	Notch dikes (2) that connect to shoreline	31.740	31.740	0.000	31.740	0.000	$1,452.00	$45.75	1670.867	50.24%	$25,236.00	31.740	$45.75
39.8L	Notch modified revetment at 39.3L and 39.7L	24.469	24.469	0.000	31.190	6.722	$1,452.00	$46.55	1702.057	51.18%	$26,688.00	31.190	$46.55
148.7-150.4R	Avoid disposal, notch dike at 149R	22.383	13.179	-9.204	13.537	-8.846	$726.00	$53.63	1715.594	51.58%	$27,414.00	13.537	$53.63
290R	Notch existing dike if feasible	13.490	13.490	0.000	13.490	0.000	$726.00	$53.82	1729.084	51.99%	$28,140.00	13.489	$53.82
238.5-239.9L	*Existing tern island at 239.5L, avoid disposal in AR238.5L-D, alternately use 240.1-241.0 L, investigate terrestrial disposal, create and/or exend island, notch land side of dikes, do not cut off backwater at 241.1L	89.120	59.221	-29.900	78.331	-10.790	$4,303.93	$54.95	1807.414	54.34%	$32,443.93	78.331	$54.95
70.0-70.7L	Notch two longest existing dikes (2)	14.815	14.815	0.000	23.203	8.387	$1,452.00	$62.58	1830.617	55.04%	$33,895.93	23.203	$62.58
37.5-38.6L	Notch raised L-dikes	10.671	10.671	0.000	10.671	0.000	$726.00	$68.04	1841.288	55.36%	$34,621.93	10.671	$68.04
242-244.1L	Avoid disposal in AR242.2L-D at entrance to Hartman Lake, utilize AR241.8R-D and AR244.0R-D if needed, deepen notch in modified revetment	12.531	8.327	-4.204	9.118	-3.413	$726.00	$79.63	1850.405	55.64%	$35,347.93	9.118	$79.63

Table C.9-1. Aquatic Mitigation Features – Arkansas Portion													
Nav. Mile	**Project**	**Future without Project AAHUs**	**Total AAHUs with 12-ft Project**	**AAHUs Effected by 12-ft Project**	**Total AAHUs with Mitigated 12-ft Project**	**Change in Mitigated 12-ft AAHUs Relative to Baseline (1)**	**Cost**	**Cost Per AAHU**	**Running Total AAHU's**	**Percent Mitigation**	**Running Total Cost**	**Incremental Change in AAHU's**	**Incremental Cost**
142.5-143.4R	Notch modified dikes (2) at entrance to beaver dam channel for flow-through	11.991	11.991	0.000	18.217	6.226	$1,452.00	$79.71	1868.622	56.19%	$36,799.93	18.217	$79.71
27.5-29R	Notch modified dikes (4) and existing dike (1)	43.173	29.517	-13.656	42.052	-1.120	$3,630.00	$86.32	1910.675	57.45%	$40,429.93	42.052	$86.32
31.8-33.1L	Avoid LB disposal, utilize RB, notch modified revetment (4) and existing dike (1) across backwater	38.022	25.995	-12.026	29.703	-8.319	$3,630.00	$122.21	1940.377	58.34%	$44,059.93	29.703	$122.21
189.9.190.5L	Notch modified revetment in two places (2)	13.525	13.525	0.000	10.995	-2.530	$1,452.00	$132.06	1951.372	58.67%	$45,511.93	10.995	$132.06
101.5-103.7L	Avoid disposal, notch existing dikes (10-12) for flow-through and to enhance diversity	82.702	54.599	-28.102	54.599	-28.102	$7,260.00	$132.97	2005.971	60.31%	$52,771.93	54.599	$132.97
105.2-106.0L	*Existing tern island(s), avoid work during nesting season, construct high water notches in dikes (4) to restore and maintain islands	2.162	2.162	0.000	21.582	19.420	$2,904.00	$134.56	2027.554	60.96%	$55,675.93	21.582	$134.56
280.6-280.9	280.8L - Notch modified dikes (3)	11.850	11.850	0.000	16.034	4.185	$2,178.00	$135.83	2043.588	61.45%	$57,853.93	16.034	$135.83
161.2-162.2L	Notch existing dikes (3-4) from 161.2-162.2L	13.337	13.337	0.000	20.621	7.284	$2,904.00	$140.83	2064.209	62.07%	$60,757.93	20.621	$140.83
275-276L	Notch modified dikes (3)	10.157	10.157	0.000	13.744	3.587	$2,178.00	$158.47	2077.953	62.48%	$62,935.93	13.744	$158.47
48.7-50.2R	Utilize land within cells for disposal in 49.4R-D, avoid aquatic areas, notch existing revetments/dikes in two most u/s cells (2)	5.118	4.524	-0.594	8.593	3.475	$1,452.00	$168.97	2086.546	62.74%	$64,387.93	8.593	$168.97
64-65R	Avoid disposal in AR64.5R-D, notch existing revetments and/or dikes (3)	11.677	8.794	-2.882	12.105	0.428	$2,178.00	$179.93	2098.651	63.10%	$66,565.93	12.105	$179.93
150-151.7L	Avoid disposal from 150-151L that would block side channel and backwater entrance, construct a series of tern islands where feasible, notch existing dike at 150.8L for fish passage and backwater entrance	62.810	36.983	-25.827	76.463	13.653	$13,805.40	$180.55	2175.113	65.40%	$80,371.33	76.463	$180.55
145.2-146.2L	Notch modified dikes (7)	17.130	17.130	0.000	26.566	9.436	$5,082.00	$191.30	2201.679	66.20%	$85,453.33	26.566	$191.30
113-114L	Notch underwater dikes on backside of islands (4)	9.040	9.040	0.000	14.853	5.813	$2,904.00	$195.51	2216.533	66.65%	$88,357.33	14.853	$195.51
38.8L	Avoid disposal, utilize RB, notch modified revetment	4.269	3.774	-0.496	3.652	-0.617	$726.00	$198.78	2220.185	66.76%	$89,083.33	3.652	$198.78
131.8-132.5R	Notch upper end of modified revetment (1)	3.540	3.540	0.000	3.540	0.000	$726.00	$205.07	2223.725	66.86%	$89,809.33	3.540	$205.07
174.1-176.7R	Utilize land disposal on Lentz property, notch existing dikes (4))	7.943	6.905	-1.039	12.314	4.370	$2,904.00	$235.84	2236.039	67.23%	$92,713.33	12.314	$235.84
43.4-44.1L	Avoid disposal in LB aquatic areas, utilize land and RB disposal, notch existing dikes/revetments (3)	10.388	9.182	-1.206	9.182	-1.206	$2,178.00	$237.20	2245.221	67.51%	$94,891.33	9.182	$237.20
82.5-	Notch existing dikes along RB (14)	23.570	23.570	0.000	37.968	14.398	$10,164.00	$267.70	2283.189	68.65%	$105,055.33	37.968	$267.70

Table C.9-1. Aquatic Mitigation Features – Arkansas Portion

Nav. Mile	Project	Future without Project AAHUs	Total AAHUs with 12-ft Project	AAHUs Effected by 12-ft Project	Total AAHUs with Mitigated 12-ft Project	Change in Mitigated 12-ft AAHUs Relative to Baseline (1)	Cost	Cost Per AAHU	Running Total AAHU's	Percent Mitigation	Running Total Cost	Incremental Change in AAHU's	Incremental Cost
85.5R													
126.7-127.4L	Utilize LB for disposal and notch modified dikes (4)	3.609	3.026	-0.583	10.734	7.125	$2,904.00	$270.54	2293.923	68.97%	$107,959.33	10.734	$270.54
165.8-167.0L	Avoid aquatic disposal, dispose on land within cells, notch existing revetment (4)	9.262	6.574	-2.688	10.718	1.456	$2,904.00	$270.94	2304.642	69.30%	$110,863.33	10.718	$270.94
91.4-91.7R	Recommend constructing island downstream at 90.5-91.0L behind underwater revetment, if proposed location must be utilized, place disposal off bank and create island(s) and notch backside of existing dikes	29.788	17.635	-12.154	28.207	-1.581	$7,669.67	$271.91	2332.849	70.14%	$118,533.00	28.207	$271.91
122.9-123.6R	Notch existing dikes (2-4) for flow-through and access	4.374	4.374	0.000	7.986	3.611	$2,178.00	$272.74	2340.834	70.38%	$120,711.00	7.986	$272.74
94	Notch existing revetment (1)	1.591	1.591	0.000	2.383	0.792	$726.00	$304.69	2343.217	70.45%	$121,437.00	2.383	$304.69
169.6-172L	Notch raised dike at 170.1L and existing dikes at 170.7L and 171L, utilize land within cells for disposal or create/enhance tern island, (*existing tern island)	45.727	32.455	-13.272	32.455	-13.272	$9,929.60	$305.95	2375.672	71.43%	$131,366.60	32.455	$305.95
251.8-253.8L	Notch dikes (5-10) on left and right bank up and downstream	14.982	14.982	0.000	22.545	7.563	$7,260.00	$322.02	2398.217	72.11%	$138,626.60	22.545	$322.02
133.5-135.2L	Avoid aquatic disposal on LB, utilize land disposal on island or construct another island on RB, notch longest existing dike for flow-through (*potential existing tern site)	23.015	19.298	-3.717	15.561	-7.455	$5,327.80	$342.39	2413.778	72.58%	$143,954.40	15.561	$342.39
188.9-190.4L	*Existing least tern island, avoid disposal, notch raised revetment (1) and existing dike (1), utilize area upstream at 191R for disposal	40.705	28.873	-11.832	41.166	0.461	$14,600.00	$354.66	2454.944	73.81%	$158,554.40	41.166	$354.66
116.6-116.8R	Notch existing dikes 116.6 to 116.8R (2) *may have already been done	2.333	2.333	0.000	3.993	1.660	$1,452.00	$363.65	2458.936	73.93%	$160,006.40	3.993	$363.65
36-36.5L	Notch modified dikes (3) and existing dike (1)	7.727	7.727	0.000	7.727	0.000	$2,904.00	$375.83	2466.663	74.17%	$162,910.40	7.727	$375.83
82.6R	Notch existing dike and maintain entrance to backwater at 82.6R by periodically dredging	18.425	18.425	0.000	44.376	25.951	$17,388.00	$391.83	2511.039	75.50%	$180,298.40	44.376	$391.83
155.6R	Notch existing revetment (2)	2.056	2.056	0.000	3.416	1.360	$1,452.00	$425.10	2514.455	75.60%	$181,750.40	3.416	$425.10
31.7-32.8R	*Existing tern island – enhance/create islands where feasible and avoid June-August construction, utilize disposal area and extend d/s to NM 31.0R	27.474	18.784	-8.690	21.941	-5.533	$9,622.25	$438.56	2536.396	76.26%	$191,372.65	21.941	$438.56
193.6-195L	Notch existing dikes (5) in AR194.1L-D	5.475	3.283	-2.192	7.021	1.546	$3,630.00	$517.00	2543.417	76.47%	$195,002.65	7.021	$517.00
46.5-46.7L	Notch modified revetment (1)	1.227	1.227	0.000	1.227	0.000	$726.00	$591.93	2544.643	76.51%	$195,728.65	1.227	$591.93

Table C.9-1. Aquatic Mitigation Features – Arkansas Portion													
Nav. Mile	**Project**	**Future without Project AAHUs**	**Total AAHUs with 12-ft Project**	**AAHUs Effected by 12-ft Project**	**Total AAHUs with Mitigated 12-ft Project**	**Change in Mitigated 12-ft AAHUs Relative to Baseline (1)**	**Cost**	**Cost Per AAHU**	**Running Total AAHU's**	**Percent Mitigation**	**Running Total Cost**	**Incremental Change in AAHU's**	**Incremental Cost**
80.0-82.0L	Place disposal along dike fields to create islands and notch backside of dikes (9) at 80-82L	10.786	10.786	0.000	10.786	0.000	$6,534.00	$605.81	2555.429	76.84%	$202,262.65	10.786	$605.81
123.7L	Notch existing dike for access and fish passage	0.875	0.875	0.000	1.198	0.323	$726.00	$606.08	2556.627	76.87%	$202,988.65	1.198	$606.08
281.9-283.3L	Place disposal on lower end of disposal area on existing sand bars, construct islands where feasible, avoid disposal from 283.2-283.5L	33.481	21.926	-11.555	17.398	-16.082	$10,732.17	$616.85	2574.025	77.39%	$213,720.82	17.398	$616.85
244R	Utilize two downstream cells for disposal if needed and notch two existing upper dikes for fish passage and access	2.184	1.219	-0.965	2.323	0.139	$1,452.00	$625.10	2576.348	77.46%	$215,172.82	2.323	$625.10
48.7-48.9R	Notch modified dikes (4)	3.496	3.496	0.000	4.456	0.960	$2,904.00	$651.74	2580.804	77.60%	$218,076.82	4.456	$651.74
45.4-47.3R	Construct islands where feasible in AR46.5R-D, utilize two most d/s cells for disposal first, notch dikes/revetments (4-8)	32.255	28.511	-3.744	28.511	-3.744	$19,244.50	$674.99	2609.315	78.46%	$237,321.32	28.511	$674.99
35.3-36.5L	*Existing tern island – enhance/create islands where feasible and avoid June-August construction	13.803	12.201	-1.602	28.469	14.666	$19,244.50	$675.98	2637.784	79.31%	$256,565.82	28.469	$675.98
42.8-44.6R	Notch existing and modified dikes (10-12)	10.671	10.671	0.000	10.671	0.000	$7,260.00	$680.38	2648.454	79.63%	$263,825.82	10.671	$680.38
117.1-117.7R	Notch existing dikes (3)	1.750	1.750	0.000	3.194	1.445	$2,178.00	$681.84	2651.648	79.73%	$266,003.82	3.194	$681.84
98.5R	Notch existing revetment to access backwater (1)	0.637	0.637	0.000	0.953	0.317	$726.00	$761.72	2652.602	79.76%	$266,729.82	0.953	$761.72
94.3-96.3L	Avoid aquatic disposal in uppermost cells of AR95.5L-D, extend disposal area d/s to create a series of islands for a braided system and terns, notch existing dikes (5) to enhance backwater areas	65.750	43.408	-22.342	60.160	-5.591	$46,017.99	$764.93	2712.761	81.57%	$312,747.81	60.160	$764.93
23-24L	Construct string of islands	15.938	14.088	-1.850	18.468	2.530	$14,433.38	$781.54	2731.229	82.12%	$327,181.19	18.468	$781.54
181.8-184.9R	Notch existing and raised dikes (8-10) and create a series of islands for braided system and terns	37.027	26.265	-10.763	36.261	-0.767	$30,269.00	$834.76	2767.490	83.21%	$357,450.19	36.261	$834.76
23-24L	Construct string of islands	13.282	11.740	-1.542	15.390	2.108	$14,433.38	$937.84	2782.880	83.67%	$371,883.57	15.390	$937.84
99.4L	Notch existing revetment to access backwater (1)	0.382	0.382	0.000	0.635	0.254	$726.00	$1,142.58	2783.515	83.69%	$372,609.57	0.635	$1,142.58
164.5-165.2L	165 - Notch on upstream end of revetment for flow in and out of Plummerville cutoff, and notch raised dikes (3), maintain entrance by periodically dredging	29.056	29.056	0.000	43.676	14.620	$50,500.00	$1,156.24	2827.192	85.01%	$423,109.57	43.676	$1,156.24
275.7-276.4R	Notch modified dikes (2) that connect to shoreline and extend RB disposal downstream within dike field	1.913	1.253	-0.660	1.253	-0.660	$1,452.00	$1,158.90	2828.444	85.04%	$424,561.57	1.253	$1,158.90

Table C.9-1. Aquatic Mitigation Features – Arkansas Portion

Nav. Mile	Project	Future without Project AAHUs	Total AAHUs with 12-ft Project	AAHUs Effected by 12-ft Project	Total AAHUs with Mitigated 12-ft Project	Change in Mitigated 12-ft AAHUs Relative to Baseline (1)	Cost	Cost Per AAHU	Running Total AAHU's	Percent Mitigation	Running Total Cost	Incremental Change in AAHU's	Incremental Cost
169.4-169.7L	Notch raised dikes (4)	1.799	1.799	0.000	2.434	0.635	$2,904.00	$1,192.90	2830.879	85.12%	$427,465.57	2.434	$1,192.90
42.3-43.3L	Construct islands and notch existing (3) dikes	4.743	4.193	-0.551	17.920	13.177	$21,422.50	$1,195.45	2848.799	85.66%	$448,888.07	17.920	$1,195.45
22.8R	Maintain entrance to Coal Pile by periodically dredging	118.280	118.280	0.000	140.595	22.315	$193,784.00	$1,378.32	2989.393	89.88%	$642,672.07	140.595	$1,378.32
61.0-62.1L	*Probable tern island on RB, avoid aquatic areas in AR61.4L-D, utilize land within disposal cells or enhance/create tern islands on RB	9.978	7.515	-2.463	6.913	-3.065	$9,622.25	$1,391.97	2996.306	90.09%	$652,294.32	6.913	$1,391.97
78.7L	Dredge mouth of Pastoria Bend chute and periodically dredge to maintain and notch existing dike (1) if needed to open access to backwater	11.504	11.504	0.000	21.621	10.116	$30,274.00	$1,400.23	3017.927	90.74%	$682,568.32	21.621	$1,400.23
38.8-39.6R	*Existing tern island, notch existing dikes (5) and enhance/construct tern islands where feasible	1.755	1.551	-0.204	13.651	11.896	$19,244.50	$1,409.77	3031.578	91.15%	$701,812.82	13.651	$1,409.77
50.9L	Maintain entrance to Swan Lake by periodically dredging	38.463	38.463	0.000	42.991	4.528	$61,202.00	$1,423.59	3074.569	92.44%	$763,014.82	42.991	$1,423.59
279-280.1R	Utilize AR280.0R-D for disposal and construction of string of islands, notch modified dikes (4) to create and maintain backwater channel	9.737	6.376	-3.360	7.423	-2.314	$10,732.17	$1,445.84	3081.992	92.67%	$773,746.99	7.423	$1,445.84
180.4-181.3R	Extend disposal area upstream to raised dike at 181.5R and dispose along bank downstream of dike, notch existing dikes (2)	5.285	3.169	-2.116	1.344	-3.940	$2,178.00	$1,619.94	3083.336	92.71%	$775,924.99	1.344	$1,619.94
273.7-276L	Avoid disposal in AR274.0L-D and AR275.0L-D, alternatively use RB disposal to create or enlarge islands,	6.559	4.296	-2.264	3.939	-2.621	$6,708.00	$1,703.11	3087.275	92.83%	$782,632.99	3.939	$1,703.11
46.2R	Notch modified revetment/dike (1)	0.368	0.368	0.000	0.368	0.000	$726.00	$1,973.09	3087.643	92.84%	$783,358.99	0.368	$1,973.09
78.9-79.7L	79.0L - First option - Inquire about upland disposal on Pine Bluff Arsenal property first to avoid any impacts, second option - investigate island disposal upstream on LB at 80.1, third option to place in proposed location and notch modified dikes (4)	2.247	0.872	-1.375	1.243	-1.004	$2,904.00	$2,336.25	3088.886	92.88%	$786,262.99	1.243	$2,336.25
19.0R	Construct island	7.969	7.044	-0.925	7.044	-0.925	$19,244.50	$2,732.09	3095.930	93.09%	$805,507.49	7.044	$2,732.09
92.6L	Notch existing revetment (1) and maintain entrance to backwater by periodically dredging	3.310	3.310	0.000	6.195	2.885	$17,188.00	$2,774.41	3102.125	93.27%	$822,695.49	6.195	$2,774.41
276.8-277.5R	Avoid backwater disposal in 277.0R-D, place disposal on land and d/s along bottom end to extend island	1.162	0.761	-0.401	0.761	-0.401	$2,236.00	$2,939.41	3102.886	93.30%	$824,931.49	0.761	$2,939.41
42.1-42.7L	*Existing tern island, use disposal to enhance/construct tern islands, notch backside of existing dikes to maintain	5.408	4.780	-0.628	6.259	0.851	$19,244.50	$3,074.71	3109.145	93.48%	$844,175.99	6.259	$3,074.71

Table C.9-1. Aquatic Mitigation Features – Arkansas Portion

Nav. Mile	Project	Future without Project AAHUs	Total AAHUs with 12-ft Project	AAHUs Effected by 12-ft Project	Total AAHUs with Mitigated 12-ft Project	Change in Mitigated 12-ft AAHUs Relative to Baseline (1)	Cost	Cost Per AAHU	Running Total AAHU's	Percent Mitigation	Running Total Cost	Incremental Change in AAHU's	Incremental Cost
	flow and islands 42.5L												
168.7-169.5L	Utilize AR169.4R-D for disposal first, AR169.0L-D second, construct tern islands where feasible	1.426	1.240	-0.186	4.205	2.779	$13,148.00	$3,126.82	3113.350	93.61%	$857,323.99	4.205	$3,126.82
146.5-147.5L	* Existing tern island – enhance/construct a series of islands along LB where feasible, notch dikes (5), move disposal from LB to RB for excess disposal	5.448	4.568	-0.880	7.273	1.826	$23,009.00	$3,163.52	3120.623	93.83%	$880,332.99	7.273	$3,163.52
110.4	Install culvert through structure at Willow Beach Lake for fish passage	27.191	27.191	0.000	46.537	19.346	$156,898.00	$4,472.00	3167.160	95.23%	$1,037,230.99	46.537	$4,472.00
90.5-91.0L	Construct island(s) at 90.5-91.0L behind underwater revetment	2.673	1.583	-1.091	1.583	-1.091	$7,669.67	$4,472.00	3168.742	95.28%	$1,044,900.66	1.583	$4,472.00
42.8-43R	Utilize this disposal area, notch existing and modified dikes (10-12) and extend disposal u/s	1.423	1.258	-0.165	1.258	-0.165	$7,260.00	$5,771.83	3170.000	95.31%	$1,052,160.66	1.258	$5,771.83
70.6L	Maintain channel to backwater by periodically dredging	12.583	12.583	0.000	14.939	2.356	$88,053.00	$5,894.16	3184.939	95.76%	$1,140,213.66	14.939	$5,894.16
132.2L	Maintain entrance to Rector Chute by periodically dredging	13.082	13.082	0.000	15.532	2.450	$91,787.00	$5,909.43	3200.471	96.23%	$1,232,000.66	15.532	$5,909.43
169.2-169.8R	Utilize AR169.4R-D for disposal first, AR169.0L-D second, construct tern islands where feasible	2.506	2.179	-0.328	2.179	-0.328	$13,148.00	$6,034.83	3202.650	96.30%	$1,245,148.66	2.179	$6,034.83
243.7-244.2L	Notch revetment and dike at u/s end to Hartman lake to allow flow-through and fish passage	16.727	16.727	0.000	51.738	35.011	$321,000.00	$6,204.31	3254.388	97.85%	$1,566,148.66	51.738	$6,204.31
285.6-286.2L	Extend disposal area to 286.2L dike, place disposal behind dikes on LB from 286.2-285.6L to create islands and maintain gravel instream, notch modified (2) and existing (2) dikes	7.036	2.976	-4.060	0.974	-6.062	$6,708.00	$6,887.38	3255.362	97.88%	$1,572,856.66	0.974	$6,887.38
75.3L	Maintain channel to backwater by periodically dredging	2.022	2.022	0.000	2.401	0.379	$16,662.00	$6,939.85	3257.763	97.95%	$1,589,518.66	2.401	$6,939.85
44.6L	Maintain a 1/2 mile boating lane at the entrance to Little Bayou Meto (44.6L) and 1/2 mile lane at u/s end of Bayou Meto by periodically dredging	28.100	28.100	0.000	33.401	5.301	$237,977.00	$7,124.87	3291.164	98.96%	$1,827,495.66	33.401	$7,124.87
222.5R	Construct islands along RB if feasible	0.000	0.000	0.000	0.000	0.000	$7,155.86	$7,155.86	3291.164	98.96%	$1,834,651.52	0.000	$7,155.86
225.5L	Construct islands along LB if feasible	0.000	0.000	0.000	0.000	0.000	$7,155.86	$7,155.86	3291.164	98.96%	$1,841,807.38	0.000	$7,155.86
88.2R	Maintain entrance to Tar Camp Creek by periodically dredging	8.987	8.987	0.000	10.694	1.708	$96,892.00	$9,060.02	3301.858	99.28%	$1,938,699.38	10.694	$9,060.02
276.0R	Maintain entrance to Courthouse Slough by periodically dredging	7.046	7.046	0.000	8.299	1.253	$91,787.00	$11,059.37	3310.158	99.53%	$2,030,486.38	8.299	$11,180.00
102-104R	Utilize RB disposal as alternative, construct/enhance tern islands if feasible	5.283	3.128	-2.155	3.128	-2.155	$30,678.66	$11,180.00	3313.285	99.62%	$2,061,165.04	3.128	$9,809.31
158.8-	Utilize existing island for disposal and/or	2.382	1.690	-0.691	-0.076	-2.458	$1,000.00	$13,122.35	3313.209	99.62%	$2,062,165.04	-0.076	$13,122.35

Table C.9-1. Aquatic Mitigation Features – Arkansas Portion

Nav. Mile	Project	Future without Project AAHUs	Total AAHUs with 12-ft Project	AAHUs Effected by 12-ft Project	Total AAHUs with Mitigated 12-ft Project	Change in Mitigated 12-ft AAHUs Relative to Baseline (1)	Cost	Cost Per AAHU	Running Total AAHU's	Percent Mitigation	Running Total Cost	Incremental Change in AAHU's	Incremental Cost
159.2R	construct tern islands												
15.3R	Reconnect Lower Merrisach Lake to Canal with culvert or water control structure for fish passage	22.055	22.055	0.000	26.216	4.161	$356,639.00	$13,603.96	3339.425	100.41%	$2,418,804.04	26.216	$356,639.00
*227.2,229,230,233.5,233.3, 234	Construct islands where feasible in Lake Dardanelle	0.000	0.000	0.000	0.000	0.000	$14,311.72	$14,311.72	3339.425	100.41%	$2,433,115.76	0.000	$14,311.72
**32.2R	Maintain entrance to oxbow lake by avoiding disposal and periodically dredging	2.146	2.146	0.000	2.041	-0.105	$39,111.00	$19,162.20	3341.466	100.47%	$2,472,226.76	2.041	$19,162.20
*61.5-62.5R	Place disposal in string of islands along RB	3.280	1.839	-1.441	0.758	-2.521	$19,244.50	$25,373.60	3342.225	100.49%	$2,491,471.26	0.758	$25,373.60
**71.3L	Dredge canals at Lake Langhofer	5.618	5.618	0.000	7.239	1.622	$299,844.00	$41,418.56	3349.464	100.71%	$2,791,315.26	7.239	$41,418.56
**110.4L	Install culvert through land mass at Willow Beach Park to connect oxbow lake to river	3.263	3.263	0.000	5.584	2.321	$320,272.00	$57,351.03	3355.048	100.88%	$3,111,587.26	5.584	$57,351.03
***131.0 L	Dredge upper end of Rector Brake to improve habitat	5.139	5.139	0.000	8.136	2.997	$533,708.00	$65,602.34	3363.184	101.12%	$3,645,295.26	8.136	$65,602.34
***116.2 R	Dredge backwater at 116.2R	0.350	0.350	0.000	0.733	0.383	$96,895.00	$132,145.16	3363.917	101.15%	$3,742,190.26	0.733	$132,145.16
		Mitigation Target HU											
Totals		3325.836	2728.237	-597.599	3363.917	38.081	$3,742,190.26						

Cut-off point for 100% mitigation (1) Negative numbers represent minimization of impacts by implementing mitigation measure. Island creation benefits T&E species

*** Features retained due to terrestrial and T&E species habitat improvement opportunities**

**** Features retained for contribution to environmental sustainability**

***** Mitigation Features dropped from consideration due to Incremental Cost Analysis (ICA)**

Source: USACE, 2005

Table C.9-2. Aquatic Mitigation Features – Oklahoma Portion													
Nav. Mile	**Project**	**Future without Project AAHUs**	**Total AAHUs with 12-ft Project**	**AAHUs Effected by 12-ft Project**	**Total AAHUs with Mitigated 12-ft Project**	**Change in Mitigated 12-ft AAHUs Relative to Baseline (1)**	**Cost**	**Cost Per AAHU**	**Running Total AAHU's**	**Percent Mitigation**	**Running Total Cost**	**Incremental Change in AAHU's**	**Incremental Cost**
311.5-313.7	New Dikes, designed to maintain variable habitat (J-hook)	0.758	0.720	-0.038	2.034	1.276	$0.00	$0.00	$2.03	0.3863%	$0.00	2.034	$0.000
314.8-315.8	New & existing dikes LD recommend J-hook design	0.875	0.831	-0.044	1.445	0.570	$0.00	$0.00	$3.48	0.6607%	$0.00	1.445	$0.000
348.3	Add to existing island + riprap (beneficial use of dredge material)	15.941	6.444	-9.497	3.222	-12.719	$0.00	$0.00	$6.70	1.2726%	$0.00	3.222	$0.000
353.5-354.3	Restore bank, stabilize w/riprap (beneficial use of dredge material)	0.996	0.403	-0.594	0.403	-0.594	$0.00	$0.00	$7.10	1.3491%	$0.00	0.403	$0.000
355	Create 3 - 10 acre tern island w/riprap (beneficial use of dredge material)	12.011	4.855	-7.156	4.039	-7.972	$0.00	$0.00	$11.14	2.1162%	$0.00	4.039	$0.000
sbc 6.6	expand island, design to avoid impacts to mussels; height of disposal will be 1 - 2 ft below water surface (beneficial use of dredge material)	2.214	0.895	-1.319	0.895	-1.319	$0.00	$0.00	$12.04	2.2862%	$0.00	0.895	$0.000
sbc 6.9	expand island, design to avoid impacts to mussels; height of disposal will be 1 - 2 ft below water surface (beneficial use of dredge material)	2.214	0.895	-1.319	0.895	-1.319	$0.00	$0.00	$12.93	2.4561%	$0.00	0.895	$0.000
395 - 401.4	Impacts to Verdigris	9.000	0.000	-9.000	0.000	-9.000	$0.00	$0.00	$12.93	2.4561%	$0.00	0.000	$0.000
367.4	alternative disposal site for 367.5 - create tern island/w riprap	6.310	2.551	-3.759	2.551	-3.759	$0.00	$0.00	$15.48	2.9405%	$0.00	2.551	$0.000
392.1-393.0	Notch and design new dikes to create variable habitat, create tern island in middle cell	13.284	5.370	-7.914	5.126	-8.158	$0.00	$0.00	$20.61	3.9141%	$0.00	5.126	$0.000
393.8-394.6	Notch added dikes to avoid fill,design to minimize fill (J-hook)	9.686	9.201	-0.485	10.033	0.347	$0.00	$0.00	$30.64	5.8196%	$0.00	10.033	$0.000
401.4 - 421.7	Impacts to Verdigris	29.000	0.000	-29.000	0.000	-29.000	$0.00	$0.00	$30.64	5.8196%	$0.00	0.000	$0.000
421.7 - 445	Impacts to Verdigris	33.900	0.000	-33.900	0.000	-33.900	$0.00	$0.00	$30.64	5.8196%	$0.00	0.000	$0.000
379 - 380	dredge upper end of oxbow; maintain upper/lower openings to reconnect to backwater area	89.667	89.667	0.000	127.760	38.093	$10,000.00	$78.27	$158.40	30.0838%	$10,000.00	127.760	$78.272
408.9	dredge mouth of Billy Creek Cutoff to reconnect to backwater area	39.923	39.923	0.000	57.432	17.508	$5,000.00	$87.06	$215.83	40.9912%	$15,000.00	57.432	$87.060
320-321	Notch 3 interior dikes to create variable habitat	14.127	14.127	0.000	22.434	8.307	$2,190.00	$97.62	$238.27	45.2519%	$17,190.00	22.434	$97.620
321-323	Notch 5 dikes to create variable habitat	23.614	23.614	0.000	31.640	8.026	$3,650.00	$115.36	$269.91	51.2609%	$20,840.00	31.640	$115.361
310.4	Notch parallel dikes (1) for scour	3.033	3.033	0.000	5.972	2.939	$730.00	$122.24	$275.88	52.3950%	$21,570.00	5.972	$122.244
323-324	Notch 9 dikes to create variable habitat	33.576	33.576	0.000	45.702	12.126	$6,570.00	$143.76	$321.58	61.0747%	$28,140.00	45.702	$143.758
414.7	Dredge at culvert structure to reconnect backwater area	25.169	25.169	0.000	30.172	5.003	$5,000.00	$165.71	$351.75	66.8051%	$33,140.00	30.172	$165.715
326.7-328.1	notch 7 dikes interior/exterior to create variable habitat	16.620	16.620	0.000	27.712	11.092	$5,110.00	$184.39	$379.47	72.0682%	$38,250.00	27.712	$184.394
309.8-310.3	Notch 4 dikes for scour to create variable habitat	6.999	6.999	0.000	14.700	7.701	$2,950.00	$200.69	$394.17	74.8599%	$41,200.00	14.700	$200.687

Table C.9-2. Aquatic Mitigation Features – Oklahoma Portion

Nav. Mile	Project	Future without Project AAHUs	Total AAHUs with 12-ft Project	AAHUs Effected by 12-ft Project	Total AAHUs with Mitigated 12-ft Project	Change in Mitigated 12-ft AAHUs Relative to Baseline (1)	Cost	Cost Per AAHU	Running Total AAHU's	Percent Mitigation	Running Total Cost	Incremental Change in AAHU's	Incremental Cost
360.6	Notch 2 dike to create variable habitat	3.321	3.321	0.000	6.298	2.977	$1,460.00	$231.83	$400.46	76.0560%	$42,660.00	6.298	$231.832
442	Dredge lower end of oxbow to reconnect backwater area	6.365	6.365	0.000	6.365	0.000	$1,667.00	$261.92	$406.83	77.2648%	$44,327.00	6.365	$261.917
419.5	Dredge mouth of Bull Creek to reconnect tributary	9.836	9.836	0.000	14.150	4.314	$5,000.00	$353.36	$420.98	79.9521%	$49,327.00	14.150	$353.362
323.7 - 323.9	Notch 2 dikes to create variable habitat	2.909	2.909	0.000	4.041	1.133	$1,460.00	$361.26	$425.02	80.7196%	$50,787.00	4.041	$361.261
393.2 - 394.1	1st priority dispose in terrestrial cell, notch internal & lower end dikes to create variable habitat; 2nd priority dispose in dike cell above and below bridge.	15.111	6.108	-9.003	9.804	-5.307	$3,650.00	$372.30	$434.82	82.5816%	$54,437.00	9.804	$372.299
408.8	Dredge mouth of Strawberry Creek to reconnect tributary	6.654	6.654	0.000	7.977	1.323	$5,000.00	$626.83	$442.80	84.0965%	$59,437.00	7.977	$626.833
426.7	Dredge mouth of Commodore Creek to reconnect tributary	2.604	2.604	0.000	2.604	0.000	$1,667.00	$640.24	$445.40	84.5910%	$61,104.00	2.604	$640.243
439.7	Dredge lower end of oxbow to reconnect backwater area	2.314	2.314	0.000	2.314	0.000	$1,667.00	$720.27	$447.72	85.0306%	$62,771.00	2.314	$720.273
416.7	Dredge/rework culvert structure to reconnect to backwater area	35.295	35.295	0.000	42.311	7.016	$50,000.00	$1,181.73	$490.03	93.0662%	$112,771.00	42.311	$1,181.735
sbc 0.4	aquatic disposal; create HQ marsh; variable depth 6-in - 2 ft; mussels will be protected from impacts resulting from disposal (beneficial use of dredge material	22.140	8.949	-13.191	13.424	-8.716	$35,000.00	$2,607.26	$503.45	95.6157%	$147,771.00	13.424	$2,607.263
418.8	Dredge/rework culvert structure to reconnect to backwater area	10.415	10.415	0.000	12.485	2.070	$50,000.00	$4,004.77	$515.94	97.9869%	$197,771.00	12.485	$4,004.768
sbc.4.8	Site will be designed to preserve mussel patch.aquatic disposal will only occur if mussels won't be impacted; create HQ marsh; variable depth 1 - 2 ft; (beneficial use of dredge material)	19.926	8.054	-11.872	8.054	-11.872	$35,000.00	$4,345.44	$523.99	99.5166%	$232,771.00	8.054	$4,345.438
383.2	Dredge mouth of Hopewell Creek to reconnect tributary	0.221	0.221	0.000	0.210	-0.011	$5,000.00	$23,775.03	$524.20	99.5565%	$237,771.00	0.210	$23,775.033
407	Dredge Upper/lower end Tullahassee Loop; rework culvert structure to reconnect backwater area	0.289	0.289	0.000	0.347	0.058	$55,000.00	$158,588.81	$524.55	99.6224%	$292,771.00	0.347	$158,588.811
398.8	dredge upper/lower end Okay oxbow install culvert structure to reconnect to backwater area	0.221	0.221	0.000	0.263	0.041	$55,000.00	$209,220.29	$524.81	99.6723%	$347,771.00	0.263	$209,220.287
		Mitigation Target HU											
		526.537	**388.447**	**-138.090**	**524.812**	**-1.726**	**$347,771.00**						
		(1) Negative numbers represent minimization of impacts by implementing mitigation measure. Island creation benefits T&E species											

Source: USACE, 2005

For this analysis, IWR plan was not as appropriate as the development of sorted matrices in spreadsheets presented in this report. The number of measures exceeded the 26 solutions (or plans) that IWR allows. Each IWR solution/plan may have up to 20 scales. As noted above, an optimum/single scale was identified for each measure. The value of IWR plan is in being to analyze assorted combinations of measures at various scales to identify the incremental cost of each plan. IWR Report 94-PS-2 (Cost Effectiveness Analysis for Planners) notes that "ICA is not applicable in avoidance planning since only one level of output is considered" (page 56). Additionally the IWR report says, "if you have a defined target level of output ...then you may also use "lowest cost" as the selection rule...In this case, selection of the lowest cost solution (either lowest average cost or lowest total cost) makes economic sense" (page 58). The ICA presented here combines the measures with lowest average cost resulting in the lowest total cost being the recommended mitigation plan.

C.11

Geomorphic Assessment

Arkansas River Preliminary Geomorphic Assessment
Draft Final Report

By

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1. Study Objective

The objective of this study was to conduct a preliminary geomorphic assessment for the Arkansas River Navigation Study proposed deepening of the navigation channel of the McClellan-Kerr Arkansas River Navigation System (MKARNS). As part of this study, geomorphic reaches were classified, gravel bar locations were identified and correlated with bed material data, and the impacts of the proposed project on channel stability were evaluated. A helicopter reconnaissance was made of the entire navigation channel, with a geo-referenced digital video prepared.

2. Geomorphic Classification of Reaches

River Channel Classification. River channel classification is a means of reducing a complex system into a series of more easily understandable units, which in turn facilitates further study and the organization of management options. In this study, one goal of channel classification is to provide information that can be related to fish sampling data and management options. With this in mind, the 445-mile length of navigation channel was divided into geomorphic reaches (two to five per pool) that were classified using a modification of the Brice classification system (Brice, 1975).

Division into Reaches. Identification of geomorphic reaches (GRs) involves breaking down each main reach into discrete sub-reaches based on similarities in form and process. The aerial photographs were evaluated to identify changes in channel morphology, such as sinuosity and presence of islands. Lawson Smith's report on the lower portion of the Arkansas River gave valuable information on changes in geology and geologic controls. Significant occurrences such as the inflow from a major tributary were also used to locate breakpoints between geomorphic reaches.

Brice Classification. The Brice Classification describes the morphology of rivers or sections of rivers additively in terms of their degree and character of sinuosity, braiding, and anabranching. Each of these three aspects of planform is assigned a number and letter code for the degree and character, respectively, such that each reach can be described by a six letter code. Figure 2-1 shows the details of the classification. For example, a river section assigned the code 1D 2B 3C would be described as: 1D = having a sinuosity between 1 and 1.05 and be single phase, wider at bends with chutes common; 2B = between 35% and 65% braided with mostly bars and islands; and 3C = have >65% anabranching with split channel, sub-parallel anabranches. A total of 3,120 river types can be identified in this way (Brice 1975).

The system was developed based on the morphological characteristics that were observed from aerial photographs of about 250 river reaches, mostly within the United States but from other parts of the world also, and occurring in climates ranging from arctic to equatorial. In addition to the photographs, large-scale topographic maps, and gauging station data for 200 reaches were used to develop the classification (Brice 1975).

Modified Brice Classification (for Arkansas River). The Arkansas River is highly controlled, since it is a series of navigation pools, with a planform that is fixed in place by training structures. These factors make the Brice categories of braiding and anabranching less useful here. The braiding category was retained, since there were a few reaches where braiding was noted. The anabranching category was dropped, and was replaced with two additional categories: bars and islands. The breakpoints for the "degree of sinuosity" category were also modified slightly. The "modified Brice" classification is described in Table 2-1. The limits and modified Brice classification for the geomorphic reaches for each pool are given in Tables 2-2 through 2-5.

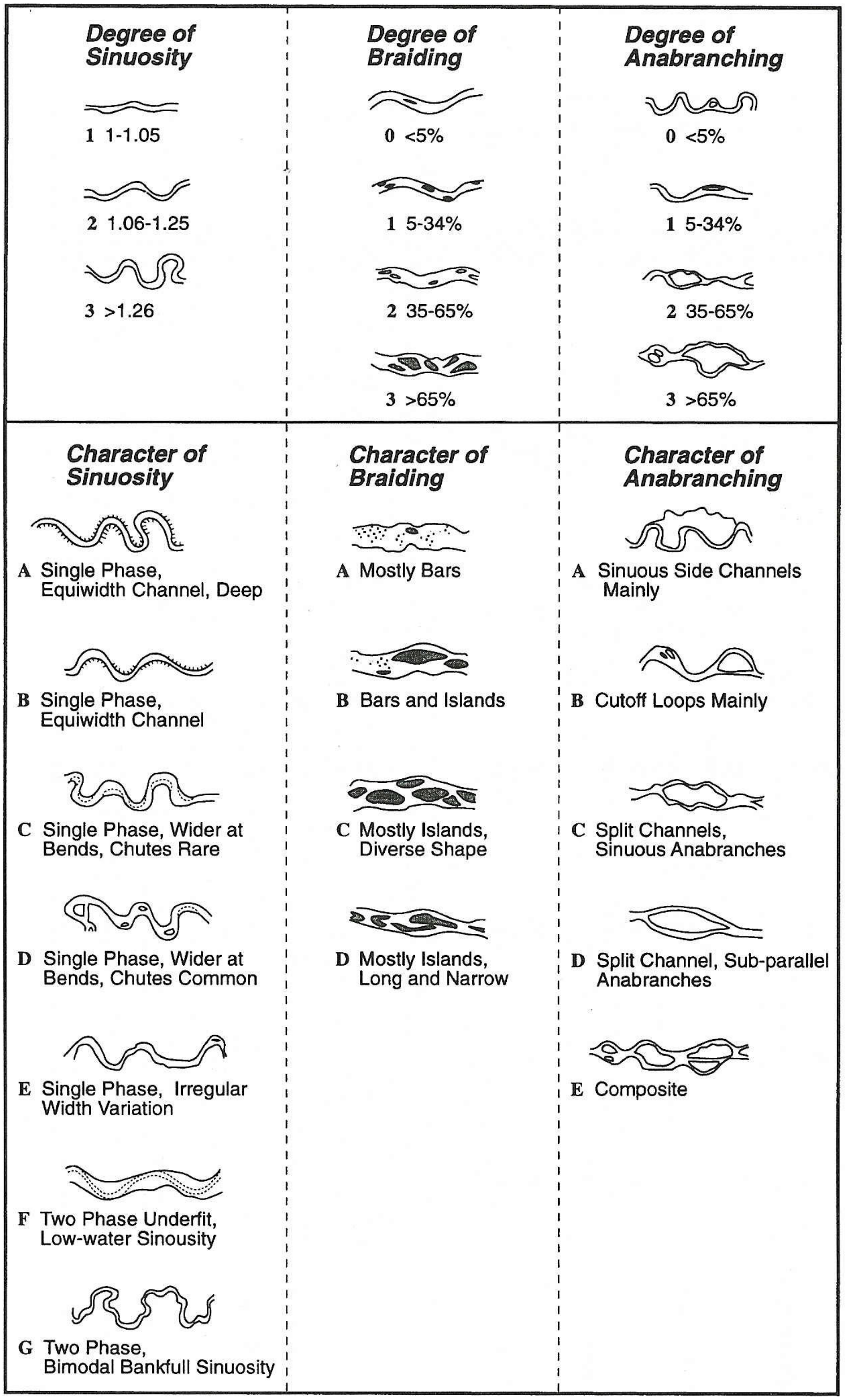

Figure 2-1. Brice Classification System (Brice, 1975)

Table 2-1. Modifications to Brice Classification for Arkansas River Project

Degree of Sinuosity – Brice classification modified as follows:
- (1) is a sinuosity of 1 – 1.10
- (2) is a sinuosity of 1.11 – 1.25
- (3) is a sinuosity of 1.26 and above

Character of sinuosity – Brice classification used
Degree of braiding – Brice classification used
Character of braiding – Brice classification used
Degree and character of anabranching – not used
Degree of bar formation – new category as follows:
- 0 is less than 5%
- 1 is 5 – 34%
- 2 is 35 – 65%
- 3 is over 65%

Character of bar formation – new category as follows:
- A is within main channel
- B is along side of channel
- C is in both main channel and along sides

Degree of islands – new category as follows:
- 0 is less than 5%
- 1 is 5 – 34%
- 2 is 35 – 65%
- 3 is over 65%

Character of islands – new category as follows:
- A is within main channel
- B is along side of channel
- C is in both main channel and along sides

Notes:
1. If the degree of a category was denoted as "zero," but still existed in a reach, its character was defined.
2. Braiding (degree and character) was only used in a few reaches. This category may not be applicable in a navigation channel.
3. The bars and islands categories are similar to the Brice categories, and seem to be more useful in the Arkansas River.

Arkansas River (MKARNS)
Table 2-2. Results of Geomorphic Classification for Pools 2 through 6

Reach	Navigation Mile	Degree of Sinuosity	Char. of Sinuosity	Degree of Braiding	Char. of Braiding	Degree Of Bars	Character Of Bars	Degree Of Islands	Character Of Islands	Channel Type
Pool 2										
2-1	19.0 – 22.7	1.09 (1)	A	0	0	0	B	1	B	1A00-0B1B
2-2	22.7 – 29.0	1.08 (1)	D	0	0	0	0	2	B	1D00-002B
2-3	29.0 – 47.0	1.35 (3)	A	0	0	0	A	1	B	3A00-0A1B
2-4	47.0 – 50.4	1.10 (1)	A	0	0	0	B	1	B	1A00-0B1B
Pool 3										
3-1	50.4 – 62.9	1.15 (2)	C	0	0	0	C	2	C	2C00-0C2C
3-2	62.9 – 65.9	1.09 (1)	A	0	0	0	0	0	0	1A00-0000
Pool 4										
4-1	65.9 – 76.0	1.40 (3)	C	0	0	0	0	1	C	3C00-001C
4-2	76.0 – 86.2	1.13 (2)	D	0	0	0	B	1	B	2D00-0B1B
Pool 5										
5-1	86.2 – 94.0	1.18 (2)	C	0	0	0	0	2	B	2C00-002B
5-2	94.0 –108.2	1.14 (2)	D	1	C	1	C	2	C	2D1C-1C2C
Pool 6										
6-1	108.2-114.0	1.16 (2)	D	0	C	0	0	3	C	2D0C-003C
6-2	114.0-125.6	1.08 (1)	C	0	0	0	0	0	B	1C00-000B

Arkansas River (MKARNS)
Table 2-3. Results of Geomorphic Classification for Pools 7 through 10

Reach	Navigation Mile	Degree of Sinuosity	Char. of Sinuosity	Degree of Braiding	Character Of Braiding	Degree Of Bars	Character Of Bars	Degree Of Islands	Character Of Islands	Channel Type
Pool 7										
7-1	125.6-143.0	1.21 (2)	D	1	B	1	A	3	C	2D1B-1A3C
7-2	143.0-155.9	1.45 (3)	C	0	C	1	B	1	C	3C0C-1B1C
Pool 8										
8-1	155.9-162.5	1.78 (3)	D	0	0	0	A	1	A	3D00-0A1A
8-2	162.5-169.0	1.03 (1)	B	0	0	0	B	0	B	1B00-0B0B
8-3	169.0-176.8	1.42 (3)	C	0	0	1	B	1	B	3C00-1B1B
Pool 9										
9-1	176.8-186.0	1.24 (2)	C	0	0	0	0	0	B	2C00-000B
9-2	186.0-196.0	1.02 (1)	B	0	B	1	A	1	C	1B0B-1A1C
9-3	196.0-205.8	1.11 (2)	C	0	0	0	0	1	B	2C00-001B
Pool 10	Dardanelle									
10-1	205.8-224.0	1.12 (2)	A	0	0	0	0	0	A	2A00-000A
10-2	224.0-238.8	1.45 (3)	D	1	B	0	A	2	C	3D1B-0A2C
10-3	238.8-250.5	1.08 (1)	C	0	0	0	A	1	C	1C00-0A1C
10-4	250.5-256.8	1.03 (1)	B	0	0	0	0	0	0	1B00-0000

Arkansas River (MKARNS)
Table 2-4. Results of Geomorphic Classification for Pools 12 through 15

Reach	Navigation Mile	Degree of Sinuosity	Char. of Sinuosity	Degree of Braiding	Character Of Braiding	Degree Of Bars	Character Of Bars	Degree Of Islands	Character Of Islands	Channel Type
Pool 12										
12-1	256.8-265.4	1.40 (3)	C	0	0	0	0	0	B	3C00-000B
12-2	265.4-276.2	1.03 (1)	B	0	0	0	A	1	C	1B00-0A1C
12-3	276.2-283.6	1.39 (3)	C	0	0	0	0	2	C	3C00-002C
12-4	283.6-292.6	1.06 (1)	C	0	0	0	0	1	C	1C00-001C
Pool 13										
13-1	292.6-308.0	1.84 (3)	D	0	0	0	0	2	C	3D00-002C
13-2	308.0-319.5	1.26 (3)	B	0	0	0	0	0	B	3B00-000B
Pool 14										
14-1	319.5-331.0	1.36 (3)	B	0	0	0	0	1	B	3B00-001B
14-2	331.0-336.4	1.09 (1)	B	0	0	0	0	0	B	1B00-000B
Pool 15										
15-1	336.4-350.8	1.08 (1)	A	0	0	0	0	0	A	1A00-000A
15-2	350.8-361.2	1.19 (2)	D	0	0	1	C	2	C	2D00-1C2C
15-3	361.2-366.6	1.01 (3)	B	0	0	0	B	0	B	3B00-0B0B

Arkansas River (MKARNS)

Table 2-5. Results of Geomorphic Classification for Pools 16 through 18

Reach	Navigation Mile	Degree of Sinuosity	Char. of Sinuosity	Degree of Braiding	Character Of Braiding	Degree Of Bars	Character Of Bars	Degree Of Islands	Character Of Islands	Channel Type
Pool 16										
16-1	366.6-378.0	1.30 (3)	A	0	0	0	A	0	A	3A00-0A0A
16-2	378.0-384.5	1.03 (1)	B	0	0	0	B	1	C	1B00-0B1C
16-3	384.5-395.2	1.41 (3)	C	0	0	0	0	0	B	3C00-000B
16-4	395.2-400.2	1.32 (3)	B	0	0	0	0	0	B	3B00-000B
16-5	400.2-401.3	1.00 (1)	A	0	0	0	0	0	0	1A00-0000
Pool 17										
17-1	401.3-403.0	canal	-	-	-	-	-	-	-	Not typed
17-2	403.0-409.0	1.02 (1)	B	0	0	0	0	0	0	1B00-0000
17-3	409.0-421.5	1.16 (2)	B	0	0	0	0	0	0	2B00-0000
Pool 18										
18-1	421.5-428.5	1.15 (2)	B	0	0	0	0	0	B	2B00-000B
18-2	428.5-437.6	1.37 (3)	B	0	0	0	B	0	B	3B00-0B0B
18-3	437.6-444.8	No maps	-	-	-	-	-	-	-	Not typed

3. Summary and Plots of Gravel Information

Plots of gravel data. The following plots combine information from several sources to assist in locating gravel bars. Information used is the following:

a. Bed material gradation data from USGS sampling
b. Gravel bars located during fish sampling by ERDC-EL
c. Gravel bars located during a helicopter reconnaissance by ERDC-CHL
d. Tributaries with a gravel load located during a helicopter reconnaissance by ERDC-CHL

Bed material samples collected by USGS. The percent gravel (sediment larger than 2 mm) was determined by subtracting the percent smaller than 2 mm in the gradation data. Zero values are plotted. The percent gravel was plotted against the river mileage. This data is extensive (although there are some gaps). The largest particle sizes were 16-32 mm (coarse gravel). The percentage of silt and clay in the bed samples was less than 10% in all but a handful of cases, with the exception of Pools 15 and 18.

Lock and dam locations. These were plotted to show the ends of the reaches, and assigned an arbitrary value of 50 percent.

Sources of gravel bar information. In order to see whether there was any correlation between the bed material samples and the presence of gravel bars, information on gravel bars from the field work was plotted. Sources of data are discussed in the following paragraphs.

Fish sampling. ERDC-EL conducted fish sampling during the summer of 2004, and could locate some gravel bars from the sound of the sampling equipment on the river bed. Fish sampling was only conducted in certain reaches.

Helicopter reconnaissance. ERDC-CHL conducted a helicopter reconnaissance in August 2004, during which exposed gravel bars (in both the Arkansas River and in tributaries) were noted. The entire navigation reach was flown, but many gravel bars may have been hidden by medium-high water levels. The gravel bar locations are from the field notes (rather than the digital movie record). Gravel bars were noted in some tributaries (and sand bars in others). The bed material in many tributaries was not visible because of the backwater from the navigation pools. These tributaries probably transport sediment (perhaps including gravel) into the river channel under high flow conditions.

Legend for bar locations. The gravel bar locations were plotted versus river mileage, and given arbitrary y-axis values (since no percentage is known).

e. G – FS. Gravel bar located during fish survey. (Arbitrary value of 50.)
f. G – H. Exposed gravel bar in Arkansas River noted during helicopter reconnaissance. (Arbitrary value of 50.)
g. G – trib. Gravel bar in tributary mouth noted during helicopter reconnaissance. (Arbitrary value of 55.)

Conclusions from plots. The comparison of gravel percentages in bed material with actual gravel bar locations produced some surprising results. One would expect to have gravel bars coincide with high gravel percentages (and many do), but there were some gravel bar locations with bed material gravel percentages as low as 2 and 5 percent. The table below includes a tabulation of the range of bed material gravel percentages in the reaches where there were gravel bars identified (within approximately one mile of the gravel bar location). If multiple bar locations were identified, the gravel percentages are listed separately for each.

Table 3-1. Gravel Percentages in Bed Samples in Areas near Field-Located Gravel Bars

Pool	Gravel bars located during field work	River Mile	Range of gravel percentages in bed material samples near the gravel bar
Pool 2	G – FS	44-45	0-1-5 %
Pool 3	none located	--	--
Pool 4	none located	--	--
Pool 5	G – FS	106-108	7-10-39%
Pool 6	G – FS	121-125	33% (one sample only)
Pool 7	G – FS G – H	146-150 154.5	0-2-4-9-20-27% 0-2-3-17%
Pool 8	G – trib	169	--
Pool 9	G – H G – FS	202 205.2	58-65-72% 38-54%
Pool 10 (Dardanelle)	G – FS G – trib G – FS	230 251 254-256	0-5% -- 26-31-49%
Pool 12 (Ozark)	G – trib G – FS and G - H	272 289-295	-- 0-2-8-17-34-35%
Pool 13	none located	--	--
Pool 14	none located	--	no samples
Pool 15	G – trib G – H	361 363.7	-- 0-2%
Pool 16	G – trib	394	--
Pool 17	G – FS G – FS	401.5-403 421.5	no samples
Pool 18	none located	--	--

Use of gravel percentages to locate additional gravel bars. It was hoped that the bed material sampling data could be used to refine the field search for additional gravel bars; that is, since the bed material data is fairly extensive, that search areas could be limited to (for instance) reaches where the gravel percent exceeded twenty percent. The table above and the following plots indicate that gravel bars exist in some areas with low percentages of gravel in the bed material (as low as 2 to 5%). For instance, in Pool 2, gravel bars were noted although there is less than 10% gravel throughout the pool. In Pool 7, gravel bars were observed in a reach where there is less than 10% gravel in the bed material. This seems to indicate that the hydraulic sorting of the bed material is an important factor in forming gravel bars from bed material mixture that contains both sand and gravel.

Formation of gravel bars. Gravel bars form where there is both a sufficient supply of gravel size material and the hydraulic (sediment transport) conditions necessary to ensure that the coarsest grain sizes (gravel) remain and the finer grain sizes (sand and silt) are transported downstream. It might be helpful to perform a sediment budget for gravel size classes only in order to evaluate the potential replenishment of gravel areas. It seems likely that each lock and dam acts as a barrier to gravel movement, so that each pool is self-contained. There is evidently gravel coming in from some of the tributary streams. There may be gravel contributed by eroding stream banks along the main stem: even if erosion occurs at a slow rate, the cumulative contribution of miles of eroding riverbank could be significant. From the data from Pool 2, it seems that a small percentage of gravel in the bed material can be concentrated to form gravel bars by the hydraulics and sediment transport. This indicates that gravel bars may be formed by hydraulic sorting of material, with the finer sediments winnowed away to leave a residue of coarser material. As long as there is some gravel fraction present, the hydraulic conditions may be the determining factor in gravel bar formation. This hypothesis, if correct, would improve our chances of being able to successfully preserve or create gravel bars, by using modeled (or measured) velocities and sediment transport rates to predict future conditions. The links between gravel supply, hydraulic properties, and sediment transport rates should be investigated to see if a better understanding of these processes can aid in predicting gravel bar locations and suitable gravel bar mitigation sites.

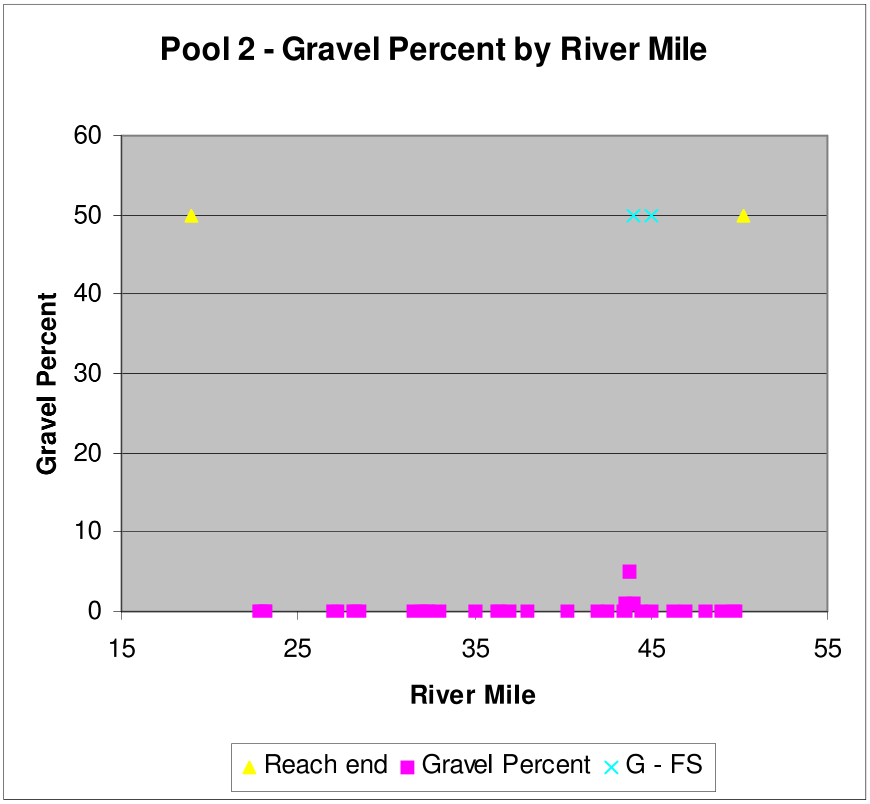

Figure 3-1. Pool 2 – Gravel Percent by River Mile

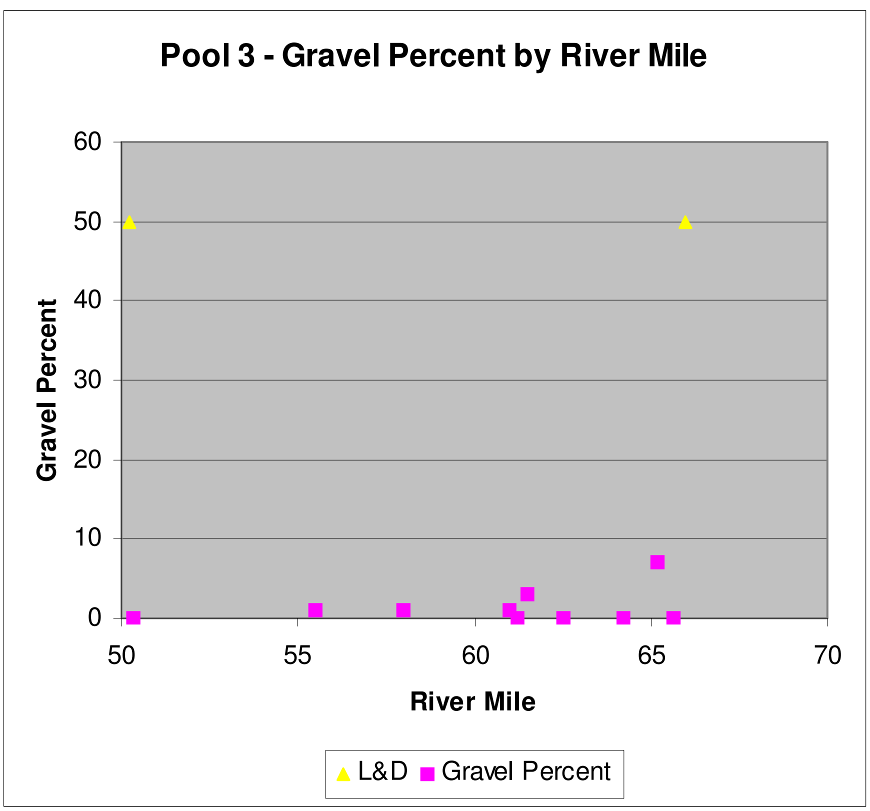

Figure 3-2. Pool 3 – Gravel Percent by River Mile

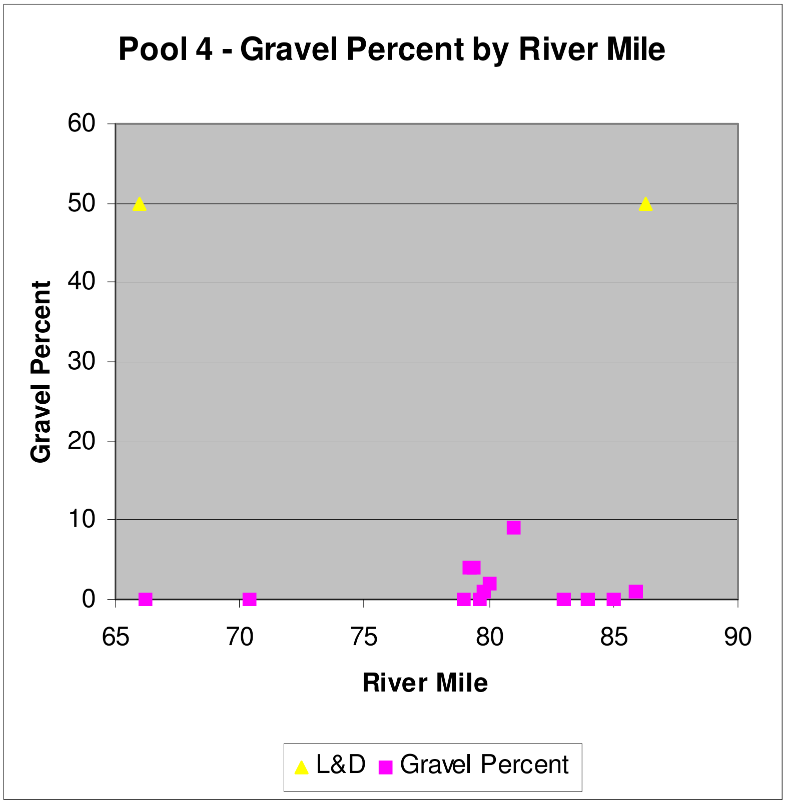

Figure 3-3. Pool 4 – Gravel Percent by River Mile

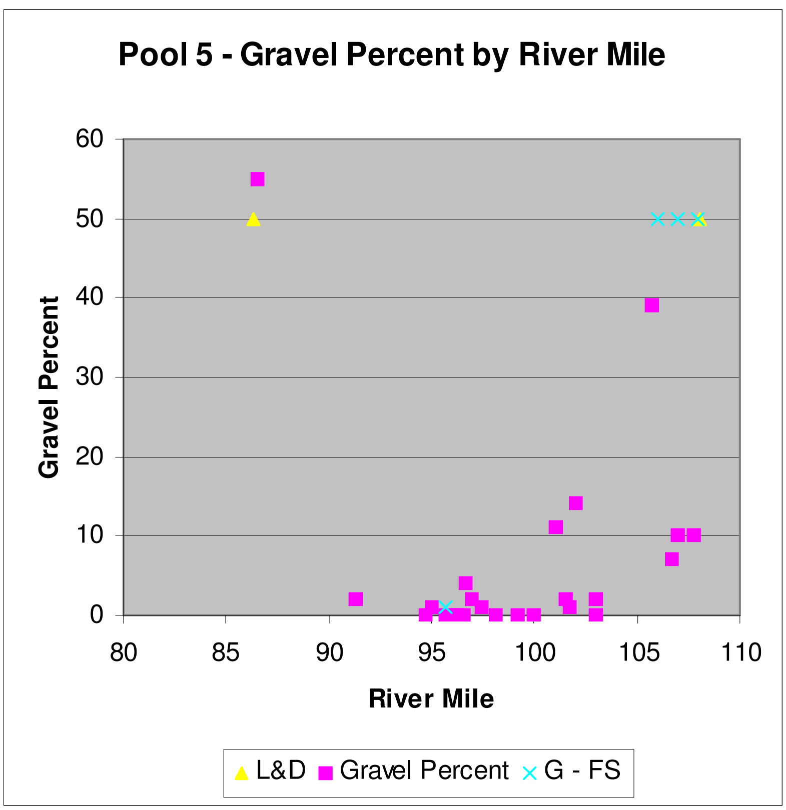

Figure 3-4. Pool 5 – Gravel Percent by River Mile

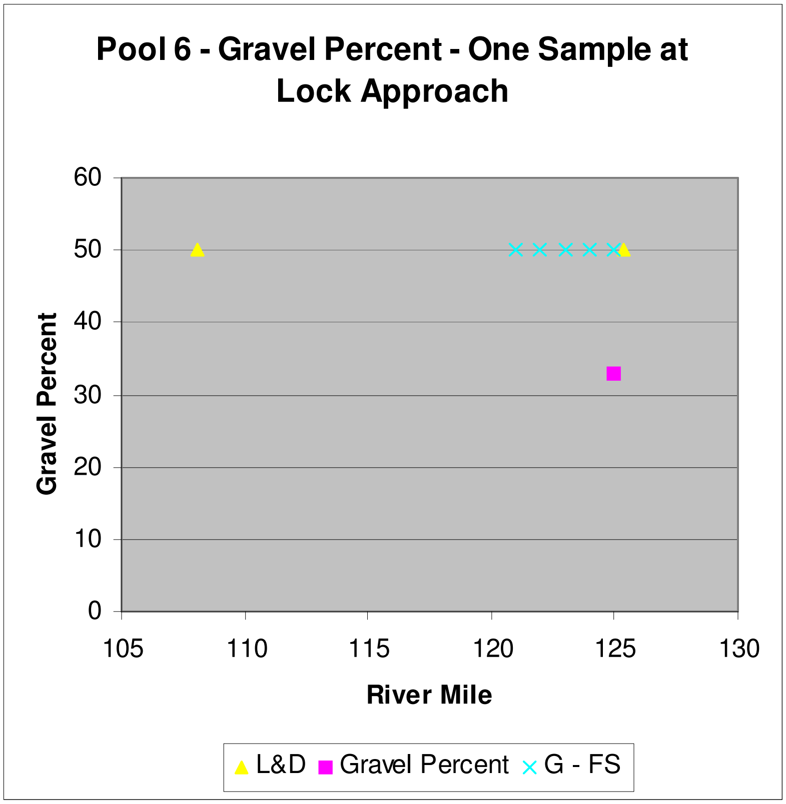

Figure 3-5. Pool 6 – Gravel Percent by River Mile

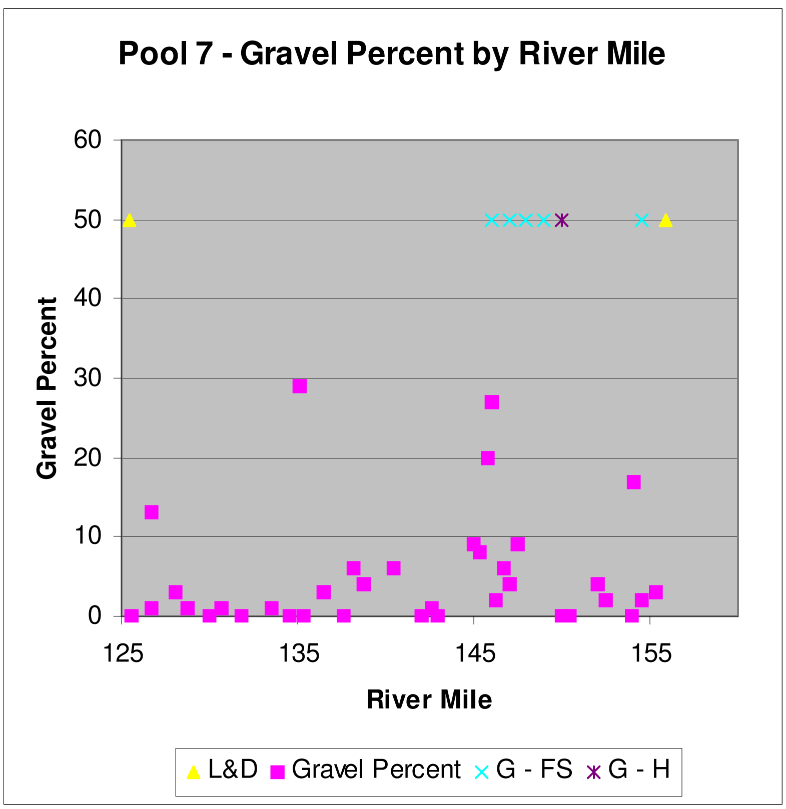

Figure 3-6. Pool 7 – Gravel Percent by River Mile

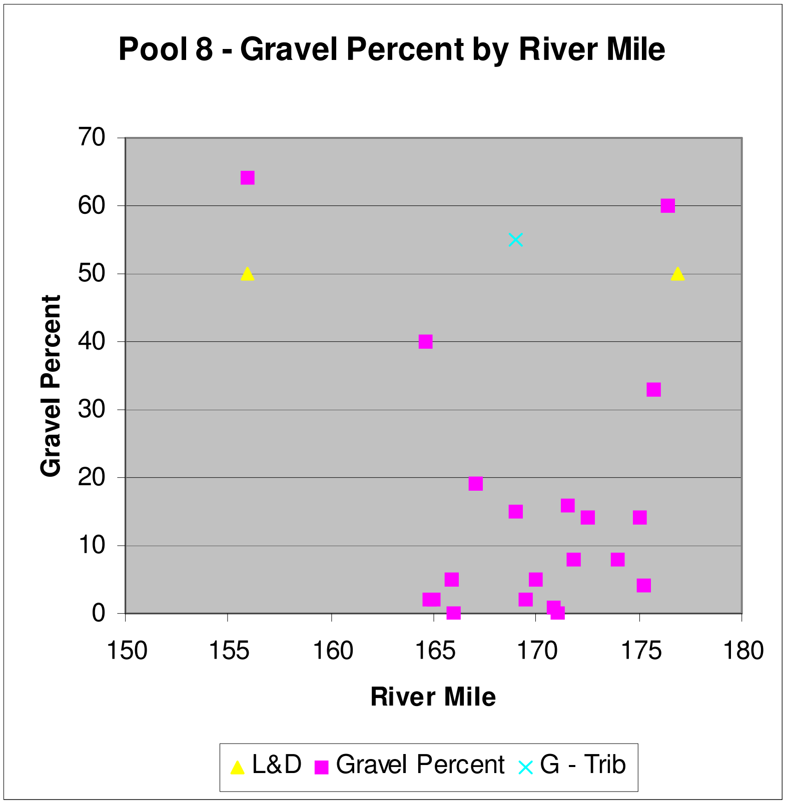

Figure 3-7. Pool 8 – Gravel Percent by River Mile

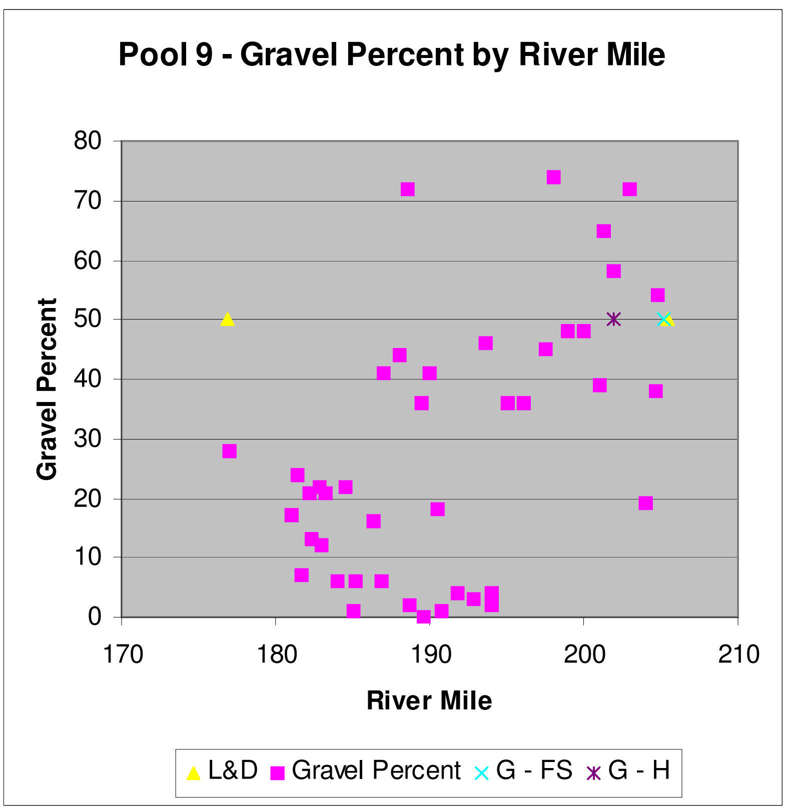

Figure 3-8. Pool 9 – Gravel Percent by River Mile

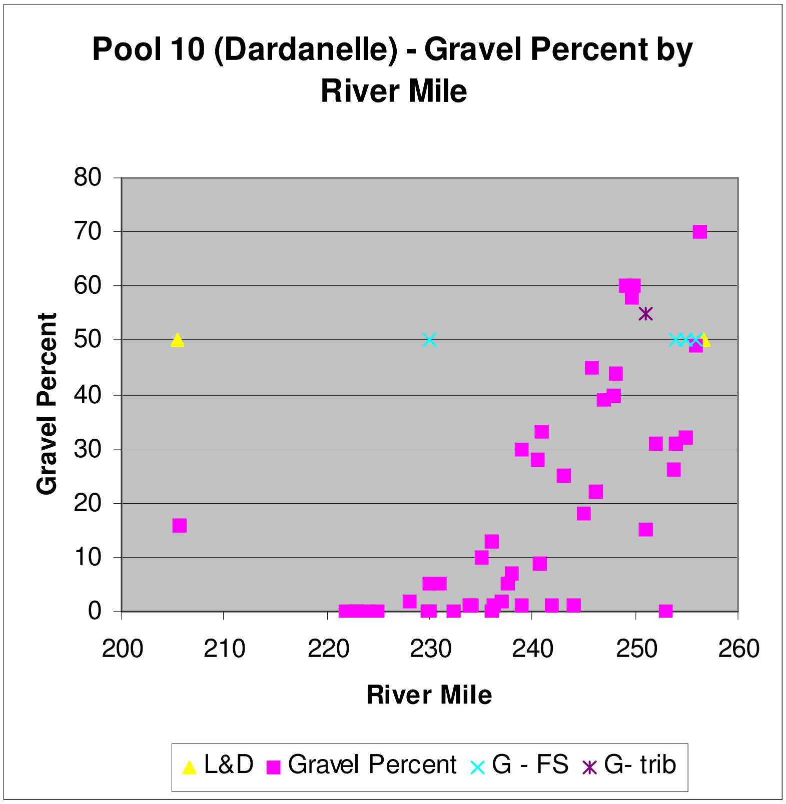

Figure 3-9. Pool 10 – Gravel Percent by River Mile

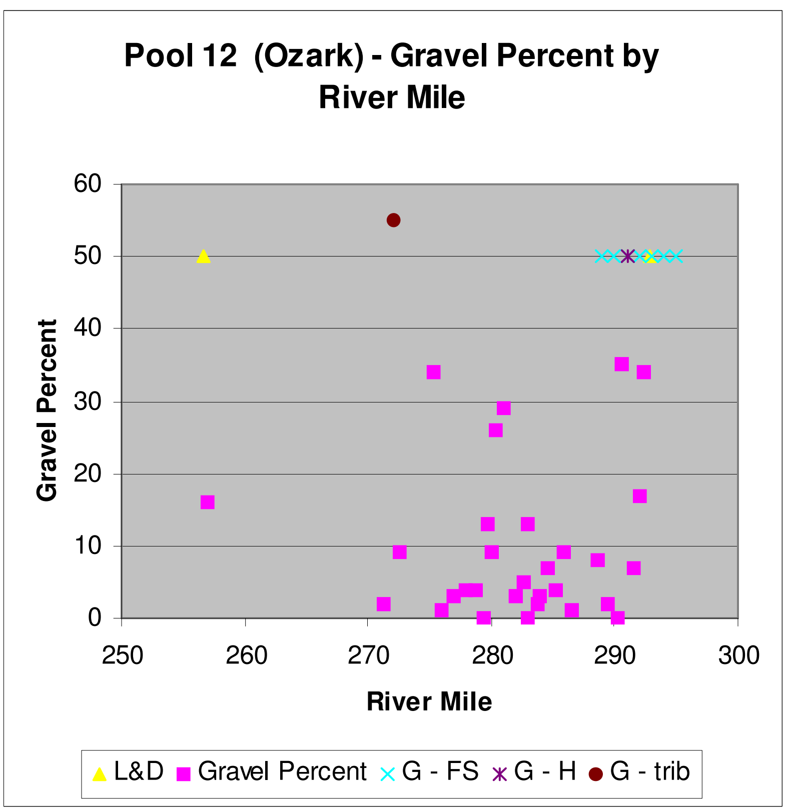

Figure 3-10. Pool 12 – Gravel Percent by River Mile

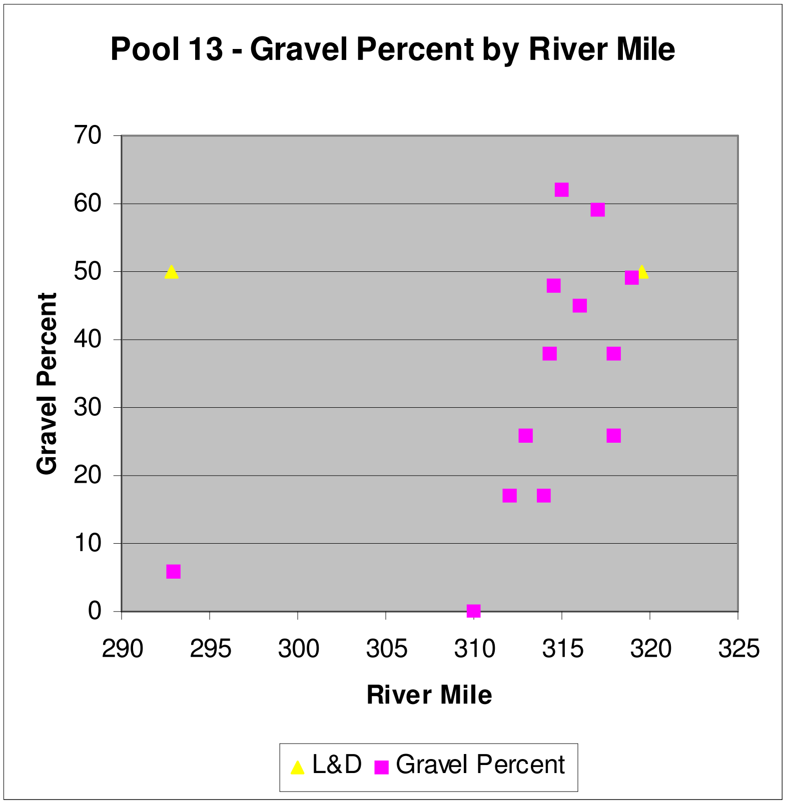

Figure 3-11. Pool 13 – Gravel Percent by River Mile

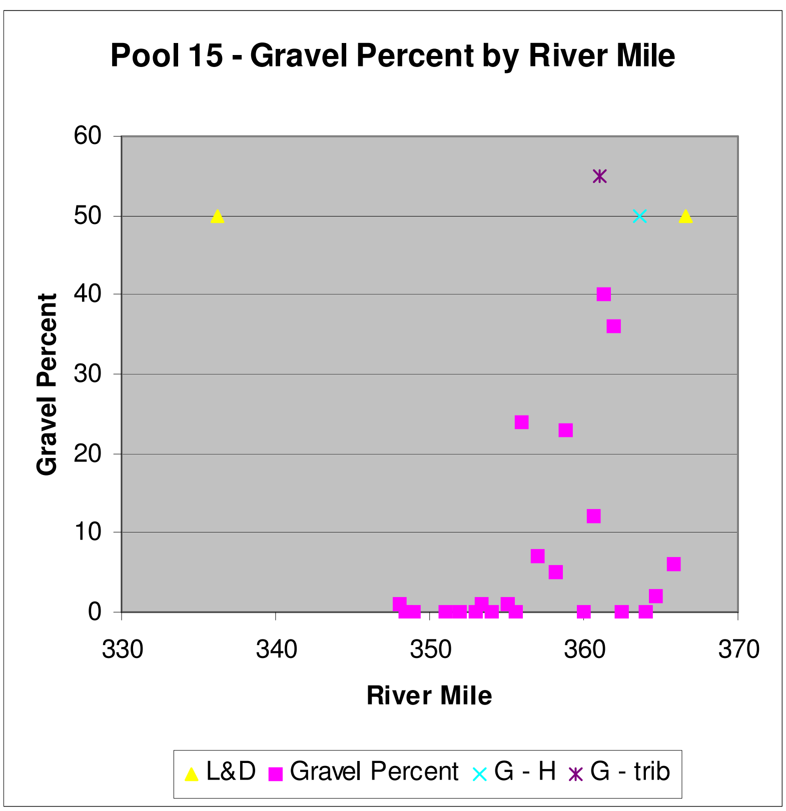

Figure 3-12. Pool 15 – Gravel Percent by River Mile

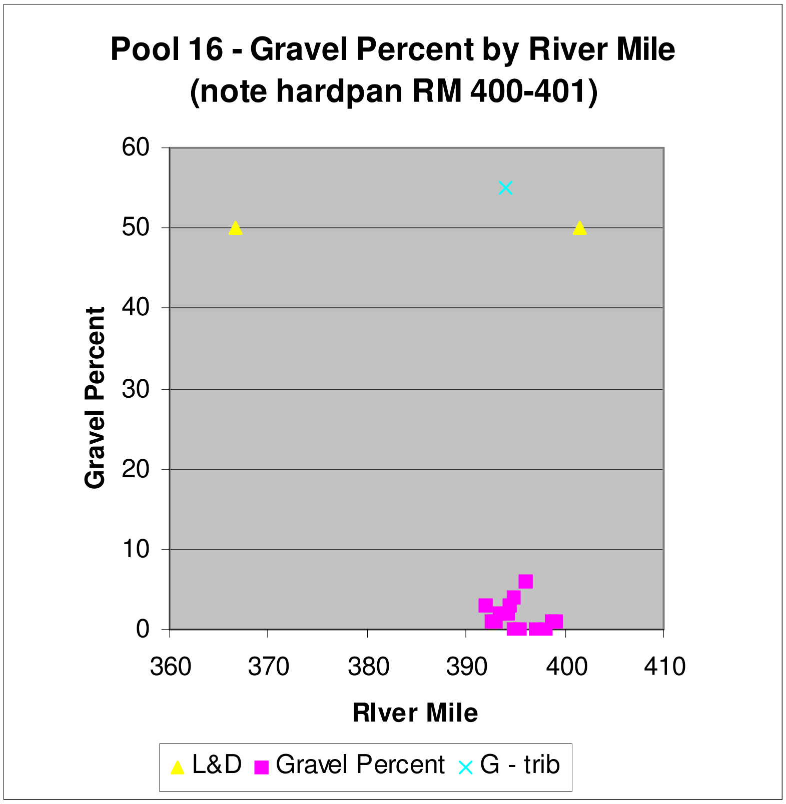

Figure 3-13. Pool 16 – Gravel Percent by River Mile

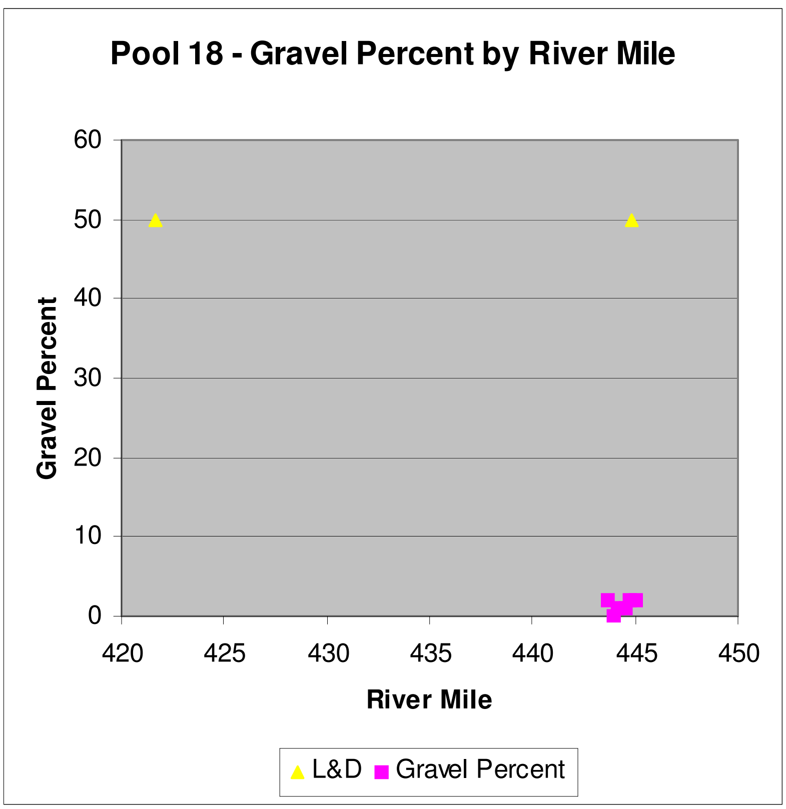

Figure 3-14. Pool 18 – Gravel Percent by River Mile

4. SIAM Modeling of Proposed Navigation Project, Pool 7, Arkansas River

Study Objective. The objective of this portion of the study was to evaluate potential impacts of the proposed navigation project on channel stability in the Arkansas River.

Study methodology. Project-related impacts on channel stability will occur through changes in sediment transport rates in affected river reaches. The magnitude and direction of these changes are driven by the hydraulic impacts of the project. If a project feature does not cause significant changes in hydraulic parameters, there should be no associated sediment (and channel stability) impacts. If a project modification does cause changes in channel shear stress, sediment transport computations are necessary to determine the magnitude of channel stability impacts. The incoming sediment load is compared to the sediment transport capacity to determine whether the channel bed will erode (if transport capacity exceeds sediment supply) or aggrade (if the inflowing sediment load exceeds the transport capacity). If sediment transport capacity is approximately equal to the inflowing sediment load, then the channel is stable (neither aggrading nor degrading) and is said to be in equilibrium. However, the determination of project impacts on channel stability derives directly from the hydraulic impacts shown by the HEC-RAS modeling.

Selection of Pool 7 for channel stability analyses. HEC-RAS models for existing and with-project conditions were obtained from Little Rock and Tulsa districts. Model results for existing (“base”) and with-project (“modified”) conditions were compared to locate reaches with the most sedimentation impacts. Changes in stage, channel velocity, and channel shear stress were tabulated for the entire project. Since changes in channel shear stress are the most direct indicator of changes in sediment transport rates, this was weighted most heavily in selecting reaches to model. Pool 7 has the largest change in shear stress, and also has known gravel locations that could be affected by the project.

Channel stability analyses. Long-term impacts on channel stability were evaluated using methods recommended in USACE EM 1110-2-1418, “Channel Stability Analyses for Flood Control Projects”. An annual average sediment budget analysis was conducted. The sediment transport capacity as a function of discharge was integrated with an annual flow duration curve to obtain a value of annual average bed material sediment transport capacity for a given reach (values in tons per year). This value was compared with the annual average bed material inflow to the reach, in order to determine the long-term sediment balance. If the annual average sediment inflow exceeds the annual average sediment transport capacity, then bed deposition (aggradation) is indicated. If annual average sediment transport capacity exceeds the annual average sediment inflow, then bed erosion (degradation) is indicated. The differential quantity of sediment (in tons per year) can be converted to an average depth of erosion or deposition using the channel dimensions. The Sediment Impact Assessment Model (SIAM), which is described in more detail below, was used to perform sediment budget computations for this study.

Bed material load and wash load. The total sediment load can be divided into two portions: the bed material load and the wash load. The distinction is important because the bed material load is hydraulically controlled, while the wash load is limited only by availability. The wash load is composed of grain sizes that are not found in the channel bed in significant amounts. For practical purposes, the stream can carry a quantity limited only by availability of material. The bed material load is composed of the grain sizes that make up the channel bed. The stream has a certain finite transport capacity for bed material, which is functionally related to hydraulic variables such as shear stress. The evaluation of channel stability focuses on the bed material load. The sediment sizes finer than the smallest 10 percent of the bed material are commonly designated as wash load. This usually includes silts and clays, and often includes different sand fractions. The dividing grain size between wash load and bed material load can (and often does) vary between river reaches.

SIAM model. Pool 7 was modeled with SIAM to assess impacts of project features. SIAM uses the hydraulic output from HEC-RAS to compute average hydraulic parameters for reaches selected by the user. The hydraulic data is used in conjunction with sediment and hydrology data input by the user to compute average annual sediment transport capacity and average annual erosion or deposition in tons per year, per reach, for existing and modified conditions. Since the model was not precisely calibrated, the absolute values of the average annual aggradation or degradation are not exact; rather, its proper utility in this type of situation is to compare relative changes between with and without project features. The model will give a reasonable representation of the trend and magnitude of the impacts of channel and flow alterations on channel stability, as well as a reasonable picture of the sensitivity of the impacts to changes in various parameters.

Sediment reaches. Pool 7 was broken up into five reaches:

Reach	**Navigation Mile**
Reach 1	148-155
Reach 2	141-147
Reach 3	135-141
Reach 4	128-135
Reach 5	125-127

The reach break points were based on several factors: project modifications (channel dredging and dikes); changes in channel cross-section or profile; and geomorphic reach boundaries.

Bed material. The USGS bed material sample data was averaged for each reach. The D_{10} of this average was used to select the size fraction of the wash load for each reach. In Reaches 1, 3, and 4, fine sand (and all smaller grain sizes) are wash load. The bed material in Reach 2 is slightly coarser; medium sand and all smaller grain sizes were designated as wash load. Reach 5, which is at the downstream end of the pool (just above the dam), has the finest bed material: very fine sand (and all smaller grain sizes) are wash load. This information is shown in Table 4-1 below.

Sediment Size	Very Fine Sand (VFS)	Fine Sand (FS)	Medium Sand (MS)	Coarse Sand (CS)
Reach 1	**Wash load**	**Wash load**	**Bed material**	**Bed material**
Reach 2	**Wash load**	**Wash load**	**Wash load**	**Bed material**
Reach 3	**Wash load**	**Wash load**	**Bed material**	**Bed material**
Reach 4	**Wash load**	**Wash load**	**Bed material**	**Bed material**
Reach 5	**Wash load**	**Bed material**	**Bed material**	**Bed material**

Table 4-1. Bed Material Load and Wash Load for Reaches 1 – 5 in Pool 7

Inflowing sediment load. Since no inflowing sediment load data were available for Pool 7, an estimate had to be made based on the report, "Downward Trend in Mississippi River Suspended-Sediment Loads", (Dardeau and Causey, 1990). This report gives an average postconstruction figure of 11.4 million tons per year suspended sediment for the Arkansas River at Little Rock. (For comparison, the preconstruction sediment load averaged 63.6 million tons per year.) Unfortunately, no gradation values for these loads were reported. Therefore, the percentages for the different size classes of sediment were based on gradation data from long-term sampling data on the Mississippi River at various locations. The breakdown into size classes was estimated as follows: 70% silt and clay (8.0 million tons); 30% sand (3.4 million tons). Since silt and clay are transported as wash load through the entire reach (they are not found in the bed in significant amounts), this fraction of the inflowing load does not affect channel stability within the reach, and was not modeled. The sand fraction of the inflowing load was broken down into four size classes:

VFS (very fine sand) - 60% or 2.0 million tons per year
FS (fine sand) - 25% or 0.85 million tons per year
MS (medium sand) - 10% or 0.34 million tons per year
CS (coarse sand) - 5% or 0.17 million tons per year

It must be re-emphasized that these data are only estimates based on previously published reports from the Mississippi River, and therefore, may not reflect actual conditions at Pool 7. Due to the uncertainty in the sediment data, an analysis was performed to evaluate the sensitivity of the model to changes in the inflowing sediment load. Results of the sensitivity analysis are discussed below.

Sediment concentration. The inflowing sand load of 3.4 million tons per year is equivalent to 80 mg/l. The total inflowing load of 11.4 million tons per year is equivalent to 265 mg/l. These values were computed using a mean discharge of 43,390 cfs, and the equation

$$Q_{sed} = 0.0027 \times Q \times \text{concentration}$$

Where Q_{sed} is the sediment load in tons per day
Q is the mean discharge
Concentration is the sediment concentration in mg/l or ppm

Hydrology. A flow duration curve for the Arkansas River at Little Rock was obtained from Tulsa District, and was used for both existing and with-project conditions. Additional HEC-RAS runs were made (for both base and modified conditions) at lower discharges to better evaluate the sediment transport capacity of frequent events. The flow duration curve was input as days per year to determine annual average values of sediment load.

Sediment transport function. The Laursen (with Copeland modification) sediment transport function was used because of its ability to handle the sand and gravel sizes found in the bed material.

Conversion of model results to depth of deposition or degradation.. Model results were given in tons per year, and converted into feet of aggradation/degradation per year (using methods recommended in EM 1110-2-1418). The average bottom width for each reach was estimated from the cross sections. The reach length was taken from the navigation mileage. A unit weight of 90 pounds per cubic foot was used for sediment density. A depth of 0.15 foot of aggradation or degradation per year was taken as the threshold for equilibrium. It should be noted that since the model evaluates conditions on a reach-averaged basis, that sedimentation conditions at any one point in the reach can be expected to vary from the average.

Evaluation of model results for existing conditions. The model results for existing conditions were evaluated to see if they corresponded with the known prototype conditions. If model inputs are reasonable, then the results should not conflict with observed conditions and common sense. Model results for existing conditions are given in Table 4-2. Reaches 1 through 4 are in equilibrium (using 0.15 ft/year as a threshold). Reach 5 is aggrading, at an estimated rate of 0.64 feet/year. Since this is the reach immediately upstream of the lock and dam, deposition would be expected. (Further investigation would improve the precision of this number, but is outside the scope of this study.) Due to the lack of comparative survey or gage trend data in Pool 7, a precise calibration of SIAM is not possible, however, the computed trends do appear reasonable, and therefore, the model should be adequate to capture the significant changes between pre- and post-project conditions.

Evaluation of model results for project conditions. As stated above, the differences between alternatives are more precise than the predictions for the alternatives themselves. The results are listed in Table 4-2. The maximum difference between project conditions and existing conditions is 0.04 foot (one-half inch) per year of average bed change. These small changes are well within the uncertainty limits of the model, and suggest that there are no discernible impacts in Pool 7.

Sensitivity analyses. Sensitivity analyses were conducted to evaluate the model's response to reasonable changes in program inputs. The sensitivity of the model was evaluated for two parameters: 1) changes in the inflowing sediment load, and 2) modification of the wash load threshold in Reach 2 (from medium sand to fine sand). The results are listed in Tables 4-3, 4-4, and 4-5. SIAM was run with the inflowing sediment load multiplied by 1.5 and 0.5 to test the sensitivity of the results. (This would correspond to a sand fraction of 15% to 45% of the total load.) When the inflowing sediment load is multiplied by 1.5 or 0.5, the net aggradation and degradation numbers change (for reaches 1 and 5 only), but there is no change in the difference between existing and modified conditions. When the wash load grain size is changed for Reach 2, then Reach 2 becomes slightly more degradational and Reach 3 becomes slightly more aggradational. However, both reaches remain within the equilibrium range. There are no changes at other reaches. The maximum difference between existing and modified conditions increases to 0.07 foot per year, or less than one inch. This is still low enough to be categorized as no discernible impact. The results of the sensitivity analysis indicate that the modeled results are relatively insensitive to reasonable changes in program inputs.

Conclusion. A sediment budget analysis was conducted to evaluate project impacts on long-term channel stability. Pool 7 was selected for analysis because of the impacts of the project on shear stress, and the presence of gravel bars (and potential project impacts). The HEC-RAS results (for existing and with-project conditions) were used along with the SIAM model to compare sediment transport capacity to sediment inflow for the bed material load for average reach conditions. The sediment budget analysis (conducted according to methods recommended in EM1110-2-1418) showed no significant project impacts. Sensitivity runs were performed and showed no significant increase in project impacts for reasonable modifications of data inputs. The study results suggest that the hydraulic impacts of the navigation project are unlikely to cause long-term channel stability impacts. These results should be considered preliminary due to the data limitations of the model and lack of prototype information. However, the results do indicate the utility of SIAM to evaluate impacts on the Arkansas River.

Table 4-2. SIAM Results for Existing and With-Project Conditions							
Pool 7	**Comparison of Existing and With-Project Conditions**						
Sand load only	Tons per average year						
	agg (+) and deg (-)						
Reach	**Existing conditions**		**With-Project conditions**		**Project impact**		**Direction of impact**
	(tons)		(tons)		(tons)	(feet)	
Inflowing sand load	3,360,000		3,360,000				
Reach 1 (NM 148-155)	**93,000**	**aggradation**	**109,000**	**aggradation**	**16,000**	**0.01**	**increased aggradation**
	3,267,000		3,251,000				
Reach 2 (NM 141-147)	**-139,000**	**degradation**	**-188,000**	**degradation**	**-49,000**	**-0.03**	**increased degradation**
	3,406,000		3,439,000				
Reach 3 (NM 135-141)	**188,000**	**aggradation**	**222,000**	**aggradation**	**34,000**	**0.02**	**increased aggradation**
	3,218,000		3,217,000				
Reach 4 (NM 128-135)	**171,000**	**aggradation**	**172,000**	**aggradation**	**1,000**	**0.00**	**no change**
	3,047,000		3,045,000				
Reach 5 (NM 125-127)	**665,000**	**aggradation**	**627,000**	**aggradation**	**-38,000**	**-0.04**	**decreased aggradation**
Outflowing sand load	2,382,000		2,418,000				
total deposition	1,117,000		1,130,000				
total erosion	-139,000		-188,000				
Sed. Outflow / Inflow	0.71		0.72				
% passing Pool 7	71%		72%				

Table 4-2. SIAM Results for Existing and With-Project Conditions

Table 4-3							
Pool 7	**Sensitivity Analysis for Inflowing Sediment Load Increased by 50%**						
Sand load only	Tons per average year						
	agg (+) and deg (-)						
Reach	**Existing conditions**		**With-Project conditions**		**Project impact**		**Direction of impact**
	(tons)		(tons)		(tons)	(feet)	
Inflowing sand load	5,040,000		5,040,000				
Reach 1 (NM 148-155)	**348,000**	**aggradation**	**364,000**	**aggradation**	**16,000**	**0.01**	**increased aggradation**
	4,692,000		4,676,000				
Reach 2 (NM 141-147)	**-139,000**	**degradation**	**-188,000**	**degradation**	**-49,000**	**-0.03**	**increased degradation**
	4,831,000		4,864,000				
Reach 3 (NM 135-141)	**188,000**	**aggradation**	**222,000**	**aggradation**	**34,000**	**0.02**	**increased aggradation**
	4,643,000		4,642,000				
Reach 4 (NM 128-135)	**171,000**	**aggradation**	**172,000**	**aggradation**	**1,000**	**0.00**	**no change**
	4,472,000		4,470,000				
Reach 5 (NM 125-127)	**1,090,000**	**aggradation**	**1,053,000**	**aggradation**	**-37,000**	**-0.04**	**decreased aggradation**
Outflowing sand load	3,382,000		3,417,000				
total deposition	1,797,000		1,811,000				
total erosion	-139,000		-188,000				
out/in	0.67		0.68				
% passing Pool 7	67%		68%				

Table 4-3. Sensitivity Analysis for Inflowing Sediment Load Increased by 50%

Table 4-4							
Pool 7	**Sensitivity Analysis for Inflowing Sediment Load Decreased by 50%**						
Sand load only	Tons per average year						
	agg (+) and deg (-)						
Reach	**Existing conditions**		**With-Project conditions**		**Project impact**		**Direction of impact**
	(tons)		(tons)		(tons)	(feet)	
Inflowing sand load	1,680,000		1,680,000				
Reach 1 (NM 148-155)	**-162,000**	**degradation**	**-146,000**	**degradation**	**16,000**	**0.01**	**decreased degradation**
	1,842,000		1,826,000				
Reach 2 (NM 141-147)	**-139,000**	**degradation**	**-188,000**	**degradation**	**-49,000**	**-0.03**	**increased degradation**
	1,981,000		2,014,000				
Reach 3 (NM 135-141)	**188,000**	**aggradation**	**222,000**	**aggradation**	**34,000**	**0.02**	**increased aggradation**
	1,793,000		1,792,000				
Reach 4 (NM 128-135)	**171,000**	**aggradation**	**172,000**	**aggradation**	**1,000**	**0.00**	**no change**
	1,622,000		1,620,000				
Reach 5 (NM 125-127)	**240,000**	**aggradation**	**203,000**	**aggradation**	**-37,000**	**-0.04**	**decreased aggradation**
Outflowing sand load	1,382,000		1,417,000				
total deposition	599,000		597,000				
total erosion	-301,000		-334,000				
out/in	0.82		0.84				
% passing Pool 7	82%		84%				

Table 4-4. Sensitivity Analysis for Inflowing Sediment Load Decreased by 50%

Table 4-5							
Pool 7	**Sensitivity Analysis for Modified Wash Load Threshold in Reach 2**						
Sand load only	Tons per average year						
	agg (+) and deg (-)						
Reach	**Existing conditions**		**With-Project conditions**		**Project impact**		**Direction of impact**
	(tons)		(tons)		(tons)	(feet)	
Inflowing sand load	3,360,000		3,360,000				
Reach 1 (NM 148-155)	**93,000**	**aggradation**	**109,000**	**aggradation**	**16,000**	**0.01**	**increased aggradation**
	3,267,000		3,251,000				
Reach 2 (NM 141-147)	**-193,000**	**degradation**	**-305,000**	**degradation**	**-112,000**	**-0.07**	**increased degradation**
	3,460,000		3,556,000				
Reach 3 (NM 135-141)	**242,000**	**aggradation**	**339,000**	**aggradation**	**97,000**	**0.06**	**increased aggradation**
	3,218,000		3,217,000				
Reach 4 (NM 128-135)	**171,000**	**aggradation**	**172,000**	**aggradation**	**1,000**	**0.00**	**no change**
	3,047,000		3,045,000				
Reach 5 (NM 125-127)	**665,000**	**aggradation**	**627,000**	**aggradation**	**-38,000**	**-0.04**	**decreased aggradation**
Outflowing sand load	2,382,000		2,418,000				
total deposition	1,171,000		1,247,000				
total erosion	-193,000		-305,000				
out/in	0.71		0.72				
% passing Pool 7	71%		72%				

Table 4-5. Sensitivity Analysis for Modified Wash Load Threshold in Reach 2

5. References

Brice, J. C. (1975). Airphoto Interpretation of the Form and Behavior of Alluvial Rivers. Final Report to the U.S. Army Research Office – Durham, Box CM, Duke Station, Durham, NC 27706, prepared under contract number DA-ARD-D-31-124-70-G89, Washington University, St. Louis, pp. 1-10.

Dardeau, E. A., Jr. and Causey, E. M. (1990). "Downward Trend in Mississippi River Suspended-Sediment Loads," Potomology Program (P-1), Report 5, Environmental Laboratory, US Army Engineer Waterways Experiment Station, Vicksburg, MS. Prepared for US Army Engineer District, New Orleans.

Smith, L. M., and Breland, P. L. (authors); edited by J. Dunbar and S. Jackson (2004). "Geomorphological Reconnaissance of the McClellan-Kerr Arkansas River Navigation System Dardanelle Lock and Dam to the Mississippi River," Geotechnical and Structures Laboratory, US Army Research and Development Center, Vicksburg, MS, prepared for the US Army Engineer District, Little Rock.

U.S. Army Corps of Engineers, Headquarters (1994). "Channel Stability Assessment for Flood Control Projects," Engineering Manual 1110-2-1418, Washington, DC.

C.12

Prime Farmland Coordination

C.12: Prime Farmland Coordination

C.12.1 Introduction

Federal agencies involved in proposed projects that may convert farmland, as defined in the Farmland Protection Policy Act, to nonagricultural uses, are required to coordinate a review to determine the quality of the farmland that may be impacted by the proposed project. The United States Department of Agriculture, Natural Resources Conservation Service (NRCS) is tasked with rating the relative value of the farmland to be converted on a scale of 0 to 100.

The Arkansas River Navigation Study has identified several agricultural land parcels that could be converted to nonagricultural uses if the study becomes a project and is implemented. These parcels are associated with creating new dredge material disposal sites necessary for the potential deepening of the navigation channel and ongoing navigation channel maintenance. These agricultural parcels were selected in lieu of high quality wildlife habitat to minimize the impacts to biological resources associated with project implementation.

The farmland parcels potentially influenced by project implementation include the following:

- 81 acres in LeFlore County, Oklahoma
- 159 acres in Muskogee County, Oklahoma
- 68 acres in Wagoner County, Oklahoma
- 308 acres in Arkansas County, Arkansas

C.12.2 Coordination & Form AD-1006

Copies of correspondence documenting the process associated with the review of potential farmland conversion impacts are included in the following pages:

Item	Date	Page
Letter to Poteau Field Service Center (LeFlore County) requesting coordination	May 24, 2005	C-914
Letter to Muskogee Field Service Center requesting coordination	May 24, 2005	C-915
Letter to Wagoner Field Service Center requesting coordination	May 24, 2005	C-916
Letter to Dewitt Field Service Center (Arkansas County) requesting coordination	May 24, 2005	C-917
Poteau Field Service Center response form AD-1006	June 14, 2005	C-918
Wagoner Field Service Center response letter and maps	June 27, 2005	C-919
Muskogee Field Service Center response form AD-1006	June 28, 2005	C-920
Dewitt Field Service Center response form AD-1006	June 28, 2005	C-921

C.12.3 Form AD-1006 Summary

A summary of the results of the Farmland Protection Policy Act AD-1006 determinations is present below.

Table C.12.1 Summary of Farmland Protection Policy Act AD-1006 determinations for Arkansas River Navigation Study EIS.

	Part III A & B	**Part III C**	**Part IV A**	**Part IV B**	**Part IV C**	**Part IV D**	**Part V**	**Part VI**
County	Acres to be Converted	Total Acres in Site	Total Acres of Prime and Unique Farmland	Total Acres Statewide and Local Important Farmland	% of Farmland in County to be Converted	% of Farmland in county with Same or Higher Relative Value	Relative Value of Farmland to be converted	Total Site Assessment Points
LeFlore	81	81	45	0	0.004	1.3	100	159
Muskogee	159	159	145	0	0.043	45	84	140
Wagoner**	-	-	-	-	-	-	-	-
Arkansas	308	308	308	176,628	0.074	0.074	84	128

Forms AD-1006 have not been completed NRCS for Wagoner county.
Source: NRCS 2005

**This information was not provided for Wagoner County in the response letter.

PARSONS

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May 24, 2005

USDA – Natural Resources Conservation Service
Poteau Field Service Center
P.O. Box 547
Poteau, OK 74953

ATTN: Kenneth Risenhoover, District Conservationist

Re: Environmental Impact Statement, Arkansas River Navigation Study

Dear Mr. Risenhoover:

We are providing services to the U.S. Army Corps of Engineers (USACE) in preparation of the Environmental Impact Statement for the Arkansas River Navigation Study.

Attached please find the following:

1) Farmland Conservation Impact Rating Form with Parts 1 and 3 completed.
2) A figure indicating the LeFlore County disposal area.

The LeFlore County portion of the Arkansas Navigation Study comprises approximately 26,612 acres. The LeFlore County disposal area comprises approximately 81 acres and is depicted in the attached figure. The USACE intends to dispose of dredge material on these parcels and reuse of these parcels will be under the guidance of the USACE. Reuse plans developed to date do not include agricultural reuses, consequently the USACE assumes, for analysis purposes, that any prime farmland within the disposal area will be converted to non agricultural uses.

We would greatly appreciate if you could complete the enclosed Farmland Conservation Impact Rating Form and return it to our office. We would also like assistance in determining the answers to part VI, number 5 if possible. Thank you for your assistance in this matter, if you have any questions or require additional information please do not hesitate to call Ginny Flynn or me at (314) 576-7330.

Sincerely,

PARSONS

Richard E. Hall

Richard E. Hall
Arkansas River Navigation Study, EIS Project Manager

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May 24, 2005

USDA – Natural Resources Conservation Service
Muskogee Field Service Center
3001 Azalea Park Drive, Suite 1
Muskogee, OK 74401

ATTN: Steven Clark, District Conservationist

Re: Environmental Impact Statement, Arkansas River Navigation Study

Dear Mr. Clark:

We are providing services to the U.S. Army Corps of Engineers (USACE) in preparation of the Environmental Impact Statement for the Arkansas River Navigation Study.

Attached please find the following:

1) Farmland Conservation Impact Rating Form with Parts 1 and 3 completed.
2) A figure indicating the Muskogee County disposal area.

The Muskogee County portion of the Arkansas Navigation Study comprises approximately 46,709 acres. The Muskogee County disposal area comprises approximately 159 acres and is depicted in the attached figure. The USACE intends to dispose of dredge material on these parcels and reuse of these parcels will be under the guidance of the USACE. Reuse plans developed to date do not include agricultural reuses, consequently the USACE assumes, for analysis purposes, that any prime farmland within the disposal area will be converted to non agricultural uses.

We would greatly appreciate if you could complete the enclosed Farmland Conservation Impact Rating Form and return it to our office. We would also like assistance in determining the answers to part VI, number 5 if possible. Thank you for your assistance in this matter, if you have any questions or require additional information please do not hesitate to call Ginny Flynn or me at (314) 576-7330.

Sincerely,

PARSONS

Richard E. Hall

Richard E. Hall
Arkansas River Navigation Study, EIS Project Manager

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May 24, 2005

USDA – Natural Resources Conservation Service
Wagoner Field Service Center
1312 S.W. 3rd
Wagoner, OK 74467-5518

ATTN: Brent Pannell, District Conservationist

Re: Environmental Impact Statement, Arkansas River Navigation Study

Dear Mr. Pannell:

We are providing services to the U.S. Army Corps of Engineers (USACE) in preparation of the Environmental Impact Statement for the Arkansas River Navigation Study.

Attached please find the following:

1) Farmland Conservation Impact Rating Form with Parts 1 and 3 completed.
2) A figure indicating the Wagoner County disposal area.

The Wagoner County portion of the Arkansas Navigation Study comprises approximately 40,182 acres. The Wagoner County disposal area comprises approximately 68 acres and is depicted in the attached figures. The USACE intends to dispose of dredge material on these parcels and reuse of these parcels will be under the guidance of the USACE. Reuse plans developed to date do not include agricultural reuses, consequently the USACE assumes, for analysis purposes, that any prime farmland within the disposal area will be converted to non agricultural uses.

We would greatly appreciate if you could complete the enclosed Farmland Conservation Impact Rating Form and return it to our office. We would also like assistance in determining the answers to part VI, number 5 if possible. Thank you for your assistance in this matter, if you have any questions or require additional information please do not hesitate to call Ginny Flynn or me at (314) 576-7330.

Sincerely,

PARSONS

Richard E. Hall

Richard E. Hall
Arkansas River Navigation Study, EIS Project Manager

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May 24, 2005

USDA – Natural Resources Conservation Service
1015 West 2nd Street
DeWitt, AR 72042

ATTN: Marshall Handcock, District Conservationist

Re: Environmental Impact Statement, Arkansas River Navigation Study

Dear Mr. Handcock:

We are providing services to the U.S. Army Corps of Engineers (USACE) in preparation of the Environmental Impact Statement for the Arkansas River Navigation Study.

Attached please find the following:

1) Farmland Conservation Impact Rating Form with Parts 1 and 3 completed.
2) A figure indicating the Arkansas County disposal area.

The Arkansas County portion of the Arkansas Navigation Study comprises approximately 23,446 acres. The Arkansas County disposal area comprises approximately 308 acres and is depicted in the attached figure. The USACE intends to dispose of dredge material on these parcels and reuse of these parcels will be under the guidance of the USACE. Reuse plans developed to date do not include agricultural reuses, consequently the USACE assumes, for analysis purposes, that any prime farmland within the disposal area will be converted to non agricultural uses.

We would greatly appreciate if you could complete the enclosed Farmland Conservation Impact Rating Form and return it to our office. We would also like assistance in determining the answers to part VI, number 5 if possible. Thank you for your assistance in this matter, if you have any questions or require additional information please do not hesitate to call Ginny Flynn or me at (314) 576-7330.

Sincerely,

PARSONS

Richard E. Hall

Richard E. Hall
Arkansas River Navigation Study, EIS Project Manager

Farmland Conversion Impact Rating Form AD-1006 from Poteau Field Service Center.

U.S. DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service

NRCS-CPA-106
(Rev. 1-91)

FARMLAND CONVERSION IMPACT RATING FOR CORRIDOR TYPE PROJECTS

PART I *(To be completed by Federal Agency)*	3. Date of Land Evaluation Request 5/24/05 / 4. Sheet 1 of ____
1. Name of Project Arkansas River Navigation Study EIS	5. Federal Agency Involved U.S. Army Corps of Engineers - Little Rock and Tulsa Dist.
2. Type of Project Navigation	6. County and State Le Flore, Oklahoma

PART II *(To be completed by NRCS)*	1. Date Request Received by NRCS 6/13/05	2. Person Completing Form Kenneth Risenhoover
3. Does the corridor contain prime, unique statewide or local important farmland? (If no, the FPPA does not apply - Do not complete additional parts of this form).	YES ☒ NO ☐	4. Acres Irrigated 0 / Average Farm Size 264
5. Major Crop(s) Wheat	6. Farmable Land in Government Jurisdiction Acres: 372,281 % 36	7. Amount of Farmland As Defined in FPPA Acres: 230,041 % 23
8. Name Of Land Evaluation System Used LeFlore Co. LESA	9. Name of Local Site Assessment System None	10. Date Land Evaluation Returned by NRCS 6/14/05

PART III *(To be completed by Federal Agency)*	Maximum Points	Corridor A	Corridor B	Corridor C	Corridor D
		Alternative Corridor For Segment			
A. Total Acres To Be Converted Directly		81			
B. Total Acres To Be Converted Indirectly, Or To Receive Services		0			
C. Total Acres In Corridor		81	0	0	0
PART IV *(To be completed by NRCS) Land Evaluation Information*					
A. Total Acres Prime And Unique Farmland		45			
B. Total Acres Statewide And Local Important Farmland		—			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		.004			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		1.3			
PART V *(To be completed by NRCS) Land Evaluation Information Criterion Relative value of Farmland to Be Serviced or Converted (Scale of 0 - 100 Points)*		100			
PART VI *(To be completed by Federal Agency) Corridor Assessment Criteria (These criteria are explained in 7 CFR 658.5(c))*	Maximum Points				
1. Area in Nonurban Use	15	15.			
2. Perimeter in Nonurban Use	10	10.			
3. Percent Of Corridor Being Farmed	20	20			
4. Protection Provided By State And Local Government	20	0			
5. Size of Present Farm Unit Compared To Average	10	4			
6. Creation Of Nonfarmable Farmland	25	0			
7. Availability Of Farm Support Services	5	5			
8. On-Farm Investments	20	5			
9. Effects Of Conversion On Farm Support Services	25	0			
10. Compatibility With Existing Agricultural Use	10	0			
TOTAL CORRIDOR ASSESSMENT POINTS	160	59	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland (From Part V)	100	100			
Total Corridor Assessment (From Part VI above or a local site assessment)	160				
TOTAL POINTS *(Total of above 2 lines)*	260	159			

1. Corridor Selected:	2. Total Acres of Farmlands to be Converted by Project:	3. Date Of Selection:

5. Reason For Selection:

Signature of Person Completing this Part:

NOTE: Complete a form for each segment with more than one Alternate Corridor

If you have any questions, please call me at (918) 647-2992 Ext. 3.

Thanks,
Kenneth Risenhoover
Dist. Cons.
Poteau F.O.

Farmland Conversion Impact Rating Form AD-1006 from Muskogee Field Service Center.

U.S. DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service

NRCS-CPA-106
(Rev. 1-91)

FARMLAND CONVERSION IMPACT RATING FOR CORRIDOR TYPE PROJECTS

PART I *(To be completed by Federal Agency)*	3. Date of Land Evaluation Request 5/23/05 — 4. Sheet 1 of ___
1. Name of Project Arkansas River Navigation Study EIS	5. Federal Agency Involved U.S. Army Corps of Engineers - Little Rock and Tusla District
2. Type of Project Navigation	6. County and State Muskogee County, Oklahoma
PART II *(To be completed by NRCS)*	1. Date Request Received by NRCS May 25, 2005 — 2. Person Completing Form Steven Clark
3. Does the corridor contain prime, unique statewide or local important farmland? (If no, the FPPA does not apply - Do not complete additional parts of this form). YES ☒ NO ☐	4. Acres Irrigated 86 — Average Farm Size 202
5. Major Crop(s) Soybean, Wheat, Corn — 6. Farmable Land in Government Jurisdiction Acres: 159 % 100	7. Amount of Farmland As Defined in FPPA Acres: 159 % 100
8. Name Of Land Evaluation System Used LESA — 9. Name of Local Site Assessment System LESA	10. Date Land Evaluation Returned by NRCS June 23, 2005

PART III *(To be completed by Federal Agency)*	Maximum Points	Corridor A	Corridor B	Corridor C	Corridor D
A. Total Acres To Be Converted Directly		159			
B. Total Acres To Be Converted Indirectly, Or To Receive Services		0			
C. Total Acres In Corridor		159	0	0	0
PART IV *(To be completed by NRCS)* **Land Evaluation Information**					
A. Total Acres Prime And Unique Farmland		144.6			
B. Total Acres Statewide And Local Important Farmland		0			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		0.043			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		45%			
PART V *(To be completed by NRCS) Land Evaluation Information Criterion Relative value of Farmland to Be Serviced or Converted (Scale of 0 - 100 Points)*		Refer to	Reasons for	Selection	
PART VI *(To be completed by Federal Agency) Corridor Assessment Criteria (These criteria are explained in 7 CFR 658.5(c))*	Maximum Points				
1. Area in Nonurban Use	15				
2. Perimeter in Nonurban Use	10				
3. Percent Of Corridor Being Farmed	20				
4. Protection Provided By State And Local Government	20				
5. Size of Present Farm Unit Compared To Average	10	Refer to	Reasons for	Selection	
6. Creation Of Nonfarmable Farmland	25				
7. Availablility Of Farm Support Services	5				
8. On-Farm Investments	20				
9. Effects Of Conversion On Farm Support Services	25				
10. Compatibility With Existing Agricultural Use	10				
TOTAL CORRIDOR ASSESSMENT POINTS	160	0	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland (From Part V)	100				
Total Corridor Assessment (From Part VI above or a local site assessment)	160	0	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	0	0	0	0

1. Corridor Selected:	2. Total Acres of Farmlands to be Converted by Project:	3. Date Of Selection:	4. Was A Local Site Assessment Used? YES ☐ NO ☐

Part V

5. Reason For Selection:

Site A - 88.66　Site D - 74.64
Site B - 93.76　Site E - 100
Site C - 66.61　Site F - 79.57

Part VI #5　Site A - 1.3　Site D - 1.5
Site B - 2.2　Site E - 1
Site C - 1.7　Site F - 1

Signature of Person Completing this Part:　DATE

NOTE: Complete a form for each segment with more than one Alternate Corridor

Farmland Conversion Impact Rating Form AD-1006 from Wagoner Field Service Center.

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
1900 West Will Rogers Circle, Suite A
Claremore, OK 74017
(918) 341-3222

RECEIVED
JUN 27 2005
PARSONS
ST. LOUIS

June 23, 2005

Richard E Hall
Parsons
400 Woods Mill Road South, Suite 330
St. Louis, MO 63017

Re: Environmental Impact Statement

Dear Mr. Hall:

I have attached soil maps, a Prime Farmland list for Wagoner County, Oklahoma, and a listing of soils indicating whether the soils are prime or not.

The Form NRCS-CPA-106 was designed to compare alternate sites. Prime farmland is included in areas A and E, however the site was not rated because of lack of alternate sites.

The soils on site "A" are:

BaF- Barge silty clay loam, 0 to 30 percent slopes Not Prime Farmland
(This soil is loamy material excavated from the waterway)

Ra- Radley silt loam, 0 to 1 percent slopes, occasionally flooded Prime Farmland

The soils on site "B" are:

BaF Not Prime Farmland
Os- Osage silty clay loam, 0 to 1 percent slopes, occasionally flooded Not Prime Farmland
Oy- Osage clay, 0 to 1 percent slopes, occasionally flooded Not Prime Farmland

The soils on site "C" are:

Os- Not Prime Farmland
Oy- Not Prime Farmland

The soils on site "D" are:

Os- Not Prime Farmland
Oy- Not Prime Farmland

The soils on site "E" are:

Ra- Prime Farmland
Ma- Mason silt loam, 0 to 1 percent slopes Prime Farmland
Mo- Moreland clay, 0 to 1 percent slopes, occasionally flooded Not Prime Farmland

If you have questions, please contact me.

Sincerely,

Richard T. McCright

Richard T. McCright
Resource Soil Scientist

Wagoner County, Oklahoma
Table Y.--Prime Farmland

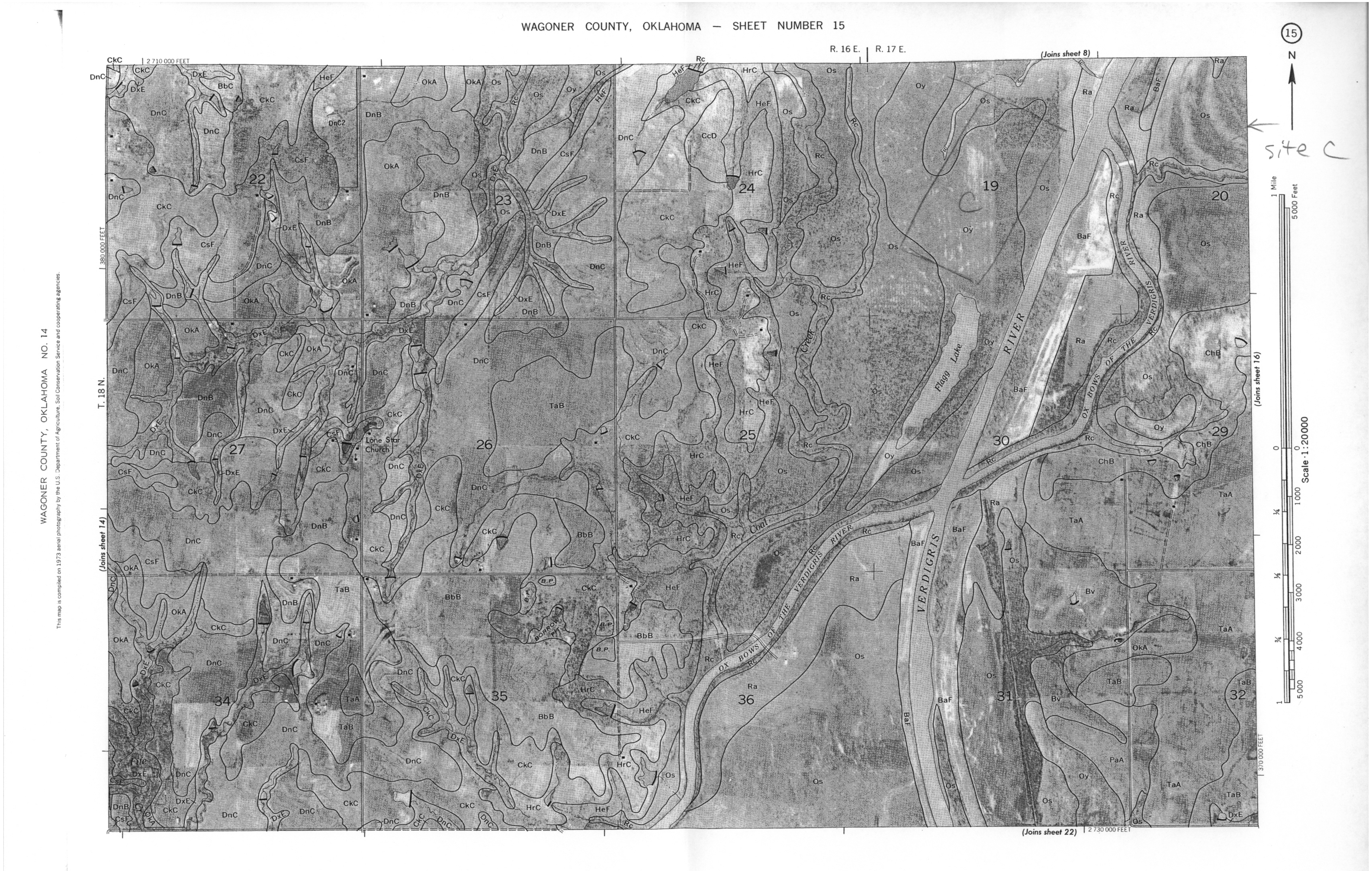
Print date: 06/22/2005

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name.)

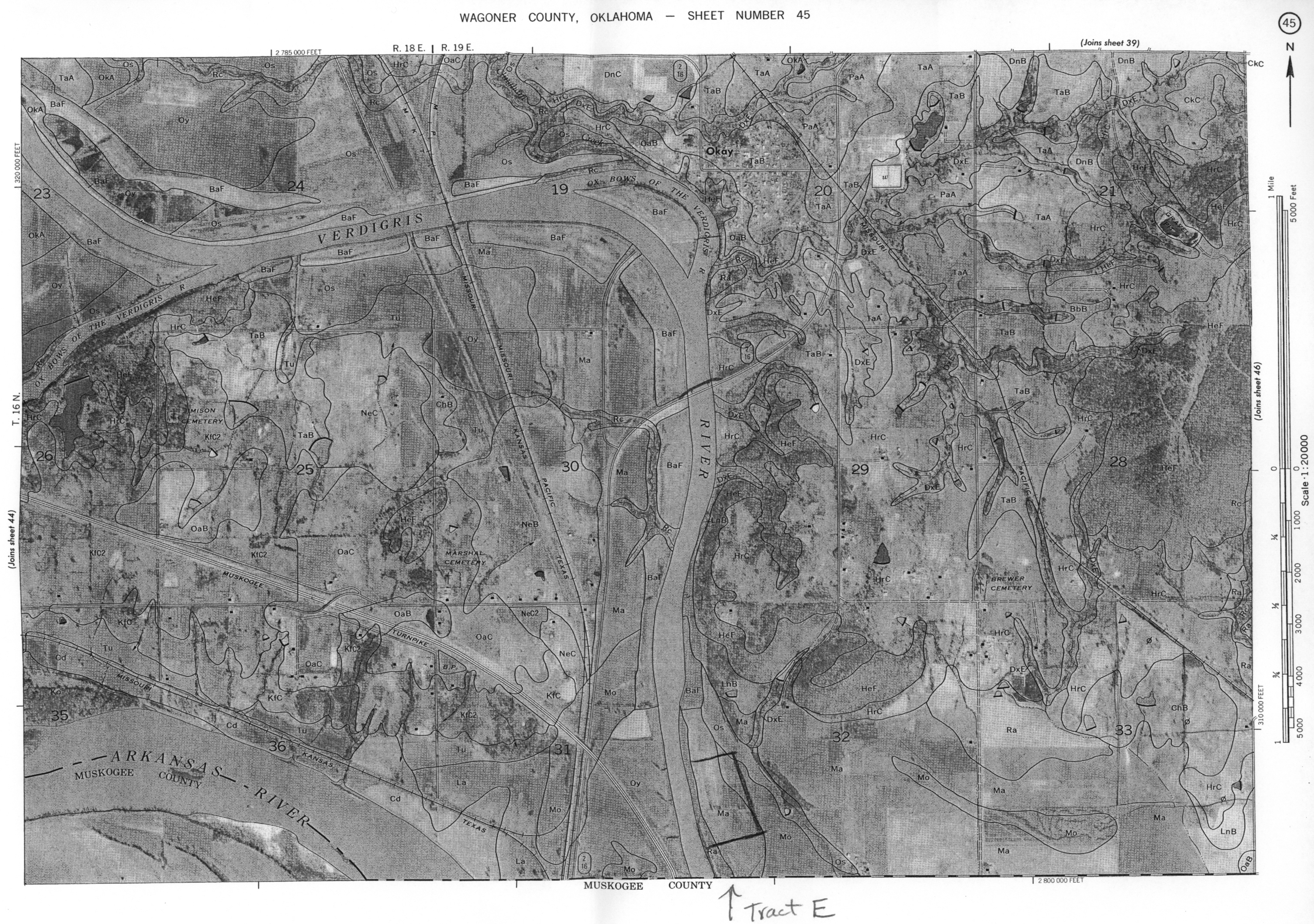
Map symbol	Soil name
BbB	Bates fine sandy loam, 1 to 3 percent slopes
BbC	Bates fine sandy loam, 3 to 5 percent slopes
Cd	Choska silt loam, 0 to 1 percent slopes, occasionally flooded
ChB	Choteau silt loam, 1 to 3 percent slopes
DnB	Dennis silt loam, 1 to 3 percent slopes
DnC	Dennis silt loam, 3 to 5 percent slopes
KfC	Kamie fine sandy loam, 1 to 5 percent slopes
Ko	Kiomatia fine sandy loam, 0 to 1 percent slopes, occasionally flooded
LnB	Linker fine sandy loam, 1 to 3 percent slopes
LuB	Lula silt loam, 1 to 3 percent slopes
Ma	Mason silt loam, 0 to 1 percent slopes, rarely flooded
NeB	Newtonia silt loam, 1 to 3 percent slopes
NeC	Newtonia silt loam, 3 to 5 percent slopes
OaB	Okay loam, 1 to 3 percent slopes
OaC	Okay loam, 3 to 5 percent slopes
OkA	Okemah silt loam, 0 to 1 percent slopes
PaA	Parsons silt loam, 0 to 1 percent slopes
Ra	Radley silt loam, 0 to 1 percent slopes, occasionally flooded
RbcA	Roebuck clay, 0 to 1 percent slopes, rarely flooded
SuB	Summit silty clay loam, 1 to 3 percent slopes
SuC	Summit silty clay loam, 3 to 5 percent slopes
TaA	Taloka silt loam, 0 to 1 percent slopes
TaB	Taloka silt loam, 1 to 3 percent slopes

WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 2
R. 15 E. | R. 16 E.
ROGERS COUNTY
N
Scale 1:20000
1 Mile
5000 Feet
(Joins sheet 1)
(Joins sheet 4)
(Joins inset, sheet 5)
Salt Creek
VERDIGRIS RIVER
ROGERS COUNTY
BIG BOTTOM
T. 19 N.
Site A
WAGONER COUNTY, OKLAHOMA NO. 2
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 8
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 15)
R. 16 E.
R. 17 E.
ROGERS COUNTY
GOODHOPE BOTTOM
GUINN BOTTOM
VERDIGRIS RIVER
OX BOWS OF THE VERDIGRIS RIVER
NEWT GRAHAM LOCK (LOCK AND DAM NO 18)
Old River Channel
Coal Creek
Legas Lake
T. 18 N.
Scale 1:20000
Tract B
WAGONER COUNTY, OKLAHOMA NO. 8
WAGONER COUNTY, OKLAHOMA NO. 9


WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 15
15
N
site C
R. 16 E. | R. 17 E.
(Joins sheet 8)
(Joins sheet 16)
(Joins sheet 14)
(Joins sheet 22)
T. 18 N.
WAGONER COUNTY, OKLAHOMA NO. 14
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Scale 1:20000
1 Mile
5000 Feet
Flagg Lake
VERDIGRIS RIVER
OX BOWS OF THE VERDIGRIS RIVER
Coal Creek
Lone Star Church
2 710 000 FEET
2 730 000 FEET
380 000 FEET
370 000 FEET

WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 22
(Joins sheet 15)
R. 16 E.
R. 17 E.
2 730 000 FEET
VERDIGRIS
RIVER
OX BOWS OF THE VERDIGRIS RIVER
Horseshoe Bend
Pile Creek
T. 17 N.
365 000 FEET
site D
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 29)
BORROW PIT
MUSKOGEE
TURNPIKE
B.P.
2 715 000 FEET
355 000 FEET
Scale 1:20000
1 Mile
5 000 Feet
N
WAGONER COUNTY, OKLAHOMA NO. 22
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
WAGONER COUNTY, OKLAHOMA NO. 23



WAGONER COUNTY, OKLAHOMA NO. 44

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA NO. 45

Farmland Conversion Impact Rating Form AD-1006 from DeWitt Field Service Center.

U.S. DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service

NRCS-CPA-106
(Rev. 1-91)

FARMLAND CONVERSION IMPACT RATING FOR CORRIDOR TYPE PROJECTS

PART I *(To be completed by Federal Agency)*		3. Date of Land Evaluation Request 5/24/05	4. Sheet 1 of ____
1. Name of Project Arkansas River Navigation Study EIS		5. Federal Agency Involved U.S. Army Corps of Engineers - Little Rock and Tulsa Dist.	
2. Type of Project Navigation		6. County and State Arkansas County, Arkansas	
PART II *(To be completed by NRCS)*		1. Date Request Received by NRCS 5/26/05	2. Person Completing Form Marshall Handcock
3. Does the corridor contain prime, unique statewide or local important farmland? (If no, the FPPA does not apply - Do not complete additional parts of this form). YES [X] NO [ ]			4. Acres Irrigated / Average Farm Size 800
5. Major Crop(s) Rice and Soybeans	6. Farmable Land in Government Jurisdiction Acres: %		7. Amount of Farmland As Defined in FPPA Acres: 412,906 %
8. Name Of Land Evaluation System Used LESA	9. Name of Local Site Assessment System Published County Soil Survey		10. Date Land Evaluation Returned by NRCS 6/28/05

PART III *(To be completed by Federal Agency)*	Maximum Points	Corridor A	Corridor B	Corridor C	Corridor D
		Alternative Corridor For Segment ____			
A. Total Acres To Be Converted Directly		308			
B. Total Acres To Be Converted Indirectly, Or To Receive Services		0			
C. Total Acres In Corridor		308	0	0	0
PART IV *(To be completed by NRCS) Land Evaluation Information*					
A. Total Acres Prime And Unique Farmland		308			
B. Total Acres Statewide And Local Important Farmland		176,628			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		.074			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		.074			
PART V *(To be completed by NRCS) Land Evaluation Information Criterion Relative value of Farmland to Be Serviced or Converted (Scale of 0 - 100 Points)*		84.5			
PART VI *(To be completed by Federal Agency) Corridor Assessment Criteria (These criteria are explained in 7 CFR 658.5(c))*	**Maximum Points**				
1. Area In Nonurban Use	15				
2. Perimeter in Nonurban Use	10				
3. Percent Of Corridor Being Farmed	20				
4. Protection Provided By State And Local Government	20	4			
5. Size of Present Farm Unit Compared To Average	10				
6. Creation Of Nonfarmable Farmland	25				
7. Availability Of Farm Support Services	5				
8. On-Farm Investments	20				
9. Effects Of Conversion On Farm Support Services	25				
10. Compatibility With Existing Agricultural Use	10				
TOTAL CORRIDOR ASSESSMENT POINTS	160	0	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland (From Part V)	100				
Total Corridor Assessment (From Part VI above or a local site assessment)	160	0	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	0	0	0	0

1. Corridor Selected:	2. Total Acres of Farmlands to be Converted by Project:	3. Date Of Selection:	4. Was A Local Site Assessment Used? YES [ ] NO [ ]

5. Reason For Selection:

Signature of Person Completing this Part: DATE

NOTE: Complete a form for each segment with more than one Alternate Corridor